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# Best Practices for Modernizing MDOT Bridge Design Manual, Guides, and Policy Documentation

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**16. Abstract**

The Michigan Department of Transportation (MDOT) Bridge Design Manual (BDM) is a comprehensive and authoritative reference for the MDOT Design Engineers and consultants. BDM provides specifications and guidelines for the design of bridges and other major structures while the Bridge Design Guides (BDG) provide the guidance for designing and detailing bridge plans. The current record keeping and institutional Knowledge Management (KM) process practiced by MDOT related to BDM and BDG is dependent on key people to piece together background information when considering policy revisions/updates. Thus, this project was initiated to catalogue and organize historical bridge design reference information and to develop a secure KM and Information Management (IM) environment that will provide information of the highest quality that is timely and accessible to facilitate and enhance decision-making and implementation with the goal of promoting uniformity in bridge design practices. The primary activities completed during this project include synthesizing best practices for documenting decisions and managing documents, scanning and archiving historical bridge design policy information, developing a KM framework to document decisions and archival and retrieval of information, and developing procedures and recommendations to implement the KM framework. One of the outcomes of this project is a proposed workflow to capture knowledge through a structured process and documenting in a folder structure. Also, a database structure is proposed to document updates/revision activities in a chronological order with respect to BDM/BDG structure.


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# Best Practices for Modernizing MDOT Bridge Design Manual, Guides, and Policy Documentation

**Final Report**
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# EXECUTIVE SUMMARY

The Michigan Department of Transportation (MDOT) presents bridge design policy in three public publications: *Bridge Design Manual* (BDM), *Bridge Design Guides* (BDG), and *Bridge Standard Plans (BSP)*. BDM consists of only bridge design policies while BDG hold visual information that provides a template for bridge plans and details. BSP present standard details of various construction items representing the current MDOT policies. The BDM is organized into 15 chapters and the information is presented in a two-column format.

From November 2011 onwards, the specific revisions/updates to these publications are published in a document named '*Monthly Updates*' (MU). Prior to that date, the revisions/updates were recorded in *Office Memorandums*. The *Monthly Updates* document the changes to the Road and Bridge Design Publications that have been released during the specified month. The updates to relevant sections of the manual and guides are published concurrently with the *MU*. The date of updates included within parentheses and provided next to the policies in BDM indicate the revision dates. These dates, after November 2011, correspond to the month and year of the *MU*. Prior to November 2011, the date, month, and year correspond to the *Office Memorandum* publication date. The *Bridge Design Guides* are organized by section and then by guide numbers. Each individual document includes an "issued" date and a "supersedes" date that informs the user with the last update date. Since the revisions/updates are not noted in the final version of the guides, user may need to review the associated *MU* to identify the change. Additionally, the rationale behind policy changes are not included in the aforementioned documents.

The current record keeping and institutional Knowledge Management (KM) process practiced by MDOT related to BDM, BDG, and BSP is dependent on key people and has become a significant burden on them. The key people are responsible to keep track of background information, often undocumented and unstructured, when questions arise or when considering revisions/updates to policy. Thus, this project was initiated to develop a robust KM and Information Management (IM) environment that will retain accurate information that is timely and accessible to facilitate and enhance decision-making and implementation with the goal of promoting uniformity in bridge design practices. The project objectives are:

1. Research best practices for documenting decisions and managing documents.
2. Assemble historical bridge design policy information from MDOT documents.
3. Develop a framework to document decisions and archival and retrieval of information.
4. Draft proposed updates to Bridge Design Manual and Guides.

Chapter 2 of this report describes the history, concepts, and implementation of KM. The KM implementations discussed here are too general for the specific scope of this project that only deals with the modernization of the bridge design documentation. Yet, the difficulties described by MDOT employees in updating, maintaining, and disseminating the bridge design documentations stems from an incomplete KM environment. In addition, a comprehensive description of the KM will be useful when an agency wide environment is envisioned. For these reasons, including these material will give this report a long lasting value.

Chapter 3 presents a summary of best practices for IM and KM related to bridge design and policy decisions. The survey conducted by the Missouri Department of Transportation in 2016 was reviewed. State DOTs that indicated the publication of a thorough revision history and provided unrestricted access to a majority of their publications were selected for review. Additional DOTs that are included in this review were selected based on a review of their websites. The synthesized information contains the practices and formats related to policy documentation, rationale behind policies, policy implementation guidelines, workflow, and communication guidelines.

All the MDOT legacy documents in paper format that were designated as valuable were converted to electronic format and stored in a folder structure designating the physical location of the specific documents. Chapter 4 presents the process and the folder structure. In addition, access to a large volume of previously converted historical documents was provided. The primary objective of providing legacy documents is to identify, capture, and store knowledge related to MDOT policies presented in bridge design documentations. Due to the extensive volume of documents and lack of uniformity in formatting, detailed review of documents to capture knowledge is not practical without first organizing the content into a folder structure that is detailed enough to specify its content, source and destination locations of the documents and files, and a brief description of the content when the file or folder names are not adequate to depict the content. Chapter 4 presents the folder structure developed for organizing MDOT historical archive. Organization of a large volume of documents requires developing an audit trail to identify the source location of files and folders and their location in the document management system. Hence, each main folder and several subfolders of the folder structure contain README files that describe the source file location and typical arrangement of the files in different folders. The log files in this folder structure are excel files that describe the source folder/file location, original folder and file names, new folder and file names, and any useful information to understand the organization of the files at the source location as well as

in the new folder structure. Such a meticulous process followed in this project allows finding the source location and the final destination of any folder or file provided by MDOT.

Four steps of KM are knowledge identification, capture, store, and transfer. The most important step in KM for the benefit of all the stake holders of an institution is to develop a structured process to capture, store, and transfer the knowledge. Chapter 5 presents a workflow and a framework for document management and knowledge transfer.

Based on the outcome of this project, the following implementation recommendations are derived:

1) The workflow is designed to capture knowledge through a structured process and document in a folder structure that is defined as per the BDM/BDG/BSP structure. It is recommended to implement the workflow and folder structure in ProjectWise® (PW). In parallel to the workflow implementation, a spreadsheet or a shadow database can compile and track workflow activities, and allow viewing of progress by the standards staff.
2) A large volume of legacy documents was organized into a folder structure that can be directly transferred to PW. README and log files included in the folders describe the content and the relationship between the specific folder that houses the documents and the original source location. Also, a document review process and synthesis of information is demonstrated. The process needs to be continued until the documents in the archive are reviewed to identify the policy information for developing a commentary manual as a complementary document to BDM.
3) The BDM commentary manual purpose is to systematically document the rationale behind the policies. The commentary manual content will consist of information synthesized from the legacy documents and through workflow activities. The commentary manual needs to be maintained as a living document. Later versions of the commentary manual will be generated from future review and updates as implemented.
4) As part of knowledge transfer, workshops will be useful to educate MDOT bridge design staff on the recent updates to the PW folder structure, resources available to design engineers, the workflow and its purpose, and the policy change/revision request submissions.

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# TABLE OF CONTENTS

# LIST OF TABLES

# TABLE OF FIGURES

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# 1 INTRODUCTION

## 1.1 OVERVIEW

The Michigan Department of Transportation (MDOT) Bridge Design Manual (BDM) is a comprehensive and authoritative reference for the MDOT Design Engineers and consultants. BDM provides specifications and guidelines for the design of bridges and other major structures on the interstate/freeway, arterial, collector and local road system governed by MDOT. The MDOT Bridge Design Guides (BDG) provide guidance for designing and detailing bridge plans. The MDOT Bridge Standard Plans (BSP) present standard details of various construction items representing the current MDOT policies. These documents are updated continuously. The information in these documents incorporates policy decisions based on past experiences, feedback from stakeholders, and the technical expertise of MDOT committees. The current practice is to communicate updates once a month with *Monthly Updates* (MU) document in order to provide timely guidance on design policies to promote uniformity in design practices. MU describes the revision and assign an effective date, but rarely discuss the background for the update. The background information regarding the revisions/updates, rationale, and relevant engineering data are documented in an unstructured fashion, in various formats including meeting minutes, committee minutes, squad leader notes, design Informational Memorandums (IM), Technical advisories, Office Memorandums (OM), etc. As needed, Design Advisories are used to reinforce or add context to existing policies, or to draw additional attention to recent policy changes.

Technical operations of MDOT and many other agencies utilize a combination of policies and manuals as well as heuristic knowledge (institutional knowledge and history) of employees. The depth of employees' heuristic knowledge increases with years of service. When employee retires or transfers to another division, the heuristic knowledge is lost. It is not really practical to implement debriefing programs to lessen this loss. Without a plan or a program to transfer and retain business processes, institutional policies and practices, and historical knowledge, organizations face knowledge discontinuities and challenges with maintaining continuity (Peña 2013). An approach to mitigate the risk is to document the critical knowledge in retainable form. Knowledge Management (KM) is the formal retention and retrieval of institutional knowledge. KM is also an effective and efficient method for the dissemination of information to the relevant authorities and stakeholders. With the advances in digital documentation, internal wikis and

content management libraries are implemented as the most common methods of accumulating institutional knowledge.

The current record keeping and institutional knowledge management process practiced by MDOT related to BDM, BDG, and BSP is dependent on key employees to piece together background information when questions arise or when considering revisions/updates to policies. Thus, the development of a robust Knowledge and Document Management Environment will remove BDM, BDG and BSP's dependence of their content on heuristic knowledge. This environment, when implemented, will retain information of the highest accuracy that is accessible to facilitate and enhance decision-making and implementation with the goal of promoting uniformity in bridge design practices. The environment will also provide security needed to maintain the integrity of the documents.

## 1.2 PROJECT OBJECTIVES AND SCOPE

The objectives of this project are:

1. Research best practices for documenting decisions and managing documents.
2. Assemble historical bridge design policy information from MDOT documents.
3. Develop a framework to document decisions and the archival and retrieval of information.
4. Draft proposed updates to Bridge Design Manual and Guides.

To achieve the objectives, the project was organized into five tasks as follows:

1. Establish best practices among state and federal design manuals, and propose a digital format for the next generation of manuals/guides.
2. Examine available resources and conduct focus group meetings with MDOT technical staff to establish the background behind policy reflected in MDOT manual, guides, and standard plans.
3. Digitize available policy information and propose, develop, and implement a content management system in accordance with the industry standards.
4. Recommend and implement procedures and a system for linking policy decision and background with actual policy.
5. Develop updates to manuals and guides per tasks 1-4 outcome.
6. Develop the deliverables including the final research report.

## 1.3 REPORT ORGANIZATION

The report is organized into seven chapters:

- Chapter 1: Introduction
- Chapter 2: State-of-the-Art Knowledge Management (KM) Practices
- Chapter 3: IM and KM Practices in DOT Bridge Design Departments
- Chapter 4: MDOT Legacy Documents
- Chapter 5: IM and KM Program for MDOT Bridge Design Policy Revision/Update
- Chapter 6: Summary and Implementation Recommendations
- Chapter 7: References

The following appendices are included in the report.

- Appendix A: Abbreviations
- Appendix B: IM and KM Practices in DOT Bridge Design Departments
- Appendix C: Survey of State DOTs
- Appendix D: MDOT Historical Policy Documentation
- Appendix E: Folder Structure for Document Management
- Appendix F: Compiled BDM/BDG Revisions/Updates from *Monthly Updates*
- Appendix G: Compiled Information from *Update Letters* and *Office Memorandums*
- Appendix H: Compiled Information from *Bridge Committee Meeting Minutes*
- Appendix I: Compiled List of Bridge Committee Action Items

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# 2 STATE-OF-THE-ART OF KNOWLEDGE MANAGEMENT (KM) PRACTICES

## 2.1 OVERVIEW

It is important to describe the difference between data, information and knowledge when presenting the concepts of knowledge management (KM). The relationship between data, information, and knowledge is presented in Figure 2-1. Data is defined as unstructured facts and figures that does not provide further information regarding the patterns (KMT 2018). Information is what is extracted out from data through analysis, interpretation, and compilation into a meaningful form. Knowledge is what resides inside the brain based on the information received in various forms through education, experience and interactions (NCHRP 2015). The knowledge allows an individual to make effective decisions based on information for developing appropriate actions or strategies. Therefore, information is static and tangible, and knowledge is dynamic and intangible.

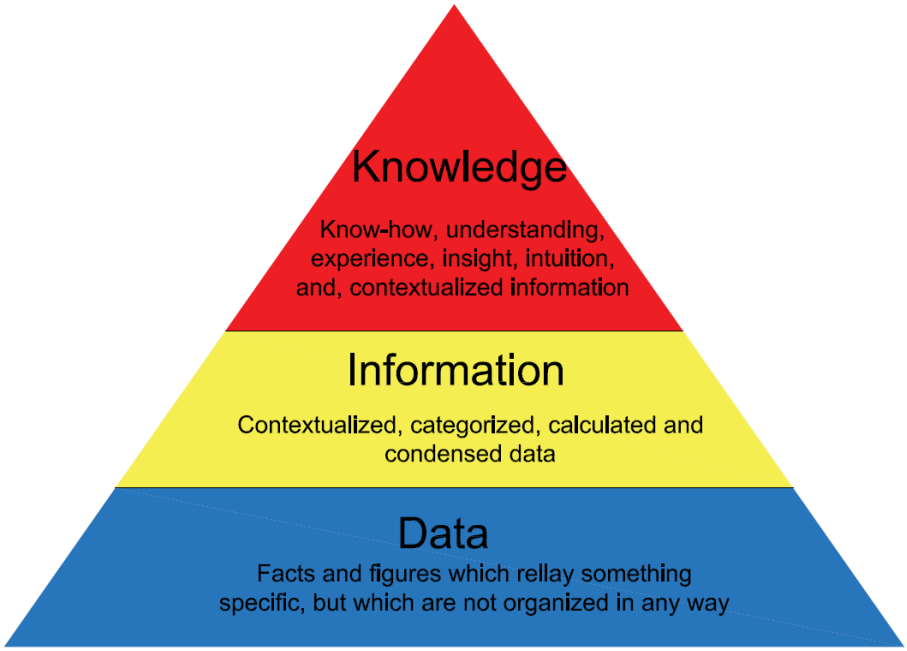



**Figure 2-1. Relationship between data, information, and knowledge (KMT 2018)**

Knowledge is grouped under two types; explicit and implicit (tacit). The distinction between explicit and tacit knowledge is presented in Table 2-1. The explicit knowledge is the knowledge that has been explained, recorded or documented. Explicit knowledge is found in databases, memos, notes, documents, etc. Unless explicit knowledge sources are organized in a user-friendly and easily accessible format, retrieving relevant information and developing

knowledge becomes a challenge. For example, BDM text consists of explicit knowledge. The tacit knowledge, often called implicit knowledge, is the expertise and assumptions that individuals develop over the years often not recorded or documented. The tacit knowledge is sometimes subconscious and internal which makes it hidden and subjective. For this reason, to capture the tacit knowledge valuable to the organization and transfer to other people within the organization is a challenge. Considering the challenges of benefitting from both the explicit and tacit knowledge relevant to an organization or a discipline, the processes and tools or techniques used for managing such resources need to be identified and documented.

**Table 2-1. Characteristics of Explicit and Tacit Knowledge (McInerney 2002)**

| Explicit Knowledge | Tacit Knowledge |
|---|---|
| Formally articulated | Subconscious |
| Elucidated | Perceived |
| Aware | Unaware |
| Fixed | Difficult to articulate or unspoken |
| Codified | Experience based |
| Documented (written, taped, recorded, etc.) | Transferred through conversation |
| Can be viewed or heard | Embedded in stories and narratives |
| Shared with others | Escapes observation |
| Organizational | Held within self |
| Pushed or pulled | Personal |
| Reports, lessons learned | Insights and understandings |
| | Judgements |
| | Assumptions |

This chapter presents the evolution of the concept of knowledge management (KM), the difference between KM and information management (IM), and the processes, tools or techniques used for KM. In addition, KM practices of a few organizations similar to MDOT—including the State Departments of Transportation (DOTs)—are discussed with examples.

## 2.2 EVOLUTION OF KNOWLEDGE MANAGEMENT

The concept of knowledge management originally emerged from the management consulting community in the mid-1990s. At that time, as the internet was becoming popular, the capability of an intranet network in an organization to link its dispersed units was identified, and KM tools and techniques such as dashboards, expertise locators and lessons learned databases were developed. McInerney and Koenig (2011) reported that the term *Knowledge Management* was first used in an internal study carried out by Brook Manville at McKinsey & Company in 1987.

Ernst & Young, an accounting firm, started using the term KM in 1992, and the concept was publicly introduced in 1993 (McInerney and Koenig 2011). The KM concepts are widely used today in many disciplines. Figure 2-2 shows the growth of its popularity during the late 1990s and early 2000s based on the number of articles published on the subject.

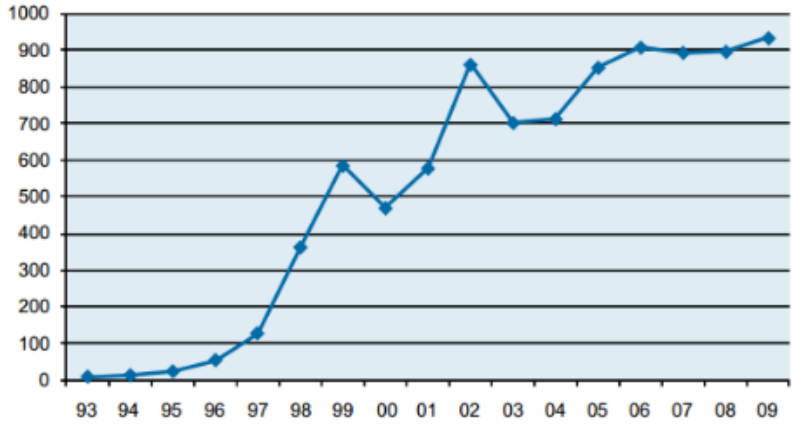



**Figure 2-2. Number of KM articles published by year (McInerney and Koenig 2011)**

McInerney and Koenig (2011) presented one of the early definitions of KM, introduced by Tome Davenport in 1994, as a process of capturing, distributing, and effectively employing the knowledge. Girard and Girard (2015) conducted a study to demonstrate the depth, breadth, and international nature of KM. They catalogued the definitions of KM available within academic literature, defined by at least 13 countries and from 23 disciplines. "Use", "create", "share", and "manage" are the four most commonly used words in defining KM. Based on the initial analysis, the following two definitions were developed:

- KM is the process of creating, sharing, using, and managing the knowledge and information of an organization.
- KM is the management process of creating, sharing and using organizational information and knowledge.

Considering the evolution of the concepts, ideas, and processes implemented since the 1990s, as shown in Figure 2-3, KM has evolved for three generations. The first generation, which began in the 1990s, highlighted the importance of using technology to identify and store the information. However, the second-generation that began in the 2000s focused more on identifying how the knowledge is created, applied, and transferred within an agency business environment.

The third generation, which began in the 2010s, uses a combination of the ideas used by the first two generations (NCHRP 2014).

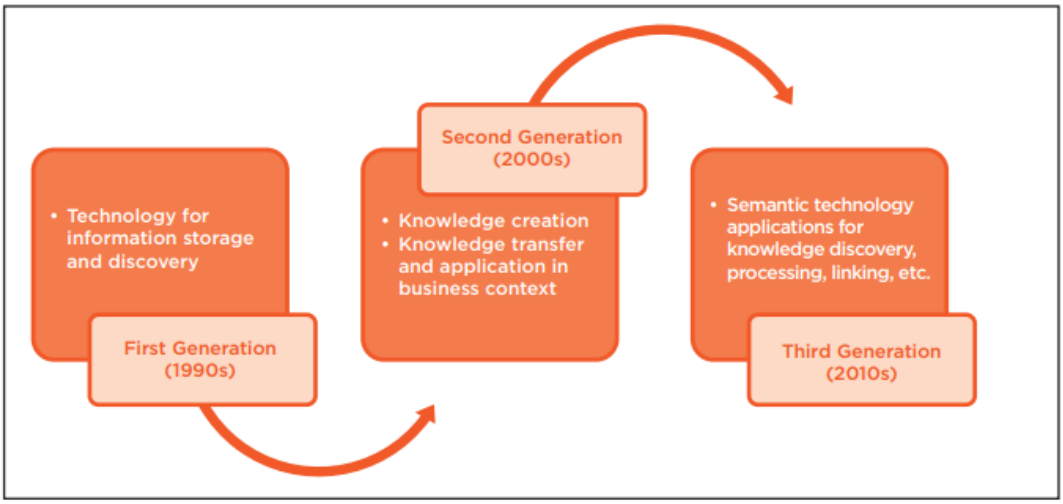



**Figure 2-3. Evolution of KM concepts and implementations (NCHRP 2014)**

KM considers knowledge as an actual asset, rather than as something intangible. In doing so, it enables an organization to better protect and exploit what it knows, and to improve and focus its knowledge development efforts to match its needs.

KM implementation:

- helps to learn from past successes and failures, and reduces the time needed to diagnose problems or clarify a situation.
- better exploits existing knowledge assets by re-deploying them in areas where the firm stands to gain something, e.g. using knowledge from one department to improve or create a product in another department, modifying knowledge from a past process to create a new solution, etc.
- promotes a long-term focus on developing the right competencies and skills, and removing obsolete knowledge.
- enhances the ability to innovate.
- protects key knowledge and competencies from being lost or copied.
- reduces training time and costs.
- helps an organization to adopt to changes faster.

## 2.3 KNOWLEDGE MANAGEMENT PROCESS

KM process is defined with three major steps - knowledge identification and capture, knowledge store, and knowledge transfer (Figure 2-4). The following sections describe each of these basic steps in detail, including different KM techniques employed in executing each of these steps.


**Figure 2-4. Major steps of KM process**

### 2.3.1 Knowledge Identification and Capture

Knowledge identification, also known as knowledge audit and knowledge sourcing, requires establishing the sources and the content. The first step of knowledge identification is to clearly define goals and objectives specific to the needs of an agency or specific group. For example, the goal of this MDOT project is to synthesize the rationale behind bridge design policy decisions. The objectives are to identify the relevant sources of information, organize the sources into a structure that can be easily accessible, and synthesize available information into a format that allows for fast retrieval. The common approaches for identifying and collecting information sources are through questionnaire-based surveys, interviews, facilitated group discussions, or a combination thereof (De Brun 2005). The other options include the search of archives, email correspondences, knowledge sharing systems (KSS), etc.

A few benefits of knowledge identification are:

- Presenting an inventory of knowledge assets, allowing them to become more visible and therefore more measurable and accountable, and giving a clearer understanding of the contribution of knowledge to organizational performance.
- Helping an organization identify what knowledge is needed to support overall organizational goals as well as individual and team activities.
- Giving tangible evidence of the extent to which knowledge is being managed and where improvements are needed.

- Providing an evidence-based account of the knowledge that exists in an organization, where it exists, and how that knowledge evolves and is used by the organization.
- Revealing both knowledge gaps and duplications, as well as the knowledge that is not currently being used.
- Providing a map of knowledge and communication flows and networks, revealing both examples of good practice and blockages and barriers to good practice.
- Supplying vital information for the development of effective knowledge management programs and initiatives that are directly relevant to the organization's specific knowledge needs and current situation.

### 2.3.2 Storing Knowledge

Storing involves accumulating, codifying, and maintaining knowledge in a reliable, secure and retrievable system. While not all the knowledge can be documented, it needs to be stored and organized in specific formats. Much of it today is stored on hard documents such as books, manuals, guides, memos, advisories, etc. Hard copy documentation makes it difficult to update, retrieve, and share the information. Digital documentation such as internal wikis and content management libraries are the most common methods for the accumulation and dissemination of information. Access, feedback, workflow management, search, and document archival are the high-level functional requirements of an Information/Content Management System. Number of files, file types, the maximum size of an individual file, storage locations, workloads, access points, and technology are a few key parameters considered for evaluating possible solutions for the storing and retrieval of documents. A number of document management products are available in the market for creating interactive technical documents that can be collaboratively authored, revised, annotated, and published in definitive versions. SharePoint (Microsoft) and ProjectWise (Bentley Systems) used by MDOT may provide the necessary functionalities for managing bridge design manuals and guides.

The data, information, and in most cases, the explicit knowledge are managed, but not the tacit knowledge. The information and knowledge are two different entities often used interchangeably. The different attributes of IM and KM are shown in Table 2-2.

**Table 2-2. Information Management vs. Knowledge Management (KMT 2018)**

| Information Management (IM) | Knowledge Management (KM) |
|---|---|
| • Focuses on data and information. | • Focuses on knowledge, understanding, and wisdom. |
| • Deals with unstructured and structured facts and figures. | • Deals with both codified and uncodified knowledge (unarticulated, context-based, and experience-based). |
| • Benefits greatly from technology, since the information being conveyed is already codified and in an easily transferrable form. | • Information Technology (IT) is useful for transferring explicit and codified knowledge. IT acts as tools to enhance communication and allows the storage and transfer of unstructured thoughts and notes, etc., (tacit knowledge). |
| • Focus on organizing, analyzing, and retrieving due to the codified nature of the information. | • Focus on locating, understanding, enabling, and encouraging - by creating environments, cultures, processes, etc., where knowledge is shared and created. |
| • Is largely about know-what, i.e. it offers a fact that you can then use to help create useful knowledge but does not convey a course of action. | • Is largely about know-how, why, and who. |
| • Is easy to copy - due to its codified and easily transferrable nature. | • Is difficult to copy - at least regarding the tacit elements. |

Document management is a challenge even today for many companies, but is a vital aspect of KM. Otherwise, it will be impossible to locate and use the documented knowledge. A few of the desired features of a knowledge documentation system are security and accountability of the information, ability to back up, and ease of use. Over the past thirty years, government agencies such as National Aeronautics and Space Administration (NASA) and the various departments within the U.S. Department of Defense (DoD) have adopted a mix of document management systems (DMS) and component content management systems (CCMS). The systems developed have depended upon the needs of the agency or department, the complexity of the online manuals, the need for information security, and how interactive the documents are needed to be.

The lessons learned in the development of electronic technical manuals within NASA and the DoD have been incorporated into two international standards that govern the design and creation of electronic technical manuals (Interactive Electronic Training Manual (IETM) Guide 1999; Rabinowitz et al. 1995). These two international standards are ISO/IEC/IEEE 26531 (International Organization for Standardization 2015) and S1000D, issue 4.2 (Technical Publications Specification Management Group 2016), published by the AeroSpace and Defense Industries Association of Europe (ASDIA). ISO/IEC/IEEE 26531 (or ISO 26531 for short) provides guidance for the development and maintenance of all types of online product life cycle and user documentation, including user manuals and equipment guides. The standard specifies that technical content is to be stored as reusable content objects that may be collaboratively reviewed, revised, searched, tracked via version control, and compiled into any standard electronic

document format such as HTML or PDF. ISO 26531 describes all aspects of content management from project initiation to publication, including workflow specification, content conversion, and search and retrieval. S1000D (2016) specifies that electronic manuals be as granular as possible, made up of numerous interlinked, reusable XML sections termed "data modules" that may be searched, retrieved, annotated, revised and compiled as needed. According to ISO 26531 and S1000D, structured electronic documents can be effectively searched through the use of metadata, collaboratively reviewed, revised and republished as needed in controlled versions, annotated by users, and integrated smoothly and seamlessly with current and legacy content (including archival policies and historical drafts).

#### *2.3.2.1 Document Management in Organizations*

##### ***2.3.2.1.1 National Aeronautics and Space Administration (NASA)***

NASA began the "Electronic Documentation Project" in 1993 to digitize and provide online access to manuals for space shuttle flight controllers at the Johnson Space Center (Rabinowitz et al. 1995; Zurier 1993). In addition, this project was tasked with developing online collaborative workspaces for widely separated NASA engineers and employees to be able to work on projects at a distance. This project continued through 2001, with the development of a number of information systems, the two most important of which were Postdoc/Postdoc-NG and HyperMan.

Postdoc was designed as a collaborative online system, what today would be called an Enterprise Content Management System (ECMS). Its development took place from 1995-2000 and included several iterations. The initial Postdoc system encompassed the following functionalities (Becerra-Fernandez et al. 2001; Becerra-Fernandez et al. 2006; Keller et al. 1999): creation and sharing of electronic documents in almost any format (word processing, spreadsheets, audio, images, video), access control via user profiles (owner, author, read, write), audit trail, controlled revision of documents, folder directory display (similar to ProjectWise), full text indexing, and group mailing lists. Conversely, HyperMan 2.0 (and its later iteration Adaptive HyperMan) was explicitly designed to be an interface for access to electronic technical manuals (Rabinowitz et al. 1995; Zurier 1993). It was a document viewer allowing users remote access to PDF copies of manuals. General users were allowed read-only access, with the option of annotating manuals for personal use, quick reference, and to improve searchability.

NASA provides access to manuals and handbooks via Adaptive HyperMan and Postdoc on internal network servers. Public facing manuals and documents are accessible via external websites, such as the NASA Technical Reports Server (https://ntrs.nasa.gov/) and the Public Lessons Learned System (NASA 2017; Office of the Inspector General 2012). The Public Lessons Learned System website, located at https://llis.nasa.gov/, contains publically published best practices that have originated from NASA projects. The NASA Public Lessons Learned System can be browsed by NASA site/center, topic, NASA directorate, and by year. Each Lessons Learned Report is in HTML format and contains an abstract; description of the "Driving Event", along with references to relevant reports; lessons learned from the event; recommendations; and evidence of recurrence control effectiveness; as well as a list of topics (metadata). There is an internal Lessons Learned site available to NASA personnel through a password protected "NASA Engineering Network."

#### *2.3.2.1.2 U.S. Department of Defense (DoD)*

In the late 1970s, development of an Interactive Electronic Technical Manual (IETM) began through a series of research projects and working groups, primarily in the Navy and the Air Force, which defined the functional needs and explored the available technologies. A more complete history can be found in Fuller (1994). The Army, Navy, Air Force and Marine Corps eventually convened a working group in 1989 that was charged with developing a consistent method of sharing technical and maintenance data via IETMs (Jorgenson & Fuller 1998). This working group, the Tri-Service Working Group for Interactive Electronic Technical Manuals, authored a series of specifications (aka standards) to govern the design of IETMs. These specifications were:

- Tri-Service Working Group for Interactive Electronic Technical Manuals. (1992). Manuals, Interactive electronic technical: General content, style, format, and user-interaction requirements for (Specification No. MIL-M–87268). Bethesda, MD. (Latest 2014)
- Tri-Service Working Group for Interactive Electronic Technical Manuals. (1992a). Data Base, revisable: Interactive electronic technical manuals, For the support of (Specification No. MIL-D-87269). Bethesda, MD. (Latest 2014)
- Tri-Service Working Group for Interactive Electronic Technical Manuals. (1992b). Quality Assurance Program: Interactive Electronic Technical Manuals and Associated Technical Information; Requirements For (Specification No. MIL-Q-87270). Bethesda, MD. (Cancelled 1996 – not replaced)

According to the updated 2014 version of MIL-DTL-87268 (Tri-Service Working Group for Interactive Electronic Technical Manuals 2014b), an IETM information system is a component

content management system made up of content pieces called "composite nodes" that are stored in a database. Data elements (the "nodes") are interlinked into desirable IETMs using entity relationships. These IETMs were to be defined by Document Type Definitions (DTDs), authored in SGML or XML, and made available to the user via a web interface resulting from either HTML or XML code (Junod et al. 2003). Information that is classified would be identified in the XML/SGML code through "a basic security classification entity to allow consistent identification of classified information within the IETM database" (Tri-Service Working Group for Interactive Electronic Technical Manuals 2014a). For security reasons, these military IETMs would be accessible only through an intranet/private DoD network (Jorgenson & Fuller 1998). Connectivity to other IETMs is maintained primarily through hyperlinks (Jorgenson & Fuller 1998).

It is clear that the DoD's main purpose in developing electronic manuals was not just to provide electronic access to traditional print manuals from any location, but to make these manuals completely interactive. Users can access relevant sections of the manuals through keyword searches or browsing tables of contents and, in addition, be able to view only particular sections. This functionality was termed "Context dependent filtering" (Tri-Service Working Group for Interactive Electronic Technical Manuals 2014b). The manuals are operational or procedural in focus with individual steps or tasks. In a sense, the IETMs would act as "expert systems" or tutorials (Belcher & Neisler 2000).

Revision status and the date of all previous revisions would be available for users to view at will, basically by allowing toggling a view on or off (Junod et al. 2003, Tri-Service Working Group for Interactive Electronic Technical Manuals 2014b). The standard practice is for previous versions of electronic manuals to always be available via some type of archive (Junod et al. 2003). Recent changes are pointed out until the next major revision. All revisions are encoded in the SGML/XML and indicated in the table of contents. All data elements or composite nodes would be revisable from a source database in order to maintain the integrity and most current form of technical information supplied in the manuals (Tri-Service Working Group for Interactive Electronic Technical Manuals 2014a). The workflow function for the composite nodes management are undefined, except that users should have a means for providing feedback or alerting manual owners of problems or errors.

IETMs within the DoD were designed to be keyword searchable through the tables of contents, file metadata, and document full text (Junod et al. 2003). Individual documents as well

as the entire document library are searchable. In addition, as mentioned earlier, "Context dependent filtering" would allow the user to only see the information relevant to a particular task (Tri-Service Working Group for Interactive Electronic Technical Manuals 2014b).

Belcher and Neisler (2000) conducted a case study of the adoption of IETM technology within the U.S. Navy. A big obstacle, particularly the more interactive IETMs, was the cost of digitizing legacy or archival (i.e. paper) content, and turning that digitized content into SGML or XML. Many departments implemented this in a gradual fashion, creating raster scans or indexed PDFs of previously printed manuals that could, at some later point, be further converted to a structured format (Belcher & Neisler 2000).

### 2.3.3 Knowledge Transfer

The process of knowledge transfer includes organizing, capturing and distributing knowledge, as well as ensuring its availability for future users (IGI Global 2018). The knowledge transfer tools are based on the type of knowledge involved, i.e. tacit or explicit. These techniques and tools can be directed to individuals, to groups, or towards both. A few techniques and tools used in the knowledge transfer are boot camp, best practices meetings/studies (In-House workshops, Education committees, tailgate meetings), communities of practice, critical incident reviews/lessons learned, expert storytelling, knowledge fairs, cross training (position backup), job shadowing, mentoring programs, structured on-the-job training (OJT), transitional training ("double fill"), etc. Table 2-3 lists a few of these knowledge transfer techniques. A majority of organizations use several of these techniques to capture, store, and transfer knowledge. As an example, a properly structured workflow can integrate a documented process, subject matter experts (SMEs), best practices, lessons learned, etc., to capture, store, and transfer knowledge.

**Table 2-3. Techniques and Tools Used in Knowledge Transfer (Perkins and Bennet 2012, Tucker et al. n.d.)**

| Technique/Tool | Description |
|---|---|
| Formal training | Training includes a variety of activities designed to facilitate gaining of knowledge, developing abilities, and improving skills and competencies of individuals. Training methods include classroom instruction, simulations, role-plays, computer or web based instructions, small and large group exercises, etc. The training can be instructor led or self-directed. |
| Boot camp | A subject matter expert (SME) conducts a training session or sessions on a specific topic(s). |
| Best practices meetings/Studies | These meetings/studies look for different processes or systems that have proven to be successful and effective. These can streamline a process, identify efficiencies, improve one's expertise, and can spark innovation. |
| Communities of practice (CoPs) | A group of individuals (not part of a formally constituted team) sharing a common working practice over a period of time. This helps to improve a network of contacts, provides peer recognition and continuous learning, and provides a mechanism to share tacit knowledge. |
| Critical incident reviews / Lessons learned | This provides discussions or an analysis of critical incidents and perspectives of the subject matter experts. This is an approach for problem solving or an opportunity for an open discussion on the challenges and potential solutions. |
| Knowledge fairs | This event displays information about an organization or a specific topic(s). Its main purposes are to share knowledge with a targeted audience or a group and to increase awareness of and knowledge about a certain topic(s). |
| Process documentation | This involves a written and/or a graphical representation of a specific work process. |
| Peer assist | This involves sharing of knowledge and experience between individuals or teams based on dialogue and mutual respect. An example is a team, that is starting up a new project or task, calling upon another team with experience in the respective field of activity. |
| Mentoring programs | This includes pairing an experienced and skilled person, i.e. a mentor, with a lesser experienced and skilled person, i.e. a mentee or a protégé, with the goal of developing the strengths and competence of the protégé. |
| Structured on-the-job training (OJT) | Any kind of instruction that takes place at the actual job site and involves learning tasks, skills, and procedures in a hands-on manner. |
| Transitional training ("Double Fill") | The practice of the employee who is leaving a position and the replacement employee to occupy the same position for a period of time. This allows the new employee to easily acquire the knowledge about the position and make the transfer more effective. |
| Knowledge maps | This is an effort to discover the location, form, ownership, value, and use of knowledge. This helps to learn about people's expertise, to find opportunities to make better use of existing knowledge within the organization, and to identify the barriers to knowledge sharing. |
| Wiki pages | A web-based communication/collaboration tool where users can create/capture knowledge and information. It allows any authorized individual or team to edit subject, material, add comments, or provide additional content. |
| Expert storytelling /Expert interviews | Sessions where one or more people (subject matter experts - SMEs) meet with others to share knowledge. The SME can be within or outside of the organization. |
| Co-op/Internships | Formal arrangements for an experienced person to pass along knowledge and skills to a novice. These help agencies to meet their short term staffing needs. |
| Documenting processes | This involves developing a written or electronic record of a specific work process. This could include the steps in the process, key dates, relationship to other processes that come before and after, key players, contact information, required references and legal citations, back up procedures and copies of forms, software, data sets, and file names associated with the process. |
| Job aids | These are the tools that help people perform tasks accurately and efficiently. These include checklists, reference tables, decision tree diagrams, etc. |

**Table 2-3. Techniques and Tools Used in Knowledge Transfer (Continued)**

| Technique/Tool | Description |
|---|---|
| Learning games | Type of structured learning activity used to make learning fun. These games test the current level of knowledge, help to apply a newly learned skill, and help to practice what is taught to reinforce the initial learning. These can be used with other learning methodologies such as presentations and discussions. |
| Exit interviews | These are structured meetings held with departing employees to capture their experience on key aspects. |
| Job rotation | An employee occupies different positions for several weeks or months so that the knowledge about those jobs can be transferred directly into the employees permanent job assignment. |
| Job shadowing | An employee observes another employee in the everyday conduct of the job to capture the essentials. This is less active and short term than the job rotation. |
| Yellow pages | This is a special kind of knowledge map listing knowledge areas, persons knowledgeable in those areas (could be within or outside the organization), and their respective contact information. |

## 2.4 KNOWLEDGE MANAGEMENT IMPLEMENTATIONS OF STATE DEPARTMENTS OF TRANSPORTATION (DOTs)

The concept of KM has been widely embraced by diverse organizations such as NASA, DoD, the World Bank, State Farm Insurance, Kraft Foods, state DOTs, etc. The private sector implements KM to build competitive advantage over other companies whereas public-sector organizations use KM to manage risk, improve operational effectiveness, and make the maximum use of employee experience.

State DOTs employ the skills and experience of their workforce to plan, fund, design, construct, and maintain the transportation network and associated infrastructure. A large volume of the tacit knowledge resides within the most experienced and senior employees. Retirements and changing jobs have challenged the agencies on how to retain the experience and knowledge. The following are few suggested approaches to minimize knowledge loss due to changing workforce dynamics (NCHRP 2014),

- Identify the gap between the needed skills and existing skills within the organization to develop communities of practice or expertise directories (yellow pages).
- Capture specialized knowledge from retiring or resigning employees before they leave the organization.
- Document lessons learned during previous projects for future efforts.
- Develop structured documentation processes to retain important institutional knowledge enabling employees to find information in a timely manner.

Currently, KM programs or initiatives are in place at USDOT administrations and in several state Departments of Transportation (DOTs); Caltrans, Georgia DOT, Virginia DOT, and Wisconsin DOT are a few to name. A scan workshop of KM within transportation agencies conducted by a team consisting of DOTs and USDOT staff identified the driving factors for interest in KM programs within state DOTs (NCHRP 2014). These driving factors are listed in Table 2-4.

**Table 2-4. Driving Factors for Interest in KM at State DOTs (NCHRP 2014)**

| Agency | Factors driving KM initiatives |
|---|---|
| Virginia DOT | • Need to manage and mitigate loss of knowledge associated with major reductions in workforce (30% of employees are eligible to retire)<br>• Shift in mission from construction to maintenance and system operations, requiring greater internal and external collaboration<br>• Need to adapt the organization to meet new demands and increase efficiency |
| Washington State DOT | • Loss of knowledge due to aging workforce on the cusp of retirement<br>• Reduced resources and increasing need for greater efficiency<br>• Commitment to innovation |
| Georgia DOT | • Need to mitigate impact of retirements on loss of institutional knowledge<br>• Organizational commitment to providing an effective environment for innovation and knowledge sharing |
| Wisconsin DOT | • High workforce attrition and high retirement vulnerability<br>• Commitment to innovation within transportation engineering-related functions<br>• Lean Government and Performance Management initiatives |
| Alaska DOT & PF | • High percentage of workforce is within five years of retirement, as well as industry shifts and changing workforce demands<br>• Geographically dispersed workforce – many remote locations<br>• Diverse agency functions (e.g., aviation, marine, and highways) |
| Missouri DOT | • Deliver project benefits for reduced costs through innovative practices<br>• Downsizing and reorganization – review and rethink all key business processes |
| Kansas DOT | • Concern about "knowledge walking out the door" with large numbers of retiring employees |
| Alberta Transportation | • Retirement of key staff with no knowledge transfer<br>• "Lost generation" of employees due to cutbacks in the 1990s created need to quickly develop leadership qualities in new and existing staff<br>• Need for innovative approaches – old solutions not appropriate given today's environment – and means of addressing different problems and attaining a greater level of integration<br>• Inefficiency and risk associated with heavy reliance on a small percentage of staff for expertise; recognition that not distributing knowledge makes the organization vulnerable<br>• Shift from paper to electronic records |

The Virginia Department of Transportation (VDOT) established a KM Division in late 2003 to address the critical knowledge identification, collection, organization, and dissemination. This was after experiencing a loss of knowledge in the mid-90s, during two statewide workforce reductions that lead to a loss of 20% of total staff in less than 5 years. The VDOT KM Division includes a KM Office, the Virginia Local Technical Assistance Center, and the VDOT Research

Library (NCHRP 2014). KM tools and techniques used by VDOT and their output (services) are shown in Figure 2-5.

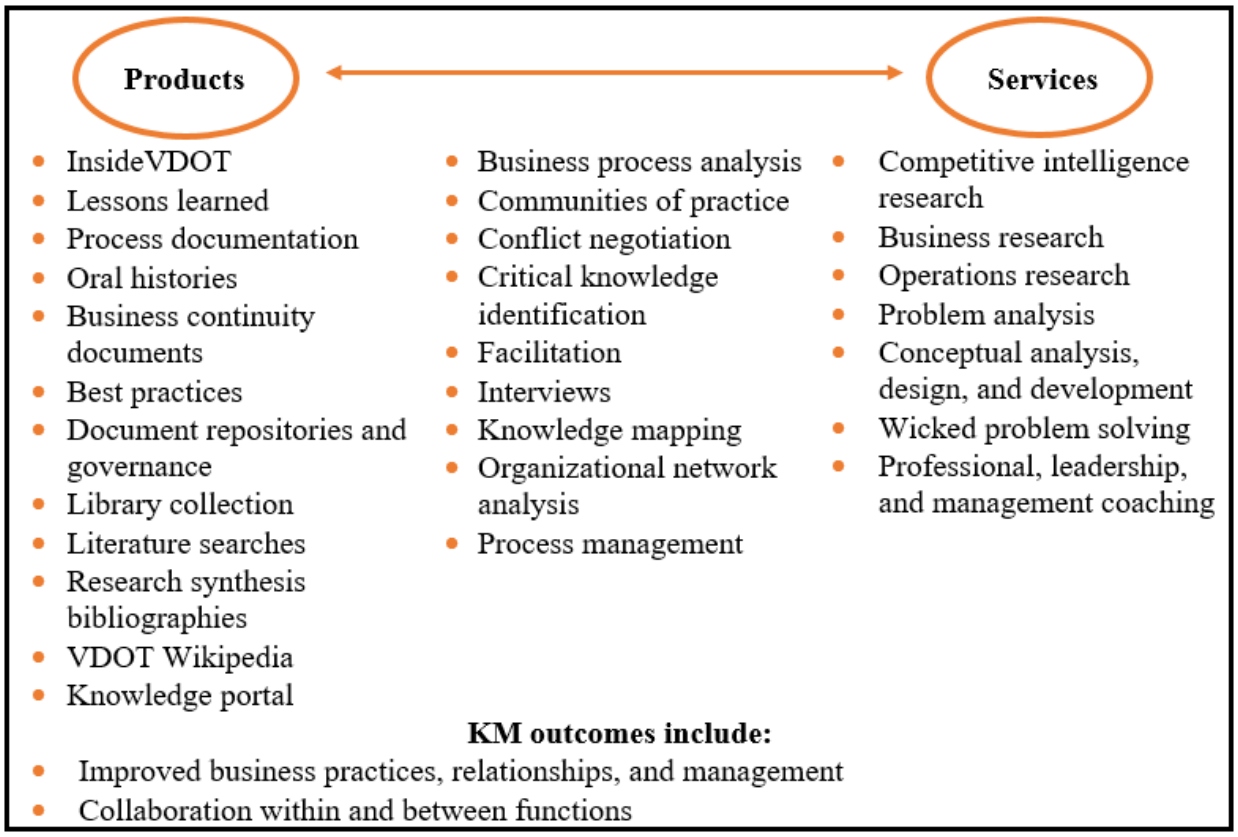
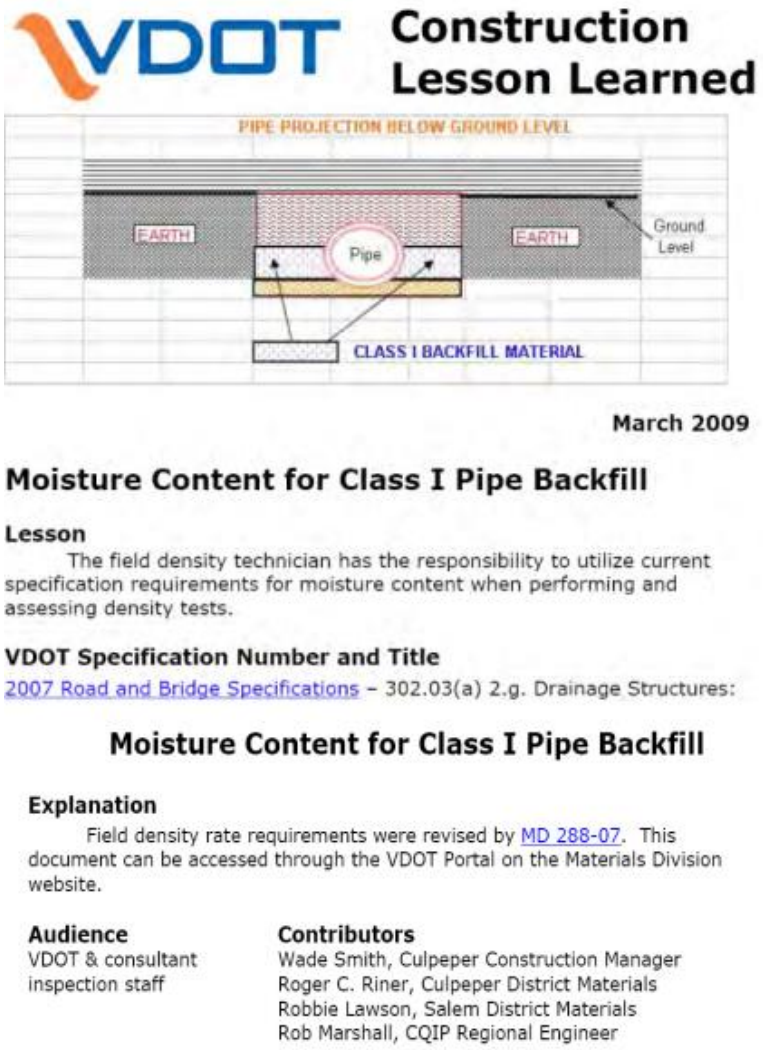



**Figure 2-5. VDOT KM products and services (NCHRP 2014)**

VDOT has an active Communities of Practice program with over 40 communities that integrate horizontally and vertically to provide awareness across different functions and levels in the organization (NCHRP 2014). VDOT uses UCINet, an organizational network analysis program along with a web-based questionnaire to provide a visual image on how the employees are interconnected and how the knowledge is transferred between them. Further, VDOT's Construction Quality Managers Community of Practice implemented an agency wide construction lessons learned initiative in 2007, which received the Trailblazer award in 2009 from the AASHTO Officials Performance Improvement Committee. The lessons learned documentation consists of over 75 articles. These articles are peer reviewed prior to publishing to ascertain the accuracy of the materials (NCHRP 2014). Figure 2-6 illustrates an example of a lessons learned article at VDOT.



VDOT Construction Lesson Learned



March 2009

## Moisture Content for Class I Pipe Backfill

**Lesson**

The field density technician has the responsibility to utilize current specification requirements for moisture content when performing and assessing density tests.

**VDOT Specification Number and Title**

2007 Road and Bridge Specifications – 302.03(a) 2.g. Drainage Structures:

## Moisture Content for Class I Pipe Backfill

**Explanation**

Field density rate requirements were revised by MD 288-07. This document can be accessed through the VDOT Portal on the Materials Division website.

**Audience**
VDOT & consultant inspection staff

**Contributors**
Wade Smith, Culpeper Construction Manager
Roger C. Riner, Culpeper District Materials
Robbie Lawson, Salem District Materials
Rob Marshall, CQIP Regional Engineer

**Figure 2-6. Example of a lesson learned documentation by VDOT (NCHRP 2014)**

In addition, VDOT uses process mapping to indicate the steps involved in different processes across separate functions, the accountable person, and the relevant documentation supporting the process. VDOT uses SharePoint platform for its intranet and extranet. The VDOT research library provides access to external content through an online catalog, electronic resources, and through subscriptions to databases (NCHRP 2014).

Similarly, Table 2-5 lists the responsible group or division of each DOT for managing KM functions.

**Table 2-5. The Group or Division Responsible for Managing KM Functions Within DOTs (NCHRP 2014)**

| Agency | Organizational home of KM function |
|---|---|
| Alaska DOT & PF | Strategic workforce planning and knowledge sharing function within the Administrative Services Division; activities related to IM are being pursued under the Transportation Information Group within the Program Development Division |
| Georgia DOT | Functions distributed across multiple offices |
| Kansas DOT | Informal program; no single home |
| Missouri DOT | Functions are distributed across multiple offices. Innovations engineer within the Design Division coordinates Value Engineering studies. The Engineering Policy Group within the Design Division is responsible for the consolidated Engineering Policy Guide. |
| US DOT FHWA | Office of Technical Services, under the Administrator |
| US DOT FTA | Learning and Knowledge Management (LKM) Group, under the Office of Administration |
| Virginia DOT | Knowledge Management Office (KMO), under the Virginia Center for Transportation Innovation and Research (The Research Library function is under the KMO.) |
| Washington State DOT | Office of Research and Library Services, under the Strategic Planning Division |
| Wisconsin DOT | Functions distributed across multiple offices |
| Alberta Transportation | The Canadian Council of Motor Transport Administrators KM Advisory Subcommittee is pursuing a pilot project.<br>Traffic Safety Services Division, Business Knowledge and Coordination Unit |

In 2006, Pennsylvania Department of Transportation (PennDOT) initiated a KM strategic plan based on worker needs, work force demographics, available technologies, and existing KM assets. With the progress achieved since then, PennDOT developed a program for managing both tacit and explicit knowledge by 2012 (Perkins and Bennet 2012).

The Maryland Department of Highway Administration initiated a KM program to overcome the classic pressures of changing workforce. The business plan presented by Maryland DOT included an exclusive section on workforce development. Table 2-6 shows one of the sub-sections with the objectives, performance measures, and strategies (Perkins and Bennett 2012).

**Table 2-6. Subsection on KM by Maryland DOT (Perkins and Bennett 2012)**

| Sub-Objective 4.3C Knowledge Management |
|---|
| Ensure employee awareness of, access to and use of the most current policies and procedures and key processes through an (State Highway Administration) SHA-wide knowledge management (KM) portal.<br><br>**Performance measures:**<br><br>• Number of key processes and number of current policies<br>• Number of key policies and documented processes published to the portal<br>• Percent complete<br>• Number of FAQs posted on the SHA-wide KM portal<br>• Percent of Research Centers (RCs) participating.<br><br>**Strategies:**<br><br>• Each office/district validates and documents their key policies, procedures and processes and enters them through an SHA-wide KM portal by June 30 of every year.<br>• On a quarterly basis, each RC will create, validate and update as needed, FAQs answering of their most relevant questions.<br>• Placeholder: Strategy for communication/marketing benefits. |

Another example is the WisDOT's KM program. As part of the KM program, a matrix was developed by incorporating a list of specific topics, associated tasks, brief description of each task, applicability of the outcome for specific tasks, and the impact of the outcome as a resource (low, medium, or high). Table 2-7 shows the matrix. Five topics selected for this purpose are: documenting process; formalizing process; experiencing together; sharing experience; and developing leaders. Automating process and expert decision system tasks listed under the topic formalizing process show medium to high impact as potential resources to improve KM. Hence, these two tasks can be integrated to provide a systematic and structured approach for documenting policy change decisions and the rationale behind such decisions. With this formalizing process, the information collected will be managed and retained to be used as needed; thus the institutional knowledge is preserved.

**Table 2-7. WisDOT's KM Tools Matrix (NCHRP 2014)**

| Topic and tasks | Brief description | Might be good for | Resources |
|---|---|---|---|
| Documenting process | | | |
| Writing down processes | Incumbent writes down steps in key tasks | Stable, routine tasks; quick reference | Low |
| Videotaping processes | Incumbent is videotaped performing key tasks | Quick capture, including context | Low |
| Formalizing process | | | |
| Formalizing process | Manually require steps be completed in certain way | More complex tasks | Low |
| Automating process | Automation requires steps be completed in certain way | Highly complex tasks with many players | Med |
| Expert decision system | Incorporates expert judgement; provides decision | Complex decisions that can be modeled | High |
| Experiencing together | | | |
| Double-filling key positions | New employee and retiring employee work together | Critical positions with sole complex knowledge | Low |
| Cross-training | Train employees to do a range of overlapping work | Positions with sole knowledge | Med |
| Communities of practice | Employees with similar work regularly communicate | Positions scattered throughout agency | Med |
| Sharing experience | | | |
| Exit interviews | HR or supervisor asks questions of departing employee | All departing employees | Med |
| Expert Interviews | Interviewer asks questions of knowledgeable employee | Employees with extensive specific knowledge | Med |
| Last lectures | Departing employee gives open-ended talk | Departing employees with extensive tacit knowledge | Med |
| Storytelling | Current employees share stories of challenges faced | Current employees with extensive tacit knowledge | High |
| Developing leaders | | | |
| Rotation program | Selected employees work in one or more new areas | Employees showing leadership promise | High |
| Leadership program | Selected employees receive agency exposure | Employees showing leadership promise | High |

The Alaska Department of Transportation & Public Facilities (ADOT & PF) evaluated workforce demographic and retirement projections through data collection and analysis. As a result, the Workforce Excellence Program was launched in 2011. This program was designed to address issues such as industry shifts and changes in workforce demands through strategic recruitment, employee retention, and leadership development. As a part of the strategic recruitment plan, developing the existing internal workforce and outside target advertising was proposed to fill the key vacancies within the organization. Moreover, the employee retention plan included regular satisfaction surveys, training, mentoring, and recognition of the employees. The leadership development plan included creating a line of leaders to fill the key positions within the organization (NCHRP 2014).

Kansas Department of Transportation (KDOT) in 2005, implemented a mentoring program for district field inspectors in each of its six districts. The goal was to capture the tacit knowledge possessed by the long-term employees.

Reduced resources, reduced work force, staff churning, and the need for efficiency contributed the initiation of KM practices at the Washington State Department of Transportation (WSDOT). The Office of Research & Library Services, residing within the Strategic Planning Division, is responsible for implementing KM programs. The KM initiatives at WSDOT include knowledge mapping and knowledge interviews. WSDOT formed the Enterprise Information Governance Group to develop principles for data and information management as well as to create a domain for explicit information resources. Many groups within WSDOT meet to share information based on organizational position (e.g. the statewide design engineers) or topic (e.g. Highway Safety Executive and Highway Safety Improvement Group). Typically, the individuals with responsibility for the topic lead the groups while senior managers support and participate. E-mail list servers, SharePoint team sites, or face-to-face meetings with remote meeting support is used to manage the activities. In addition, the Office of Research and Library Services conduct knowledge interviews with employees who are within weeks of retirement. Each interview is summarized and shared with the employee and the supervisor. The Construction Office maintains a lessons-learned database for design and construction activities. The Safety Office uses lessons learned for improving workforce safety. SharePoint Team sites, shared servers, and Internet/intranet sites are used to share information (NCHRP 2014). According to the response provided to the scan team of the NCHRP Project 20-68a, the contributors to the externally hosted wiki developed by WSDOT through a pooled-fund study were limited. Current status of the wiki is not discussed in this report since the weblink to access the wiki is not available externally.

## 2.5 SUMMARY

This chapter described the history, concepts and implementation of knowledge management (KM). The general KM implementations discussed here are too general for the specific scope of this project which only deals with the modernization of the bridge design documentation. Yet, the need for modernizing the design documents described by the MDOT stems from a lack of a complete KM environment. In addition, a comprehensive description of the KM will be useful when an agency-wide environment is envisioned.

The KM concept originally emerged from the management consulting community in the mid-1990s. With the advances of information management technologies, various tools and techniques such as dashboards, expertise locators, and lessons learned databases were developed. When an agency is exploring means and methods for developing a KM program, it is necessary to

understand the need for managing knowledge in historical records and the new knowledge as it is being generated. Much of the historical knowledge is retained in paper documents such as books, manuals, guides, memos, advisories, etc., making it harder to locate, capture, and retrieve in order to share. The experiences of the agencies that have already developed successful KM programs indicate that the biggest obstacle is the cost of converting legacy or archival (i.e. paper) content, organizing discrete documents into an easily identifiable and retrievable file structure of relevant information, and capturing of the knowledge. Many agencies accomplished this task by implementing a multi-step approach of converting documents to digital formats, indexing as PDFs, storing files in a structured folder structure, and reviewing and synthesizing information in a format that could accommodate the new information and knowledge as it is being generated.

Information management technology offers various tools and techniques such as dashboards, internal/external wikis, user groups, expert groups, etc., to capture and share knowledge. Even though such tools and techniques provide advantages over traditional paper based and employee dependent processes to piece together institutional knowledge, several factors need to be considered in capturing, storing, and sharing institutional knowledge. The factors that affect the effectiveness are the cost of maintenance of discrete tools, lack of coherence in the information, possibility of retrieving all relevant information with a reasonable effort and time, and the reluctance of the employees to use such tools due to the perceived learning curve. Another alternative method of capturing institutional knowledge is developing a documenting process to implement an electronic record of a specific work process (i.e. a workflow). This could include the steps in the process, key dates, relationship to other processes that come before and after, specific employee group, contact information, required references and legal citations, back up procedures and copies of forms, software, data sets, and file names associated with the process.

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# 3 IM AND KM PRACTICES IN DOT BRIDGE DESIGN DEPARTMENTS

## 3.1 OVERVIEW

The bridge design manual, guides, and the relevant web contents of multiple agencies were reviewed. The objective was to establish the best practices for information and knowledge management (IM and KM) related to bridge design and policy decisions. The survey conducted by the Missouri Department of Transportation in 2016 indicated distinct practices by Ohio and Texas DOTs. Hence, those two agencies were contacted to gather more details on their practices. State DOTs that published manual and guides with a thorough revision history and provided unrestricted access to the majority of their publications were selected for review. Additional DOTs that are included in this review were selected based on a cursory review of their websites. The publications were reviewed, and synthesized the practices and formats related to policy documentation, rationale behind policies, policy implementation guidelines, workflow, and communication guidelines.

For BDM content presentation, AASHTO LRFD Bridge Design Specifications, the 16$^{th}$ edition of the AASHTO Standard Specifications of Highway Bridges, 1998 version of the American Oil and Chemists' Society Standards, 2017 edition of the National Electrical Code, and the 2015 edition of the ASD/LFRD Manual - National Design Specification for Wood Construction were reviewed. Appendix B provides a summary of each agency's practice and a list of web links to the relevant publications. Appendix C presents Ohio and Texas DOT responses to a few questions posted by the research team.

## 3.2 OVERVIEW OF MDOT PRACTICE

The Michigan Department of Transportation (MDOT) documents bridge design policy in three public publications: BDM, BDG, and *BSP*. BDM is specific to bridge design policies while BDG hold visual information that serves as an aid for designing and detailing bridges. BSP present standard details of various construction items representing the current MDOT policies. The BDM is organized in 15 chapters and the information is presented in a two-column format. Since November 2011, the specific revisions/updates to these publications are recorded in a document named '*Monthly Updates*' (MU). Prior to that date, the revisions/updates were recorded in *Office Memorandums*. The *Monthly Updates* document the changes to the Road and Bridge Design Publications that have been released during the specified month. The updates to relevant sections

of the manual and guides are published concurrently with the *MU*. The date of updates included within parentheses and provided next to the policies in BDM indicate the revision dates. These dates, after November 2011, correspond to the month and year of the *MU* publication date. Prior to November 2011, the date, month, and year correspond to the *Office Memorandum* publication date. The *Bridge Design Guides* are organized by section and then by guide numbers. Each individual document includes an "issued" date and a "supersedes" date that designates the last update. Since the revisions/updates are not shown, a user may need to check the associated *MU* if there is a need to identify the specific change. Most of the time, the rationale behind policy changes are not described from the aforementioned documents.

The process for initiating and processing the revisions/updates to BDM and BDG is ad hoc and not structured. The update process often starts with the initiative of individual MDOT staff, MDOT committees, FHWA requests, and changes to AASHTO specifications. Currently, there is one staff member with title of 'Specification Coordinator' to coordinate the revision/update process. Also, one staff member, who is in charge of the documents integrity, holds the title 'Specification Poster'.

### 3.2.1 Policy Documentation

The *Bridge Design Manual* is organized by chapter and section numbers, as seen in the table of contents shown at the beginning of each chapter (see Figure 3-1). The table of contents provide hyperlinks to navigate to the relevant sections within the manual. The separate LFD and LRFD policies are presented for a few sections, which are organized as different, but consecutive chapters. Within the chapter, the information is presented in a two-column format (see Figure 3-2). References to other chapters are hyperlinked. The rationale behind bridge design policies is not a part of the manual. The date of updates included within parentheses next to the policies indicate the revision/update dates. As shown in Figure 3-2; these dates, after November 2011, correspond to the month and year of the *Monthly Updates*.

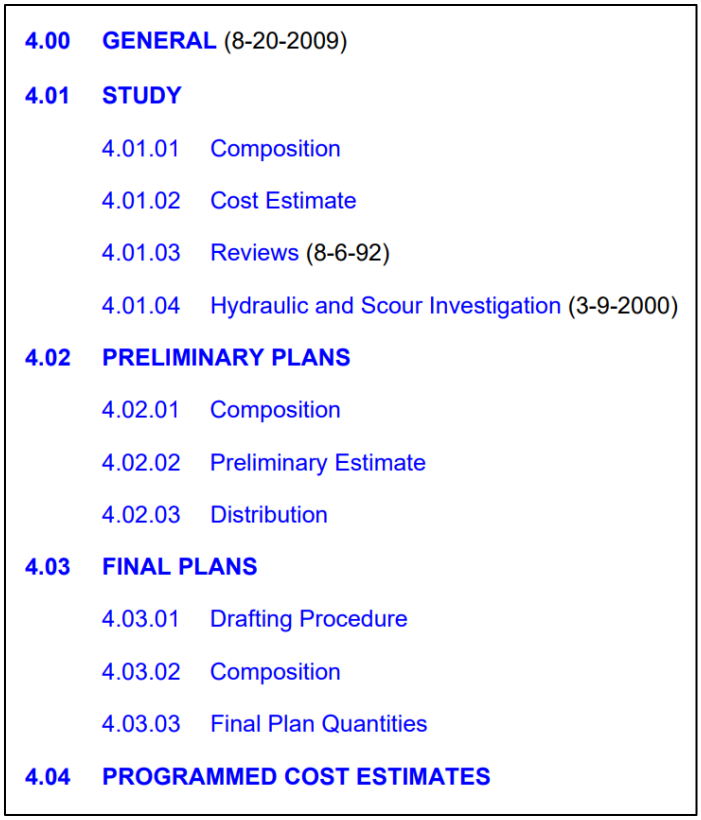
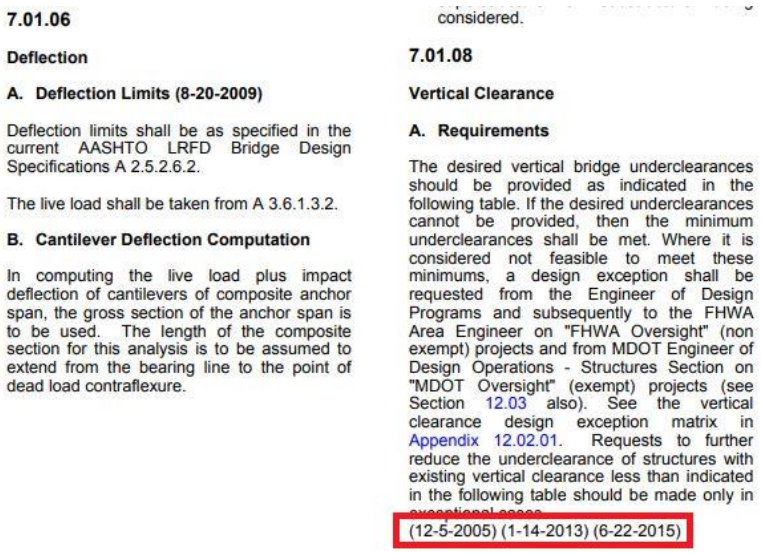



**Figure 3-1. BDM table of content showing the organization of policies (MDOT 2018a)**



**7.01.06**

**Deflection**

**A. Deflection Limits (8-20-2009)**

Deflection limits shall be as specified in the current AASHTO LRFD Bridge Design Specifications A 2.5.2.6.2.

The live load shall be taken from A 3.6.1.3.2.

**B. Cantilever Deflection Computation**

In computing the live load plus impact deflection of cantilevers of composite anchor span, the gross section of the anchor span is to be used. The length of the composite section for this analysis is to be assumed to extend from the bearing line to the point of dead load contraflexure.

considered.

**7.01.08**

**Vertical Clearance**

**A. Requirements**

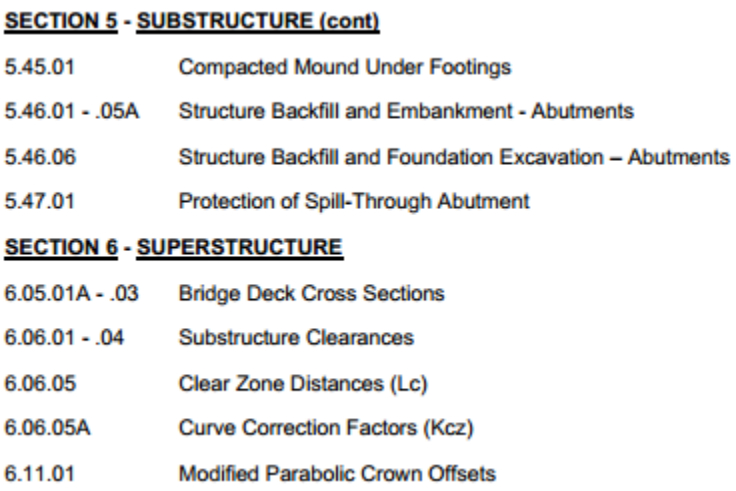
The desired vertical bridge underclearances should be provided as indicated in the following table. If the desired underclearances cannot be provided, then the minimum underclearances shall be met. Where it is considered not feasible to meet these minimums, a design exception shall be requested from the Engineer of Design Programs and subsequently to the FHWA Area Engineer on "FHWA Oversight" (non exempt) projects and from MDOT Engineer of Design Operations - Structures Section on "MDOT Oversight" (exempt) projects (see Section 12.03 also). See the vertical clearance design exception matrix in Appendix 12.02.01. Requests to further reduce the underclearance of structures with existing vertical clearance less than indicated in the following table should be made only in

(12-5-2005) (1-14-2013) (6-22-2015)

**Figure 3-2. Format of the *Bridge Design Manual* (MDOT 2018a)**

The *Bridge Design Guides* are organized by section and then by guide numbers (see Figure 3-3). The *Bridge Design Guides* are available as a single PDF document, as well as individual PDF sheets. As shown in Figure 3-4, each individual document includes an "issued" date and a "supersedes" date that allows the user to know the last update date. Hyperlinks are not included

within the guides even though other guides are referenced within the text. Since the revisions/updates are not noted in the final version of the guides, user may need to review the associated *Monthly Updates* to identify the changes to that version. Users may enroll with MDOT to receive email updates of the Road and Bridge Design Publications, including the *Bridge Design Manual* and *Bridge Design Guides.*



**SECTION 5 - SUBSTRUCTURE (cont)**

| | |
|---|---|
| 5.45.01 | Compacted Mound Under Footings |
| 5.46.01 - .05A | Structure Backfill and Embankment - Abutments |
| 5.46.06 | Structure Backfill and Foundation Excavation – Abutments |
| 5.47.01 | Protection of Spill-Through Abutment |

**SECTION 6 - SUPERSTRUCTURE**

| | |
|---|---|
| 6.05.01A - .03 | Bridge Deck Cross Sections |
| 6.06.01 - .04 | Substructure Clearances |
| 6.06.05 | Clear Zone Distances (Lc) |
| 6.06.05A | Curve Correction Factors (Kcz) |
| 6.11.01 | Modified Parabolic Crown Offsets |

**Figure 3-3. Table of contents of the *Bridge Design Guides* (MDOT 2018b)**


**Figure 3-4. Title bar of a design guide showing a "issued" and "supersedes" dates (MDOT 2018b)**

### 3.2.2 Rationale Behind Policies

The policy revisions/updates since 2011 are listed in the *Monthly Updates*, which are organized by month and year as shown in Figure 3-5. This process is only effective if the user is only looking for a specific change and the date of the change. However, if a user is looking for changes made to one section over time; *Monthly Updates* for that time period needs to be reviewed. Within the *Monthly Updates*, the changes are organized by the publication (e.g. *Bridge Design Manual* or *Bridge Design Guide*) and the relevant section or guide numbers. Hyperlinks for supporting documents are provided. The rationale behind policy changes are not provided in any of the aforementioned documents.

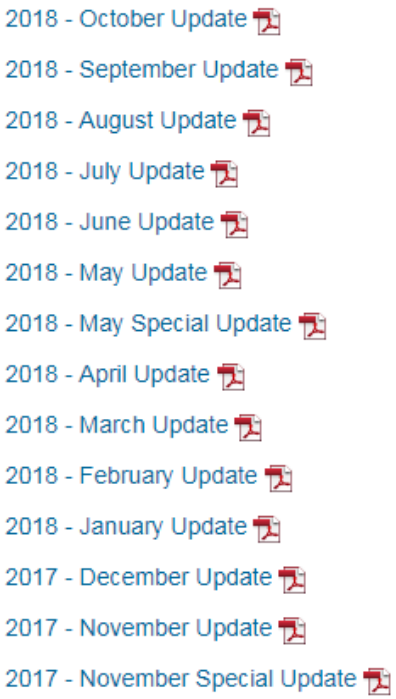



**Figure 3-5. List of the Monthly Updates (MDOT 2018c)**

The revisions/updates prior to November 2011 were disseminated using *Office Memorandums* (OMs). OMs were issued separately for BDM and BDG revisions/updates, as shown in Figure 3-6 and Figure 3-7. A rationale is provided when the revisions/updates are significant, as shown in Figure 3-8. This process again is sufficient if the user is looking for a specific revision/update. However, if a user is looking for many revisions/updates to one section over a time period, all the OMs within that time period need to be reviewed. Within the OMs, the revisions/updates are organized by section number or guide number.

MDOT Michigan Department of Transportation

OFFICE MEMORANDUM

DATE: February 23, 2001

TO: Metric Bridge Design Manual Holders

FROM: Mark A. VanPortFleet, Engineer of Bridge Design

SUBJECT: Chapters 5 and 6 of Bridge Design Manual

This is another partial distribution of the Bridge Design Manual. Please insert these sections and Chapter 6 in the appropriate location in your manual.

The sections listed below have been updated as indicated. The date following the note has been and will be updated when the change to note is a policy update. If the note was updated for non policy (editorial/grammatical, pay item, Standard Specifications section) reasons then the date following the note was not updated.

The following is a description of the new and revised material in the chapters.

**Chapter 5**

**Chapter 5: Table of Contents** - Updated the titles of Appendices 5.03.03 A.1.e. & f.

**5.04.07** - Added information to coordinated permit application procedures with Design Engineer -

**Figure 3-6. OM for BDM revisions/updates**

MDOT Michigan Department of Transportation

OFFICE MEMORANDUM

**DATE:** June 9, 1999

**TO:** Metric Bridge Design Guide Holders

**FROM:** Mark A. Van Port Fleet
Engineer of Bridge Design

**SUBJECT:** Revisions to Metric Bridge Design Guides

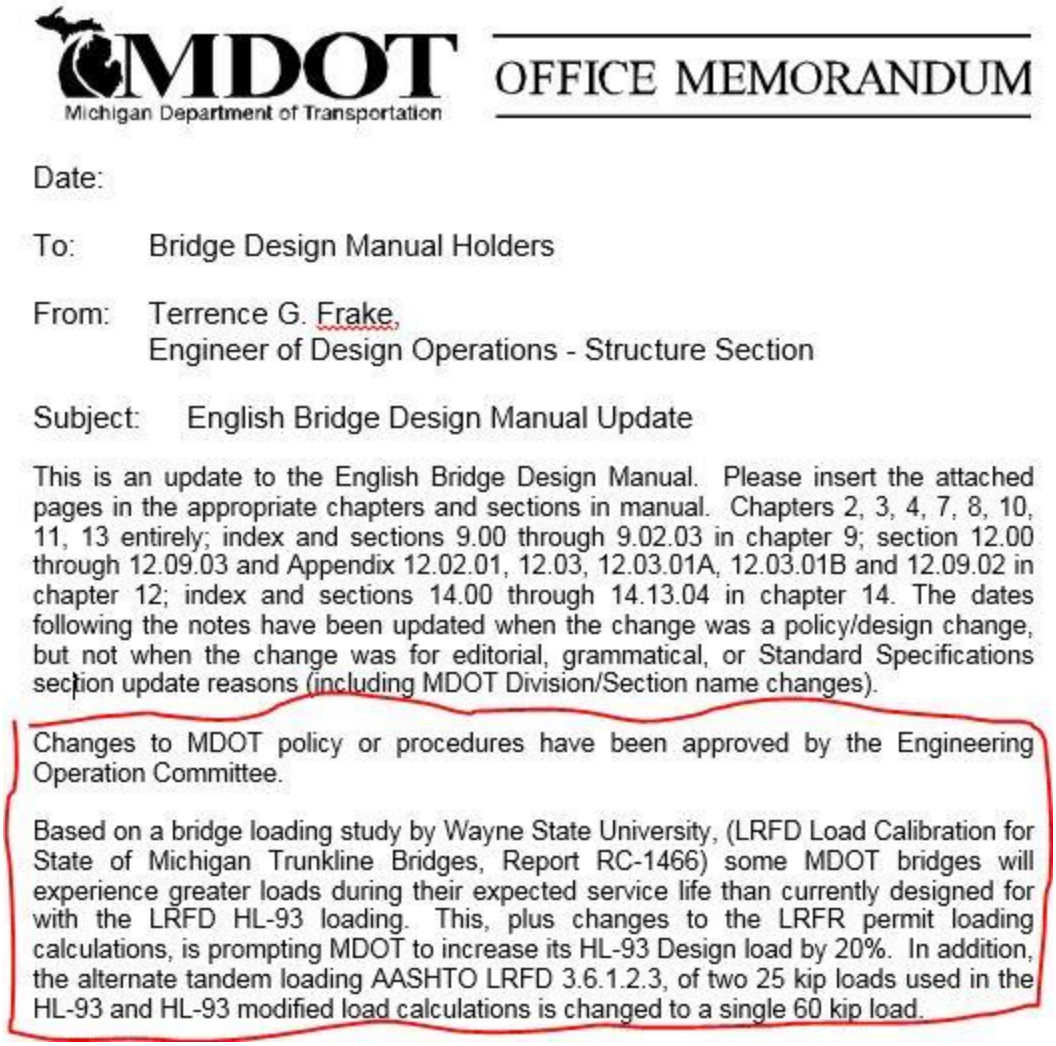
The attached design guides are new, revised, or deleted as indicated below. The new guides deal with Prestressed Concrete I- beams and Box Beams. The revised guides deal with Integral and Semi-Integral Abutments along with Utility Charges for Diaphram fabrication.

Please incorporate the new guides into the metric bridge design guides and replace existing copies.

1.00.02, .03, .04, .05 - Table of Contents was updated.

5.45.01 - Note change. "Backfill with Suitable Material" to "Embankment C.I.P."

**Figure 3-7. OM for BDG revisions/updates**



MDOT Michigan Department of Transportation

OFFICE MEMORANDUM

Date:

To: Bridge Design Manual Holders

From: Terrence G. Frake,
Engineer of Design Operations - Structure Section

Subject: English Bridge Design Manual Update

This is an update to the English Bridge Design Manual. Please insert the attached pages in the appropriate chapters and sections in manual. Chapters 2, 3, 4, 7, 8, 10, 11, 13 entirely; index and sections 9.00 through 9.02.03 in chapter 9; section 12.00 through 12.09.03 and Appendix 12.02.01, 12.03, 12.03.01A, 12.03.01B and 12.09.02 in chapter 12; index and sections 14.00 through 14.13.04 in chapter 14. The dates following the notes have been updated when the change was a policy/design change, but not when the change was for editorial, grammatical, or Standard Specifications section update reasons (including MDOT Division/Section name changes).

Changes to MDOT policy or procedures have been approved by the Engineering Operation Committee.

Based on a bridge loading study by Wayne State University, (LRFD Load Calibration for State of Michigan Trunkline Bridges, Report RC-1466) some MDOT bridges will experience greater loads during their expected service life than currently designed for with the LRFD HL-93 loading. This, plus changes to the LRFR permit loading calculations, is prompting MDOT to increase its HL-93 Design load by 20%. In addition, the alternate tandem loading AASHTO LRFD 3.6.1.2.3, of two 25 kip loads used in the HL-93 and HL-93 modified load calculations is changed to a single 60 kip load.

**Figure 3-8. OM for BDM revision/changes with rationale**

### 3.2.3 Policy Implementation Guidelines

The BDM content lacks implementation procedures, such as examples or references to such information, which can be useful to ensure consistency in calculation procedures and documentation of the bridge design process. Section 3.3.3 and Appendix B present few implementation examples from other DOTs.

## 3.3 DOT AND OTHER AGENCY PRACTICES

The bridge policy revision/update and documentation practices of 17 different DOTs, as well as the content presentation formats of several other manuals and guides, were reviewed and the best practices are summarized in this section. Best practices include the design manuals and guides

presentation format, documentation of revisions/updates and rationale, and workflow procedures for updating/revising the policies.

### 3.3.1 Design Manual Format

In the manuals of several agencies, similar to the MDOT BDM, only the policies are presented. Adding commentary to the manual itself may make it of excessive length and difficult to navigate unless advanced document management features are used. One such option is a multilayer document of which the layers can be activated or deactivated to display policies, commentaries, different versions, recent changes, or a combination thereof. Since commentaries are rarely helpful to experienced engineers, the initiation and maintenance cost of using advanced document management features needs to be justified. However, the educational value of the layered document, especially for the new staff and consultants, are indisputable. Hence, several agencies provide separate documents for commentaries and revision histories with rationale. As an example, the Iowa DOT Design Manual and associated commentary are presented as a discrete set of documents for each section. As shown in Figure 3-9, a set of hyperlinks is provided to access the commentaries for each section of the manual. Policies followed by some state DOTs are different from what is listed in the AASHTO Specifications. These exceptions are very clearly marked in the manuals using highlighted or bold textboxes. ALDOT manual provides such examples.

The AASHTO LRFD Bridge Design Specifications is published in a two column format, one documenting the policies and the other documenting the corresponding commentary. The AASHTO Standard Specifications of Highway Bridges, 16$^{th}$ edition, and the 2015 edition of the ASD/LFRD Manual - National Design Specification for Wood Construction include commentaries as appendices. The 1998 version of the American Oil and Chemists' Society Standards provides commentaries as notes, in paragraph formats or as numbered lists, at the end of each section. The 2017 edition of the National Electrical Code provides commentary notes at the end of each section in a smaller font.


**Figure 3-9. Iowa DOT webpage with hyperlinks to manual sections and commentaries**

### 3.3.2 Process of Revisions/Updates to Design Manuals

DOTs organize revision histories in multiple formats, the most common methods being with respect to the date of revision (as shown in Figure 3-10 and Figure 3-11 ) and by section (as shown in Figure 3-12). Organizing histories by section provides the user with an overview of the changes to a specific section over time, while organizing by date provides users with a chronological list of all changes to the manual. Alternatively, revision histories compiled in a spreadsheet or an interactive database can be sorted as per a user desired criterion.

Minnesota DOT publishes memorandums to provide a detailed rationale behind the changes. These memorandums are archived. New Hampshire DOT also documents the change, a summary of the changes, and the associated rationale. Another means for documenting rationale is the use of a 'Revision Proposal Form', similar to what is seen in Alaska and Montana DOT practices. The information required in the form includes the date, name and contact information of the proposer, applicable manual sections, proposed revision, and the justification for revision, as shown in Figure 3-13.

**CHANGES TO DESIGN MANUAL - 2018**

| Date | Chapter | Section | Description |
|---|---|---|---|
| 1/25/2018 | 1 | 2 | Added milestone activity and description for Endangered Species Act Consultation (ESACO). Revised milestone activity description for Biological Assessment (BIOAS). |
| 1/25/2018 | 2 | 4 (Section 1) | -Added direction to clip wetlands off of the existing inslope when determining wetland impacts<br>-Removed Stream order Systems<br>-Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 2) | Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 3) | -Added what is expected in a conceptual mitigation plan<br>-Added culvert sinking criteria based on 2017 revised 404 Nation Wide Permit Regional Conditions<br>-Added 408 Permission and Outgrant information.<br>-Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 4) | Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 5) | -Added detail to what is needed in conduction annual mitigation bank monitoring.<br>-Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 6) | -Added detail to what is needed in conduction annual onsite mitigation monitoring.<br>-Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 7) | -Deleted section 7 Mitigation Tracking<br>-Added more detail to Section 9 Woody Vegetation Mitigation |

**Figure 3-10. Revisions and other changes to the NDDOT *Design Manual* in 2018**

| Date | Standard | Revision | Additional Comments |
|---|---|---|---|
| 2018/03/01 | SCST-(00 thru 09)-17 | UPDATED BRIDGE ENGINEER SIGNATURE. | |
| 2018/04/01 | 1043P, 1081P | CHANGED AND REMOVED NOTES REFERING TO APPROVAL OF NONSTANDARD DETAILS THAT ARE DESIGNED AND SEALED BY A PROFESSIONAL ENGINEER. ADDED NOTE "THE PRECAST BOX CULVERT AND EXTENSION SHALL BE BUILT TO THE DIMENSIONS AND SPECIFICATIONS SHOWN IN THESE PLANS." CHANGED CLASSIFICATION OF 6" BEDDING UNDER THE BARREL DETAILS TO "SPECIAL BACKFILL". (WAS REFERRED TO AS GRANULAR MATERIAL OR GRANULAR BEDDING.) REMOVED FROM GENERAL NOTES "THE 6 INCH GRANULAR BEDDING SHALL BE BID AS SPECIAL BACKFILL." | |
| 2018/04/01 | 1044P | UPDATED "COLLAR PART SECTION ILLUSTRATION". | |
| 2018/04/01 | 1082P | CHANGED DESCRIPTION OF 6" BEDDING UNDER THE BARREL DETAILS TO "SPECIAL BACKFILL". (WAS REFERRED TO AS GRANULAR MATERIAL OR GRANULAR BEDDING.) | |
| 2018/04/01 | 1037 | MOVED DIMENSION TEXT IN 8'-0 DECK PANEL DETAIL. IT WAS OVERLAPPED BY DIMENSION LINE. | |
| 2018/04/01 | 1037B | CORRECTED DETAIL B CALL-OUT CIRCLE LOCATION. MOVED DIMENSION TEXT IN 8'-0 DECK PANEL DETAIL. IT WAS OVERLAPPED BY DIMENSION LINE. | |
| 2018/04/01 | 1054 | ADDED ADDITIONAL WELD SYMBOL ARROWS TO DRAIN TRENCH DETAILS IN PART SECTIONS B-B. | |
| 2018/04/01 | P10L | CHANGED PERMISSIBLE ALTERNATE ENCASEMENT DIAMETER FOR HP14x73 & HP14x89 TO 30"DIA. (WAS 28"DIA.) UPDATED BRIDGE ENGINEER SIGNATURE. | |

**Figure 3-11. Part of the Excel spreadsheet showing the changes made to the *Iowa DOT design standards***

**B920**
**Temporary Portable Precast Concrete Barrier Anchorage (Temporary Usage In Limited Barrier Displacement Areas)**

Approved, and signed, December 21, 2011. Last date revised: May, 24 2012

**Revised 05-24-2012**
Changed: "MnDOT" to "SPEC."at multiple locations on the detail and in the notes.

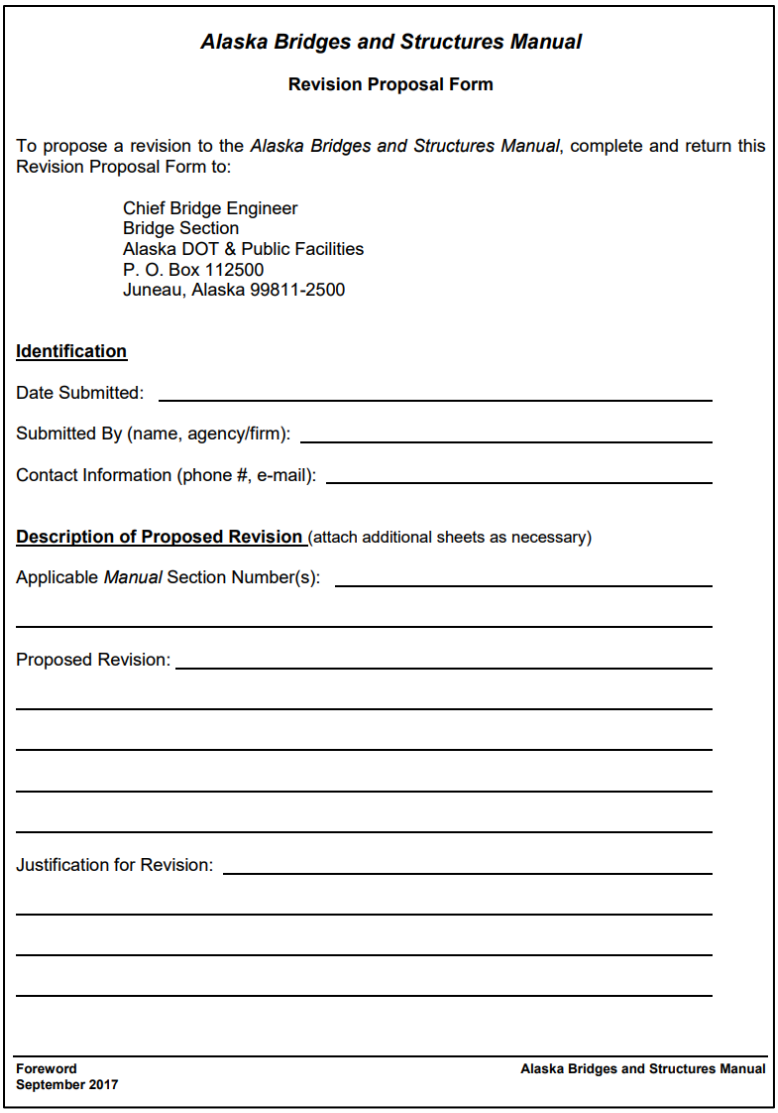
At ANCHORAGE DETAILS, OPTION 1 and OPTION 2: Added the wearing coarse to the details on the traffic side of the barrier.

At SIDE VIEW: Added "TORQUE ANCHOR BOLTS TO 80 FT. LBS." to the end of the existing note.

UNDER NOTES:

- Changed the 3rd note *From*: "Cost of anchorages, anchor removal …. *To:* Cost of anchorage system, anchor removal……..
- Changed 4th note *From:* "Pin barriers together per MnDOT standard plate 8337." *To:* "Pin barriers together per standard plate 8337."
- Removed the 9th note: "Fill anchorage holes with……"
- Changed 10th note *From:* "See special provisions for barrier removal requirements." *To:* "See special provisions for barrier installation and removal requirements."

**Figure 3-12. Example of a change recorded in the *MnDOT Bridge Design Manual***



***Alaska Bridges and Structures Manual***

**Revision Proposal Form**

To propose a revision to the *Alaska Bridges and Structures Manual*, complete and return this Revision Proposal Form to:

Chief Bridge Engineer
Bridge Section
Alaska DOT & Public Facilities
P. O. Box 112500
Juneau, Alaska 99811-2500

**Identification**

Date Submitted: _____

Submitted By (name, agency/firm): _____

Contact Information (phone #, e-mail): _____

**Description of Proposed Revision** (attach additional sheets as necessary)

Applicable *Manual* Section Number(s): _____

_____

Proposed Revision: _____

_____

_____

_____

_____

Justification for Revision: _____

_____

_____

_____

Foreword
September 2017

Alaska Bridges and Structures Manual

**Figure 3-13. The revision proposal form used by the Alaska DOT**

### 3.3.3 Policy Implementation Guidelines

Supplemental documents provided by many state DOTs serve to ensure consistency in the work and documentations completed during the bridge design process. As an example, FDOT provides a suite of documents, MathCAD scripts, software developed through research, etc. Figure 3-14 shows part of the outline of the FDOT LRFD flat slab bridge design example available for the public. Other DOTs, such as Iowa DOT, provide the implementation guidelines as part of the bridge design manual or its commentary (Figure 3-15).

LRFD DESIGN EXAMPLE:
CAST-IN-PLACE FLAT SLAB BRIDGE DESIGN

## Table of Contents



**Figure 3-14. FDOT LRFD flat slab bridge design example**

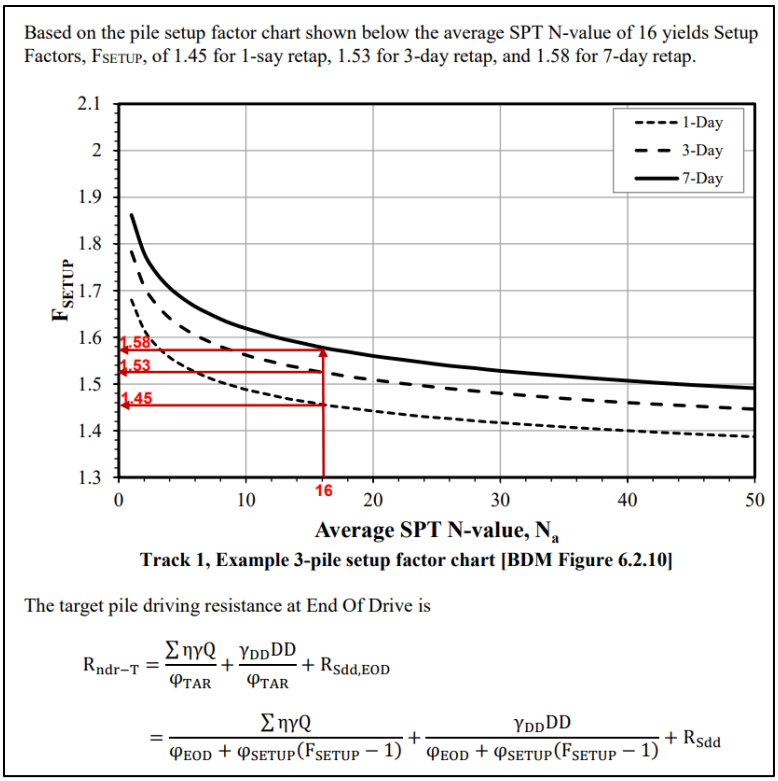



**Figure 3-15. Example of the contents and format of the Iowa DOT commentary document**

### 3.3.4 Design Manual and Guide Revision/Update Workflow

Several states such as Florida, Texas, and Minnesota outline the workflow related to the revisions/updates of the policies in bridge design manuals and guides. Figure 3-16 shows the Texas workflow. As shown in the diagram, Texas uses Adobe Framemaker to compile the documents. Hence, a specific template either in Word or Framemaker (FM) format is provided. Use of templates assures a consistent process. Figure 3-17 shows the MnDOT workflow that lists many committees and outside resources as subject matter experts included in the process. However, this diagram does not include the actions needed to be taken to define the workflow in a document and workflow management system such as ProjectWise®. Figure 3-18 and Figure 3-19 show the FDOT Structures Design Bulletin Development and Structures Manual Development/Revision processes. The FDOT processes describe the actions by specific members of the workflow but do not provide any guidance or actions needed to manage the relevant documents. Hence, these workflows lack the document management aspects required to implement such workflows in a document and workflow management system such as ProjectWise®.

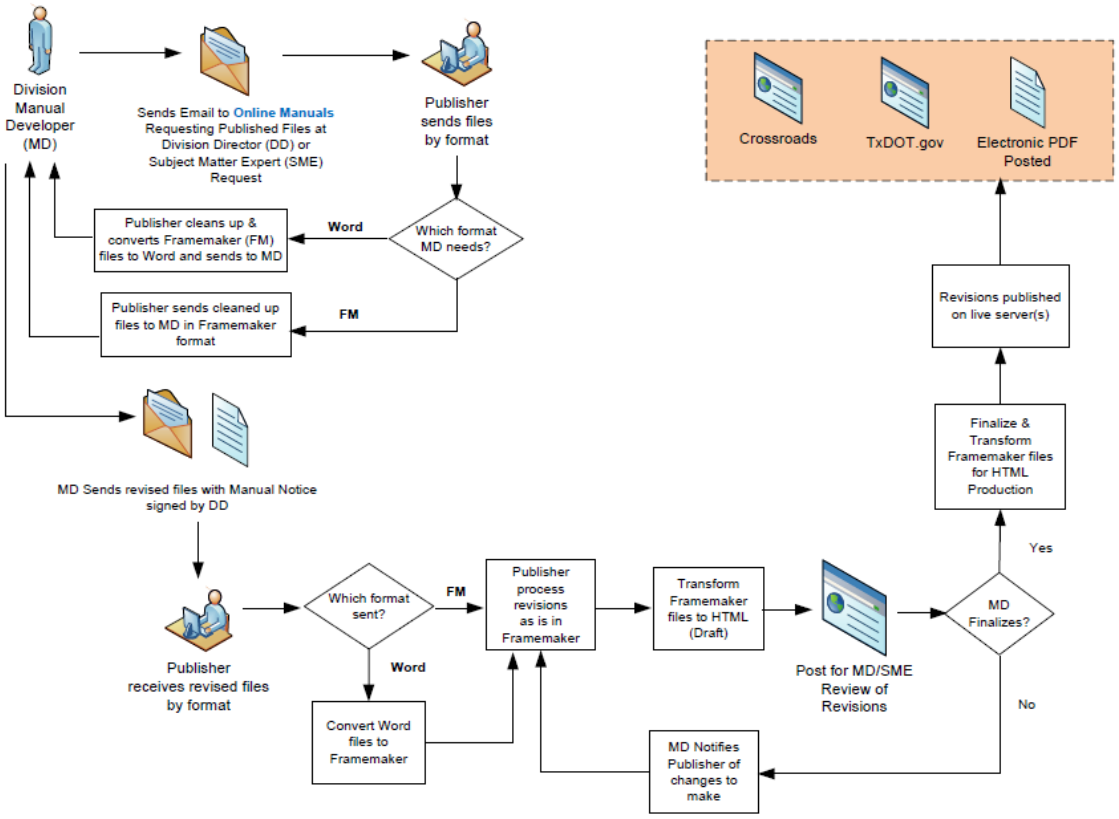



**Figure 3-16. Flowchart detailing the revision and publication process for the online manuals (NCHRP 2014)**

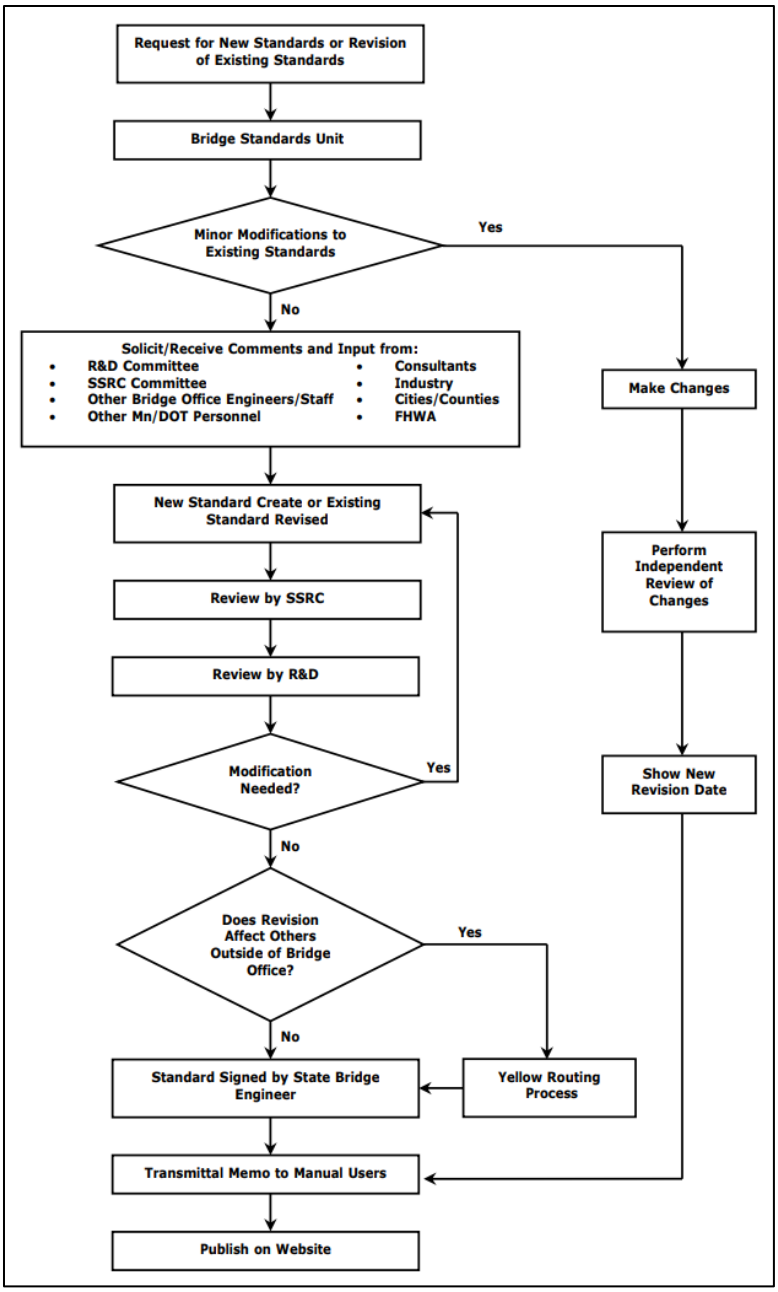



**Figure 3-17. The flowchart showing the workflow process for the creation and/or revision of MnDOT standards**

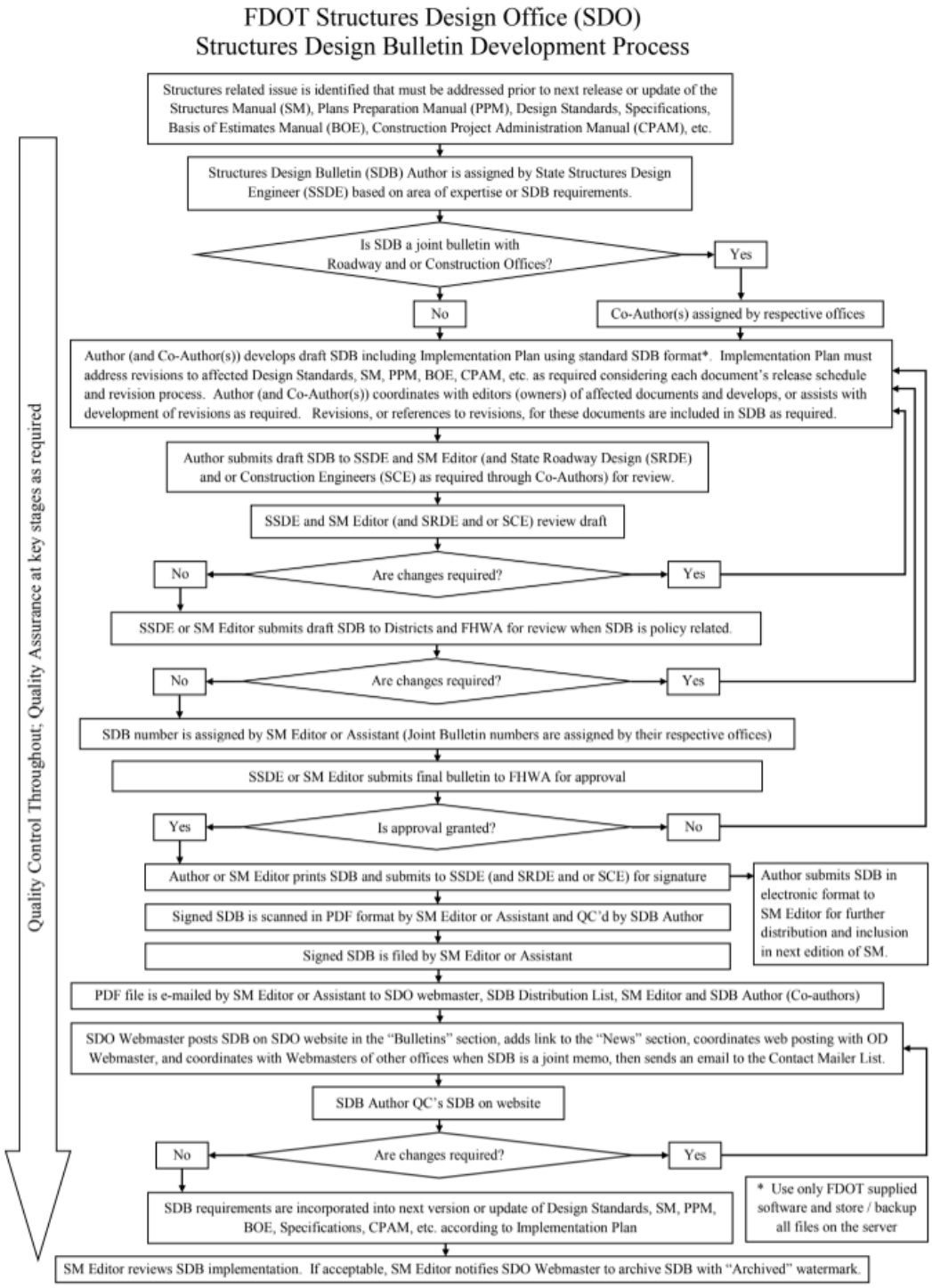



**Figure 3-18. The FDOT Structures Design Bulletin Development Process flowchart**

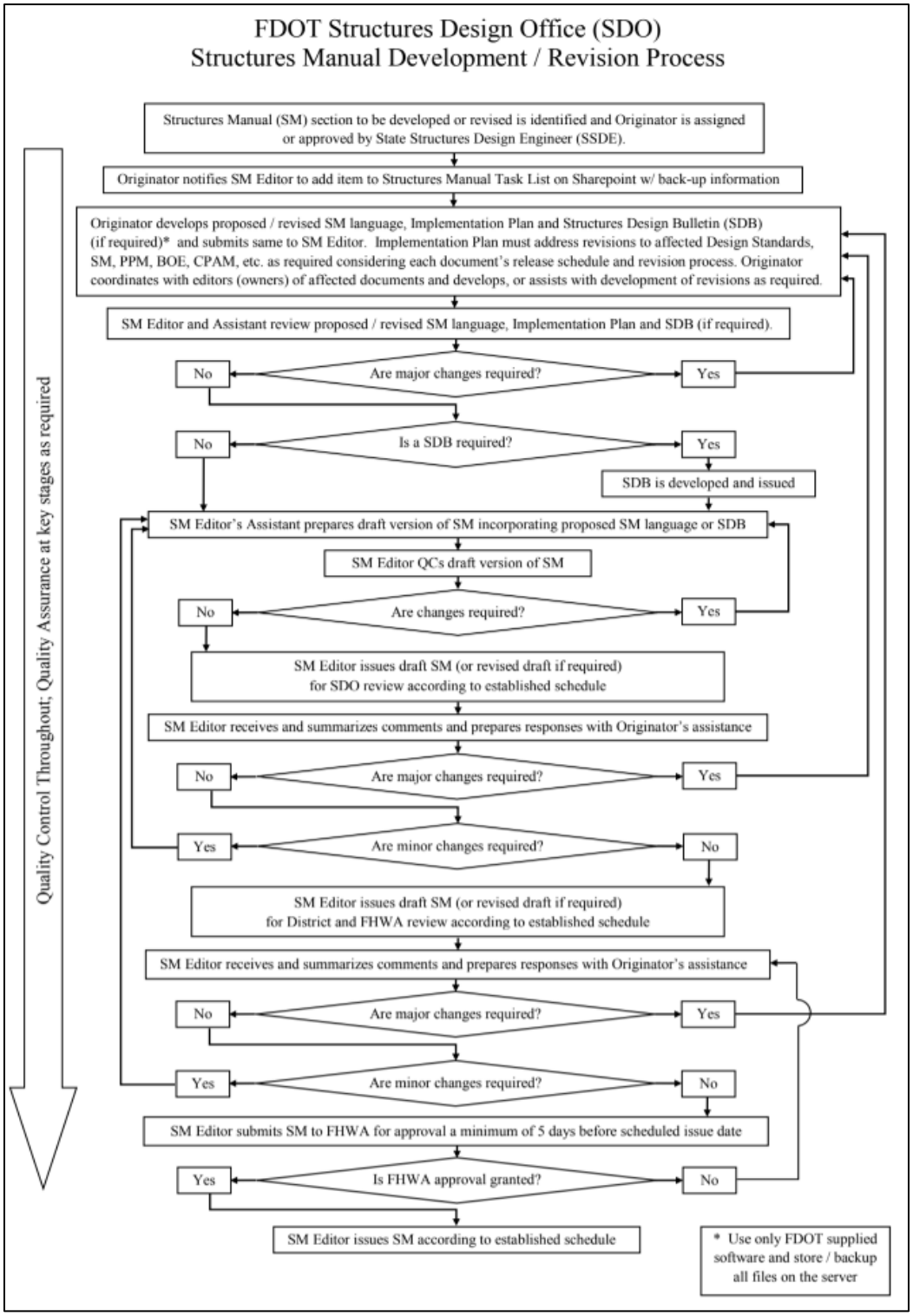



**Figure 3-19. The FDOT Structures Manual Development/Revision Process flowchart**

### 3.3.5 Communication Guidelines

Several manuals and guidelines are presented to improve the consistency of the process and deliverables. For example, TxDOT provides a *Local Government Projects Best Practices Workbook*, which is a workbook-style set of documents that guides users on how to record their responsibilities and track the process of a project. TxDOT *Communications Manual* provides guidelines and templates to improve the effectiveness and efficiency when communicating with diverse groups/individuals for various purposes. Several states, including Alaska, provide users with checklists that can be used as a self-check prior to the submission of reports and other documentation. These checklists contain specifics on the required content in specific reports and a structured process to guide users to organize the information to improve consistency.

# 4 MDOT LEGACY DOCUMENTS

## 4.1 OVERVIEW

A critical project task is to convert MDOT legacy documents from paper to electronic form and store them in an easily identifiable folder structure. Paper documents are located at the MDOT office in four physical locations and multiple file cabinets. Considering the overwhelming task of reviewing and identifying the relevant content for digitizing, and due to the volume of documents in those file cabinets, a folder structure was developed in PW to archive the digitized documents with a naming convention addressing their physical location. In the physical location labelled as 'Location 1' there was only one filing cabinet. The content was indicated to be nonessential and was not converted to electronic form. Hence, only Location 2, 3, and 4 were archived in electronic form.

The conversion process started with assigning a location number, labeling the cabinets based on their physical locations and the number of cabinets at each location, labeling groups of folders based on their content, and generating a photo log. Following digitizing and developing the archive, access was also provided to a large volume of additional documents that were previously converted into an electronic medium and archived in PW. Appendix D describes the process of converting paper documents into an electronic format and the associated file structure in PW. This chapter presents an overview of the process and proposed formats for linking the information in the documents to BDM, BDG, and BSP policy changes.

## 4.2 PHYSICAL LOCATION AND FILE NAMING FORMATS

All the paper copies of the legacy documents were in the MDOT Design Department offices. The cabinets with the paper documents were assigned a location index as shown in Figure 4-1. The next step was to assign folder names for uploading the electronic versions, based on the group of folders or binders in the cabinet, as shown in Figure 4-2. Subsequently, the documents were converted to an electronic format and uploaded to the subfolders in PW. Table 4-1 shows the folder and subfolder names, notes (directions) for the team, and the actions completed by the team.

A folder *Bridge Research Project* was created as a subfolder in the *Scanning Squad* folder (Figure 4-3). For location #2, a folder *Location 2* was created as shown in Figure 4-3. Since location 2 has only one filing cabinet, a subfolder *2.1* was created. Inside this subfolder, six additional subfolders were created and named as per the labels shown in Figure 4-2. Each of these

six subfolders contain additional subfolders with the electronic content. Folder names are shown in the 2nd column of Table 4-1. Same procedure was followed for the rest of the file locations with paper documents to develop the archive of the legacy documents. In addition, a large volume of previously converted historical documents were uploaded to PW folder named *Historical Archive* for the purposes of this project. Figure 4-4 shows the content of the *Historical Archive* folder.


**Figure 4-1. Location 2: File Cabinet is located between column A13 and B13**


**Figure 4-2. Location 2 filing cabinet content and assigned names for each group of folders or binders**

**Table 4-1. Folder Names, Notes for the Team, and Actions Completed by the Team**

| Folder Name Based on Location | Folder Name Based on Folder/ Document Title | Notes for the Team | Actions Completed by the Team |
|---|---|---|---|
| 2.1.1 BDM 87-88-92 | Bridge Design Manual (05/26/1987 Version) | Scan only the pages before Ch. 1 | Scanned |
| | Bridge Design Manual (12/07/1987 Reformatted Version) | | |
| | Bridge Design Manual (09/01/1988 Version) | | |
| | Bridge Design Manual (08/06/1992 Version) | | |
| | Computer Seminar Structural Steel Design and PC Box Beam | | |
| 2.1.2 BDM Update | Bridge Design Manual Update | Scan all | |
| 2.1.3 Crash Test Railing | Crash Test Railing 1 | | |
| | Crash Test Railing 2 | | |
| | Bridge Railings | | |
| 2.1.4 Squad Leader Notes | Squad Leader Notes 1 | | |
| | Squad Leader Notes 2 | | |
| | Squad Leader Notes 3 | | |
| | Squad Leader Notes 4 | | |
| | Squad Leader Notes 5 | | |
| 2.1.5 BDG | Bridge Design Guide | Already Scanned | Reviewed and verified the content |
| 2.1.6 Bridge Specs | Bridge Design Specifications 1901-1936 | Scan all | Scanned |

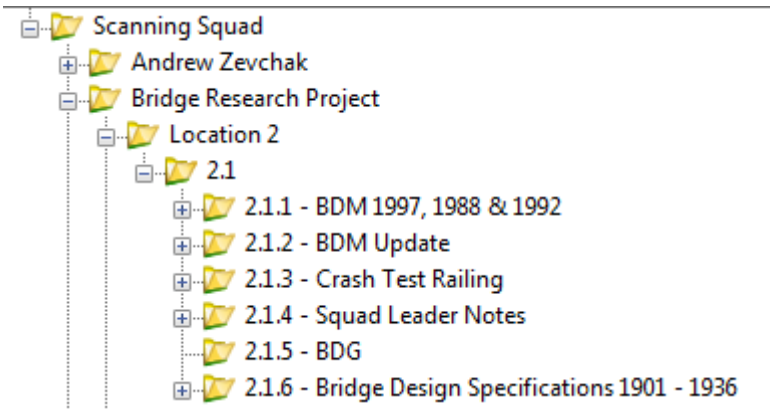



**Figure 4-3. Folder structure in PW for location 2**

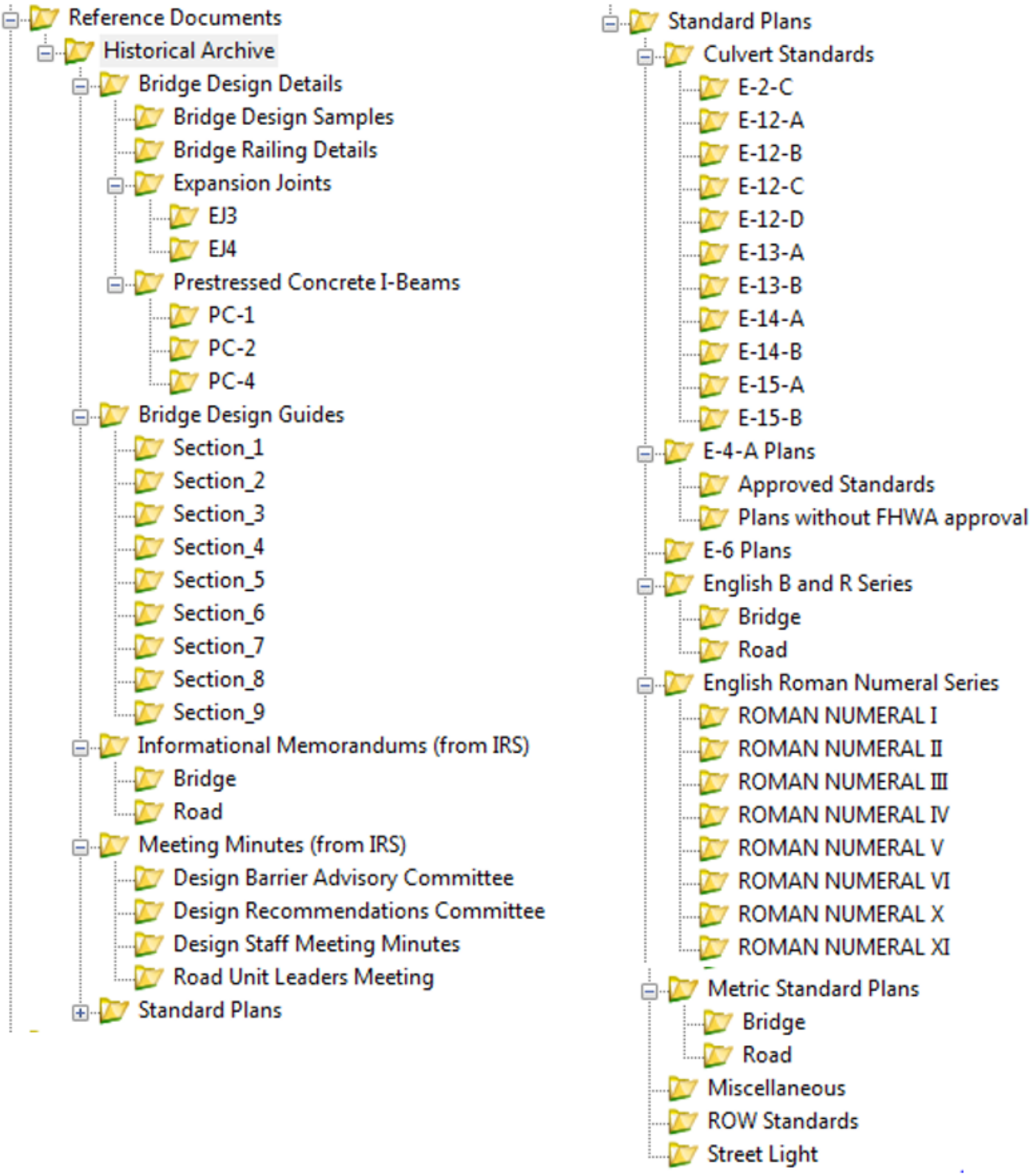



**Figure 4-4. Content of the *Historical Archive* folder in PW**

## 4.3 KNOWLEDGE CAPTURE AND STORE

The primary objective of converting legacy documents into an electronic form is to identify, capture, and store knowledge related to MDOT policies documented in BDM, BDG, and BSP. Due to the extensive volume of documents and lack of uniformity in formatting, detailed review of documents to capture knowledge is not practical without first organizing the content into a folder structure. This requires developing a content or document management structure.

Development of a content or document management structure and system begins with an audit that specifies what content is to be included, source and destination locations of the documents and files, and a brief description of the content when the file or folder names are not adequate to describe the content (Wachter-Boettcher 2012. As part of specifying the content, it is essential to identify any document and file types regularly used by MDOT (International Council on Archives 2008; Koelsch 2016; Synergis Software n.d.; The National Archives 1999). These may include emails, word processed documents, spreadsheets, Adobe Acrobat PDF files, CAD and other design documents, and multimedia files. These file types need to be accessible, editable, and storable within the document or content management system. For a diverse range of file types to be usable within such a system, the system should ideally support integration with other commonly used software platforms, so that a user may preferentially open and edit a document in its native software. For instance, the ProjectWise content management system used by MDOT allows for integration with Microsoft Office, Microsoft Outlook, and MicroStation programs (Bentley Systems Incorporated 2012) – the most commonly used AEC ("architecture, engineering, construction") document types. Hence a folder structure and nomenclature need to be designed for the legacy files related to BDM, BDG, and BSP policy changes.

The National Archives of the United Kingdom (1999) recommends that the folders be organized by name and/or structured numerical code, as well as be hierarchical in structure. Considering the best practices, the folder structure shown in Figure 4-5 was developed to organize the documents in *Historical Archive* and *Bridge Research Project* folders. This folder structure has five primary folders: *Bridge Design Guides*, *Bridge Design Manuals*, *Informational Memorandums (from IRS)*, *Other*, and *Standard Plans*. All the folders, other than the *Informational Memorandums (from IRS)* folder, contain subfolders. As an example, Figure 4-6 shows the BDG folder and file structure. The *Bridge Design Guides* folder contains 11 subfolders: *BDG Updates*, *Miscellaneous*, and *Section 1* to *Section 9*. Also, this main folder contains a

README and four log files. Figure 4-7 shows the arrangement of *Bridge Design Guides* folders and documents in a File Explorer window. As shown in Figure 4-6 and Figure 4-7, *Section 1* to *Section* 9 folders contain three subfolders: *Current*, *Reference info*, and *Retired*. The *Current* folder contains copies of active guides compiled with their respective precedent versions as shown in Figure 4-8. The *Retired* folder contains copies of guides that are no longer available in *BDG* as of 09/11/2019, compiled with their respective precedent versions as shown in Figure 4-9.

Organization of a large volume of documents requires developing an audit trail to identify the source location of files and folders and their location in the document management system. Since it is vital to document the source file locations, the original location of the source files that are moved into each folder is listed next to the respective folder, as shown in Figure 4-6. Additional information is provided in the respective log files. The *Informational Memorandums (from IRS)* folder contains individual documents such as a README file, Log file, and a large number of IMs in PDF format.

Each main folder and several subfolders include README files that describe the source file location and typical arrangement of the files in different folders. The log files are spreadsheets that describe the source folder/file location, original folder and file names, new folder and file names, and any useful information to understand the organization of the files in the *Historical Archive* and *Bridge Research Project* folders as well as in the new folder structure depicted in Figure 4-5. The meticulous process followed in this project allows finding the source location and the final destination of any folder or file. A similar process was implemented to develop a document management structure and the details are presented in Appendix E.

In order to make this process effective, the significance of the documents need to be prioritized and considered for disposal if they are no longer necessary or have no historical value to MDOT (International Council on Archives 2008). During the process of reorganizing the documents into the new folder structure shown in Figure 4-5, documents that require a special review by MDOT were moved into folders *Miscellaneous* and *Other*. Hence, the content of the documents in these folders need MDOT review.

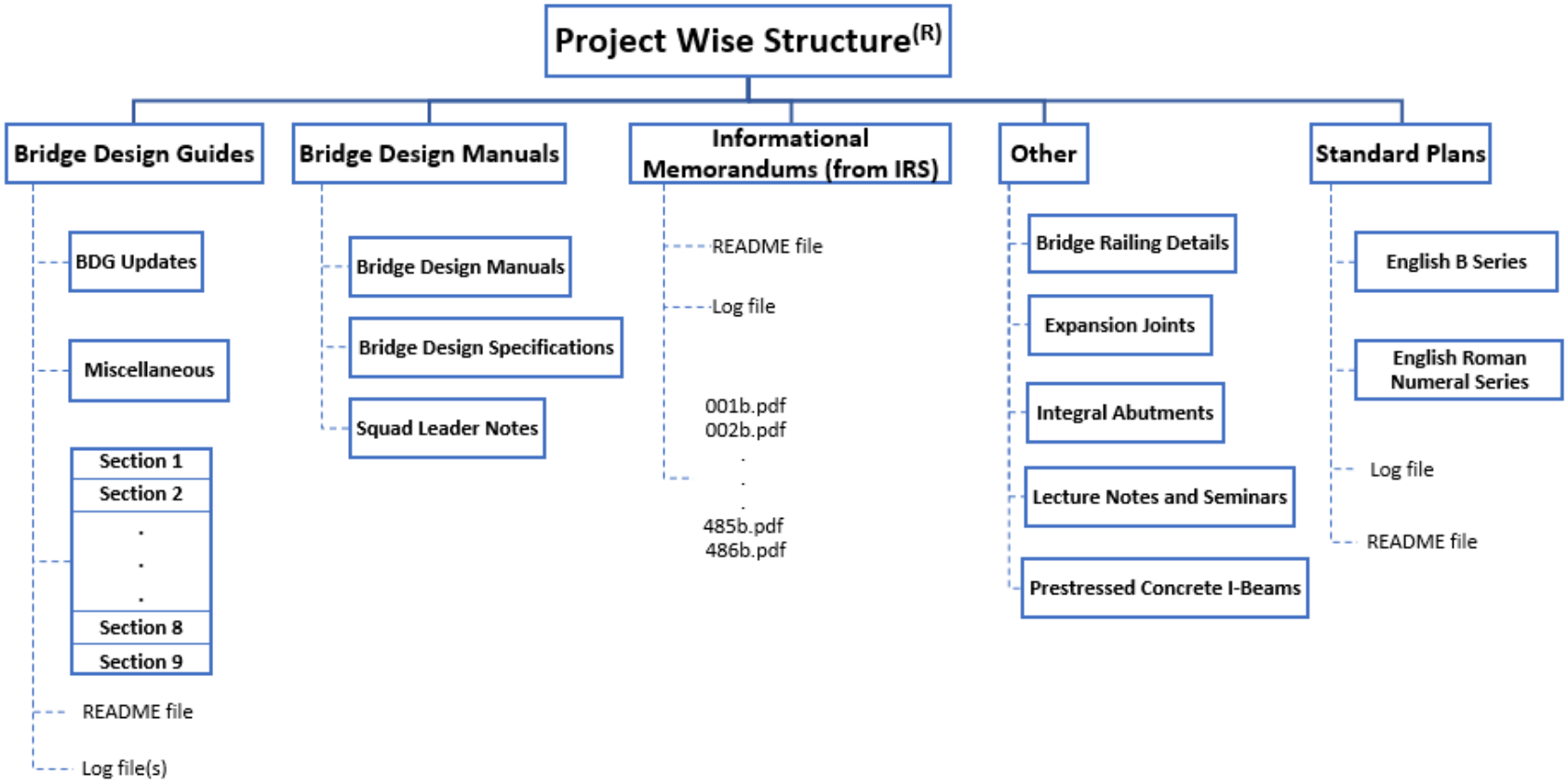



**Figure 4-5. Folder structure for organizing *Historical Archive* and *Bridge Research Project* folder content**

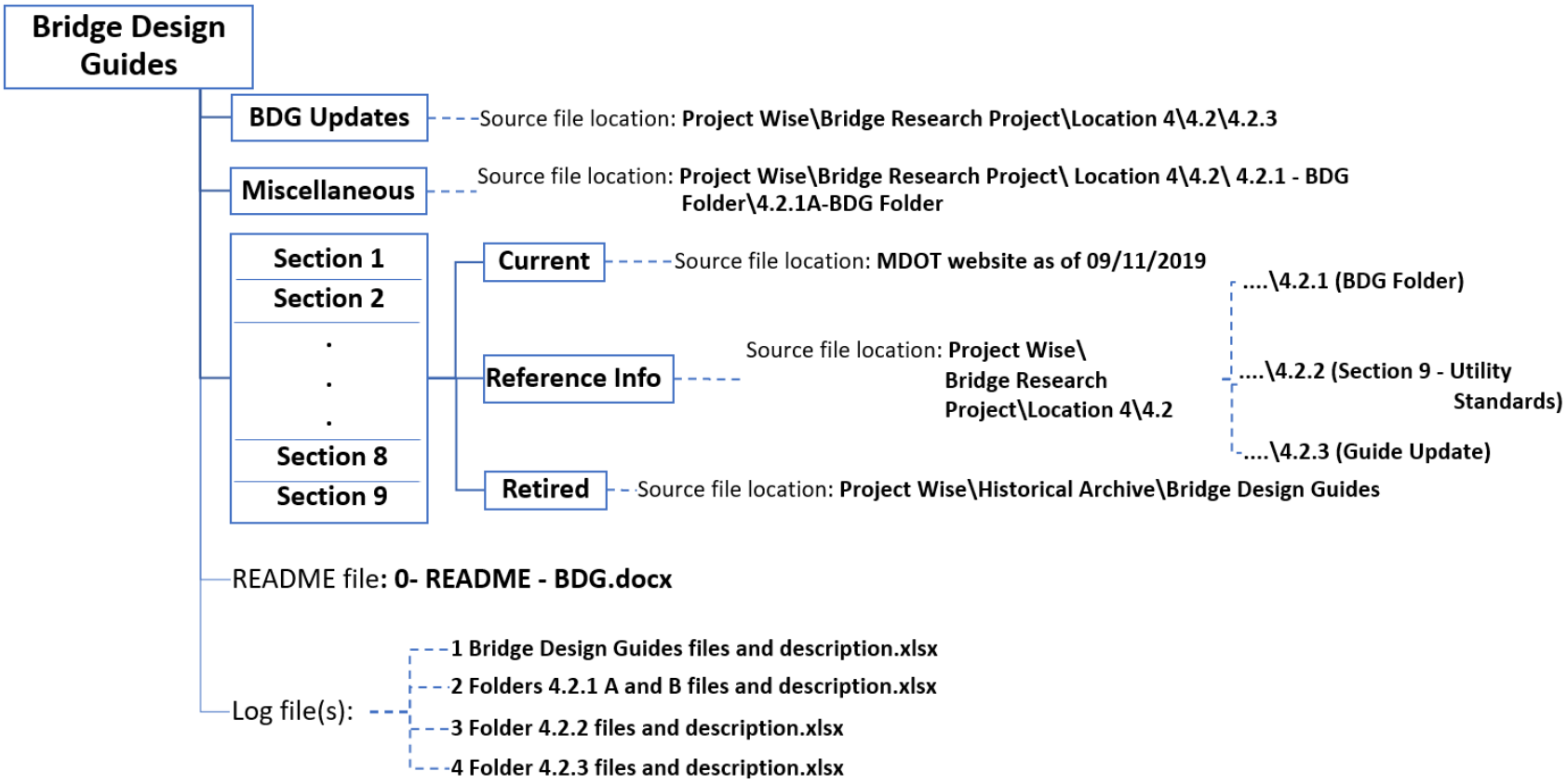



**Figure 4-6. BDG file and folder structure**

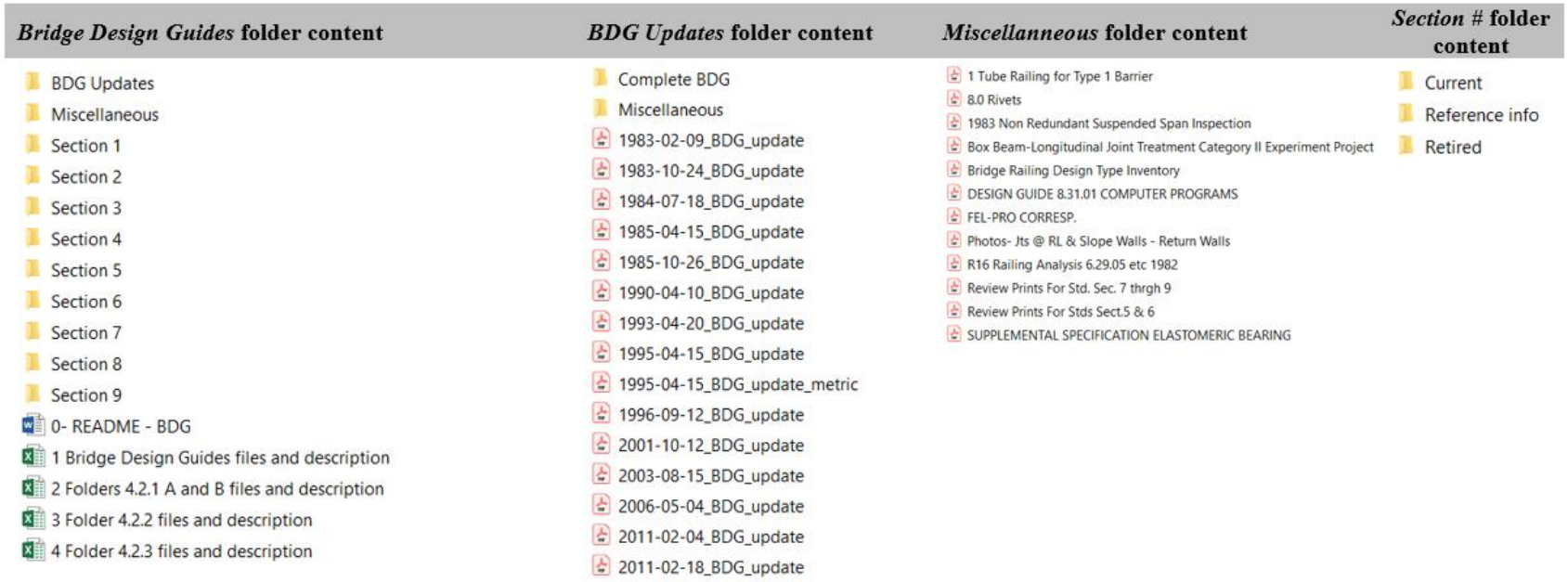



**Figure 4-7. Graphical representation of BDG folder and file structure**

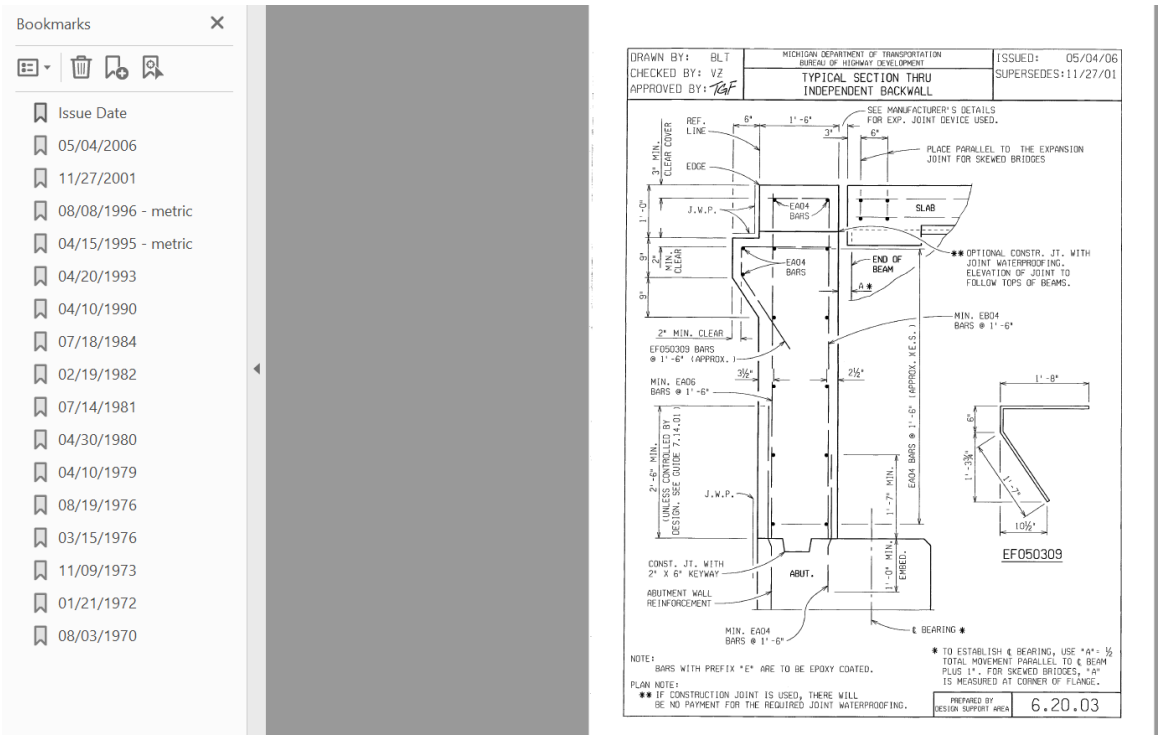



**Figure 4-8. Active guide 6.20.03 compiled with its precedent versions**

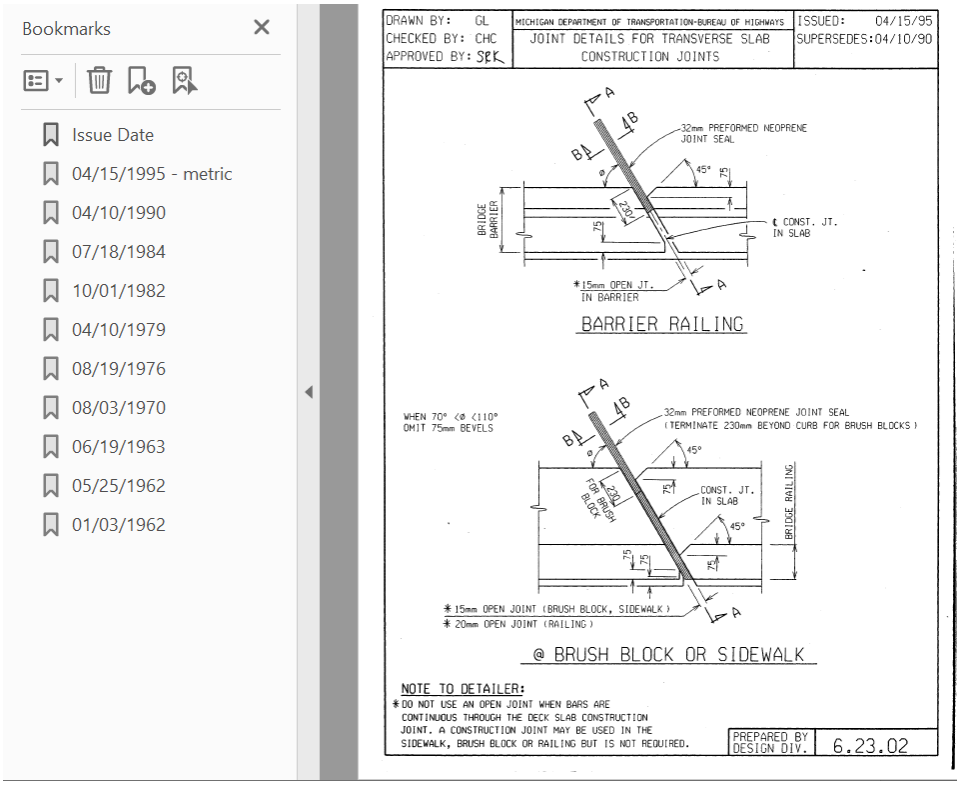



**Figure 4-9. Guide 6.23.02 that is no longer available in *BDG* as of 09/11/2019, compiled with its precedent versions**

Users need to be able to efficiently and effectively search and retrieve documents within the document system. Options for searching may include searching by document full text (Rivera 2018; Synergis Software n.d.), document and folder metadata (Synergis Software n.d.; The National Archives 1999) and through the use of controlled vocabulary (Technical Publications Specification Management Group 2016; The National Archives 1999). Metadata is "structured information used to find, access, and manage information resources, primarily in a digital environment. A metadata scheme consists of a pre-defined set of elements that contain information about a resource" (Velluci 2003, p.417). A controlled vocabulary is a standardized list of terminology that is used to classify or categorize documents – like a subject heading list (Svenonius 2003). One potential source of controlled vocabulary terms for use as metadata in the MDOT Bridge Design Manual database is the Transportation Research Thesaurus developed by the National Academies of Sciences Engineering and Medicine (2017).

At this time, use of keywords or metadata for MDOT historical documents is not effective until the institutional knowledge is captured through a careful review of each document stored in the file structure shown in Figure 4-5. This is primarily due to the lack of non-standardized document layouts or structures, inconsistent terminology, and integration of drawings, handwritten notes, hand sketches and other formats in describing the background information. With the document and folder arrangement presented in this report, systematic review of the content to develop a database of revisions/updates will drastically reduce the need for using metadata and keywords to locate the relevant documents.

As noted previously, the primary objective of converting legacy documents into an electronic form is to identify, capture, and store knowledge related to MDOT policies documented in BDM, BDG, and BSP. Due to the extensive volume of documents and lack of uniformity in formatting, detailed review of documents to capture knowledge was not practical without first organizing the content into a folder structure. Hence, a document management structure was developed and the legacy documents were organized. To capture background information related to bridge design policies and heuristic knowledge documented in the legacy documents, MDOT needs to continue this work to systematically review the organized documents. To systematically review and synthesize the information upon deciding on the significance of documents file review logs need to be prepared. Figure 4-10 to Figure 4-13 are suggested example formats for developing log files. Figure 4-10 was prepared for the documents available in the *BDG Update Letters* folder

in PW. As shown in the figure, file name, description of the content of each document, and review status is sufficient. Figure 4-11 shows a sample spreadsheet prepared to synthesize the information retrieved from office memorandums located in the *BDG Update Letters* folder. The information is grouped with respect to the BDG section numbers. The spreadsheet provides the relevant updates, the effective date, and URL link to the source file. A file name can be hyperlinked to the source document in PW, and file path is retained for future access even after rearranging the files. The review status "Completed", shown in Figure 4-10, indicates that the content has been incorporated in the spreadsheet shown in Figure 4-11. The status "Reviewed" indicates that the specific file was reviewed but the content is not related to MDOT bridge design policies. MDOT Specification Coordinator may need to re-review these documents to determine their significance or dispose if they are no longer essential or have no archival value to MDOT. The status "Skipped" indicates that the content is related to MDOT policies but not relevant to the information summarized in the spreadsheet shown in Figure 4-11. Hence, the reviewer "Skipped" over to the other documents without taking further actions until the relevant information is summarized in the spreadsheet shown in Figure 4-11.

The *Monthly Updates* accessible on the MDOT website were also reviewed and the BDG and BDM policy related information was recorded into two spreadsheets. Figure 4-12 shows the revisions/updates for the BDG. The spreadsheet includes the section number, guide section title, dates, revision summary, and the reference. Figure 4-13 shows BDM revisions/updates in a similar format. A limited number of *Office Memorandums*, *Bridge Committee Meeting Minutes*, and *Bridge Committee Action Items* were reviewed and information was summarized in spreadsheets. Appendices F, G, H, and I describe details of the content of these spreadsheets.

| File Name | Description | Review Status |
|---|---|---|
| 2006 Bridge Design Guides Update.doc | Office memorandum: created on May 4, 2006.<br>From: Terrence G. Frake (Engineer of Bridge Design)<br>To: Bridge Design Guide Holders<br>Subject: English Bridge Design Guides Updates. Sections that are involved are | Completed |
| 2010 Bridge Design Guides Update.doc | Office memorandum: created on February 18, 2011.<br>From: Terrence G. Frake (Engineer of Bridge Design)<br>To: Bridge Design Guide Holders<br>Subject: Bridge Design Guides Updates. Sections that are involved are Preface, | Completed |
| 2011 Bridge Design Guides Update.docx | List of updates made to the Bridge Design Guide with the associated dates. Sections affected are Table of Content, Chapter 5, 6, and 8 | Completed |
| 6.60.12.D.Spread Box Diaphragm.pdf | Box beam diagram for Interior and Exterior Diaphragms | SKIPPED |
| bdg64101.doc | Standard Bridge Slab Reinforcement (Load Factor Design). From Bridge Program: 10- | SKIPPED |
| BDGDIS2001.doc | Office memorandum: created on November 27, 2001.<br>From: Terrence G. Frake (Engineer of Bridge Design)<br>To: Metric Bridge Design Guide Holders<br>Subject: English Bridge Design Guides | Completed |
| BDGDIS2003.doc | Office memorandum: created on August 15, 2003.<br>From: Terrence G. Frake (Engineer of Bridge Design)<br>To: Bridge Design Guide Holders<br>Subject: English Bridge Design Guides | Completed |
| Bridge Barrier Pay Items Clarification and Introduction.pdf | Office memorandums created on May 14, 2004.<br>To: Myron G. Frierson, Director (Bureau of Finance and Administration)<br>Subject: Clarification and Introduction of New Bridge Barrier Pay Items | REVIEWED |
| Bridge Design Guide 6.20.03 A.doc | Bridge Design Guide 6.20.03A, Design interface between bottom of slab fascia (and/or haunches) and top of backwall to allow for bridge expansion. | Completed |
| Interstate shoulder.doc | Additions to Bridge Design Guide 6.05.01, 6.06.01, 6.06.02, and 6.06.03 | SKIPPED |
| OLD PLANS List.pdf | Old Plans list. Created on March 13, 1991 | Completed |
| Superelevation Using a Straight Line Friction Ratio Chart.doc | Decision to add information from Road Design Manual 3.11.03F to the Bridge Design Manual (12.04) and 3.11.04 to the Bridge Design Guides (6.11.02) was made. These additions are mainly about reducing superelevation using Straight Line Friction Ratio | SKIPPED |
| UpdatedStandards(Post Tensioning).xls | Spreadsheet showing Transverse Post Tensioning Forces for Side by Side Box Beam | SKIPPED |

**Figure 4-10. Review log for BDG Update Letters**

| Section | Update | Date | Source document |
|---|---|---|---|
| 1.00.02 | Guide designation updated to include Guide 5.46.06, Structure Backfill and Foundation Excavation - Abutments and Guide 6.11.02, Straight Line Superelevation | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 1.00.04 | Guide 8.11.04 updated with "30° to 45°". | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 1.00.05 | Guide 9.12.01 updated Mass to Weight, Guides 9.21.03, 9.21.04 and 9.33.01 deleted Ameritech due to frequent name changes, Guide 9.40.02 updated to Consumers | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 5.16.01 | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 5.06.01A | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 5.18.01 | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 5.18.01.A | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 5.24.01 | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 6.20.03 | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 5.20.01 | Preformed Waterproofing Membrane changed to Preformed Joint Waterproofing. | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 5.27.03 | Cap bars changed to epoxy coated | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 6.05.01 | Updated auxiliary lane sections, specifically when gore is on structure. | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 6.05.03 | Delete designation for urban and rural ramps (details are equal). Two guides combined into one (6.05.04 deleted). Updated for auxiliary lane sections, specifically when gore | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 6.05.04 | Delete designation for urban and rural ramps (details are equal). Two guides combined into one (6.05.04 deleted). Updated for auxiliary lane sections, specifically when gore | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 6.11.02 | New guide for Straight Line Superelevation. Use on overlay projects and certain deck replacements when Standard Plan R-107-Series yields too much wedging or excessive | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 6.20.03A | Bit updated to HMA and pay item update. Bond breaker (¼") changed to 0.025" bond | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 6.20.04B | Bit updated to HMA and pay item update. EA04 bars added below stub. | 05/04/06 | 2006 Bridge Design Guides Update.doc |
| 6.20.04C | Bit updated to HMA and pay item update. EA04 bars added below stub. | 05/04/06 | 2006 Bridge Design Guides Update.doc |

**Figure 4-11. BDG related information retrieved from office memorandums**

| Section Numbe | Guide Section | Issue Date | Supersedes Date | Revision Summary | Reference |
|---|---|---|---|---|---|
| 6.06.05 | 6.06.05 Clear Zone Distance (Lc) labeled Clear Zone Chart in MU | 11/21/2013 | 8/15/2003 | For design speeds of 40 mph or less and cut slopes 1:4 or flatter, the clear zone distances for ADTs of 750 or greater were revised to meet the 2011 Roadside Design Guide. | MU-11-2013 |
| 6.05.05. A | 6.06.05A Curve Correction Factors (Kcz) labeled Curve correction factors table in MU | 11/23/2015 | 11/21/2013 | The table was revised to meet the 2011 Roadside Design Guide. (Most Radii values were revised with minor changes to the values in the 65 mph and 70 mph Design Speeds.) | MU-11-2013 |
| 6.05.05. A | 6.06.05A Curve Correction Factors (Kcz) labeled Curve correction factors table in MU | 11/23/2015 | 11/21/2013 | Updated note. | MU-11-2015 |
| 6.11 | **6.11** | | | | |
| 6.11.01 | 6.11.01 Modified Parabolic Crown Offsets | 11/27/2001 | 4/15/1995 | | |
| 6.11.02 | 6.11.02 Straight Line Superelevation | 2/14/2011 | 5/4/2006 | | |

**Figure 4-12. BDG updates from *Monthly Updates***

| Section Number | Manual Section | Revision Date | Revision Summary | Reference |
|---|---|---|---|---|
| **7.01** | **7.01 GENERAL** | | | |
| 7.01.01 | 7.01.01 Design Specifications | 8/20/2009 | **Prior to 11/2011** | |
| 7.01.02 | 7.01.02 Design Method | 8/20/2009 | **Prior to 11/2011** | |
| 7.01.03 | 7.01.03 Design Stresses | 1/29/2018 | Added Grade S2M, P1M and DM concrete. Use note with Special Provision for Grade S2M, P1M & DM concretes. | MU-01-2018 |
| 7.01.03 | 7.01.03 Design Stresses | 10/17/2016 | Updated designation for pre-stressing strand tensile strength to $f_{pu}$ from $f'_s$. | MU – 10 - 2016 |
| 7.01.03 | 7.01.03 Design Stresses | 11/24/2014 | Increased prestressed concrete strengths and introduced release strengths (7000 psi max) for concrete beams. | MU – 11 - 2014 |
| 7.01.03 | 7.01.03 Design Stresses | 11/28/2011 | Even though the date is listed, this section is not referred in the monthly update. | MU-11-2011 |
| 7.01.03 | 7.01.03 Design Stresses | 12/5/2005 | **Prior to 11/2011** | |
| 7.01.04 | 7.01.04 Design Loading | 8/20/2009 | **Prior to 11/2011** | |
| 7.01.04. A | A. Interstate and Trunklines | 8/20/2009 | **Prior to 11/2011** | |
| 7.01.04. B | B. Local Roads and Streets | 8/6/1992 | **Prior to 11/2011** | |
| 7.01.04. B | B. Local Roads and Streets | 8/20/2009 | **Prior to 11/2011** | |
| 7.01.04. C | C. Pedestrian and Bicycle (Nonmotorized) Bridges | 8/20/2009 | **Prior to 11/2011** | |
| 7.01.04. C | C. Pedestrian and Bicycle (Nonmotorized) Bridges | 11/28/2011 | Even though the date is listed, this section is not referred in the monthly update. | MU-11-2011 |
| 7.01.04. C | C. Pedestrian and Bicycle (Nonmotorized) Bridges | 5/25/2015 | Combined sections 7.01.04 C & E. Updated maintenance vehicle loading requirements. Updated deflection limits in 8.02 A2 & 8.05 A2. | MU – 05-2015 |
| 7.01.04. D | D. Railroad Bridges | | | |

**Figure 4-13. BDM updates from *Monthly Updates***

## 4.4 SUMMARY

The legacy documents in paper format that MDOT deemed valuable were converted to electronic format and stored in an easily identifiable folder structure designating the physical location of the specific documents. In addition, a large volume of additional historical documents was provided by MDOT. These documents were in a folder named *Historical Archive*. Both sets of legacy documents were organized in the folder structure shown in Figure 4-5. README and log files included in the folders describe the content and the relationship between the current folder and the original source location. The folder structure and its content are described in Appendix E.

In addition to organizing legacy documents into a new folder structure, a document review process and synthesis of information is demonstrated. The review process needs to be continued until the information in the archive is completed. Upon completion, the policy information can be compiled into a spreadsheet with format similar to what is proposed in Figure 4-11. This spreadsheet can be the basis in developing a commentary manual as a complementary document to BDM. In order to maintain this commentary manual as a living document, and as the next step in structuring the policy update/revision process, a workflow and the associated folder structure needs to be developed and implemented.

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# 5 IM AND KM PROGRAM FOR MDOT BRIDGE DESIGN POLICY REVISION/UPDATE

## 5.1 OVERVIEW

Four steps of KM are knowledge identification, capture, store, and transfer. The knowledge (tacit or explicit) is the result of information derived from various forms of data gathered through many years of service. Hence, the most important step in KM for the benefit of all the stake holders of an institution is to develop a structured process to capture, store, and transfer the knowledge.

Following the review of state-of-the-art, practice and technology for KM, a workflow and a framework for document management and knowledge transfer are developed. The scope of the work presented in this chapter is specific to MDOT BDM, BDG, and BSP policy revisions/updates. MDOT licenses ProjectWise (PW) as the primary workflow and document management platform. The workflow and document management processes described in this chapter can be implemented in other platforms, however, direct reference to PW is given where needed.

## 5.2 WORKFLOW AND DOCUMENT MANAGEMENT

Controls are required to define the revision/update of BDM, BDG, and BSP. The controls will define how the documents are used, modified, versions of the documents being revised and versions that are locked with "read only" access.

Access control is generally defined through user roles/profiles and user groups (International Council on Archives 2008; The National Archives 1999; Synergis Software n.d.) with specific permissions set up to read or edit documents. A scheme of authentication needs to be setup to validate users attempting to access the system (Koelsch 2016). The use of documents (read, revision) is generally tracked through an "audit trail" which ICA (International Council on Archives 2008) defines as "Data that allows the reconstruction of a previous activity, or which enables attributes of a change (such as date, time, operator) to be recorded so that the sequence of activities can be recorded in chronological order" (p.145). The audit trail also enables the tracking of the rationale and background for those revisions (Technical Publications Specification Management Group 2016; International Council on Archives 2008; Koelsch 2016; The National Archives 1999; Wilkinson 2005). Tracking the decision-making process is an essential part of organizational knowledge management (International Council on Archives 2008; Rezgui & Miles 2011).

The review and revision process for BDM, BDG, or BSP has to be managed with workflows. A workflow follows all actions on an electronic document during the document lifespan from inception through change requests (International Organization for Standardization 2015) to revision, archiving and deletion (Becerra-Fernandez, McCarthy & Rodriguez 2001; The National Archives 1999). The ProjectWise software includes workflow functionality which has been used by Departments of Transportation (Pratt & Connors 2017).

Once the Bridge Design Manual or one of the Design Guides or Standard Plans is revised and an official version is released, it is recommended that the files for that version be locked to preserve the integrity of that document. In addition, versions of the manuals, guides, and plans, whether current or redlined, should be tracked so that user has awareness of the version being accessed. This is defined as version control (Synergis Software n.d.; Technical Publications Specification Management Group 2016; The National Archives 1999) and is especially important for policy documents and documents with legal implications. Some systems for maintaining version control may include the capability of linking together all versions, so that the document history may be accessible to a designated group of users (The National Archives 1999).

Finally, MDOT needs to consider policies for the retention or archiving of the Bridge Design Manuals and Guides, and all related policy documents (The National Archives 1999.) The versions of manuals and historical documents that are in the electronic repository are needed for historical context and knowledge management purposes. Some documents may be considered for disposal if no longer necessary for decision making purposes and have no historical value to MDOT (International Council on Archives 2008).

As a deliverable of this project, a workflow for initiating and completion of updates such as policy changes to the BDM, BDG, and BSP is described. In conjunction with the workflow, a file structure is defined that includes links to all pertinent supporting documents and templates related to each specific update. So, the purpose of the workflow is defined as a process for:

1. Initiating and implementing updates (Policy Changes) to BDM, BDG, and BSP.
2. Accommodating timely flow of assignments to designated members with notifications and deadlines.
3. Supporting an environment such that ongoing updates and associated status can be readily observed.

In addition to the functions described above, the following post workflow functions should also be seamlessly integrated in conjunction with initiating and implementing the updates.

1. Create and retain an archive of implemented revisions with supporting documents, background, and reasoning behind the update.
2. Provide quick searchable access to revisions archive with BDM chapter and BDG and BSP numbers as well as with revision date.
3. Incorporate a simple archive such that revised and released copies of BDM, BDG, and BSP are retained and accessible to perpetuity.

### 5.2.1 Workflow Document Management

The document management is a key aspect of an effective workflow. Hence, before describing the workflow, the structure of the proposed folder arrangement in a document management system, such as PW, is described. The document management system shown in Figure 4-5, includes *Bridge Design Guides*, *Bridge Design Manual, and Bridge Standard Plans* parent folders.

The *Bridge Design Guides* folder has 9 subfolders representing each section. Each of these subfolders contain three subfolders: *Current*, *Retired*, and *Reference Info*. The *Current* subfolder hosts the published version. However, a separate folder structure is needed for the workflow to handle change or update requests. Hence, the folder structure shown in Figure 5-1 is proposed. The *BDG-BDM-BSP Revision* folder can be included as a parent folder in the folder structure shown in Figure 4-5 to use with the workflow. The content of each subfolder, *Revision Active*, *Revision Rejected,* and *Revision Completed* is described below,

***Revision Active***: With a revision being initiated, a folder is created manually with a sequence number (e.g. xxx) inside a parent folder defining the year (i.e. YYYY). This specific folder, xxx, in which all the activities take place, contains the revision request and links to supporting documents that are reviewed for the next course of action (i.e. to approve or reject the revision request). If the revision request is not considered, the entire folder, with a rationale, is moved and placed in a parent folder for the corresponding year created inside the *Revision Rejected* folder.

If the request is approved to proceed, an additional document(s) is placed in the folder with the current version of the BDM/BDG/BSP text for the specific sections and details that will be affected. Then, BDM/BDG content is reviewed, revised, and finalized to reflect the necessary changes. At the end of this process, the entire folder is moved and

placed in a parent folder for the corresponding year created inside the *Revision Completed* folder

***Revision Rejected***: This folder contains all the documents in the corresponding *Revision Active* folder and the rationale for not acting on the revision request. For archival purposes, folders and the content of the *Revision Rejected* folder are structured in the same format as the *Revision Active* folder.

***Revision Completed***: This folder content is structured in a format similar to the *Revision Active* folder for archival. This folder hosts all documents and files until the content is moved to respective folders. As an example, each *Bridge Design Guides/Section */Current* folder needs to contain the corresponding guides in an editable format as working copies. If BDG is revised and approved, the BDG sheets are updated with the corresponding sheets from the *Revision Completed* folder. Following the approval for release, the guide sheets are dated, converted to PDF or other approved formats for electronic publication, and published. While the working copies and the published copy of the guides are retained in the corresponding Section folder (e.g. *Section 1*), the prior version is moved to the corresponding *Retired* folder. The reference information is moved to the corresponding *Reference info* folder, combined and bookmarked with the file already in the folder.

***BDM***: The document management system shown in Figure 4-5, includes the *Bridge Design Manual* parent folder and a subfolder with the same name. Fifteen (15) subfolders, one for each chapter of BDM (i.e. *Chapter **), are created in the *Bridge Design Manual* subfolder. The most recent copy of the chapter in editable (MS Office) format is designated as the working copy. This document is updated using the revised text included in the *Revision Completed* folder. When the chapter is approved for release, the document is dated, converted to PDF or other approved format for electronic publication, and published. While the edited version of the chapter is retained in the corresponding Chapter folder (e.g. *Chapter 1*) for incorporating future revisions/updates, the published chapter is moved to the corresponding archive (e.g. *Chapter 1 archive*). The reference information retains at source locations within PW (if they are hyperlinked to policy change form) or in the *Revision Completed* folder.

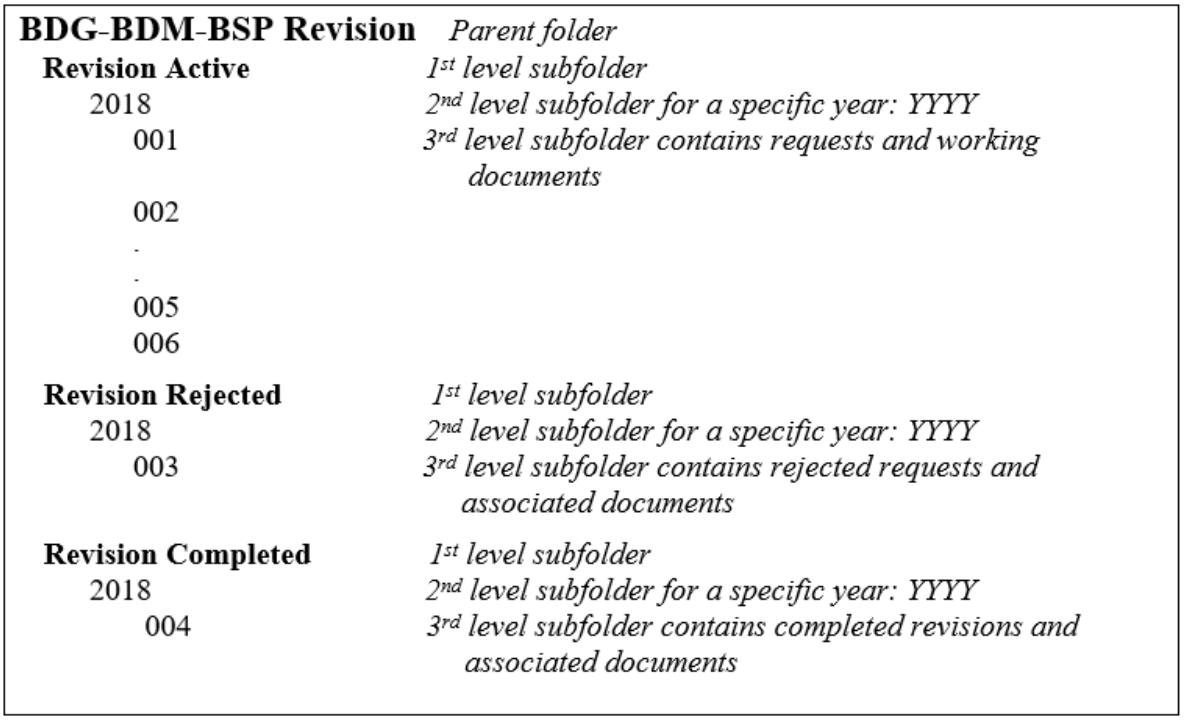


**Figure 5-1. BDG-BDM-BSP Revision folder structure for the proposed document management system**

### 5.2.2 Workflow

A workflow in PW is implemented for a folder. The documents in the folder are part of the workflow. In other words, documents remain in the same folder during the workflow stages. The document state will be changed for different stages of the workflow. As a state change is initiated, a comment can be incorporated describing the reason for the change that is included in the notification emails. Since workflow communication email contents are not structured, a form is developed to systematically document the revision requests, workflow activities, and the rationale for the decisions. Figure 5-2 shows the *Design Standards, Manuals and Guides Revision Request* form. Figure 5-3 shows the workflow for revisions and updates to MDOT bridge design policies. Section 5.2.2.1 lists the actions to be completed before initiation of the workflow. Section 5.2.2.2 lists the actions to be executed for the completion of the workflow.

#### *5.2.2.1 Activities Before Workflow Initiation*

1) Change requests are initiated based on AASHTO updates or by MDOT staff, bridge committee, and others.
2) The initiator completes items 2 – 11 of the *Design Standards, Manuals and Guides Revision Request* form (Figure 5-2) and forwards to the Specifications Coordinator (SC).
3) SC reviews and if needed revises the form, completes item 1 (*Req #: xxx-YYYY*) and, if needed, requests additional information from the initiator.

4) If a change is a result of specification update or Bridge Committee (BC) action item, SC completes items 1– 11 of the form.

#### *5.2.2.2 Activities of the Workflow*

1) SC creates a subfolder with a sequence number (e.g. xxx) inside a parent folder for the corresponding year (i.e. YYYY) under the folder *Revision Active*, and populates metadata fields.
2) If the reason for change is not from a bridge committee action item, SC changes the state of the form to BDSE (Bridge Design Supervising Engineer) review. Purpose is to keep the BDSE in the loop on all the change requests.
3) BDSE and SC decide if changes are warranted. As needed, they can seek advice from the Subject Matter Expert (SME) and/or BC.
4) SC updates the form.
5) SC changes the state to "Revision request – rejected" or "Revision request – development".
6) If the request is rejected, SC records the decision and rationale in the *Revision Spreadsheet*. (This is NOT a ProjectWise workflow state, but rather a KM task that allows identifying the revision, revision history, relevant documentation location in PW, etc.)
7) SC moves the specific folder and places it in the *Revision Rejected* folder.
8) If the request moves forward, state is changed to "Revision request – development", and SC drafts update. As needed, SC consults BDSE, SME, and BC.
9) Upon completion of revisions, SC changes state to "Ready for MU."
10) SP prepares Monthly Updates (MU) and update relevant sections of BDM/BDG/BSP.
11) SP changes the folder state to SC.
12) SC reviews updates and coordinates with the SP as needed again using folder state change.
13) SC approves the updates and changes folder state to Publish.
14) SP posts update and archives the published copy of MU in MU Folder. (This folder is not located within the *BDG-BDM-BSP Revision* main folder.)
15) SP publishes revised versions of BDM, BDG, and/or BSP.
16) SP records the rationale in the *Revision Spreadsheet* if used as a shadow system to PW. (This is NOT a ProjectWise workflow state, but rather a KM Task that allows identifying the revision, revision history, relevant documentation location in PW, etc.)

17) SP changes state to “Published”. This folder now contains revision form, and MU explanation of change, highlighted version of guide, manual, or standard plans, and the published version of guide, manual, or standard plans.
18) SC moves the specific sequence number folder and places it under *Revision Completed* folder.
19) SC moves the published version of guides, manuals, and/or standard plans to respective folders. As an example, the published version of BDG is placed in the *Current* folder under the respective *Section #* folder, as shown in Figure 4-6. The guide that was in the *Current* folder is moved to the *Retired* folder, combined with the existing document, and bookmarked. The *Reference info* folder contains documents describing the rationale for changes. Hence, a document with hyperlinks to the respective folder in *Revision Completed* folder and the *Revision Spreadsheet* can be provided

**MICHIGAN DEPARTMENT OF TRANSPORTATION**

**Design Standards, Manuals and Guides Revision Request**

| | |
|---|---|
| | **1. Req #:** |
| **2. Submitted By:** | **3. Date:** |
| **4. Contact Information:** | |
| **5. Issue Statement:** (Change and reason for change) | |
| **6. Major Issue(s):** (Impacts, conflicts, etc.) | |
| **7. Background:** (Historical policies and practices, need for change, statewide or localized…) | |
| **8. Recommendation(s):** (Describe the reasons for recommended changes, approval or rejection) | |
| **9. Change Type:** ☐ Editorial ☐ Other | **10 Bridge Committee Action Item:** ☐ Yes ☐ No |
| **11. Affected Documents:** (Chapters, sections, guide numbers, etc.)<br>Design Guides:<br>Design Manuals:<br>Standard Plans: | |
| **12. Status:** (For Standards Unit use only) ☐ **Change request – rejected** ☐ **Change request – development** | |
| **13. Approvals and Authorities:** (For Standards Unit use only) | |
| **14. Disposition:** (For Standards Unit use only, state MU if applicable) | **15. Date:** |

**Figure 5-2. BDM/BDG/BSP Revision Request Form**

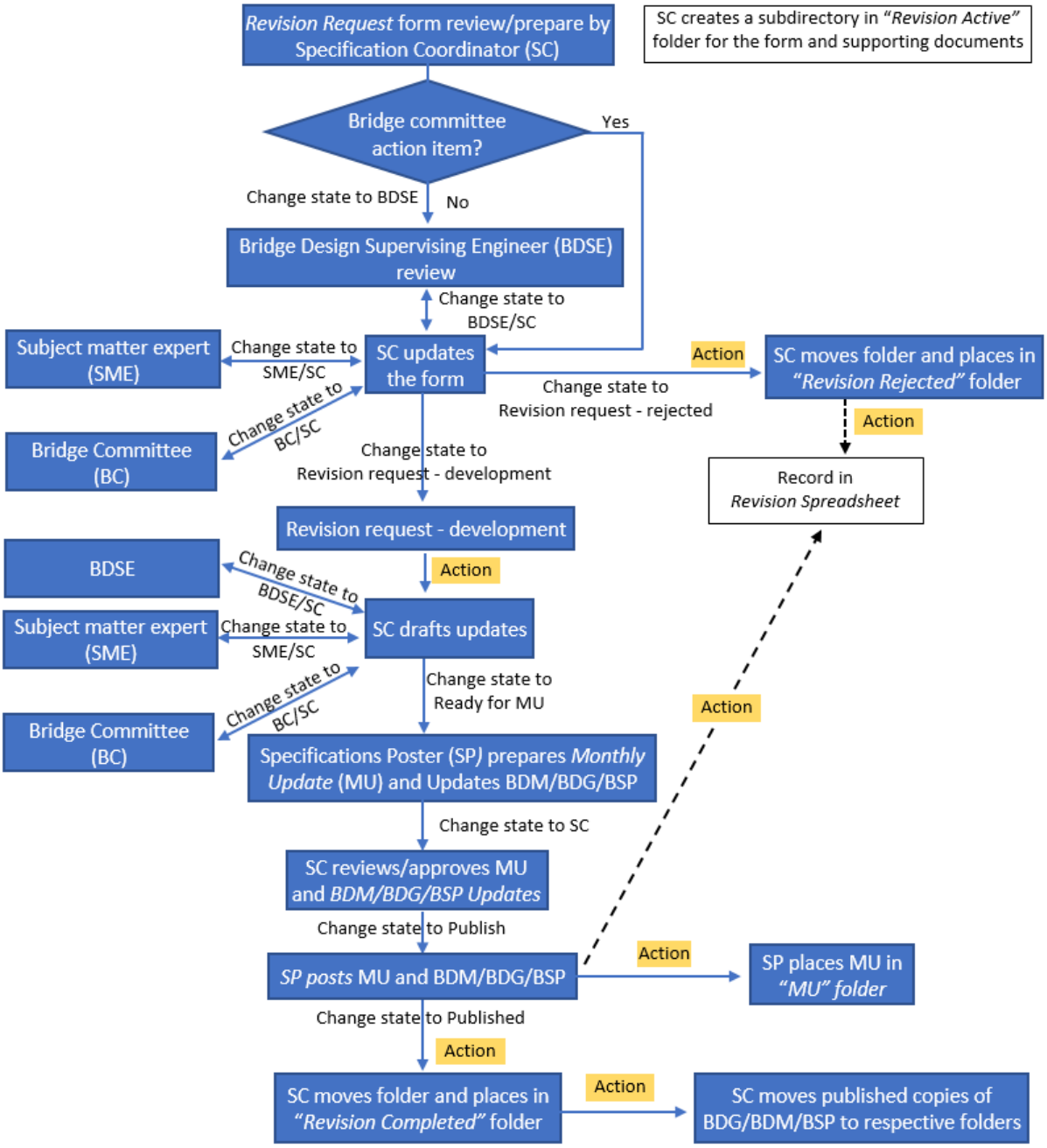


**Figure 5-3. PW workflow for BDM/BDG/BSP revisions**

## 5.3 KNOWLEDGE TRANSFER

As a result of the structured document revision/update process, knowledge is captured and systematically documented through the use of the workflow. The third step of an effective KM program is knowledge transfer. KM and knowledge transfer can be accomplished by implementing the following steps,

1) Developing a revision history database as part of the work flow and requiring the database to be available through PW. The suggested format was a simple spreadsheet, as noted in the workflow shown in Figure 5-3. Instead of a spreadsheet, a database can be developed through an automated process by extracting information from the *Design Standards, Manuals and Guides Revision Request* form or providing a fillable form in a format of an interactive window. Having hyperlinks to the references in PW allow direct access to supporting documents in PW.
2) Developing commentary manual(s) that can be populated with the information in the revision history database.
3) Developing implementation examples for MDOT policies, conducting workshops, and providing access to complementary documents.

# 6 SUMMARY AND IMPLEMENTATION RECOMMENDATIONS

The Michigan Department of Transportation (MDOT) Bridge Design Manual (BDM) is the comprehensive and authoritative source for the MDOT Design Engineers and consultants. BDM provides specifications and guidelines for the design of bridges and other major structures on the road system governed by MDOT. The MDOT Bridge Design Guides (BDG) provide guidance for designing and detailing bridge plans. The MDOT Bridge Standard Plans (BSP) present standard details of various construction items representing the current MDOT policies. These documents are updated continuously. The record keeping and institutional Knowledge Management (KM) process practiced by MDOT related to bridge design policy revisions is currently dependent on key staff members to piece together background information when policies are revised/updated. Thus, this project was initiated to develop a secure KM and Information Management (IM) environment that will provide information that is timely and accessible to facilitate and enhance decision-making and implementation with the goal of promoting uniformity in bridge design practices.

The activities completed during this project include (1) synthesizing the best practices for documenting decisions and managing documents, (2) scanning and archiving historical bridge design policy information, (3) developing a framework to document decisions, as well as the archival and retrieval of information, (4) developing procedures and recommendations to implement into the framework, and (5) synthesizing background behind bridge design policies documented in *Monthly Updates, Bridge Committee Meeting Minutes, and BDG/BDM Office Memorandums*. One of the outcomes of this project is a workflow to capture knowledge through a structured process and document the process in a folder structure.

The following activities are recommended for implementation to develop a secure KM and IM environment to enhance policy revision/update process with the goal of promoting uniformity in bridge design practices:

1) A workflow and the activities of the workflow: The workflow is designed to capture knowledge through a structured process and document in a folder structure that is defined as per the BDM/BDG/BSP structure. Also, a database structure is proposed to document updates/revision activities in a chronological order. Hence, it is recommended to implement the workflow and folder structure in ProjectWise® (PW). In parallel to the workflow implementation, a spreadsheet or a shadow database can compile and track workflow activities, and allow viewing of progress.

2) The legacy documents in paper format that MDOT deemed valuable were converted to electronic format and stored in an easily identifiable folder structure designating the physical location of the specific documents. In addition, a large volume of previously converted historical documents were uploaded to a PW folder named *Historical Archive* and shared with the project team. All the documents were organized into the folder structure that can be directly transferred to PW. README and log files included in the folders describe the content and the relationship between the specific folder that houses the documents and the original source location. In addition to organizing documents into the proposed folder structure, a document review process and synthesis of information is demonstrated. The process needs to be continued until the information in the archive is completed. Once this process is completed, the policy information can be identified and compiled with an ultimate goal of developing a commentary manual as a complementary document to BDM.

3) The commentary manual purpose is to systematically document the rationale behind the policies. This task can be accomplished using the information synthesized from the legacy documents and through workflow activities. Even though the background information related to bridge design policies documented in spreadsheets were not worded in format and language appropriate for BDM and BDG, this information can be integrated into the workflow to provide access to available information thus far. As needed, focused group meetings with MDOT bridge design teams can be conducted to fill the information and knowledge gaps to complete the commentary manual. In order to maintain this commentary manual as a living document, a revision history database needs to be developed as part of the work flow. Instead of a spreadsheet, a database can be developed through an automated process by extracting information from the *Design Standards, Manuals and Guides Revision Request* form or providing a fillable form in a format of an interactive window.

4) As part of knowledge transfer, workshops will be useful to educate MDOT bridge design staff on the recent updates to the PW folder structure, resources available to design engineers, the workflow and its purpose, and the policy change/revision request submissions.

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103. Website Builder. (2018). “WordPress Review 2018-Is WordPress Right for You?” <https://www.websitebuilderexpert.com/wordpress-review/> (November 25, 2018).

# APPENDIX A: ABBREVIATIONS

**A**

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| ASD | Allowable Stress Design |
| ASDIA | AeroSpace and Defense Industries Association of Europe |
| Alaska DOT&PF | Alaska Department of Transportation and Public Facilities |
| ALDOT | Alabama Department of Transportation |

**B**

| | |
|---|---|
| BDG | Bridge Design Guides |
| BDM | Bridge Design Manual |
| BSP | Bridge Standard Plans |

**C**

| | |
|---|---|
| CAD | Computer Aided Design |
| Caltrans | California Department of Transportation |
| CMS | Content Management System |
| CoPs | Communities of Practices |

**D**

| | |
|---|---|
| DM | Document Management |
| DOT | Department of Transportation |
| DoD | Department of Defense |
| DTD | Document Type Definitions |

**E**

| | |
|---|---|
| ECMS | Enterprise Content Management System |
| EDMS | Electronic Document Management Systems |

**F**

| | |
|---|---|
| FAQs | Frequently Asked Questions |
| FDOT | Florida Department of Transportation |
| FHWA | Federal Highway Administration |

**G**

| | |
|---|---|
| GDOT | Georgia Department of Transportation |

**H**

| | |
|---|---|
| HTML | Hypertext Markup Language |

**I**

| | |
|---|---|
| ICT | Information and Communication Technologies |

| | |
|---|---|
| IETM | Interactive Electronic Technical Manual |
| IM | Information Management |
| ITD | Idaho Transportation Department |
| **K** | |
| KM | Knowledge Management |
| KDOT | Kansas Department of Transportation |
| KSS | Knowledge Sharing Systems |
| **L** | |
| LFD | Load Factor Design |
| LRFD | Load and Resistance Factor Design |
| **M** | |
| MDOT | Michigan Department of Transportation |
| MDT | Montana Department of Transportation |
| MnDOT | Minnesota Department of Transportation |
| **N** | |
| NASA | National Aeronautics and Space Administration |
| NCHRP | National Cooperative Highway Research Program |
| NDDOT | North Dakota Department of Transportation |
| NHDOT | New Hampshire Department of Transportation |
| NMDOT | New Mexico Department of Transportation |
| NYSDOT | New York State Department of Transportation |
| **O** | |
| OJT | On-the Job Training |
| ONA | Organizational Network Analysis |
| OM | Office Memorandum |
| **P** | |
| PennDOT | Pennsylvania Department of Transportation |
| PDF | Portable Document Format |
| **Q** | |
| QA | Quality Assurance |
| QC | Quality Control |
| **R** | |
| RIDOT | Rhode Island Department of Transportation |

**S**

| | |
|---|---|
| SDG | Structures Design Guidelines |
| SDM | Structures Detailing Manual |
| SGML | Standard Generalized Markup Language |
| SHA | State Highway Agency |
| SME | Subject Matter Expert |

**T**

| | |
|---|---|
| TxDOT | Texas Department of Transportation |

**U**

| | |
|---|---|
| US | United States |
| USDOT | United States Department of Transportation |

**V**

| | |
|---|---|
| VDOT | Virginia Department of Transportation |

**W**

| | |
|---|---|
| WisDOT | Wisconsin Department of Transportation |
| WSDOT | Washington State Department of Transportation |

**X**

| | |
|---|---|
| XML | Extensible Markup Language |

# APPENDIX B: IM AND KM PRACTICES IN DOT BRIDGE DESIGN DEPARTMENTS

# B. IM AND KM PRACTICES IN DOT BRIDGE DESIGN DEPARTMENTS

This appendix includes a summary of a selected number of agency practices related to policy documentation, presentation of rationale behind policies, policy implementation guidelines, workflow, and communication guidelines. A list of weblinks to the relevant publications is provided at the end.

## B.1 ALABAMA

Alabama Department of Transportation (ALDOT) publishes their bridge design policies in the *Structural Design Manual* and standard details in the *Bridge Special Project Drawings.*

### B.1.1 Policy Documentation

The *Structural Design Manual* is structured by chapter numbers, with the entire chapter titles in the table of contents being hyperlinks (see Figure B-1). The subsections within a chapter, which are not mentioned in the table of contents but are present in the body of the manual, are not numbered, which poses a problem if a user is looking for a specific policy. The subsections are, however, clearly labeled in bold and underlined which makes them stand out from the rest of the text. The organization of the text varies: some policies are written as small, well-spaced paragraphs while others are composed of bullets, lists, and tables (see Figure B-2). There is no background information provided in the text about any policy. On the right-hand margin of each page, a small arrow symbol acts as a hyperlink that takes the users directly back to the table of contents, allowing for ease of navigation through the manual (see Figure B-2). While the ALDOT *Structural Design Manual* mainly follows the AASHTO LRFD Bridge Design Specifications guidelines, they do make exceptions for some policies. These exceptions are shown inside a textbox to distinguish them from the rest of the manual (see Figure B-3).

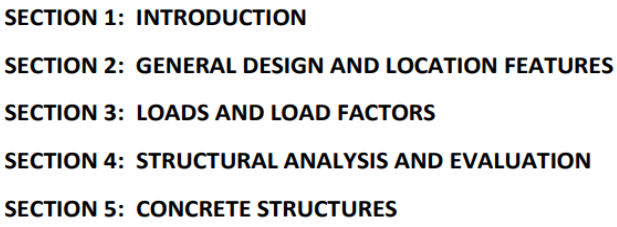



**Figure B-1. Excerpt from the table of contents showing the chapter headings, all of which are hyperlinks (ALDOT 2017)**

**SECTION 3: LOADS AND LOAD FACTORS**

**Design Loads**

All loads shall be in accordance with the currently adopted version of the AASHTO LRFD code noted in Section 1 of this document, as well as interims, unless otherwise specified as ALDOT exceptions in this Manual.

For superstructure design, the following design loads shall be used:

- Metal stay-in-place forms – Allow 15 psf dead load (this includes the dead weight concrete in the forms).
- Thermal loads – Erection temperature shall be assumed to be 70ºF.
- Wind loads – Special consideration shall be given to high-level coastal structures for hurricane wind loads.
- Barrier rail load distribution – The barrier rail dead load shall be considered equally distributed across all girders. However, the dead load for girder design shall not be less than 25% of a single barrier rail weight.

**Figure B-2. Example of the organization of the text within the manual (ALDOT 2017)**

**ALDOT exception to AASHTO:**

Bridges on secondary roads and other non-interstate roadways, Federal highways, or State roads shall continue to use the TL-3 Jersey rail.

**Figure B-3. Example of an ALDOT exception to the AASHTO guidelines (ALDOT 2017)**

The *Bridge Special Project Drawings* contain the standard details (see Figure B-4). The standards are divided by individual topic; however, the complete set of standards can also be accessed. There is no revision history provided.

**Bridge Special Project Drawings**

- Standard Notes & Details
- Details for Edge Beams & End Walls
- Bridge End Slab with Barrier Rail Transition
- Industrial Fence Standard Details for Bridge Sidewalks
- Cast In-Place Abutment Details
  - 24'-0" Roadway & 24'-0", 34'-0", or 40'-0" Spans (AB2400)
  - 28'-0" Roadway & 24'-0", 34'-0", or 40'-0" Spans (AB2800)
- Miscellaneous Details
- Precast Concrete End Bent Cap for Use with Steel Piling & Precast Concrete Bridge Slabs
- Precast Concrete Bent Cap for Use with Steel Piling & Precast Concrete Bridge Slabs
- Master List of Bridge Special Project Drawings (ASD and LRFD)

**Figure B-4. Standard details list with hyperlinks (ALDOT n.d.)**

### B.1.2 Rationale Behind Policies

The appendices of the *Structural Design Manual* are located at the end of the manual and focus on manual revision processes. The first appendix outlines the revision proposal guidelines and the second appendix contains a summary of the latest revisions (see Figure B-5 and Figure B-6). The changes are numbered and rationale is provided under each change. A record of changes prior to the latest set is not given. While this method makes the revisions very clear and easy to understand, it would be helpful if all the appendices containing revisions from every version of the manual were compiled as a separate document.

**APPENDIX A: PROPOSING CHANGES TO THE DESIGN MANUAL**

In order to effect a change to the document:

1) copy & paste the passage in question into an e-mail twice
2) on the second paste, make the proposed change, with all changes in color (deletions in red, additions in blue)
3) send the e-mail to the Miscellaneous Structures and Bridge Design Section Supervisor for dissemination to the Design Manual Oversight Committee

**Figure B-5. Appendix A with the process for proposing revisions to the design manual (ALDOT 2017)**

**APPENDIX B: MODIFICATIONS FROM PREVIOUS EDITION**

Modifications reflected in this version (month year) of the Design Manual include:

1. Throughout Manual

Modified: cover sheet and footers, replacing October 2016 with May 2017

2. Page 1-1

Modified: John F. "Buddy" Black

To: W. Tim Colquett

The change was made due to the retirement of John Black and the promotion of Tim Colquett from Assistant State Bridge Engineer to State Bridge Engineer.

**Figure B-6. Appendix B with a summary of the latest revisions and the rationale (ALDOT 2017)**

Various parameters are given throughout the *Structural Design Manual* however, there are no equations or variable definitions to be found describing policy implementation procedures.

## B.2 ALASKA

The *Bridges and Structures Manual* of the Alaska Department of Transportation and Public Facilities (Alaska DOT&PF) is divided into three parts: Part I (Administration and Procedures), Part II (Structural Design), and Part III (Existing Bridges/Bridge Operations). There are only three

bridge design standards. In addition, Alaska DOT&PF publishes their *Bridges and Structures Manual* as separate chapters on their website.

### B.2.1 Policy Documentation

The *Bridge Manual* is organized using a numerical system with separate topics that are divided further using subsections (see Figure B-7). The table of contents does not have hyperlinks leading directly to sections, which makes it difficult to navigate quickly through the manual. The information in the manual is organized within the subsections using bolded headings (see Figure B-8). The manual primarily presents the policies without background information. In the appendix for Chapter 25, various checklists are given to be used as a self-check for shop drawings (see Figure B-9).



**Figure B-7. Example showing the organization of the table of contents (Alaska DOT 2017)**

***18.1.1. General Abutment Design and Detailing Criteria***

The following applies to the design and detailing of abutments:

1. **Minimum Thickness**. The minimum allowable wall thickness is 12 inches.
2. **Abutment Slope**. The preferred abutment slope is 2H:1V measured normal to the centerline of bearing. This slope may sometimes be steepened to a minimum of 1½H:1V to avoid the need for a deeper prestressed concrete girder.
3. **Terminology**. An "end diaphragm" is always integral with the superstructure. The term "backwall" only applies where the wall is part of a seat abutment and, therefore, not integral with the superstructure.

**Figure B-8. Example of the policy presentation within the manual (Alaska DOT 2017)**

**PRECAST, PRE-TENSIONED CONCRETE GIRDERS**

| Are the following items properly included on the shop drawings for precast, pre-tensioned concrete girders? | Yes | No | N/A |
|---|---|---|---|
| 1. All dimensions including total length of girder adjusted to accommodate roadway profile grade and elastic shortening. | ☐ | ☐ | ☐ |
| 2. The number and size of all members. | ☐ | ☐ | ☐ |
| 3. The number, size, and type of prestressing strands, their locations, and the forces in these prestressing elements. | ☐ | ☐ | ☐ |
| 4. Girder end details, including size of blockouts, location, and diameter of holes or inserts, and embedded bearing plates. | ☐ | ☐ | ☐ |
| 5. The location and details of lifting devices and support points if the girder will not rest on its bearings while being stored or transported. | ☐ | ☐ | ☐ |
| 6. The location and type of any inserts required for rail posts, utilities, and other attachments. Verify that correct coating is noted. | ☐ | ☐ | ☐ |
| 7. The layout of the casting bed to be used for casting the prestressed girders showing the location of hold-down devices for any harped strands. | ☐ | ☐ | ☐ |
| 8. Methods for providing and controlling required girder camber during casting, transport, and erection. | ☐ | ☐ | ☐ |
| 9. The location and length of any de-bonded prestressing strands. | ☐ | ☐ | ☐ |
| 10. Jacking forces and number of strands. | ☐ | ☐ | ☐ |
| 11. Path of straight and harped strands, including deflecting saddles (details and required number). | ☐ | ☐ | ☐ |
| 12. The details and type of reinforcing steel including bar size, number per girder, total number, length each, total length, total weight, bent bar, bar coating, minimum lap for size of bar used, and grade of bar used. | ☐ | ☐ | ☐ |
| 13. All general notes and construction notes presented in the contract plans reflected in the shop drawings. | ☐ | ☐ | ☐ |
| 14. Concrete compressive strength at release and at 28 days. | ☐ | ☐ | ☐ |

**Figure B-9. Example of the checklists found in the appendices of some chapters (Alaska DOT 2017)**

Part II and III of the *Bridge Manual*, labeled "Structural Design" and "Existing Bridges/Bridge Operations", focus on bridge policies. Part II focuses primarily on the bridge design policies while Part III focuses on policies concerning the maintenance and rehabilitation of existing bridges. Some of the standard design details are integrated into the manual and are not in a separate file; there are three separate *Standard Drawings* for bridge design.

### B.2.2 Rationale Behind Policies

Users are not given access to the revision history or the rationale behind changes, the only indication of revision is at the bottom of each page where the latest date of revision is noted (see Figure B-10). The Alaska DOT&PF states that revisions will made on an annual basis as needed and after approval from the Federal Highway Administration (FHWA). The manual also includes a revision proposal form for users to propose changes (see Figure B-11).

**Figure B-10. Example of the latest revision date found at the bottom of each page (Alaska DOT 2017)**

***Alaska Bridges and Structures Manual***

**Revision Proposal Form**

To propose a revision to the *Alaska Bridges and Structures Manual*, complete and return this Revision Proposal Form to:

Chief Bridge Engineer
Bridge Section
Alaska DOT & Public Facilities
P. O. Box 112500
Juneau, Alaska 99811-2500

**Identification**

Date Submitted: _____

Submitted By (name, agency/firm): _____

Contact Information (phone #, e-mail): _____

**Description of Proposed Revision** (attach additional sheets as necessary)

Applicable *Manual* Section Number(s): _____

_____

Proposed Revision: _____

_____

_____

_____

_____

Justification for Revision: _____

_____

_____

_____

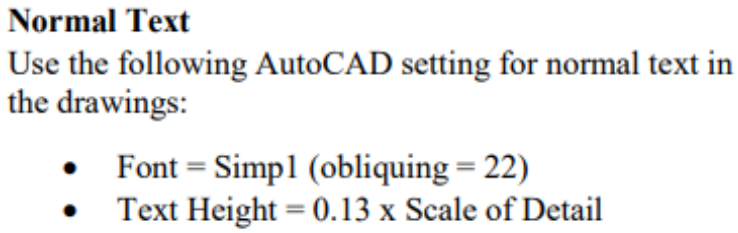


**Figure B-11. The revision proposal form provided at the beginning of the manual (Alaska DOT 2017)**

### B.2.3 Policy Implementation Guidelines

Part I of the *Bridge Manual*, labeled "Administration and Procedures", focuses on the project development process and provides guidelines, reports, and other documents and procedures that are needed throughout the process. Examples of documents, such as memorandums, are provided

throughout the section to ensure consistent formatting. Further instructions on formatting is provided in the text, which clearly defines the section that should be included in the document, as well as the points that each section should cover. Very specific instructions on formatting, writing, drawing, and other actions pertaining to the covered subjects are provided to ensure that consistency is not an issue between different users (see Figure B-12). The appendix for Part I Chapter 6, which is found directly after Chapter 6 in the manual, provides checklists and tables that can be used as a guideline and self-check for the projects mentioned in the chapter.


**Normal Text**

Use the following AutoCAD setting for normal text in the drawings:

- Font = Simp1 (obliquing = 22)
- Text Height = 0.13 x Scale of Detail

**Figure B-12. Example of the extremely specific formatting specifications included in the manual (Alaska DOT 2017)**

## B.3 FLORIDA

The Florida Department of Transportation (FDOT) publishes the *Structures Manual* with four Volumes: Volume 1 – Structures Design Guidelines (SDG), Volume 2 - Structures Detailing Manual (SDM), Volume 3 – FDOT Modifications to LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (LRFDLTS-1), and Volume 4 – Fiber Reinforced Polymer Guidelines (FRPG). The Structures Manual provides hyperlinks to these four volumes and to other related manuals and standards such as the *Archived Structures Manuals, Structures Design Standards, Structures Design Standard Details & Data Tables, CADD Manual,* etc. Options are available to download or view the *Structures Manual* on a web browser. The *Structures Manual* is accessible in the EXE format. All the previous *Structures Manual* publications are made available as *Archived Publications.*

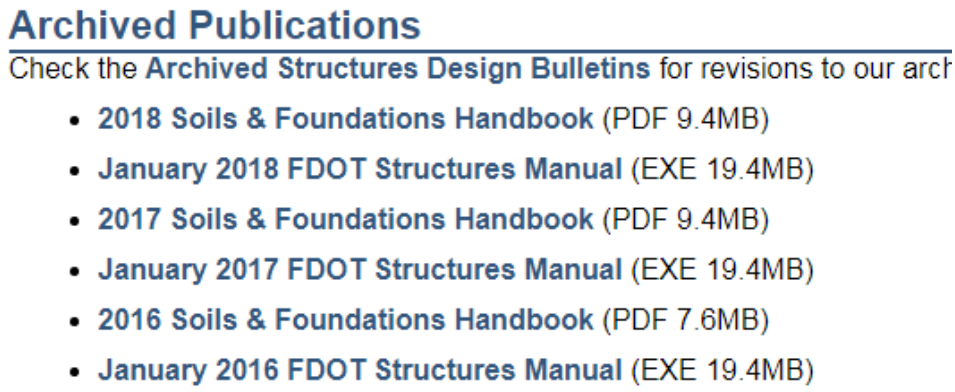



**Figure B-13. Archived Publications of Structures Manual (FDOT 2018c)**

### B.3.1 Policy Documentation

The table of contents is organized numerically by chapter, section, and then by various levels of subsections (see Figure B-14). It also includes separately labeled figures and tables within each section. Each referenced item in the table of contents is a direct hyperlink leading to the specified section. The table of contents also indicates the sections that have been revised in the published version. As shown in Figure B-14, red fonts are used to present the revision date within brackets.



**Figure B-14. Example of the table of contents of the *Structures Manual* (FDOT 2018a)**

Within the manual, the text is written as small paragraphs in alphabetical listings separated by bold headings (see Figure B-15). There are numerous diagrams and tables included. Purple textboxes are included to distinguish "Modification for Non-Conventional Projects" from the normal policies (see Figure B-15). Sections that have been revised for the latest publication have the revision date listed by their section heading (see Figure B-15). Hyperlinks are included within the text when different FDOT documents are referenced.

**1.4 CONCRETE AND ENVIRONMENT [5.12.1]**

**1.4.1 General (Rev. 01/18)**

A. Use $\mathbf{K_1}$ = 1.0 as the correction factor when calculating the Modulus of Elasticity in ***LRFD*** [5.4.2.4]. Use $\mathbf{w_c}$ = 0.145 kcf.

*Commentary: These values are based on the use of Florida limerock aggregate.The $K_1$ factor has been revised to be consistent with new Modulus of Elasticity equations in the **LRFD** 2015 Interims.*

| **Modification for Non-Conventional Projects:** |
|---|
| Delete ***SDG*** 1.4.1.A and insert the following:<br>A. If Florida limerock coarse aggregate or other similar limerock aggregate is used in design, use $\mathbf{K_1}$ = 1.0 as the correction factor when calculating the Modulus of Elasticity in ***LRFD*** [5.4.2.4]. For concrete made with limerock coarse aggregate, use $\mathbf{w_c}$ = 0.145 kcf. |

**Figure B-15. Example of the organization of the text within the manual as an alphabetical listing with the revision date (FDOT 2018a)**

The access to *Structures Standard Drawings* is provided through hyperlinks. The webpage contains links to both the *Current Drawings* and the *Archived Drawings* (see Figure B-16). The current design standards are located within the hyperlink *Structures Design Office Design Standards Details & Data Tables* and are organized by topic. The Design Standards are divided into *Standard Plans* and *Archived Drawings*.

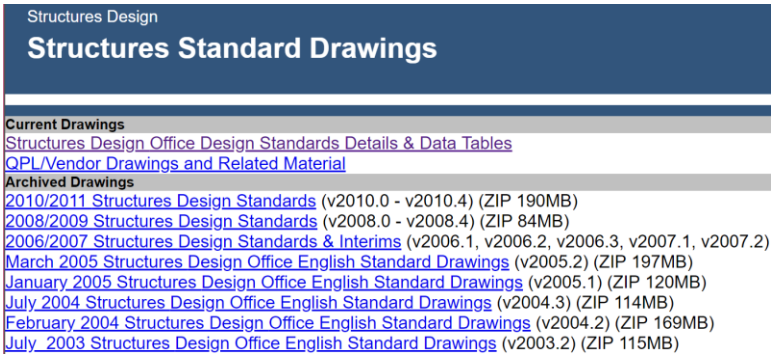



**Figure B-16. The webpage containing the link for "Structures Design Office Design Standards Details & Data Tables" as well as the list of Archived Drawings (FDOT 2018b)**

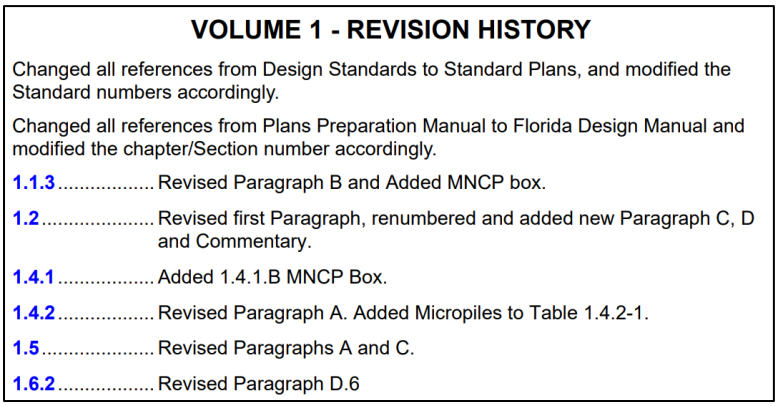
## B.3.2 Rationale Behind Policies

FDOT suggests that the *January 2018 Distribution Memo* be read prior to downloading the 2018 version of the *Structures Manual.* The memo explains the purpose of the manual and states that revision and republication of the manual takes place every January; it also states that revisions will be shown at the end of each volume of the manual and that change bars appear in the text besides the revised or added text of each volume.

Commentary, which is integrated into the manual and found under each policy, serves to provide a summary of the rationale behind the policy (see Figure B-17).

There are a couple of documents that record the manual's revision history. The *Revision History* located at the end of each volume summarized all the revisions made to that document. The *Revision History* is a list of revised and added material that is organized by section number and the change that was made (see Figure B-17).

The *2018 Structures Manual Revision History* only lists the changes made to the introduction of the manual, as seen in Figure B-17



**VOLUME 1 - REVISION HISTORY**

Changed all references from Design Standards to Standard Plans, and modified the Standard numbers accordingly.

Changed all references from Plans Preparation Manual to Florida Design Manual and modified the chapter/Section number accordingly.

1.1.3 ..... Revised Paragraph B and Added MNCP box.

1.2 ..... Revised first Paragraph, renumbered and added new Paragraph C, D and Commentary.

1.4.1 ..... Added 1.4.1.B MNCP Box.

1.4.2 ..... Revised Paragraph A. Added Micropiles to Table 1.4.2-1.

1.5 ..... Revised Paragraphs A and C.

1.6.2 ..... Revised Paragraph D.6

**Figure B-17. Revision History at the end of Volume I in *Structures Manual* (FDOT 2018)**

Archived versions of the *Structures Standard Drawings* are listed on the same page as the current drawings. They are organized by date and format (English/Metric).

*Current Bulletins/Memorandums* are organized into a table by their publication date; the table also lists their subject matter, effective date, and referenced documents (see Figure B-18). The link to the *Archived Bulletins* is provided at the bottom of the page and leads to a table of past bulletins that are organized the same way as the current ones (see Figure B-19). *Archived Bulletins* have been implemented into the referenced document(s) or superseded. All bulletins are in PDF format (see Figure B-20).

Structures Design

## Current Bulletins/Memorandums

| Date of Bulletin/Memo | Subject | Effective Date | Referenced Documents |
|---|---|---|---|
| November 1, 2018 | FY2019-20 Standard Plans | Immediately | Standard Plans |
| April 18, 2018 | SDB 18-01 Redundancy, Ductility and Operational Importance | Immediately | Structures Manual |

**Figure B-18. Current bulletins/memorandums (FDOT 2018d)**

Structures Design

## Archived Bulletins

**Archived Bulletins have been implemented into the referenced document(s) or superseded.**

All bulletins are in Adobe Acrobat (PDF) format.

**Archived Structures Design Bulletins:**

| Date ofBulletin | Subject | Effective Date | Referenced Documents |
|---|---|---|---|
| December 21, 2017 (1.60MB) | RDB 17-18 / SBD 17-11 / PMB 17-11 Box Culvert Summary of Quantities | Immediately | Standard Plans, Structures Manual & CADD Manual |
| November 1, 2017 (0.06MB) | SDB 17-10 / RDB 17-13 FY 2018-19 Standard Plans for Road and Bridge Construction | Immediately | Standard Plans |
| July 19, 2017 (0.82MB) | SDB 17-09 / PSB 17-01 Inclusion of FDOT Standard Plans for Bridge Construction in Contract Plans | Immediately | Structures Manual & CADD Manual |
| July 12, 2017 (0.14MB) | SDB 17-08 Pretensioned/Post-Tensioned I-Beams and U-Girders | Immediately | Structures Manual |

**Figure B-19. Archived Bulletins (FDOT 2018e)**

FDOT

Florida Department of Transportation

RICK SCOTT
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

RACHEL D. CONE
INTERIM SECRETARY

**STRUCTURES DESIGN BULLETIN 17-04**
**ROADWAY DESIGN BULLETIN 17-04**
***(FHWA Approved: April 17, 2017)***

DATE: April 17, 2017

TO: District Directors of Transportation Operations, District Directors of Transportation Development, District Design Engineers, District Construction Engineers, District Structures Design Engineers, District Structures Maintenance Engineers, Plans Preparation Manual Holders, Structures Manual Holders

FROM: Robert V. Robertson, P.E., State Structures Design Engineer

Michael Shepard, P.E., State Roadway Design Engineer

COPIES: Brian Blanchard, Courtney Drummond, Tim Lattner, David Sadler, Rudy Powell, Amy Tootle, Daniel Scheer, Gregory Schiess, SDO Staff, Jeffrey Ger (FHWA)

SUBJECT: Category 2 Structures Definition

**REQUIREMENTS**

Replace ***Plans Preparation Manual***, Volume 1, Section 26.3.2 and the associated Modification for Non-Conventional Projects box with the following:

**26.3.2 Category 2 Structures**

All structure types not listed above are classified as Category 2 Structures unless exempted by the SDO. In addition to, or in lieu of, the criteria listed above, a structure is classified as a Category 2 Structure when any of the following are present:

1. Bridge substructures containing post-tensioned components, straddle piers and/or integral caps
2. Bridges designed for vessel collision
3. Bridges with non-redundant foundations
4. Any component designed using Fiber Reinforced Polymer (FRP) composite materials
5. Braided underpass structures where the beams or flat slab superstructure element is not oriented parallel to traffic of the overlying roadway and a portion of the superstructure and substructure extends beyond the limits of the overlying traffic barriers

www.dot.state.fl.us



6. Design concepts, components, elements, details or construction techniques not normally used by Florida DOT including but not limited to:
   a. New bridge types
   b. New materials used to construct bridge components
   c. New bridge construction methods
   d. Non-standard or unusual bridge component-to-component configurations and connection details
   e. Department issued ***Developmental Design Standards*** or modified versions of ***Developmental Design Standards***
   f. Items not covered by the Department's Standard Construction ***Specifications***
   g. All atypical precast structural elements (The following are not considered to be atypical: Segmental Box Girder Superstructure Components, Spliced I and U-Girders, AASHTO Beams, and precast elements included in the ***Design Standards***.)
   h. Prefabricated Bridge Elements and Systems (PBES) not meeting all requirements of Chapter 25 of the ***Structures Detailing Manual***.

*Commentary: The Department supports the use of accelerated project construction techniques including the expanded use of precast/prefabricated bridge elements and systems as a way to reduce costs, construction time, and user impacts. However, the use of precast/prefabricated bridge elements can create long term durability and quality issues depending on the details utilized. Therefore, the designs and details for these elements must be approved by the Department prior to use.*

| Modification for Non-Conventional Projects: |
| --- |
| Items listed in Numbers 4 thru 6 above are not allowed unless they are specifically permitted in the RFP or unless they are submitted and approved during the Alternative Technical Concept (ATC) process. |

**COMMENTARY**

Prefabricated Bridge Elements and Systems constructed in accordance with ***Structures Detailing Manual*** Chapter 25 have been used successfully on FDOT projects, and their use no longer requires prior approval by the Department.

**IMPLEMENTATION**

These requirements are effective immediately on all design-bid-build projects in the pre-design phase. These requirements may be implemented immediately on all design-bid-build projects in Design Phase I, II, III or IV at the discretion of the District.

www.dot.state.fl.us



These requirements are effective immediately on all design-build projects for which the advertisement has not been released. Design build projects for which the advertisement has been released are exempt from these requirements unless otherwise directed by the District.

**CONTACT**

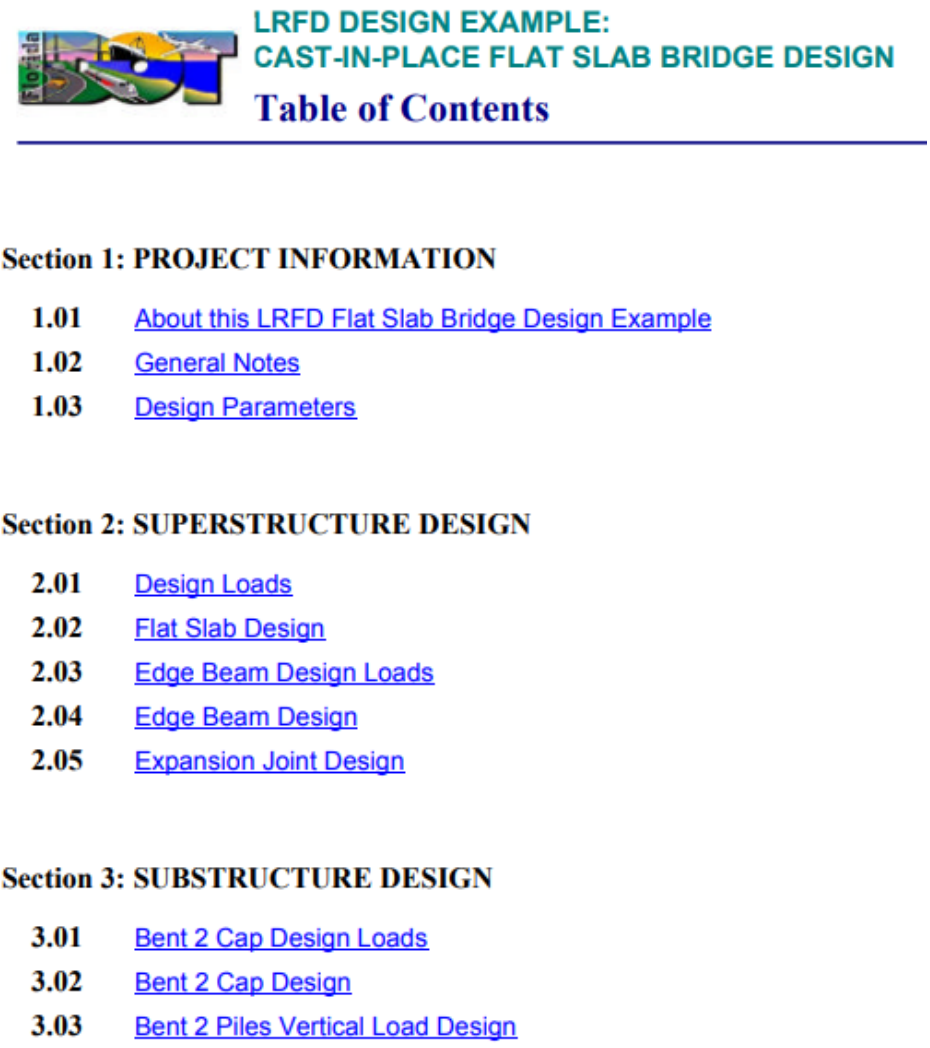
Robert V. Robertson, P.E.
State Structures Design Engineer
Phone (850)-414-4267
robert.robertson2@dot.state.fl.us

RVR/SCA

**Figure B-20. Example of a design memorandum (FDOT 2018f)**

### B.3.3 Policy Implementation Guidelines

Various tables and diagrams are included in the *Structures Manual* to aid in policy implementation. The "Modification for Non-Conventional Projects" also provides policy implementation guidelines for specific projects that do not follow the normal bridge design policies. FDOT also has a link for *LRFD Design Examples*, which are several documents that guide users through specific design projects in either a PDF or a Mathcad Workbook format; the documents are filled with sample figures, equations, and parameters (see Figure B-21).



LRFD DESIGN EXAMPLE:
CAST-IN-PLACE FLAT SLAB BRIDGE DESIGN

Table of Contents



**Figure B-21. Example of an LRFD Design Example (FDOT, n.d.)**

In response to communication between Western Michigan University and FDOT, FDOT provided the *FDOT Structures Design Office (SDO) Structures Design Bulletin Development Process* and

the *FDOT Structures Design Office (SDO) Structures Manual Development/Revision Process*, which are flowcharts detailing the workflow of the design bulletin development process (see Figure B-22) and the manual development/revision process, respectively (see Figure B-23). For the bulletin development, FDOT also provides a template of the design bulletin that can be changed and filled in to create a new bulletin, which eases the bulletin development process and ensures consistency (see Figure B-24).

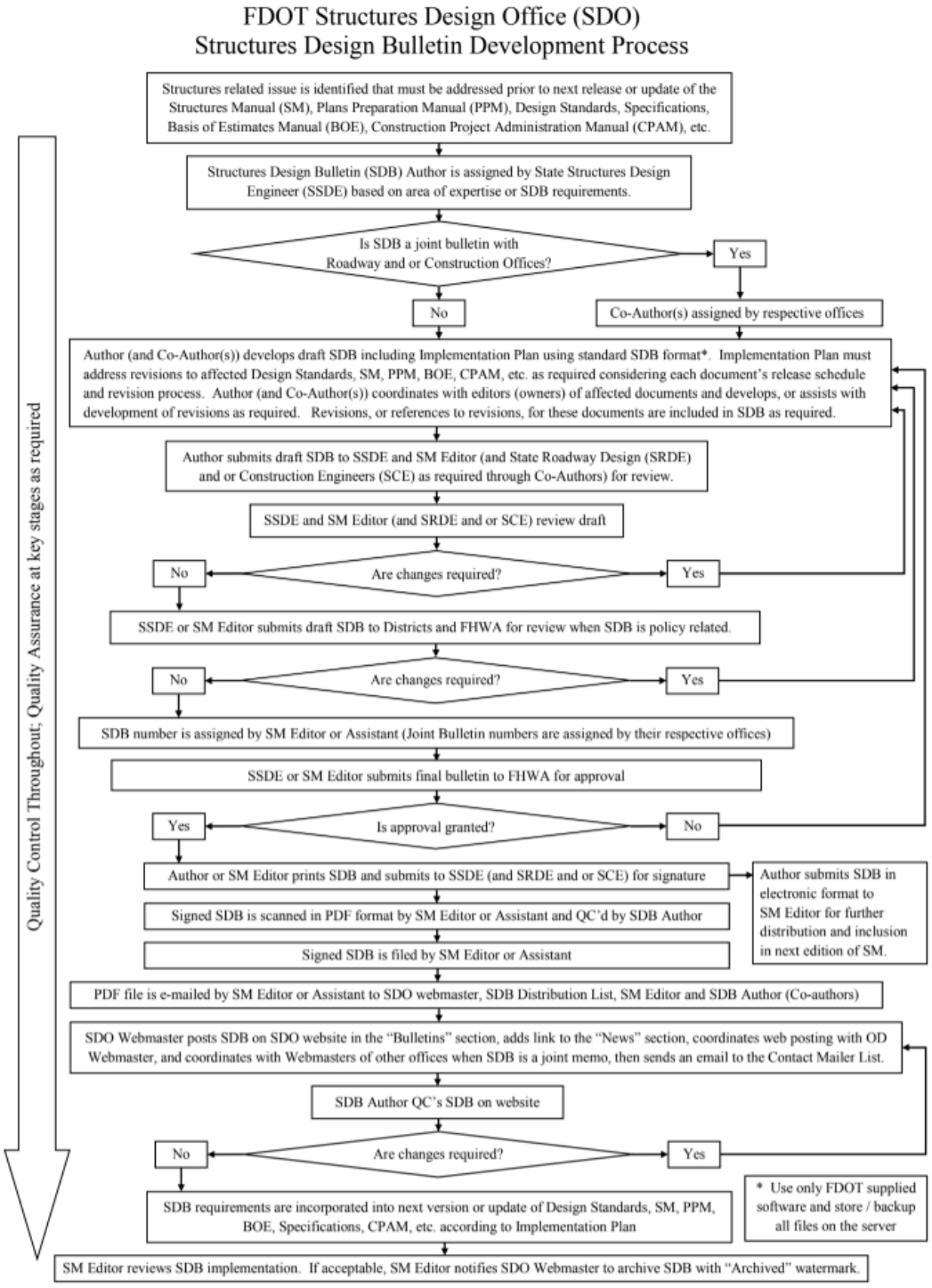



**Figure B-22. The Structures Design Bulletin Development Process flowchart detailing the steps of the development process.**

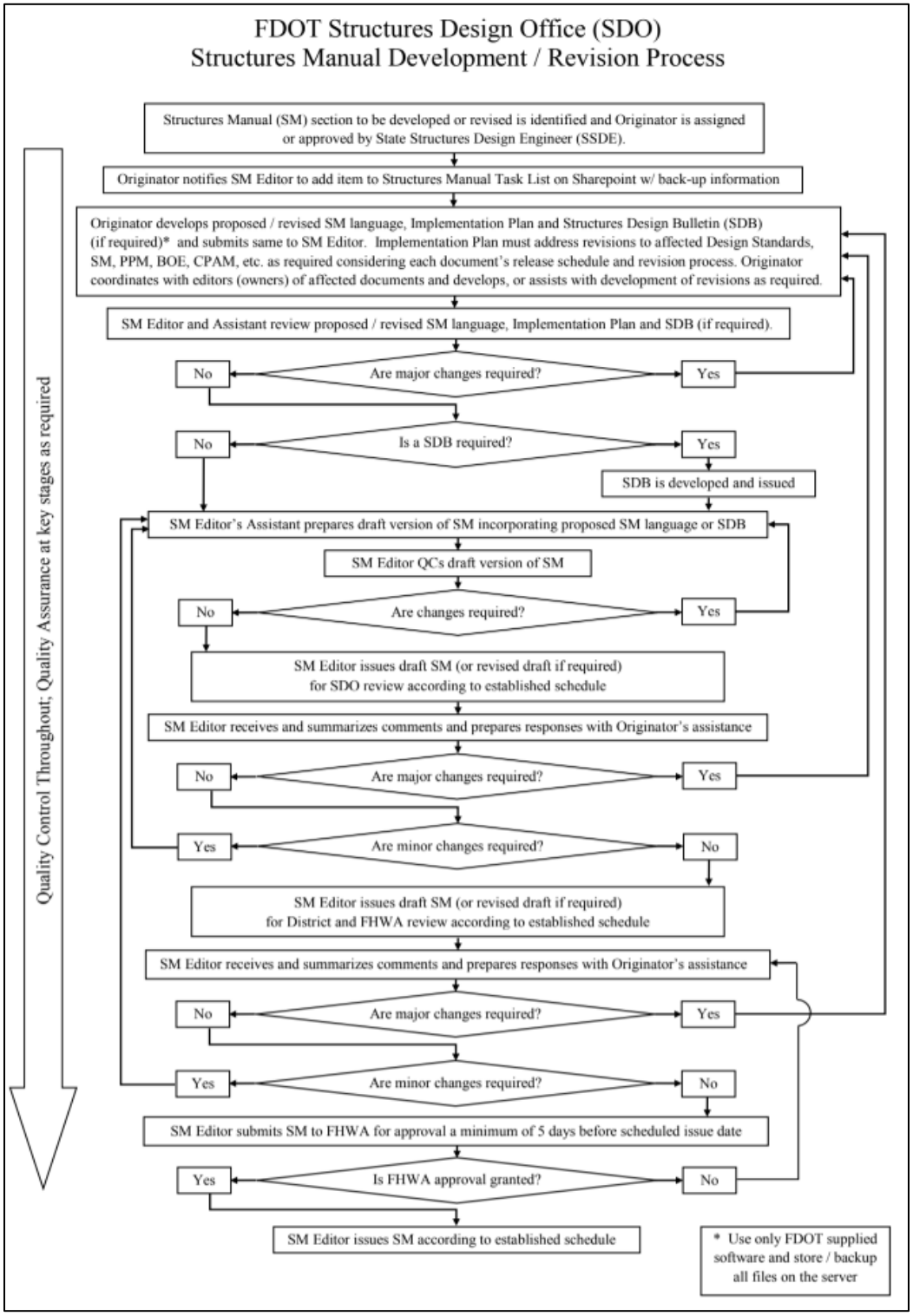



**Figure B-23. The Structures Manual Development/Revision Process flowchart detailing the manual development/revision processes.**

*Florida Department of Transportation*

RICK SCOTT
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

JIM BOXOLD
SECRETARY

**STRUCTURES DESIGN BULLETIN *XX-XX***

***ROADWAY DESIGN BULLETIN XX-XX and/or other designations (if a joint bulletin)***

***(FHWA Approved: Date)*** *[Required for changes to SDG only.]*

DATE: *Bulletin Date*

TO: *List of Intended Recipients, e.g., District Directors of Transportation Operations, District Directors of Transportation Development, District Design Engineers, District Construction Engineers, District Geotechnical Engineers, District Structures Design Engineers , District Maintenance Engineers*

FROM: Robert V. Robertson, P. E., State Structures Design Engineer
*XXX, P.E., State Roadway Design Engineer and/or others as required (if a joint bulletin)*

COPIES: *List of Intended Recipients, e.g., Brian Blanchard, Tom Byron, Tim Lattner, Duane Brautigam, David Sadler, Bruce Dana, Gregory Schiess, Jeffrey Ger (FHWA), etc. plus the Structures Manual Editor*

SUBJECT: *Bulletin Title, e.g., Mandatory Utilization of Embedded Data Collectors (EDC) in All Square Prestressed Concrete Piles*

**REQUIREMENTS**

*This section codifies exceptions, revisions and/or additions to policies or criteria as specified in current adopted specifications (i.e.,* ***Structures Manual****,* ***AASHTO LRFD Bridge Design Specifications****, etc.). Requirements must reference the specific section in the* ***Structures Manual*** *or other documents where they are to be incorporated. Revisions to the Department's* ***Standard Specifications*** *will be handled through the Specifications Office.*

*List specific items including:*
- *Design, detailing, process, plan content, etc. requirements, changes, instructions, etc.*
- *Changes, additions or deletions to the* ***Structures Manual, Plans Preparation Manual,*** *etc. in the following format: "Delete* ***January 2009 Structures Design Guidelines,*** *Section 3.5.6, Table 3.1 and insert the following:" or "Add the following new section to the* ***Plans Preparation***

**Figure B-24. Templates of the design bulletin that can be altered by the user in the creation of a new bulletin.**

## B.4 GEORGIA

Georgia Department of Transportation (GDOT) documents information on bridge design in the *Bridge and Structures Design Manual* and in the *Bridge Design Basic Drawings*, which provide information on bridge design policies and design standards respectively.

### B.4.1 Policy Documentation

The table of contents in the *Bridge and Structures Design Manual* is organized by chapter, section, and by specific policy numbers (see Figure B-25). Tables of contents for specific chapters are provided at the beginning of each chapter. Hyperlinks are provided throughout the tables of contents. Chapter appendices are located at the end of each respective chapter and they contain supplementary material such as diagrams, sample documents, and maps.

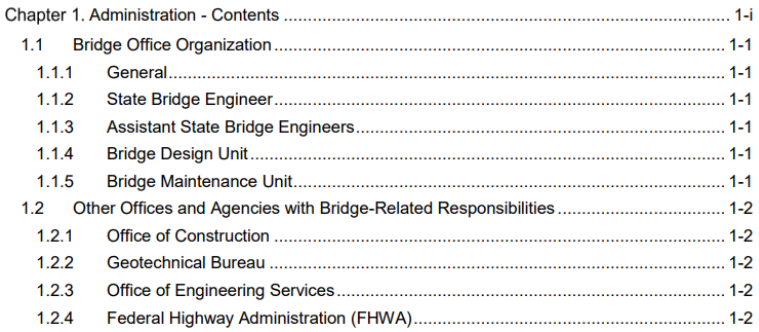



**Figure B-25. Example of the arrangement of the table of contents (GDOT 2018a)**

The text within the *Bridge and Structures Design Manual* are in a textbook-style format with paragraphs divided by bolded sections. The policies mentioned in the table of contents are divided into smaller subsections within the manual. No background information or rationale regarding the policies is given, however, small diagrams and tables are provided as supplements to the text (see Figure B-26).

**2.9.4 Guidelines for Selecting Bridge Type**

The following guidelines can be used, unless the cost of the bridge requires a Bridge Type Study (See Section 2.9.5).

**2.9.4.1 Typical Bridge Cost**

The following square foot costs for particular bridge types may be used in preparation of preliminary cost estimates:

| Item | Square foot cost (out-to-out width) |
|---|---|
| RC/PSC beams on pile bents | $90 |
| Box/Cored Slab/Next Beam on pile bents* | $150 |
| PSC beams on concrete bents | $100 |
| Steel beams on concrete bents | $125 |

*** Due to time savings on these type of structures, no net increase in total project costs are usually seen.**

**Figure B-26. Example of the text structure within the *Bridge and Structures Design Manual* (GDOT 2018a)**

The link to the *Bridge Design Basic Drawings* is provided within the *Bridge and Structures Design Manual*. The drawings are organized in a tabular format based on the units system (English/Metric) used in the drawings, a description of the drawing, what document and section it belongs in, and the latest date of revision (see Figure B-27). All drawings are only provided in CAD file formats.

MicroStation J | MicroStation V8i | Software

| Units | Basic Drawings/Details | Description | Section | Revised |
|---|---|---|---|---|
| English | psc1.dgn | Type I MOD includes End Spans and Intermediate Spans | AASHTO PSC Beams | 1/13/2015 |
| English | psc2.dgn | Type II includes End Spans and Intermediate Spans | AASHTO PSC Beams | 1/13/2015 |
| English | psc3.dgn | Type III includes End Spans and Intermediate Spans | AASHTO PSC Beams | 1/13/2015 |
| English | psc4.dgn | Type IV includes End Spans and Intermediate Spans | AASHTO PSC Beams | 1/13/2015 |

**Figure B-27. Organization of the drawings within the *Bridge Design Basic Drawings* (GDOT 2018b)**

## B.4.2 Rationale Behind Policies

The *Bridge and Structures Design Manual* contains its revisions at the beginning, listed in a table that is organized by the revision number and revision date (see Figure B-28). A summary of the

changes made and the specific policies that they apply to are also given. However, a rationale is not provided.

| Revision Number | Revision Date | Revision Summary |
|---|---|---|
| **LRFD Bridge Manual** | | |
| **Original** | 7/8/13 | Original Release Date |
| **1.0** | 10/1/13 | Section 3.2.3.3 - Removed "after all necessary grinding" from 8" overhang thickness; Removed "(LRFD 13.7.3.1.2)" from 8" overhang thickness<br><br>Section 3.5.2.1 - Changed LRFD reference from Table 4A-1 to Table A4-1<br><br>Section 4.4.2 - Modified tower bent placement directive; Added pile fixity assumption<br><br>Section 3.2.2.3 - Removed Commentary |
| **2.0** | 6/2/14 | Section 2.1 - Updated LRFD Specification to 6th edition, 2012; updated Georgia Standard Specification to 2013; defined all bridges as "typical"<br><br>Section 2.2.2.2 - Allowed Standard Specification widening of Existing Standard Specification bridges<br><br>Section 2.4 - Changed office responsible for Survey Manual<br><br>Section 2.8 - Added LRFD software submittal requirements for consultants<br><br>Section 3.1.1 - New section added - Set minimum beam requirement for bridges with vehicular traffic<br><br>Section 3.2.2.1 - Added reference to online slab design program<br><br>Section 3.2.2.4.2 - Changed placement and spacing of temperature steel in top mat of deck<br><br>Section 3.3.2.2.1 - Clarified urban area locations<br><br>Section 3.3.2.2.2 - Edited height of fence<br><br>Section 3.4.3.15.4 - New section added – limiting coping thickness to 6"<br><br>Section 3.12.2.3.1 - Check clearance between cap and PSC beam when plain pads are used<br><br>Section 3.12.2.5.2 - Added new section - Directive to minimize number of pad designs for bridge<br><br>Section 4.2.1 - Specified use of kips in lieu of tons or pounds for foundations<br><br>Section 4.2.2.3, 4.2.2.4, 4.2.2.5 - Added maximum factored resistances and stresses for all pile types<br><br>Section 4.2.3.4 - Restricted use of spirals in caisson; limited ties to maximum size of #6; Stated seismic detailing at fixity is not required in caissons<br><br>Section 4.4.1.2.1 - Added limits for depth to width |

**Figure B-28. Sample of the revision history in the *Bridge and Structures Design Manual* (GDOT 2018a)**

### B.4.3 Policy Implementation Guidelines

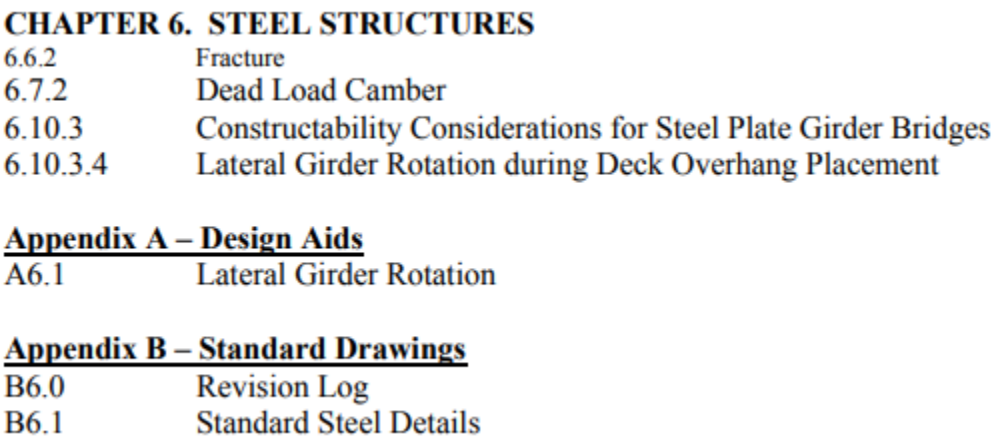
The *Bridge and Structures Design Manual* contains diagrams, tables, equations, parameters, and variables to support policy implementation.

## B.5 IDAHO

The Idaho Transportation Department (ITD) publishes their *Bridge Design Manual* as separate chapters. Standard design details are included in the manual. The end of each section of the manual contains a commentary and a list of revisions. The commentary provides rationale for some of the changes recorded in the revisions.

### B.5.1 Policy Documentation

The ITD *Bridge Design Manual* is organized using a numerical system with main topics that are divided by chapter subheadings. After every few chapters, are appendices that include design aids and standard drawings (see Figure B-29). There are no hyperlinks included in the table of contents. A drawback of the manual is that there is no way to access the full document as a single PDF as each chapter and section is labeled as a separate hyperlink in the ITD website, this makes it difficult to read the manual as a complete document (see Figure B-30).



**CHAPTER 6. STEEL STRUCTURES**

6.6.2 Fracture
6.7.2 Dead Load Camber
6.10.3 Constructability Considerations for Steel Plate Girder Bridges
6.10.3.4 Lateral Girder Rotation during Deck Overhang Placement

**Appendix A – Design Aids**

A6.1 Lateral Girder Rotation

**Appendix B – Standard Drawings**

B6.0 Revision Log
B6.1 Standard Steel Details

**Figure B-29. Table of content of the bridge design manual showing the numerically ordered policies as well as the appendices (IDT 2018)**

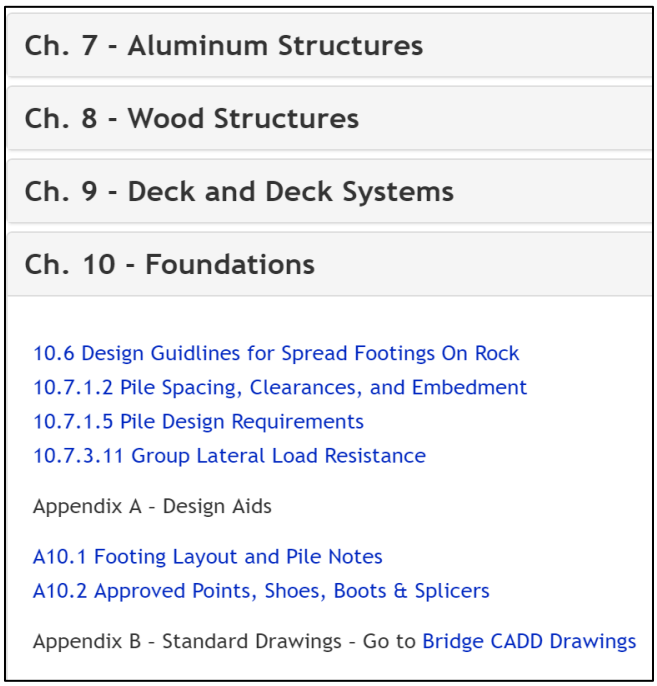



**Figure B-30. The chapter hyperlinks located on the ITD website, Chapter 10 is open showing the hyperlinks for the individual policies and appendices (IDT 2018)**

Within the manuals, the policies are written in a list format and do not include any explanations or background to the details in the policies, making it very straightforward to read and comprehend (Figure B-31). The list format highlights the intricate details of policies by breaking them up. Many sections include diagrams to help illustrate the policy. As shown in Figure 3-37, the commentary provides rationale for the policies. The standard designs are organized by chapters. They do not have any indication of revisions or commentary. However, at the beginning of each chapter of the standards, a revision log details the revisions made to all the standards in the given chapter along with the revision date.

Article 9.7.1.5
Page 1 of 1
5/2018

**9.7.1.5 DESIGN OF CANTILEVER SLABS**

**NCHRP-350 STANDARD RAILS**

Bridge Section policy for the reinforcement of deck overhangs that support ITD 32" concrete parapet, 2 tube curb-mounted rail, and combination rail shall be the reinforcement for the empirical deck design requirements for the top mat (#5 rebar at 12") with the addition of #6 rebar spaced between the standard #5 bars. This reinforcement shall be considered adequate for those areas at least 8 feet from any joint or discontinuity in the parapet. For areas less than 8 feet from joints or discontinuities in the parapet two #6 bars shall be evenly spaced between the #5 bars. The length of the additional #6 rebar shall be such that the bar extends at least halfway between the exterior girder and the first interior girder. This policy only applies to 8 inch minimum thick decks with a minimum overhang of 24 inches from the centerline of the exterior girder to a maximum overhang of 72 inches.

**MASH 42" SINGLE SLOPE CONCRETE PARAPET**

Bridge Section policy for the reinforcement of deck overhangs that support ITD 42" single slope concrete parapet shall be the reinforcement for the empirical deck design requirements for the top mat (#5 rebar at 12") with the addition of 2 bundled #6 rebar spaced between the standard #5 bars. This reinforcement shall be considered adequate for entire length of the parapet including those areas at any joint or discontinuity in the parapet. The length of the additional #6 rebars shall be such that the bar extends at least halfway between the exterior girder and the first interior girder. This policy only applies to 8 inch minimum thick decks with a minimum overhang of 24 inches from the centerline of the exterior girder to a maximum overhang of 96 inches.

**Commentary**

The 42"single slope parapet was analyzed according to AASHTO Article A13.4 for TL-4 loads to insure the parapet would yield before the cantilever deck. An 8" cantilever deck with a top mat of transverse #5 bars @ 12" and 2-#6 bundled bars at 12" between the #5 bars (As = 1.19) would provide the moment capacity greater than the parapet for a TL-4 loading.

**Revisions:**

| | |
|---|---|
| June 2013 | Article was renumbered from A13.4.1 |
| Mar 2015 | Revised article for change to #5 top mat reinforcement for the empirical design. |
| May 2018 | Added design criteria for NCHRP-350 rails and MASH rails.<br>Revised commentary. |

**Figure B-31. Example of a policy showing the condensed writing used on the policy as well as the list format (IDT 2018)**

## B.5.2 Rationale Behind Policies

The commentary below the policies in the manual adds details to the policy such as additional parameters for specific scenarios, reasoning behind some revisions, or possible concerns (see

Figure B-31). The revisions, which are located below the commentary, show the changes made to a specific policy, as well as the revision date (see Figure B-32). While the revisions are detailed, the rationale behind changes are not included unless they are mentioned in the commentary, which is not done consistently throughout.

**Revisions:**

| | |
|---|---|
| June 2013 | Article was renumbered from A13.4.1 |
| Mar 2015 | Revised article for change to #5 top mat reinforcement for the empirical design. |
| May 2018 | Added design criteria for NCHRP-350 rails and MASH rails.<br>Revised commentary. |

**Figure B-32. Example of a revision located at the bottom of a policy in the bridge design manual (IDT 2018)**

The revisions to the standard design details are similar and are detailed in the changes that have been made. However, no rationale is provided for these changes (see Figure B-33).

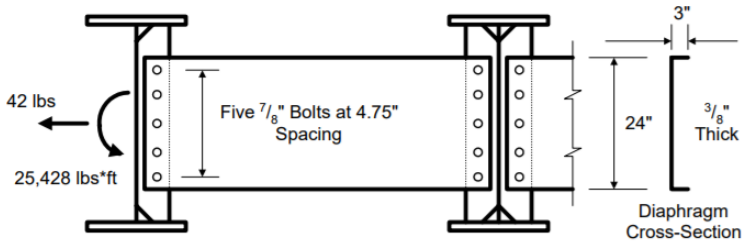
**B2.1A Approach Slab Details Sheet 1– Asphalt Pavement**

| | |
|---|---|
| March 2011 | Added 20' length of approach slab in Section C-C.<br>Revised pay limits in Section C-C to comply with 502.04.<br>Revised deadman to an "L" shape. |
| Sept 2012 | Revised Note 5 to list the requirements of ASTM C920 for the silicone sealant joint and deleted the references to Dow Corning & Watson Bowman.<br>Added Detail C for limits of ¾" base material.<br>Revised Note 1 to provide ¾" base material to the limits shown in Detail C. |
| June 2013 | Deleted "Sleeper Beam" reference from note in View D-D.<br>Changed Note 4 to Class 40AF concrete. |
| May 2014 | Split details into 2 sheets by adding sheet B2.1I<br>Changed abutment dowels to GFRP bars. |
| Aug 2016 | Deleted 16" dimension in Section A-A for thickness of wingwall & joint filler. |

**Figure B-33. Example of revisions made to the standard design guides (IDT 2018)**

### B.5.3 Policy Implementation Guidelines

The design aids given in the appendices help with policy implementation by providing additional information such as tables with parameters, equations, examples, etc. (see Figure B-34).




Article A6.1
Page 4 of 4
11/2003

The bolt pattern has a moment of inertia of 226 $in^2$ therefore the maximum bolt shear is:

$25{,}428(12)(9.5)/226 + 42/5 = 12835$ lbs

The nominal resistance of a $^7/_8$", A325 bolt for a standard hole with a Class A surface (Art. 6.13.2.8):

$K_h K_s N_s P_t = 1.0(0.33)(1.0)(39) = 12.87$ kips  12.835 kips < 12.87 kips *OK*

**Figure B-34. Examples provided in appendices as implementation guides**

## B.6 IOWA

Iowa Department of Transportation (Iowa DOT) publishes their *LRFD Design Manual* along with a commentary that supplements the bridge design policies. Their *Bridge Standard Plans* are organized in tables. Iowa DOT also keep a revision history for their manual and standards. Supplemental documents, such as the *Preliminary Design Checklist – Bridge* and the *Bridge Plan Review Checklist*, serve as tools to aid in policy implementation.

### B.6.1 Policy Documentation

The Iowa DOT has several documents that supplement their *LRFD Design Manual*. The manual itself can be downloaded either as a complete PDF or by individual sections (see Figure B-35). The manual shows recent revisions with red, underlined text (see Figure B-36). The table of contents is structured by chapter and then by two levels of subsections. Each heading in the table of contents is a hyperlink to the corresponding section. In the text of the manual, all the chapter and subsection headings are distinguished using larger, bolded text (see Figure B-36). The manual is organized into small paragraphs of text with some sections included with bulleted lists and small supplemental diagrams, tables, and images. Several sections provide some background

information on the subject matter however, not all sections do so. Hyperlinks are provided throughout the text for other documents and when other parts of the manual are referenced.

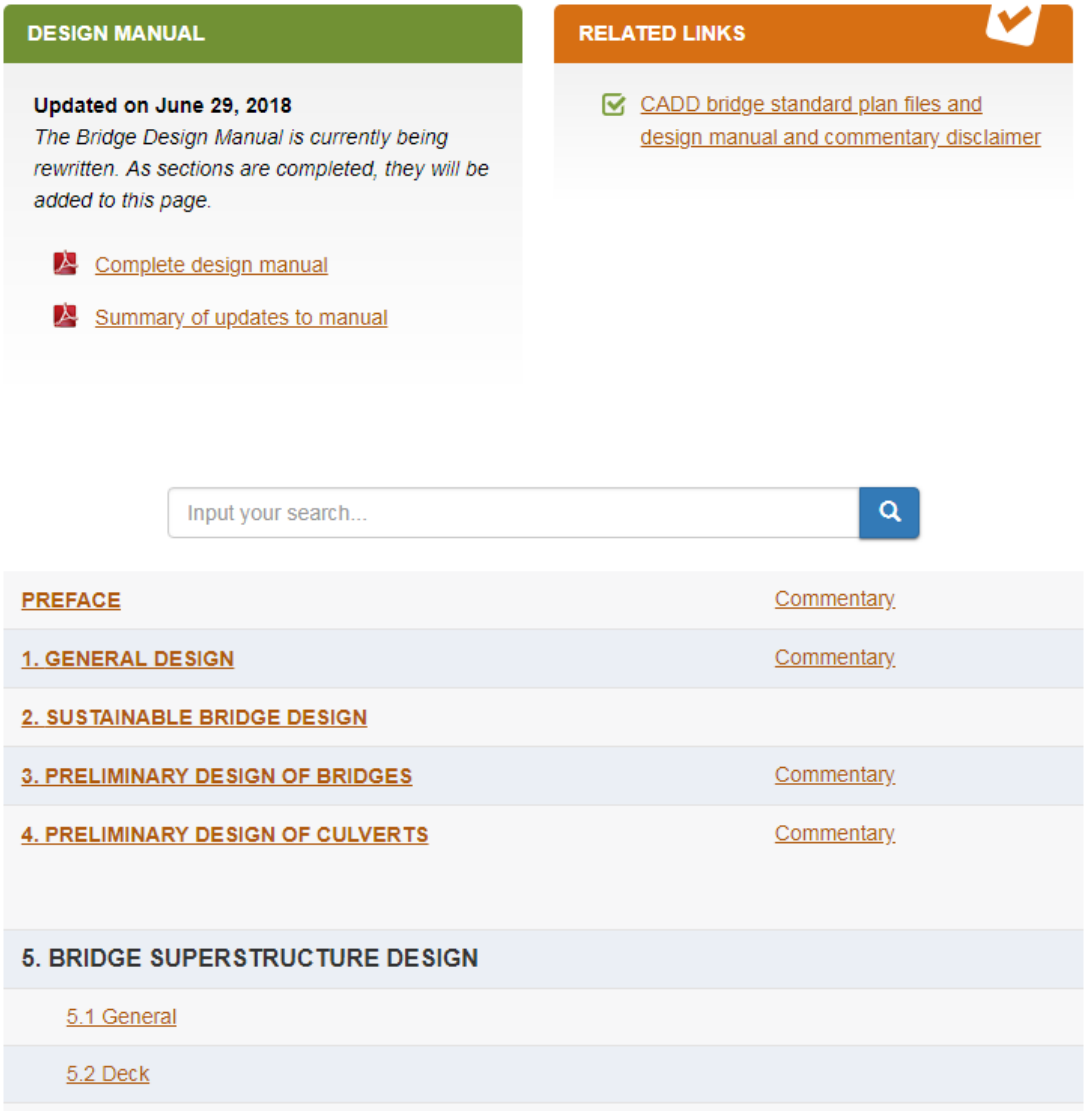
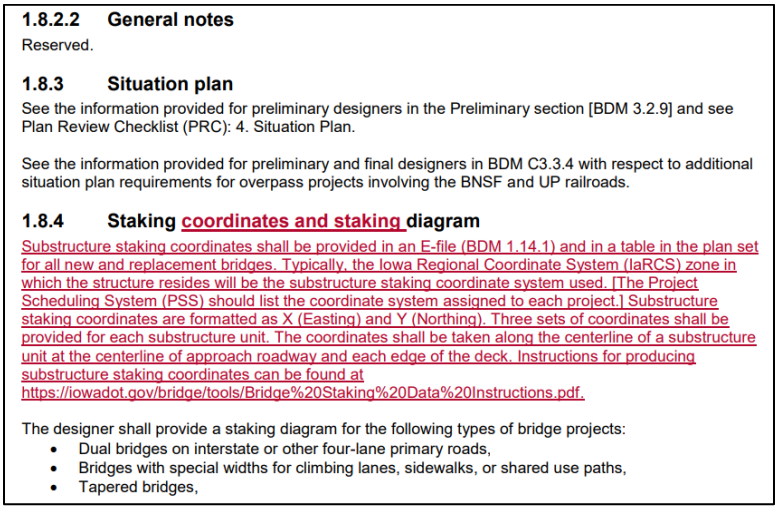



**Figure B-35. Hyperlinks to access the compiled version of the manual, the individual sections, and the commentaries for each section**



**1.8.2.2 General notes**

Reserved.

**1.8.3 Situation plan**

See the information provided for preliminary designers in the Preliminary section [BDM 3.2.9] and see Plan Review Checklist (PRC): 4. Situation Plan.

See the information provided for preliminary and final designers in BDM C3.3.4 with respect to additional situation plan requirements for overpass projects involving the BNSF and UP railroads.

**1.8.4 Staking coordinates and staking diagram**

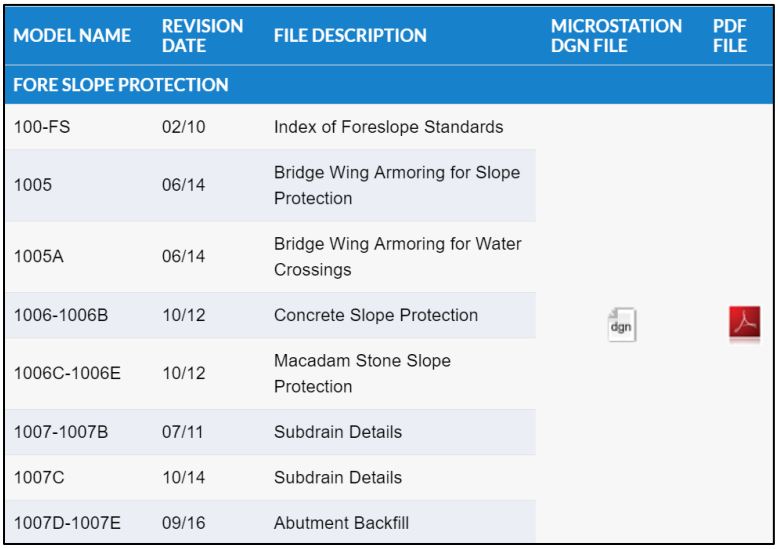
Substructure staking coordinates shall be provided in an E-file (BDM 1.14.1) and in a table in the plan set for all new and replacement bridges. Typically, the Iowa Regional Coordinate System (IaRCS) zone in which the structure resides will be the substructure staking coordinate system used. [The Project Scheduling System (PSS) should list the coordinate system assigned to each project.] Substructure staking coordinates are formatted as X (Easting) and Y (Northing). Three sets of coordinates shall be provided for each substructure unit. The coordinates shall be taken along the centerline of a substructure unit at the centerline of approach roadway and each edge of the deck. Instructions for producing substructure staking coordinates can be found at https://iowadot.gov/bridge/tools/Bridge%20Staking%20Data%20Instructions.pdf.

The designer shall provide a staking diagram for the following types of bridge projects:

- Dual bridges on interstate or other four-lane primary roads,
- Bridges with special widths for climbing lanes, sidewalks, or shared use paths,
- Tapered bridges,

**Figure B-36. Organization of the text within the *LRFD Design Manual***

The *Bridge Standard Plans* are organized into a table by model name, revision date, file description, and a link to the PDF and/or DGN files (see Figure B-37). The plans are grouped together by topic. New files are highlighted in yellow within the table.



| MODEL NAME | REVISION DATE | FILE DESCRIPTION | MICROSTATION DGN FILE | PDF FILE |
|---|---|---|---|---|
| **FORE SLOPE PROTECTION** | | | | |
| 100-FS | 02/10 | Index of Foreslope Standards | | |
| 1005 | 06/14 | Bridge Wing Armoring for Slope Protection | | |
| 1005A | 06/14 | Bridge Wing Armoring for Water Crossings | | |
| 1006-1006B | 10/12 | Concrete Slope Protection | dgn | |
| 1006C-1006E | 10/12 | Macadam Stone Slope Protection | | |
| 1007-1007B | 07/11 | Subdrain Details | | |
| 1007C | 10/14 | Subdrain Details | | |
| 1007D-1007E | 09/16 | Abutment Backfill | | |

**Figure B-37. Table showing the *Bridge Standard Plans***

## B.6.2 Rationale Behind Policies

The *LRFD Design Manual* is updated biannually on January 1st and July 1st, the changes shown in the manual are only the changes between the current manual and its preceding version. A commentary is provided for certain sections (Figure B-38). The commentary provides information

regarding the rationale behind bridge design policies as well as additional information and suggestions on specific policies. Revisions to the commentary are presented in the same format as those in the manual. The manual includes diagrams, tables, equations, as well as examples (see Figure B-39).

### 5.6 Concrete Slabs

This article now covers only the CCS LRFD superstructure type [BDM 5.6.2]. The transition to the AASHTO LRFD Specifications is complete, and the AASHTO Standard Specifications article [BDM 5.6.1] has been withdrawn.

#### 5.6.1 CCS standard

Withdrawn and archived.

#### 5.6.2 CCS LRFD

#### 5.6.2.1 General [AASHTO-LRFD Section 9, A13]

This series of articles replaces the office document *Design Criteria and Office Practice for Continuous Concrete Slab Bridges* dated 1996.

The design procedures described in this article meet AASHTO LRFD Specifications [AASHTO-LRFD Section 9 and A13], with minor modifications. The designer also should review related manual articles for decks [BDM 5.2], railings [BDM 5.8.1], deck drains [BDM 5.8.4], falsework [BDM 7, in process],

(a) Manual section 5.6

### C5.6 Concrete Slab

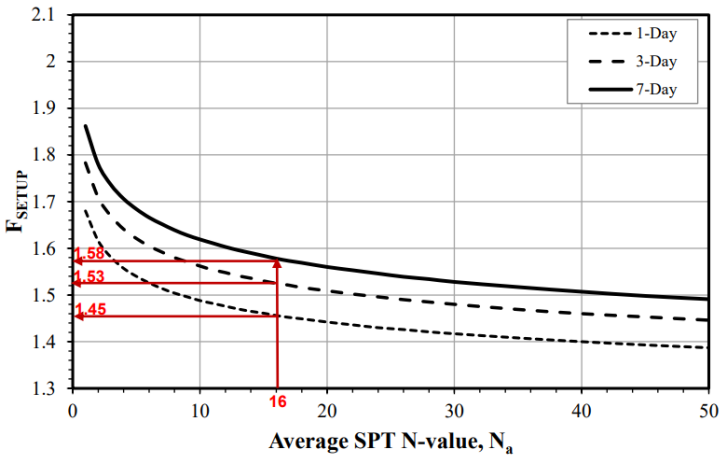
#### C5.6.2.2.1 Dead

For design under the AASHTO standard specifications the office considered the edge strip to be relatively narrow, only the width of the railing plus half the depth of the slab. When 25% of the dead load of the railing directly above was applied to the edge strip, the overall distribution of the railing loads to the bridge cross section was conservative. Under LRFD, however, the edge strip is much wider, usually 6 feet, and applying only 25% of the railing load to the edge strip would be unconservative. Therefore, the portion of the railing load to be applied to the edge strip was increased to 50%. With the increase, the railing load distribution is conservative for any bridge width more than 24 feet. At 24 feet, half the railing load will be applied to 6-foot wide edge strips and half the load to the remainder of the cross section. For greater bridge widths the remainder of the cross section will be designed to carry more than half the railing load.

(b) Commentary for section 5.6.2.2.1

**Figure B-38. Manual section 5.6 and commentary**

Based on the pile setup factor chart shown below the average SPT N-value of 16 yields Setup Factors, $F_{SETUP}$, of 1.45 for 1-say retap, 1.53 for 3-day retap, and 1.58 for 7-day retap.




**Track 1, Example 3-pile setup factor chart [BDM Figure 6.2.10]**

The target pile driving resistance at End Of Drive is

$$R_{ndr-T} = \frac{\sum \eta\gamma Q}{\varphi_{TAR}} + \frac{\gamma_{DD} DD}{\varphi_{TAR}} + R_{Sdd,EOD}$$

$$= \frac{\sum \eta\gamma Q}{\varphi_{EOD} + \varphi_{SETUP}(F_{SETUP} - 1)} + \frac{\gamma_{DD} DD}{\varphi_{EOD} + \varphi_{SETUP}(F_{SETUP} - 1)} + R_{Sdd}$$

**Figure B-39. Example of the contents and format of the commentary**

Another document supplementing the design manual is the *LRFD Bridge Design Manual Update*, which consists of a table recording all the changes made to the manual. The table is organized by the affected section(s), a description of the changes, and the implementation date (see Figure B-40).

**LRFD Bridge Design Manual Update ~ July 2018**

| BDM Articles Updated | Description of BDM Update | Implementation Date |
|---|---|---|
| Entire BDM Updated | All BDM chapters have been updated. All update markups prior to July 2018 have been accepted and the markups have been removed. All articles will be designated with a July 2018 date. Markups for the July 2018 release are included. | July 1, 2018 |
| Preface, 1.4.1, 3.1.5.2, 3.6.1.7, C3.12, 5.2, 5.2.1, 5.4, 5.4.1.4.1.7, 5.6.2.1, C6.2.6.1, 6.6.4.1.1.1, 13.2.2 | Adoption of the 2017 8th Edition of the AASHTO LRFD Bridge Design Specifications. CADD Note E50E was updated. Standard sheets can be used "as is" until they are updated. Note that many AASHTO article numbers in the BDM were updated based on the reorganization of the 8th Edition of AASHTO Section 5: Concrete Structures. BDM markups for revised AASHTO article numbers are not retained. | All final designs starting on October 1, 2018. |
| 1.8, 1.14 | Added reference to project folder structure in ProjectWise in BDM 1.8. Made other minor corrections to BDM 1.8 and 1.14. | July 1, 2018 |
| 1.5.3, 3.5, 7.2.4.11.4, 7.3.4.2.4 | Increased RCB size to 12'x11' to accommodate a typical sidewalk or shared use path through roadway embankment. | All preliminary designs completed after July 1, 2018. All final designs starting on July 1, 2018. |

**Figure B-40. Part of the design manual update history**

Changes to the design standards are recorded in an Excel spreadsheet. Columns are organized by date, standard number, revisions, and additional comments (see Figure B-41).

| Date | Standard | Revision | Additional Comments |
|---|---|---|---|
| 2018/03/01 | SCST-(00 thru 09)-17 | UPDATED BRIDGE ENGINEER SIGNATURE. | |
| 2018/04/01 | 1043P, 1081P | CHANGED AND REMOVED NOTES REFERING TO APPROVAL OF NONSTANDARD DETAILS THAT ARE DESIGNED AND SEALED BY A PROFESSIONAL ENGINEER. ADDED NOTE "THE PRECAST BOX CULVERT AND EXTENSION SHALL BE BUILT TO THE DIMENSIONS AND SPECIFICATIONS SHOWN IN THESE PLANS." CHANGED CLASSIFICATION OF 6" BEDDING UNDER THE BARREL DETAILS TO "SPECIAL BACKFILL". (WAS REFERRED TO AS GRANULAR MATERIAL OR GRANULAR BEDDING.) REMOVED FROM GENERAL NOTES "THE 6 INCH GRANULAR BEDDING SHALL BE BID AS SPECIAL BACKFILL." | |
| 2018/04/01 | 1044P | UPDATED "COLLAR PART SECTION ILLUSTRATION". | |
| 2018/04/01 | 1082P | CHANGED DESCRIPTION OF 6" BEDDING UNDER THE BARREL DETAILS TO "SPECIAL BACKFILL". (WAS REFERRED TO AS GRANULAR MATERIAL OR GRANULAR BEDDING.) | |
| 2018/04/01 | 1037 | MOVED DIMENSION TEXT IN 8'-0 DECK PANEL DETAIL. IT WAS OVERLAPPED BY DIMENSION LINE. | |
| 2018/04/01 | 1037B | CORRECTED DETAIL B CALL-OUT CIRCLE LOCATION. MOVED DIMENSION TEXT IN 8'-0 DECK PANEL DETAIL. IT WAS OVERLAPPED BY DIMENSION LINE. | |
| 2018/04/01 | 1054 | ADDED ADDITIONAL WELD SYMBOL ARROWS TO DRAIN TRENCH DETAILS IN PART SECTIONS B-B. | |
| 2018/04/01 | P10L | CHANGED PERMISSIBLE ALTERNATE ENCASEMENT DIAMETER FOR HP14x73 & HP14x89 TO 30"DIA. (WAS 28"DIA.) UPDATED BRIDGE ENGINEER SIGNATURE. | |

**Figure B-41. Part of the Excel spreadsheet showing the changes made to the design standards**

*CADD Memos* also detail the changes to the design standards; they include more details than what is given on the Excel spreadsheet. However, neither the memos nor the spreadsheet provide much rationale behind the changes (see Figure B-42). The recent memos are listed separate from the older ones; both tables are organized by memo number, date, and subject (see Figure B-42). An example of a CAD memo is shown in Figure B-43.

**MEMO UPDATES**

Updated on **September 30, 2014**

**CADD MEMOS**

Show 10 entries Search:

| NUMBER | DATE | SUBJECT |
|---|---|---|
| M0294 | 10/01/12 | Revision to English Foreslope Protection Standards 1006, 1006A thru 1006E |
| M0295 | 10/01/12 | Revision to English Culvert Standards RCB G1-12, TWRCB G1-12, and TRRCB G1-12 |
| M0296 | 10/01/12 | Revision to English Repair Standards 1038, 1040, and 1041 |
| M0297 | 11/01/12 | Revision to English LRFD Signed Culvert Standard RCB G2-12 |
| M0298 | 11/01/12 | Revision to English Deck Rail Standards 1026s1 & 1026s2 |
| M0299 | 04/01/13 | Revision to English P10L Standard and void Standard P10A |

**Figure B-42. Table of CADD Memos**

Form 000021wd
4-96

**IOWA DEPARTMENT OF TRANSPORTATION**

To Office Bridges and Structures Date April 1, 2013

Attention All Employees Ref No. 521.1

From Gary Novey

Office Bridges and Structures

Subject Revision of LRFD Culvert Standards.
(CADD M0304)

Electronic copies are available in the following Office of Bridges and Structures standard directory **W:\Highway\Bridge\Standards\Bridges** and on the Internet:

**http://www.iowadot.gov/bridge/standard.htm**

The revision of the 1043s1 Culvert Extension Standard -

- The Construction Specification year has been updated to 2012.
- The Concrete Strength has been changed to 4.0 ksi.

The revision of the 1044 Culvert Extension Standard -

- Removed the labels of the bar sizes for the b1, e1, & f1 bars due to size variances shown in LRFD RCB-12 Culvert Standards.
- The SECTION THRU BARREL placement of the b1 bars has been changed to 6 inch spacing's and the b1 bars are shown near the junction of the walls and the barrel floor and a 3 inch dimension was added to locate the b1 bar above the barrel floor.
- The PART LONGITUDINAL SECTION location of the b1 bars has been changed to 6 inch spacing's and shown near the junction of the walls and the barrel floor.
- The alternate PART LONGITUDINAL SECTION detail outside of the border outline has been changed to the 6 inch spacing's for the b1 bars.

For any questions, please check with Stuart Nielsen or Thayne Sorenson.
GAN/ssn

**Figure B-43. Example of a CADD Memo detailing revisions made to specified design standards**

### B.6.3 Policy Implementation Guidelines

The commentary contains equations, diagrams, and explanations that supplement the bridge design policies and can serve as implementation guidelines. The commentary sections provide example

calculations (Figure B-44). The manual also provides a list of checklists in PDF format (see Figure B-45).

### C5.4.1.4.1.9 Deflection and camber

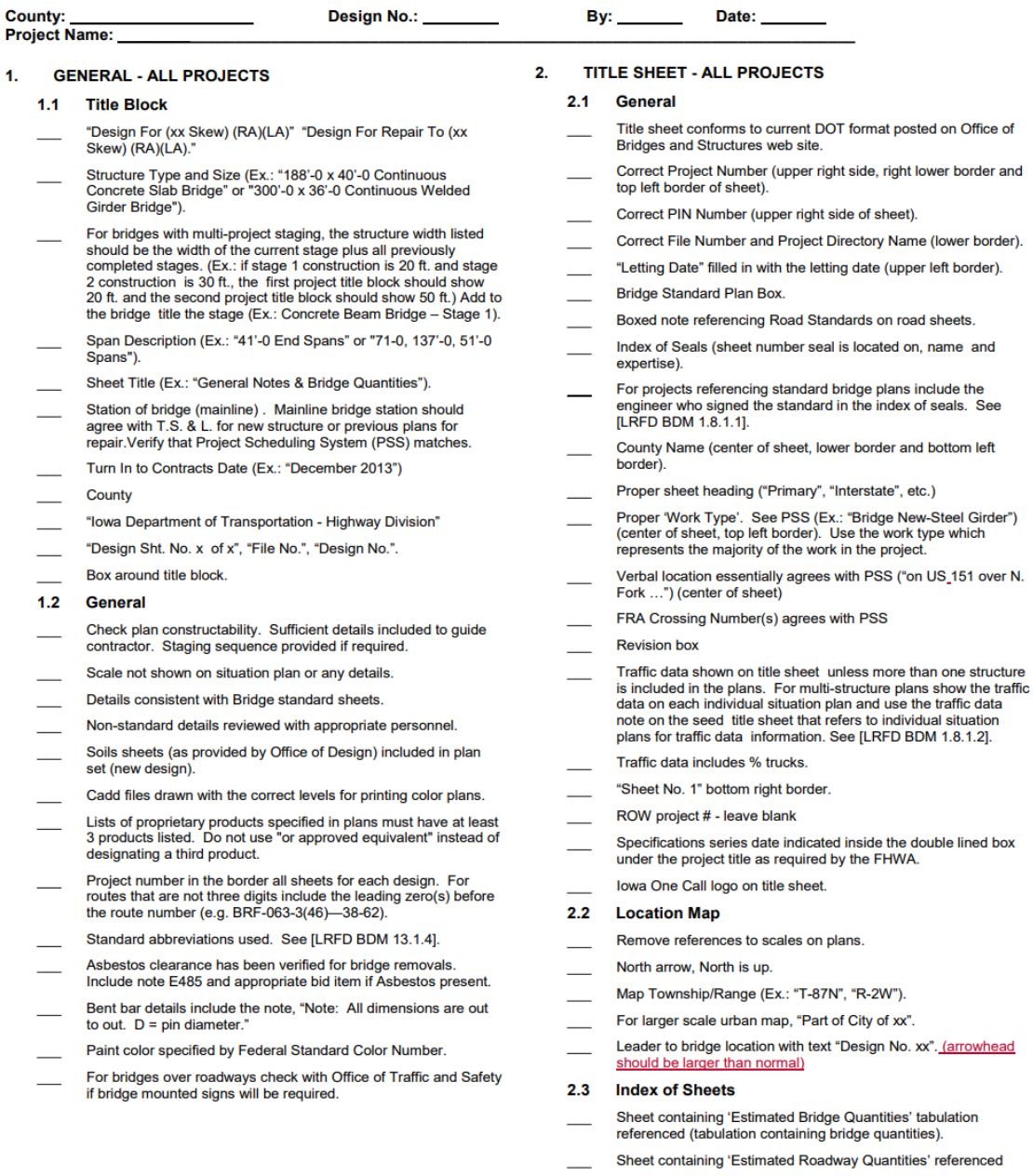
**1 January 2015**

The following example is intended to illustrate CONSPAN's camber calculation procedure and to demonstrate the use of the recommended camber deflection multipliers from the ISU camber research project. BDM 5.4.2.1.5 contains the research report reference. The prestressed beam standards will be updated to reflect the new camber values as some point in the future.

BTE145 Camber Calculation Example
End to End Beam Length = 146.333 ft
Harp Location = (0.35)*(146.333 ft) = 51.217 ft – assume harp points shifted 0.05*L towards beam ends
Beam Height = 63 in
Gross Beam Area = 807.4 $in^2$
Gross Beam Inertia = 422,790 $in^4$
Gross Beam C.G. = 28.750 in from bottom of beam
Concrete Unit Weight = 0.150 kcf
Initial Concrete Strength, $f'_{ci}$ = 7.5 ksi
Initial Concrete Modulus, $E_{ci} = (33{,}000)*((0.150\ kcf)^{1.5})*(7.5\ ksi)^{0.5} = 5250.3$ ksi
28-day Concrete Strength, $f'_c$ = 8.5 ksi
28-day Concrete Modulus, $E_c = (33{,}000)*((0.150\ kcf)^{1.5})*(8.5\ ksi)^{0.5} = 5589.3$ ksi
Strand Diameter, $d_b$ = 0.60 in
Strand Area, $A_p$ = 0.217 $in^2$
Strand Transfer Length = $60*d_b$ = (60)*(0.60 in) = 36 in
Strand Modulus, $E_p$ = 28,500 ksi
Strand Ultimate Strength = 270 ksi
Strand Jacking Percentage = 72.6%
Modular Ratio, $N = E_p/E_{ci}$ = (28,500 ksi))/(5250.2 ksi) = 5.428 – CONSPAN does not round N

ca

**Figure B-44. Calculation examples provided in the commentary section of the manual**



County: _____ Design No.: _____ By: _____ Date: _____
Project Name: _____

1. GENERAL - ALL PROJECTS

1.1 Title Block

___ "Design For (xx Skew) (RA)(LA)" "Design For Repair To (xx Skew) (RA)(LA)."

___ Structure Type and Size (Ex.: "188'-0 x 40'-0 Continuous Concrete Slab Bridge" or "300'-0 x 36'-0 Continuous Welded Girder Bridge").

___ For bridges with multi-project staging, the structure width listed should be the width of the current stage plus all previously completed stages. (Ex.: if stage 1 construction is 20 ft. and stage 2 construction is 30 ft., the first project title block should show 20 ft. and the second project title block should show 50 ft.) Add to the bridge title the stage (Ex.: Concrete Beam Bridge – Stage 1).

___ Span Description (Ex.: "41'-0 End Spans" or "71-0, 137'-0, 51'-0 Spans").

___ Sheet Title (Ex.: "General Notes & Bridge Quantities").

___ Station of bridge (mainline) . Mainline bridge station should agree with T.S. & L. for new structure or previous plans for repair.Verify that Project Scheduling System (PSS) matches.

___ Turn In to Contracts Date (Ex.: "December 2013")

___ County

___ "Iowa Department of Transportation - Highway Division"

___ "Design Sht. No. x of x", "File No.", "Design No.".

___ Box around title block.

1.2 General

___ Check plan constructability. Sufficient details included to guide contractor. Staging sequence provided if required.

___ Scale not shown on situation plan or any details.

___ Details consistent with Bridge standard sheets.

___ Non-standard details reviewed with appropriate personnel.

___ Soils sheets (as provided by Office of Design) included in plan set (new design).

___ Cadd files drawn with the correct levels for printing color plans.

___ Lists of proprietary products specified in plans must have at least 3 products listed. Do not use "or approved equivalent" instead of designating a third product.

___ Project number in the border all sheets for each design. For routes that are not three digits include the leading zero(s) before the route number (e.g. BRF-063-3(46)—38-62).

___ Standard abbreviations used. See [LRFD BDM 13.1.4].

___ Asbestos clearance has been verified for bridge removals. Include note E485 and appropriate bid item if Asbestos present.

___ Bent bar details include the note, "Note: All dimensions are out to out. D = pin diameter."

___ Paint color specified by Federal Standard Color Number.

___ For bridges over roadways check with Office of Traffic and Safety if bridge mounted signs will be required.

2. TITLE SHEET - ALL PROJECTS

2.1 General

___ Title sheet conforms to current DOT format posted on Office of Bridges and Structures web site.

___ Correct Project Number (upper right side, right lower border and top left border of sheet).

___ Correct PIN Number (upper right side of sheet).

___ Correct File Number and Project Directory Name (lower border).

___ "Letting Date" filled in with the letting date (upper left border).

___ Bridge Standard Plan Box.

___ Boxed note referencing Road Standards on road sheets.

___ Index of Seals (sheet number seal is located on, name and expertise).

___ For projects referencing standard bridge plans include the engineer who signed the standard in the index of seals. See [LRFD BDM 1.8.1.1].

___ County Name (center of sheet, lower border and bottom left border).

___ Proper sheet heading ("Primary", "Interstate", etc.)

___ Proper 'Work Type'. See PSS (Ex.: "Bridge New-Steel Girder") (center of sheet, top left border). Use the work type which represents the majority of the work in the project.

___ Verbal location essentially agrees with PSS ("on US 151 over N. Fork …") (center of sheet)

___ FRA Crossing Number(s) agrees with PSS

___ Revision box

___ Traffic data shown on title sheet unless more than one structure is included in the plans. For multi-structure plans show the traffic data on each individual situation plan and use the traffic data note on the seed title sheet that refers to individual situation plans for traffic data information. See [LRFD BDM 1.8.1.2].

___ Traffic data includes % trucks.

___ "Sheet No. 1" bottom right border.

___ ROW project # - leave blank

___ Specifications series date indicated inside the double lined box under the project title as required by the FHWA.

___ Iowa One Call logo on title sheet.

2.2 Location Map

___ Remove references to scales on plans.

___ North arrow, North is up.

___ Map Township/Range (Ex.: "T-87N", "R-2W").

___ For larger scale urban map, "Part of City of xx".

___ Leader to bridge location with text "Design No. xx". (arrowhead should be larger than normal)

2.3 Index of Sheets

___ Sheet containing 'Estimated Bridge Quantities' tabulation referenced (tabulation containing bridge quantities).

___ Sheet containing 'Estimated Roadway Quantities' referenced

**Figure B-45. Excerpt of the *Bridge Plan Review Checklist***

## B.7 MICHIGAN

The Michigan Department of Transportation (MDOT) presents bridge design policy using two main publications: *Bridge Design Manual* and *Bridge Design Guides*. The revisions to these publications are recorded in *Monthly Updates* newsletters. The *Bridge Design Manual* consists of only bridge design policies while the *Bridge Design Guides* present the standard design details. The *Monthly Updates* newsletters record and present the changes to the Road and Bridge Design

Publications that have been approved throughout the specified month. The relevant sections of the manual and guides are updated at the same time and are published concurrently with the *Monthly Updates* newsletters.

### B.7.1 Policy Documentation

The *Bridge Design Manual* is organized by policy numbers, as seen in the table of contents shown at the beginning of each chapter (see Figure B-46). The table of contents at the beginning of each chapter is hyperlinked to navigate to the relevant section within the manual. The LFD and LRFD policies are presented separately as different, but consecutive chapters. Within the chapter, the information is presented in a two-column format (see Figure B-47). References to other chapters of the manual are hyperlinks that direct the user to the relevant chapters. The rationale behind bridge policies is not given in the manual, however, there are dates in parentheses provided next to the policies indicating when revisions to the policy have taken place. As shown in Figure B-47, these dates (after November 2011) correlate with the month and year of the *Monthly Updates* newsletters.

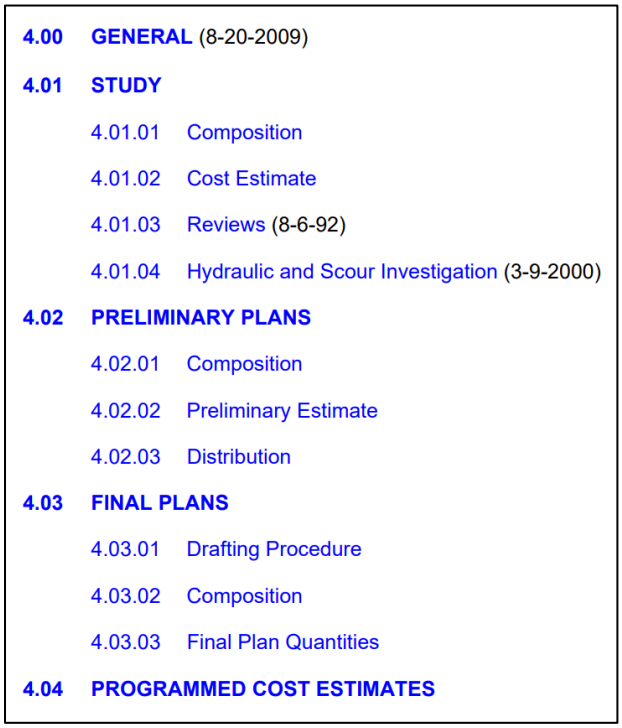
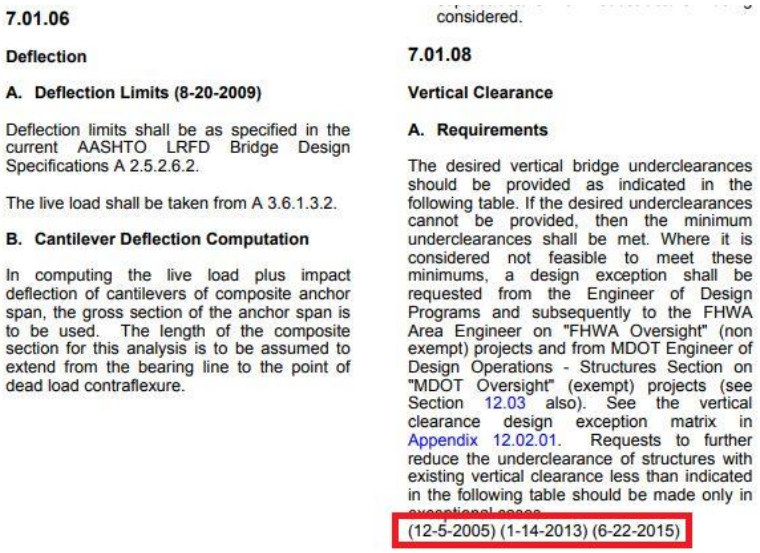



**Figure B-46. Format of the table of contents of the *Bridge Design Manual* (MDOT 2018a)**



**7.01.06**

**Deflection**

**A. Deflection Limits (8-20-2009)**

Deflection limits shall be as specified in the current AASHTO LRFD Bridge Design Specifications A 2.5.2.6.2.

The live load shall be taken from A 3.6.1.3.2.

**B. Cantilever Deflection Computation**

In computing the live load plus impact deflection of cantilevers of composite anchor span, the gross section of the anchor span is to be used. The length of the composite section for this analysis is to be assumed to extend from the bearing line to the point of dead load contraflexure.

considered.

**7.01.08**

**Vertical Clearance**

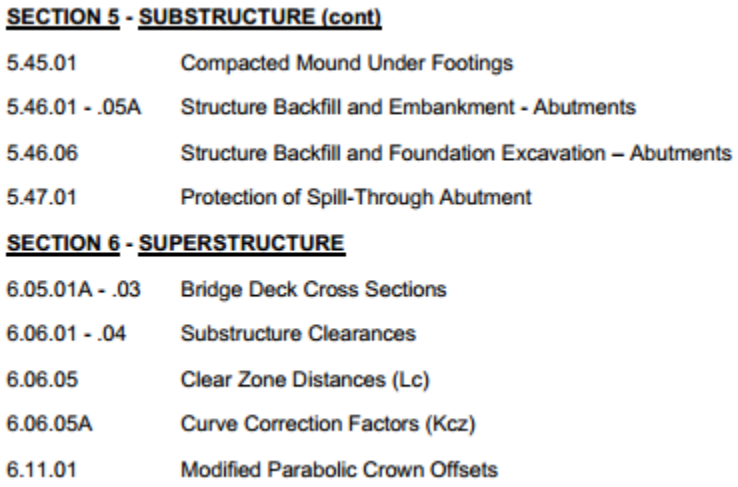
**A. Requirements**

The desired vertical bridge underclearances should be provided as indicated in the following table. If the desired underclearances cannot be provided, then the minimum underclearances shall be met. Where it is considered not feasible to meet these minimums, a design exception shall be requested from the Engineer of Design Programs and subsequently to the FHWA Area Engineer on "FHWA Oversight" (non exempt) projects and from MDOT Engineer of Design Operations - Structures Section on "MDOT Oversight" (exempt) projects (see Section 12.03 also). See the vertical clearance design exception matrix in Appendix 12.02.01. Requests to further reduce the underclearance of structures with existing vertical clearance less than indicated in the following table should be made only in

(12-5-2005) (1-14-2013) (6-22-2015)

**Figure B-47. Organization of the text within the *Bridge Design Manual* (MDOT 2018a)**

The *Bridge Design Guides* is organized by section and then by guide number (see Figure B-48). The *Bridge Design Guides* is available as both a single guide (PDF document) and as individual guides (PDF documents) for each section. The individual guides also contain an "issued" and a "supersedes" dates as seen in Figure B-49. Hyperlinks are not included within the guides, however, other guides are referenced within the text. There are no references to revisions in the guides which prevents the user from knowing the changes that have been made without first looking at the *Monthly Updates* newsletters.



**SECTION 5 - SUBSTRUCTURE (cont)**

| | |
|---|---|
| 5.45.01 | Compacted Mound Under Footings |
| 5.46.01 - .05A | Structure Backfill and Embankment - Abutments |
| 5.46.06 | Structure Backfill and Foundation Excavation – Abutments |
| 5.47.01 | Protection of Spill-Through Abutment |

**SECTION 6 - SUPERSTRUCTURE**

| | |
|---|---|
| 6.05.01A - .03 | Bridge Deck Cross Sections |
| 6.06.01 - .04 | Substructure Clearances |
| 6.06.05 | Clear Zone Distances (Lc) |
| 6.06.05A | Curve Correction Factors (Kcz) |
| 6.11.01 | Modified Parabolic Crown Offsets |

**Figure B-48. Format of the table of contents of the *Bridge Design Guides* (MDOT 2018b)**

| | | |
|---|---|---|
| DRAWN BY: BLT<br>CHECKED BY: VZ<br>APPROVED BY: DAJ | MICHIGAN DEPARTMENT OF TRANSPORTATION<br>BUREAU OF HIGHWAY DEVELOPMENT<br>SLAB HAUNCH AND<br>REINFORCEMENT COVER | ISSUED: 12/22/11<br>SUPERSEDES: 11/27/01 |

**Figure B-49. Format of the *Bridge Design Guides* header (MDOT 2018b)**

### B.7.2 Rationale Behind Policies

The policy revisions/updates are listed in the *Monthly Updates* newsletters, which are organized by month and year (see Figure B-50). This method may be effective if the user is only looking for one specific change. However, if there is an interest for a comprehensive look at the changes made to one section over the years, users would have to go through all the *Monthly Updates* individually.

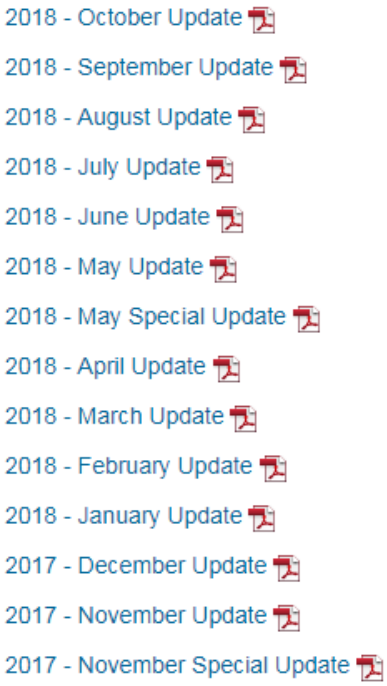



**Figure B-50. A partial list of the *Monthly Updates* newsletters (MDOT 2018c)**

Within the *Monthly Updates*, the changes are organized by the main publication (*Bridge Design Manual* or *Bridge Design Guides*) (see Figure B-51). For the *Bridge Design Manual*, policy number organizes the changes while the guide number organizes the revisions for the *Bridge Design Guides*. Hyperlinks for supporting documents are provided within the newsletter.

### B.7.3 Policy Implementation Guidelines

The manual is not detailed to provide implementation guidelines.

MDOT
Michigan Department of Transportation

# Road & Bridge Design Publications

Monthly Update – October 2018

Revisions for the month of **October** are listed and displayed below. New special details will be included in projects submitted for the **February** letting as is stated on the special detail index sheets. E-mail road related questions on these changes to MDOT-Road-Design-Standards@michigan.gov. E-mail bridge related questions to MDOT-Bridge-Design-Standards@michigan.gov.

## Special Details

24: Guardrail Anchored in Backslope: Revised the references for the anchor plate and cable assemblies (sheets three & four) from R-61-series to R-66-series.

R-66-E: Guardrail Departing Terminals: Added details for the anchor plate & cable assembly on sheet 2. Also, eliminated the references to R-61-series for these elements on sheets one & two.

## Road Design Manual

3.07.01B: Vehicle Characteristics: Revised the "design vehicle" that should be used in determining the radii for turning movements at trunkline to trunkline intersections and interchanges from a Michigan WB-62 to an AASHTO WB-67.

7.04.02: Temporary Pavement Markings: Replaced the section with a link to the Work Zone Safety and Mobility Manual. (6.01.13 – Temporary Pavement Markings)

7.04.04: Removing Permanent Pavement Markings: Replaced the section with a link to the Work Zone Safety and Mobility Manual. (6.01.13A – Pavement Marking Removal)

8.01 References: Updated the references based on current revisions.

8.02: General: Replaced the section with a link to the Work Zone Safety and Mobility Manual. (Chapter 1 – Introduction)

8.03: Maintaining Traffic Operations: Replaced the section with a link to the Work Zone Safety and Mobility Manual. (Chapter 2 – Transportation Management Plan, TMP)

8.04: Traffic Control Devices: Replaced the section with a link to the Work Zone Safety and Mobility Manual. (Chapter 6 – Traffic Control Devices and Implementation)

8.05: Specifications & 8.06: Procedures: Deleted these sections.

MDOT
Michigan Department of Transportation

Road & Bridge Design Publications

Monthly Update – October 2018

8.07: Non-Motorized Work Zone Safety and Mobility: Added a new section with a link to the Work Zone Safety and Mobility Manual. (Chapter 5 – Non-Motorized Work Zone Safety and Mobility)

14.60.05: AP Preconstruction Files: Added a bullet (a reminder) regarding proposals with multiple job numbers.

## Bridge Design Guides

6.20.04B: Updated * designation for clarity. Designers and detailers must compute the depth from the bottom of the sleeper slab to the lower limit of the aggregate base or the open graded drainage course. The minimum is 12" with shallower beams and 36" maximum with deeper beams, but the value can vary based on the top of abutment location.

Updates to MDOT Cell Library, Bridge Auto Draw Program, etc., may be required in tandem with some of this month's updates. Until such updates to automated tools can be made, it is the designer's/detailer's responsibility to manually incorporate any necessary revisions to notes and plan details to reflect these revisions.

**Figure B-51. Excerpt from a *Monthly Update* newsletter (MDOT 2018c)**

## B.8 MINNESOTA

The Minnesota Department of Transportation (MnDOT) presents their policies in the *Bridge Design Manual* and the *Bridge Details Manual*. The revisions to the design manual are recorded towards the end of the manual while the revisions to the details manual is located at the beginning of that manual.

### B.8.1 Policy Documentation

MnDOT uses the LRFD version of the *Bridge Design Manual*. The *Bridge Design Manual* is organized in broad chapters that are broken down several times into specific policies (see Figure B-52). The manual is updated multiple times per year as needed. The beginning of the manual contains background information on the workings of the department, as well as other information on general bridge specifics, such as definitions. The presentation of the text within the manual is shown in Figure B-53.



**Figure B-52. Format of the table of contents of the *Bridge Design Manual* (MnDOT 2017)**

***3.4 Live Loads [3.6]***

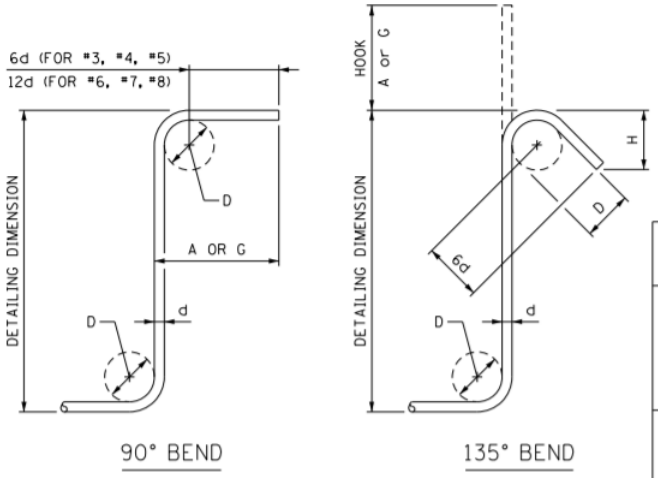
HL-93 is the designation for the calibrated design live load provided in the LRFD Specifications. It should be considered the normal design load for MnDOT highway structures.

For pedestrian bridges, in addition to the pedestrian live load, design for a maintenance vehicle live load equivalent to an H-5 truck for deck widths from 6 to 10 feet, and an H-10 truck for wider decks. Use of the dynamic load allowance is not required with the maintenance vehicle.

**Figure B-53. Bridge Design Manual format**

The standard design drawings are a separate file from the manual, however, some drawings are integrated within the design manual and are referenced within the text (see Figure B-54). There are no hyperlinks present when other parts of the manual or outside sources are referenced, except for websites, which makes navigating between referenced sources slower. There is also no mention of revisions within the main text of the manual, the only way to know whether a section has undergone revision is to go through the update archives that are listed in the memos and the update summaries located at the end of the design manual (see Figure B-55 for a sample memo).

The standard design drawings are located in the *Bridge Details Manual*. The beginning of the manual contains the drawing revisions and reapprovals (see Figure B-56).




| MINIMUM HORIZONTAL BAR SPACING (℄ TO ℄) | | |
|---|---|---|
| BAR SIZE | CONCRETE MIX: 1G52 AND 3B52 | CONCRETE MIX: 3JM, 3YHPC-M, 3YHPC-S, 3YLCHPC-M, 3YLCHPC-S, 3Y42, 3S52, 3Y82 AND 3W82 |
| 3 | 2⅝" | 1⅞" |
| 4 | 2¾" | 2" |
| 5 | 2⅞" | 2⅛" |
| 6 | 3" | 2¼" |
| 7 | 3⅛" | 2⅜" |
| 8 | 3¼" | 2½" |
| 9 | 3½" | 2⅞" |
| 10 | 3⅝" | 3¼" |
| 11 | 3¾" | 3⅝" |
| 14 | 4¼" | 4¼" |

SEE AASHTO LRFD 5.10.3.1

NOTE: MINIMUM HORIZONTAL BAR SPACING SHALL ALSO APPLY TO THE DISTANCE FROM A CONTACT LAP SPLICE TO ADJACENT SPLICES OR BARS.

| STIRRUP AND TIE HOOK DIMENSIONS | | | | |
|---|---|---|---|---|
| BAR SIZE | D | 90° HOOKS | 135° HOOKS | |
| | | A OR G | A OR G | H * |
| 3 | 1½" | 4" | 4" | 2½" |
| 4 | 2" | 4½" | 4½" | 3" |
| 5 | 2½" | 6" | 5½" | 3¾" |
| 6 | 4½" | 1'-0" | 8" | 4½" |
| 7 | 5¼" | 1'-2" | 9" | 5¼" |
| 8 | 6" | 1'-4" | 10½" | 6" |

**Figure B-54. Reinforcement data provided within the *Bridge Design Manual* (MnDOT 2017)**

**Minnesota Department of Transportation**

# Memo

**Bridge Office**
Mail Stop 610
3485 Hadley Ave.
Oakdale, MN 55128

Office Tel: (651)366-4506
Fax: 366-4497

September 18, 2008

To: Bridge Design Engineers

From: Kevin Western
Bridge Design Engineer

**MEMO TO DESIGNERS (2008-01): Prestressed Concrete Design – Calculation of Prestress Losses and Beam Camber & Deflection**

The prestress loss provisions adopted in the 2005 interims of the AASHTO LRFD Bridge Design Specifications provide loss estimates that are substantially lower than those of the previous provisions. A review by the Mn/DOT Bridge Office has resulted in the following policy for calculation of prestress losses:

1) Calculate the short term losses (elastic shortening losses) in accordance with AASHTO LRFD Article 5.9.5.2.3a or 5.9.5.2.3b as appropriate. Do not transform the strands. Also, do not include any elastic gains due to the application of loads.

**Figure B-55. A memo to designers describing policy changes**

## Bridge Details Manual Part I

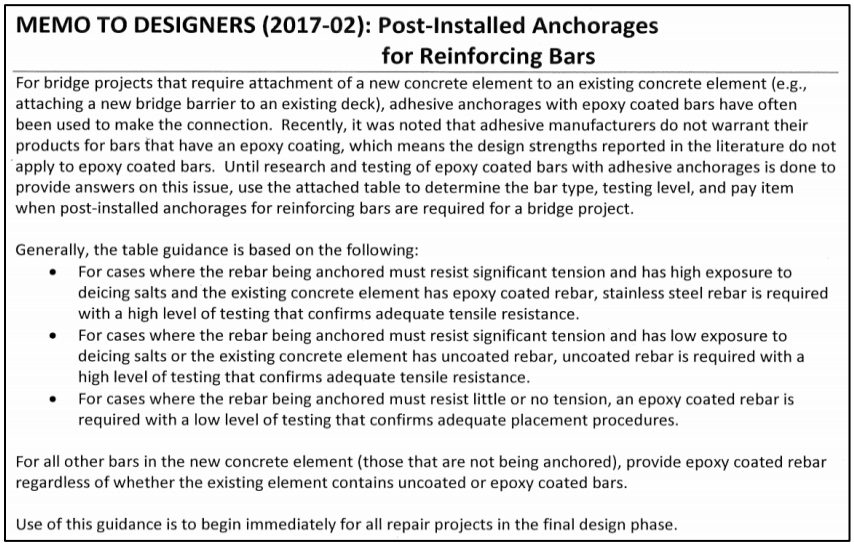
Questions? Contact leonard.barnes@state.mn.us.

| Bridge Details Manual Part I | Updated | | | |
|---|---|---|---|---|
| Download entire manual (PDF 3 MB) | May 10, 2017 | | | |
| **Bridge Nameplate** | **PDF** | **DGN** | **Approved** | **Revised** |
| New Bridges | B101 | B101 | Nov. 22, 2002 | Sept. 11, 2014 |
| Bridge Reconstruction | B102 | B102 | Nov. 22, 2002 | Sept. 11, 2014 |
| **Pile Splice** | **PDF** | **DGN** | **Approved** | **Revised** |
| Cast-In-Place Concrete Piles | B201 | B201 | Nov. 22, 2002 | Nov. 6, 2013 |
| Steel H Bearing Piles 10" to 14" | B202 | B202 | Nov. 22, 2002 | Nov. 6, 2013 |
| **Sole Plate** | **PDF** | **DGN** | **Approved** | **Revised** |
| Prestressed Concrete Beams (For Bearings with Pintles) | B303 | B303 | Sep. 22, 2011 | Jan. 5, 2017 |
| **Elastomeric Fixed Bearing Assembly** | **PDF** | **DGN** | **Approved** | **Revised** |
| Prestressed Concrete Beams (For Replacement of Inplace Bearings Only) | B304 | B304 | Nov. 22, 2002 | Jan. 5, 2017 |
| **Elastomeric Bearing Pad** | **PDF** | **DGN** | **Approved** | **Revised** |
| Prestressed Concrete Beams | B305 | B305 | Nov. 22, 2002 | May 10, 2017 |
| **Tapered Bearing Plate Assembly** | **PDF** | **DGN** | **Approved** | **Revised** |
| For Integral Abutment or Piers with Continuity Diaphragms | B309 | B309 | Nov. 3, 2015 | Nov. 3, 2015 |
| **Curved Plate Bearing Assembly** | **PDF** | **DGN** | **Approved** | **Revised** |
| Prestressed Concrete Beams (Fixed) | B310 | B310 | Nov. 3, 2015 | Jan. 5, 2017 |
| Prestressed Concrete Beams (Expansion) | B311 | B311 | Nov. 3, 2015 | Nov. 3, 2015 |
| Steel Beams (Fixed) | B354 | B354 | Nov. 3, 2015 | Nov. 3, 2015 |
| Steel Beams (Expansion) | B355 | B355 | Nov. 3, 2015 | Nov. 3, 2015 |
| **Pot Type Bearing Assembly** | **PDF** | **DGN** | **Approved** | **Revised** |
| Prestressed Concrete Beams (Guided Expansion) | B312 | B312 | Nov. 3, 2015 | Nov. 3, 2015 |
| Prestressed Concrete Beams (Non-guided Expansion) | B313 | B313 | Nov. 3, 2015 | Nov. 3, 2015 |
| Steel Beams (Guided Expansion) | B314 | B314 | Nov. 3, 2015 | Nov. 3, 2015 |
| Steel Beams (Non-guided Expansion) | B315 | B315 | Nov. 3, 2015 | Nov. 3, 2015 |
| Steel Beams (Fixed) | B316 | B316 | Nov. 3, 2015 | Nov. 3, 2015 |

**Figure B-56. Standard design drawings showing the approved and revised dates (MnDOT 2018a)**

### B.8.2 Rationale Behind Policy

At the end of the bridge design manual are *MEMO TO DESIGNERS* and update summaries. The memos contain a detailed summary of the changes that need to be made to the manual, as well as the reasoning behind those change requests (Figure B-57); they are organized by date. The update summaries state which parts of the manual have been updated and gives instructions on which parts are to be removed or where to insert new pages of a manual (see Figure B-58).



**MEMO TO DESIGNERS (2017-02): Post-Installed Anchorages for Reinforcing Bars**

For bridge projects that require attachment of a new concrete element to an existing concrete element (e.g., attaching a new bridge barrier to an existing deck), adhesive anchorages with epoxy coated bars have often been used to make the connection. Recently, it was noted that adhesive manufacturers do not warrant their products for bars that have an epoxy coating, which means the design strengths reported in the literature do not apply to epoxy coated bars. Until research and testing of epoxy coated bars with adhesive anchorages is done to provide answers on this issue, use the attached table to determine the bar type, testing level, and pay item when post-installed anchorages for reinforcing bars are required for a bridge project.

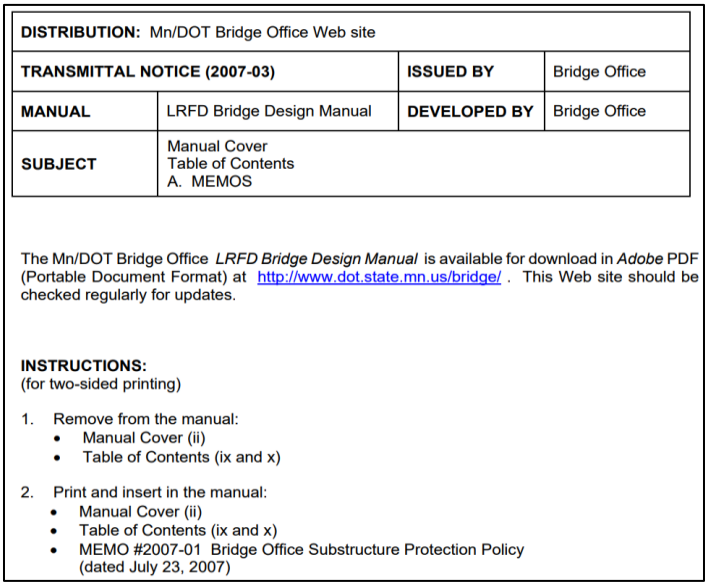
Generally, the table guidance is based on the following:

- For cases where the rebar being anchored must resist significant tension and has high exposure to deicing salts and the existing concrete element has epoxy coated rebar, stainless steel rebar is required with a high level of testing that confirms adequate tensile resistance.
- For cases where the rebar being anchored must resist significant tension and has low exposure to deicing salts or the existing concrete element has uncoated rebar, uncoated rebar is required with a high level of testing that confirms adequate tensile resistance.
- For cases where the rebar being anchored must resist little or no tension, an epoxy coated rebar is required with a low level of testing that confirms adequate placement procedures.

For all other bars in the new concrete element (those that are not being anchored), provide epoxy coated rebar regardless of whether the existing element contains uncoated or epoxy coated bars.

Use of this guidance is to begin immediately for all repair projects in the final design phase.

**Figure B-57. Example of a memo addressing the design unit and containing the rationale behind required changes (MnDOT 2017)**



| | | | |
|---|---|---|---|
| **DISTRIBUTION:** Mn/DOT Bridge Office Web site | | | |
| **TRANSMITTAL NOTICE (2007-03)** | | **ISSUED BY** | Bridge Office |
| **MANUAL** | LRFD Bridge Design Manual | **DEVELOPED BY** | Bridge Office |
| **SUBJECT** | Manual Cover<br>Table of Contents<br>A. MEMOS | | |

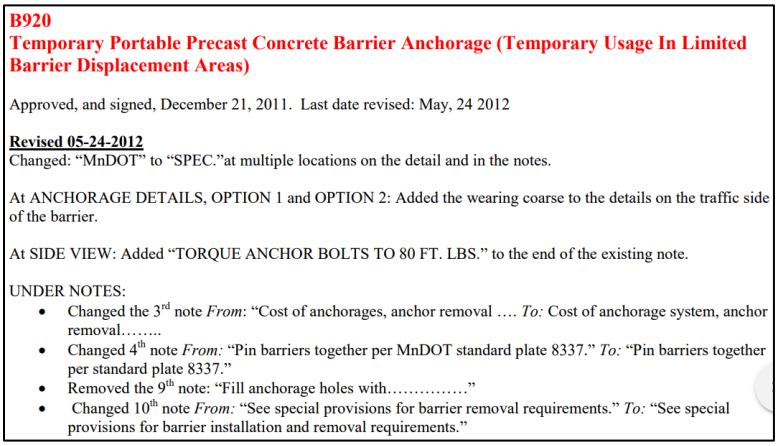
The Mn/DOT Bridge Office *LRFD Bridge Design Manual* is available for download in *Adobe* PDF (Portable Document Format) at http://www.dot.state.mn.us/bridge/ . This Web site should be checked regularly for updates.

**INSTRUCTIONS:**
(for two-sided printing)

1. Remove from the manual:
   - Manual Cover (ii)
   - Table of Contents (ix and x)
2. Print and insert in the manual:
   - Manual Cover (ii)
   - Table of Contents (ix and x)
   - MEMO #2007-01 Bridge Office Substructure Protection Policy (dated July 23, 2007)

**Figure B-58. Example of an updated summary showing a general overview of revisions in the manuals (MnDOT 2017)**

In the *Bridge Detail Manual*, the changes are organized in chronological order according to section. Again, only the changes were recorded, not the rationale behind them (see Figure B-59).



**B920**
**Temporary Portable Precast Concrete Barrier Anchorage (Temporary Usage In Limited Barrier Displacement Areas)**

Approved, and signed, December 21, 2011. Last date revised: May, 24 2012

**Revised 05-24-2012**
Changed: "MnDOT" to "SPEC."at multiple locations on the detail and in the notes.

At ANCHORAGE DETAILS, OPTION 1 and OPTION 2: Added the wearing coarse to the details on the traffic side of the barrier.

At SIDE VIEW: Added "TORQUE ANCHOR BOLTS TO 80 FT. LBS." to the end of the existing note.

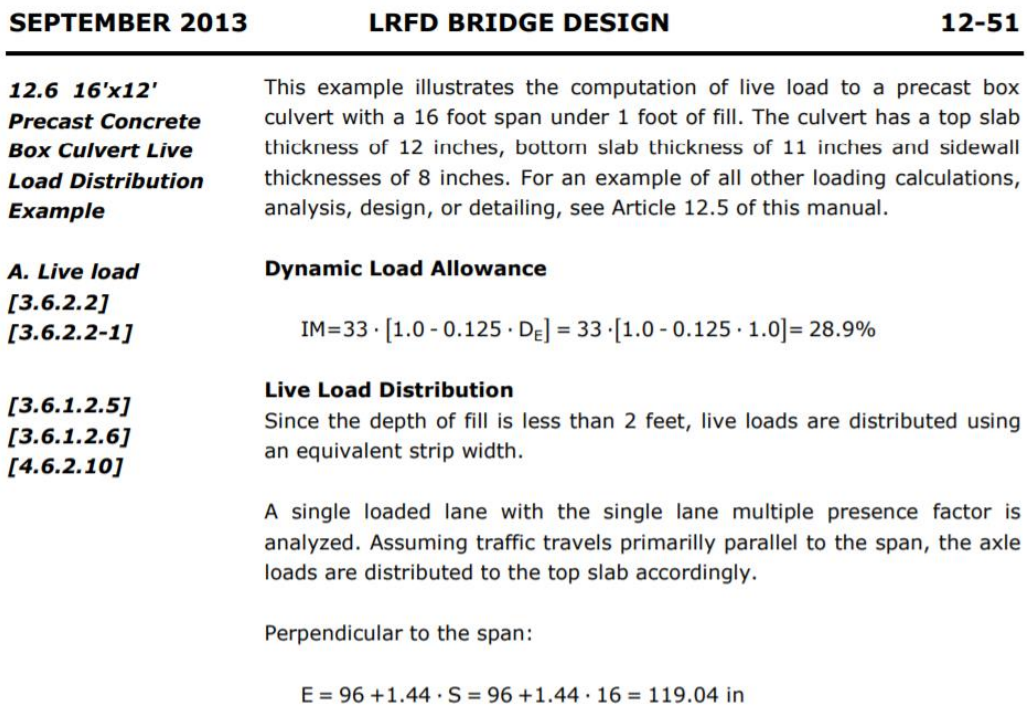
UNDER NOTES:

- Changed the 3rd note *From*: "Cost of anchorages, anchor removal …. *To:* Cost of anchorage system, anchor removal……..
- Changed 4th note *From:* "Pin barriers together per MnDOT standard plate 8337." *To:* "Pin barriers together per standard plate 8337."
- Removed the 9th note: "Fill anchorage holes with……"
- Changed 10th note *From:* "See special provisions for barrier removal requirements." *To:* "See special provisions for barrier installation and removal requirements."

**Figure B-59. Example of a change recorded in the Bridge Detail Manual (MnDOT 2018b)**

## B.8.3 Policy Implementation Guidelines

The design manual contains a large number of examples (Figure B-60), drawings (Figure B-54), and other information that can serve as policy implementation guidelines.



**SEPTEMBER 2013** **LRFD BRIDGE DESIGN** **12-51**

***12.6 16'x12' Precast Concrete Box Culvert Live Load Distribution Example***

This example illustrates the computation of live load to a precast box culvert with a 16 foot span under 1 foot of fill. The culvert has a top slab thickness of 12 inches, bottom slab thickness of 11 inches and sidewall thicknesses of 8 inches. For an example of all other loading calculations, analysis, design, or detailing, see Article 12.5 of this manual.

***A. Live load [3.6.2.2] [3.6.2.2-1]***

**Dynamic Load Allowance**

$$IM = 33 \cdot [1.0 - 0.125 \cdot D_E] = 33 \cdot [1.0 - 0.125 \cdot 1.0] = 28.9\%$$

***[3.6.1.2.5] [3.6.1.2.6] [4.6.2.10]***

**Live Load Distribution**

Since the depth of fill is less than 2 feet, live loads are distributed using an equivalent strip width.

A single loaded lane with the single lane multiple presence factor is analyzed. Assuming traffic travels primarilly parallel to the span, the axle loads are distributed to the top slab accordingly.

Perpendicular to the span:

$$E = 96 + 1.44 \cdot S = 96 + 1.44 \cdot 16 = 119.04 \text{ in}$$

**Figure B-60. Example calculation provided in the *Bridge Design Manual***

### B.8.4 Update/Revision Workflow

The implementation of policies from the bridge design manual follows a strict hierarchy. The Bridge Office Organization, which is headed by the State Bridge Engineer, has numerous units that are each assigned specific tasks (see Figure B-61). There are also detailed schedule requirements for deadlines, as well as timelines for projects. Most importantly, the manual contains a flowchart showing the process for approval of new or revised standards that starts at the point where a request for a standard is made, and ends with the publication of the standard (see Figure B-62).

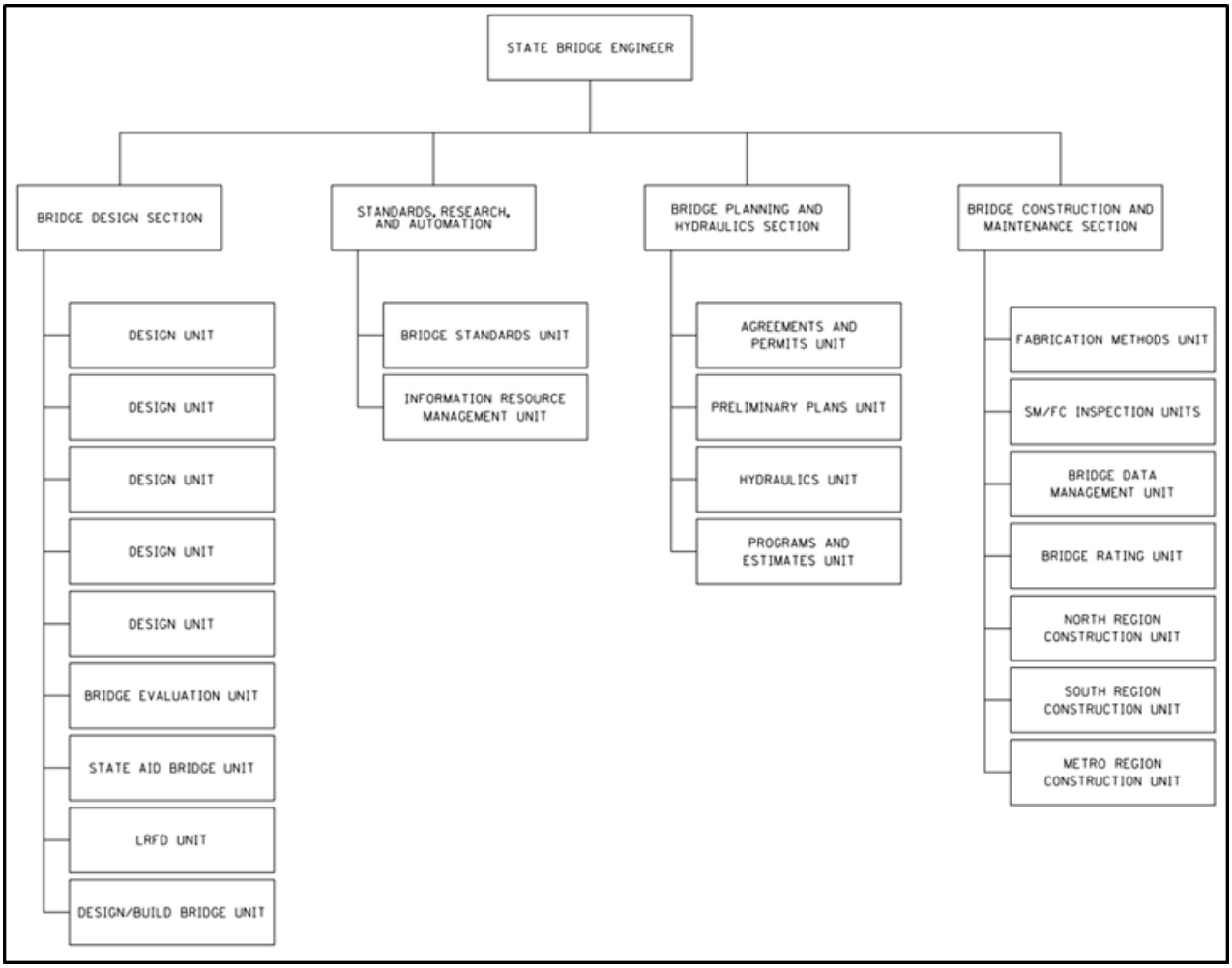



**Figure B-61. The divisions in the MnDOT Bridge Office Organization**

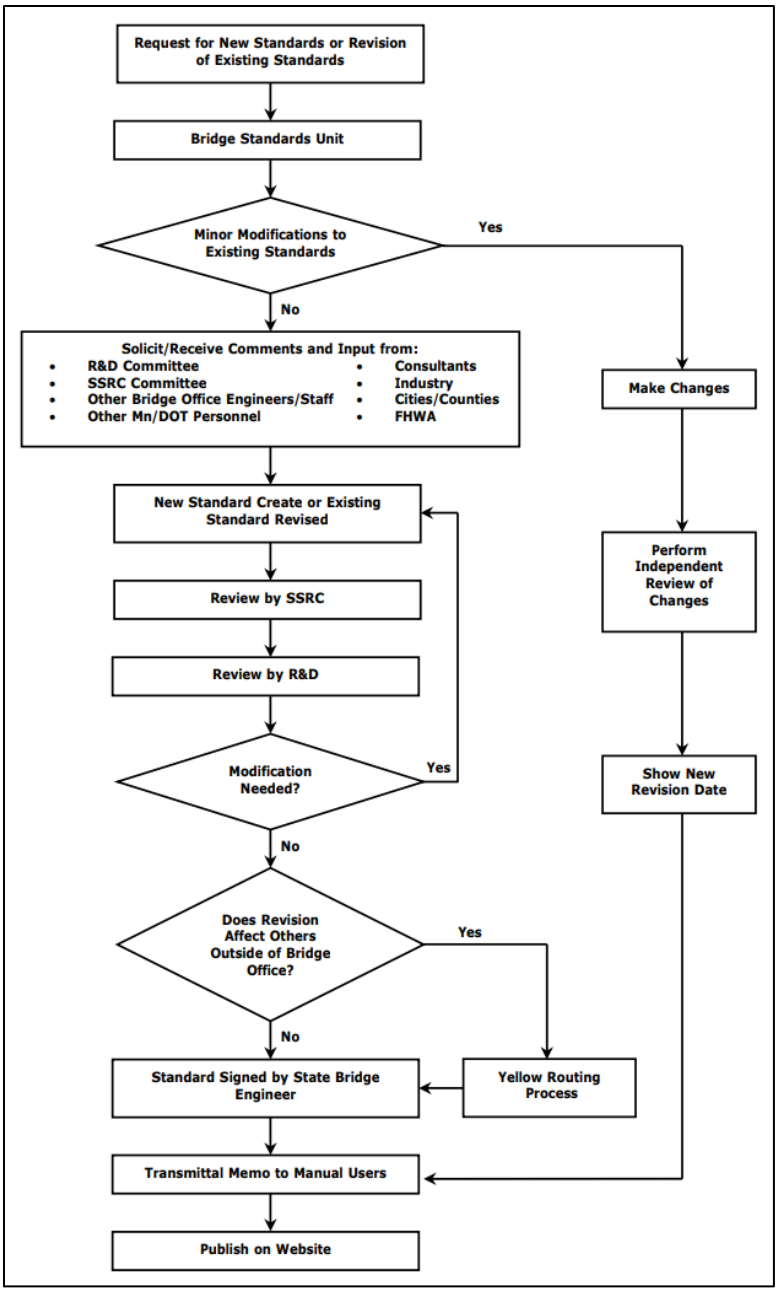



**Figure B-62. The flowchart showing the workflow process for the creation and/or revision of standards**

## B.9 MISSISSIPPI

The Mississippi Department of Transportation (Mississippi DOT) has published information regarding bridge design policy in their *Bridge Design Manual* and in their *Standards*.

### B.9.1 Policy Documentation

The current *Bridge Design Manual* is the Version 6.1., the previous versions are not available. The date of last change to the files is listed for all the documents (see Figure B-63). The cover of the *Bridge Design Manual* includes a table that contains the history of manual revisions organized by date and reason (see Figure B-64). The table of contents has hyperlinks for all listed sections however, it does not have a numbering system, which creates a hassle when finding a particular section. The different levels of chapter organization are tabbed, which helps to differentiate between sections and subsections (see Figure B-65). The text within the *Bridge Design Manual* is organized in numbered lists that are separated by bolded headings.

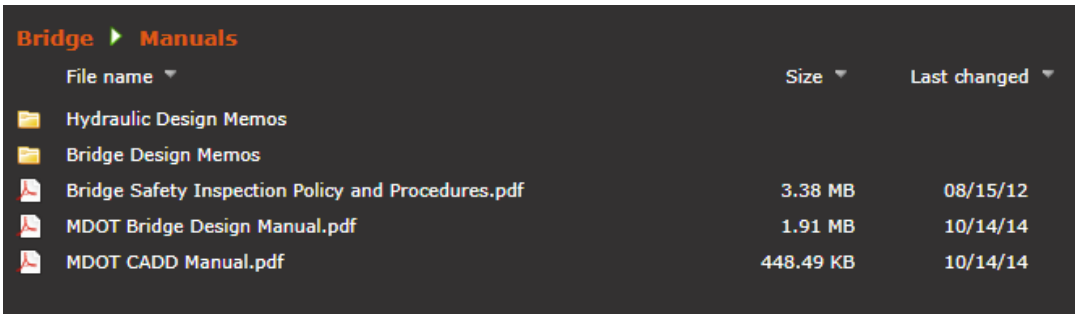



**Figure B-63. List of documents with last changed date (Mississippi DOT 2018)**

**BRIDGE DESIGN MANUAL**

To provide MDOT Bridge Design engineers a guide to the design criteria and detailing procedures for the preparation of contract bridge construction plans.

last modified (3.2010)

| REVISIONS | |
|---|---|
| DATE: | REASON: |
| 3/5/2010 | Added LRFD standards. |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**Figure B-64. History of BDM revisions (Mississippi DOT 2010)**

**Table Of Contents**



**Figure B-65. Excerpt of the organization of the sections and subsections within the table of contents (Mississippi DOT 2010)**

Some *Standard Design Detail Sheets* are included at the end of the manual, others are located separately under Standards.

### B.9.2 Rationale Behind Policies

A detailed list of memorandums related to bridge design (Bridge Design Memos) are available in PDF format with the last changed date indicated. A sample of a bridge design memo that indicates the person directed to, person who the memo is from, the date, and the details is shown in Figure B-67. However, the *Bridge Design Manual* is revised/updated without sending notice. No detailed revision history or a summary of rationale behind changes is given.

Bridge ▸ Manuals ▸ Bridge Design Memos

| File name | Size | Last changed |
|---|---|---|
| 0.6 Diameter Strands for Bulb Tee Beams.pdf | 8.81 KB | 08/02/12 |
| 1st Order Plans.pdf | 4.09 MB | 11/08/12 |
| 50ksi_Steel.pdf | 9.69 KB | 08/27/13 |
| Anchors in Direct Sustained Tension Applications.pdf | 8.92 KB | 02/09/12 |
| Beam Shear Steel Spacing Requirements.pdf | 61.59 KB | 08/15/12 |
| Bent Design.pdf | 15.34 KB | 01/23/14 |
| Closure Pour Requirement.pdf | 10.1 KB | 07/25/13 |
| Column Heights and Reinforcing.pdf | 8.99 KB | 02/21/12 |
| Column Hooked Bars into Caps.pdf | 41.13 KB | 07/31/13 |
| Detour Bridge_REV.pdf | 1004.27 KB | 12/10/14 |

**Figure B-66. List of Bridge Design Memos (Mississippi DOT 2018)**

# Bridge Design Memorandum

**To:** Bridge Design

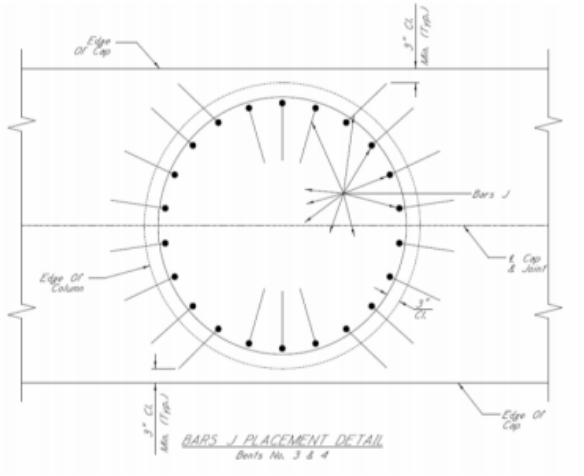
**From:** NJA/els

**Date:** 7/30/2013

**Re:** Column Hooked Bars (Scale Detail to verify placement workability)

---

As per NJA and JMW, designers shall develop a to-scale detail for the placement of the hooked bars projecting from columns into the cap. The detail should be drawn to scale in order to verify that the proposed placement will fit and does not cause undue difficulty in construction. Keep in mind that from a structural design perspective, we want to turn as many of these hooked bars outward as feasible.




Example Hooked Bar Placement Detail

**Figure B-67. Sample of the Bridge Design Memo (Mississippi DOT 2018)**

### B.9.3 Policy Implementation Guidelines

The bridge design manual is a very short document. It is supposed to be used in conjunction with the latest AASHTO LRFD Specifications. The manual provides design details (Figure B-68) and standard details. A separate *CADD Manual* is published with specific instructions for installing and using the bridge division CADD workspace in order to obtain uniformity and establish standard policies and procedures in the preparation of design and construction plans for highway structures (see Figure B-69).

## Span Design Details

**General**

1. Concrete used in slab shall be Class "AA" (4,000 psi). Reinforcing shall be Grade 60.
2. The design of longitudinal slab steel should start with #4 bars top & bottom then progress to larger bar sizes as required by design.
3. Transverse Slab Steel is typically #5 Bars. Transverse reinforcing consists of 'harped' bars (A bars) and straight bars (B & C bars). See Figure 8

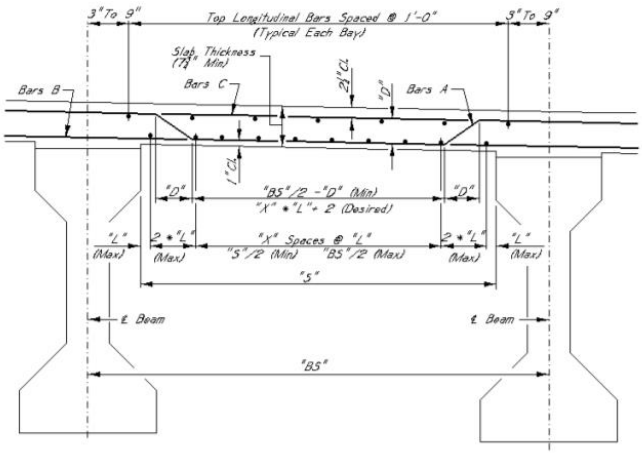



Figure 8: Guide for Reinforcing Slab of Bridge with Prestressed Concrete Beams

**Figure B-68. Sample details provided within the Bridge Design Manual**

## Drafting Practices

The purpose of this section is to provide guidelines for document preparation and submission for all digital bridge design plans submitted to or created in the Bridge Division.

### Drawing Units

The Bridge Division Workspace only recognizes English units. A summary of how this system is implemented in MicroStation is explained here.

Bridge Division uses Master Units of feet (') and Sub Units of inches ("). By clicking "Settings" -> "Design File" in the microstation menu, the Design File Settings window will open. The settings should appear in MicroStation as shown in the DGN File Settings window below.

**Figure B-69. Guidelines given in the *CADD Manual* (NMDOT 2009)**

## B.10 MONTANA

The Montana Department of Transportation (MDT) publishes the *Montana Structures Manual* and the *Bridge Design Standards*. The manual is published in two parts: Part I focuses on bridge projects in general, explaining the organization's roles and the workflow process. Part II focuses on the bridge design policies.

### B.10.1 Policy Documentation

The *Montana Structures Manual* is organized in a numerical system with topics being organized in subsections under general chapters. However, in Part I, the subsections are not as detailed as in the manuals of other states and no hyperlinks are provided. Only Part I can be downloaded as a complete PDF. Hence, the users have to manually go through each section of Part II to access the complete manual. Part II includes a detailed table of contents with subheadings listed as hyperlinks (see Figure B-70).

**Table of Contents**
(Continued)



**Figure B-70. Part of the detailed table of contents found in Part II of the manual (MDT 2002a)**

*Montana Structures Manual-Part II* is the part that focuses on bridge policies (Part I is discussed under the "Policy Implementation Guidelines" section). It is written in a two-column textbook-style format, the paragraphs of text makes it difficult to skim quickly and understand the policy (see Figure B-71). Chapters do include various equations and parameters, as well as some standard design details that are integrated within the manual. Chapter 25, which focuses on computer programs, shows screenshots of input and output screens that help users navigate through the software (see Figure B-72). However, there are no hyperlinks to other sections or outside sources provided throughout the manual.

**14.2 PERMANENT LOADS**

**14.2.1 General**

Reference: LRFD Article 3.5

The LRFD Specifications specify seven components of permanent loads, which are either direct gravity loads or caused by gravity loads. New in this group is downdrag, "DD," which is a negative load in driven piles or drilled shafts as a result of consolidation of soil through which they are driven or drilled. Prestressing is considered, in general, to be part of resistance of a component and has been omitted from the list of permanent loads in Section 3 of the Specifications. However, when designing anchorages for prestressing tendons, the prestressing force is the only load effect, and it should appear on the load side of the LRFD Equation.

As discussed previously in Section 14.1.4 and shown in Table 3.4.1-2 of the LRFD Specifications, there are maximum and minimum load factors for the permanent loads. The maximum or minimum permanent-load load factors should be selected to produce the more critical load effect. For example, in continuous superstructures with relatively short-end spans, transient live load in the end span causes the bearing to be more compressed while transient live load in the second span causes the bearing

**14.2.2 Uplift**

Reference: LRFD Article 3.4.1

In the former AASHTO Standard Specifications, uplift was treated as a separate load combination. With the introduction of maximum and minimum load factors in the LRFD Specifications, load situations such as uplift where a permanent load (in this case a dead load) reduces the overall force effect (in this case a reaction) have been generalized. Permanent load factors, either maximum or minimum, must be chosen for each load combination to produce extreme force effects.

Secondary forces from pre- or post-tensioning are included in the permanent load, EL. As specified in LRFD Table 3.4.1-2, a constant load factor of 1.0 should be used for both maximum and minimum load factors.

**14.2.3 Deck Slab**

Reference: LRFD Article 9.7.3

MDT uses the Traditional Design methodology outlined in Article 9.7.3 of the LRFD Specifications, unless otherwise approved by the Bridge Design Engineer. For bridge deck and slab design requirements, see Chapters 15 and 16 of this **Manual**.

**Figure B-71. Example of a typical section of the *Montana Structures Manual-Part II* (MDT 2002a)**

**Input Screen:**

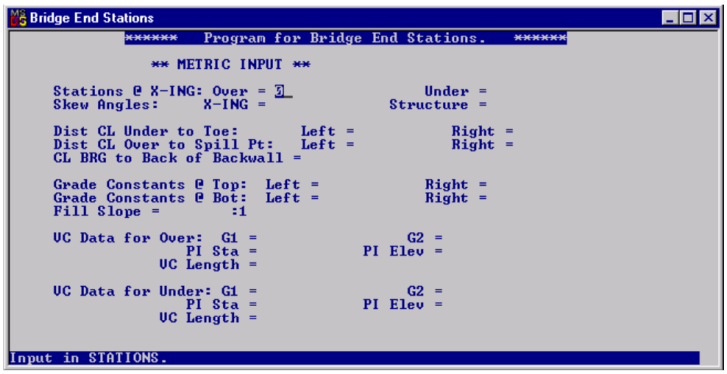
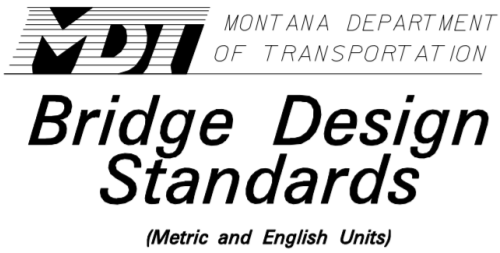



**Figure B-72. Example of a graphical user interface of a software presented in Chapter 25 of the *Montana Structures Manual-Part II* (MDT 2002b)**

The *Bridge Design Standards* is organized into standards and guidelines (Figure B-73). The majority of the document is written in a layered list format (Figure B-74).




(a) Cover page of the *Bridge Design Standards*

**Bridge Design Standards and Guidelines**

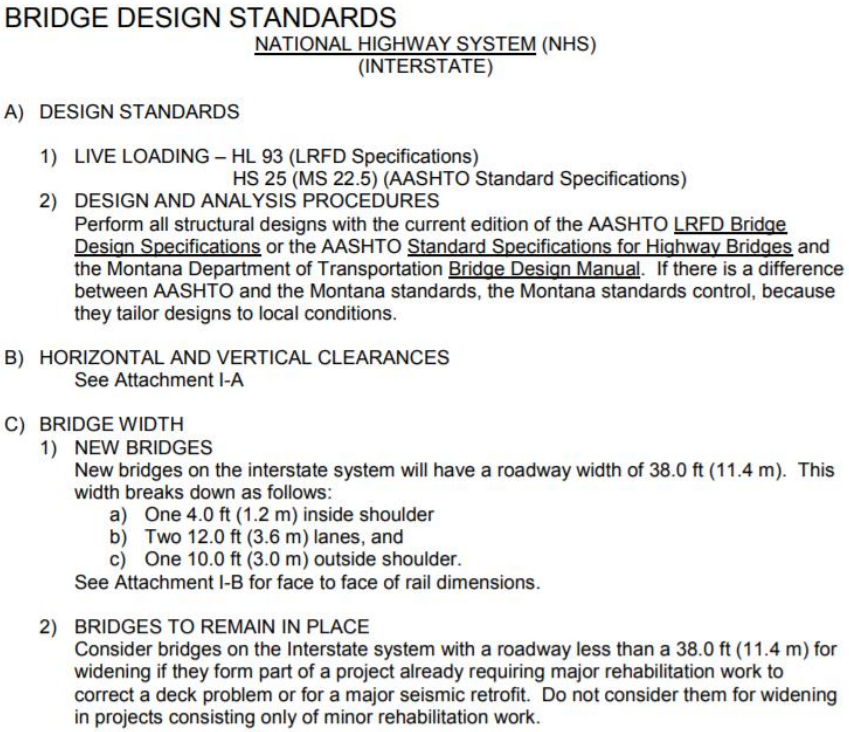
The following text and figures provide a summary of geometric design guidelines to assist the designer in preparing bridge plans. Consider the material as Standards for those projects with full Federal Oversight (those on the Interstate and NHS Systems) and as design guidelines for projects without full federal oversight. (STP, Secondary and Off-system projects)

Standards: Strict design policies that the designer must either follow or obtain a formal Design Exception to modify. The appropriate authority, usually the Road or Bridge Engineer, must grant and approve the Design Exception. The Design Exception request must include thorough justification of the reasoning for not meeting a standard. Right of Way availability and cost saving may form part of the discussion addressing design standards, but only as secondary issues. The primary focus must always remain the safety of the traveling public.

Guidelines: General rules that assist the designer to develop a project and to maintain similarity among projects, systems, and design teams. Guidelines provide flexibility within each design to allow incorporation of context-sensitive elements in the design. Document unusual design elements, including non-standard roadway geometry, bridge load capacity, or widths, and obtain agreement to their implementation in the Scope of Work Report. These variations from standards typically do not require formal Design Exceptions. The safety of the traveling public must take highest priority when considering approval of unusual or unique design features.

(b) Description of the content presented in the *Bridge Design Standards*

**Figure B-73. Description of the *Bridge Design Standards* content**



BRIDGE DESIGN STANDARDS

NATIONAL HIGHWAY SYSTEM (NHS)
(INTERSTATE)

A) DESIGN STANDARDS

1) LIVE LOADING – HL 93 (LRFD Specifications)
HS 25 (MS 22.5) (AASHTO Standard Specifications)

2) DESIGN AND ANALYSIS PROCEDURES
Perform all structural designs with the current edition of the AASHTO LRFD Bridge Design Specifications or the AASHTO Standard Specifications for Highway Bridges and the Montana Department of Transportation Bridge Design Manual. If there is a difference between AASHTO and the Montana standards, the Montana standards control, because they tailor designs to local conditions.

B) HORIZONTAL AND VERTICAL CLEARANCES
See Attachment I-A

C) BRIDGE WIDTH

1) NEW BRIDGES
New bridges on the interstate system will have a roadway width of 38.0 ft (11.4 m). This width breaks down as follows:
a) One 4.0 ft (1.2 m) inside shoulder
b) Two 12.0 ft (3.6 m) lanes, and
c) One 10.0 ft (3.0 m) outside shoulder.
See Attachment I-B for face to face of rail dimensions.

2) BRIDGES TO REMAIN IN PLACE
Consider bridges on the Interstate system with a roadway less than a 38.0 ft (11.4 m) for widening if they form part of a project already requiring major rehabilitation work to correct a deck problem or for a major seismic retrofit. Do not consider them for widening in projects consisting only of minor rehabilitation work.

**Figure B-74. Format of the *Bridge Design Standards***

## B.10.2 Rationale Behind Policies

*Montana Structures Manual-Part I* includes a systematic overview of the revision and review process. The process starts at the submission of the proposal to the Bridge Design Engineer and next to a four-person Review Committee, and then to the District Administrators if necessary. It then details that a memo of the changes is distributed to all manual holders. The Review Committee meets every three months, or as needed. The *Montana Structures Manual-Part I* also includes a list of responsibilities of the Review Committee, such as keeping a history of revisions in chronological order. A form is included for revision requests (see Figure B-75).

**MONTANA STRUCTURES MANUAL**
**(Revision Request)**

**Identification**

Date Submitted:

Section To Be Revised:

Section Title:

Page Number(s):

**Description of Revision**

List other sections of the Manual that would be affected by the revision:

A.
B.
C.

List the **Bridge Standard Drawings** that would be affected by the revision:

A.
B.
C.

**Justification For The Revision**

**Figure B-75. The Revision Request form found in *Montana Structures Manual-Part I (MDT 2004)***

### B.10.3 Policy Implementation Guidelines

*Montana Structures Manual-Part I* is organized in two-columns with the text mostly consisting of numbered lists (see Figure B-76). This part revolves mostly around the organization and how the bridge design process should be carried out. It provides an organizational flowchart of MDT that shows where each person involved in the design process falls within the organization's hierarchy (see Figure B-77).

#### 1.4.4.2 Contract Plans Bureau

The Contract Plans Bureau develops the PS&E (plans, specifications and estimate) for highway project lettings to contract. Specific responsibilities of the Bureau include:

1. preparing the work sheets to properly identify the Department and FHWA codes, funding splits, etc., for all contract items;

2. reviewing the project plans to ensure that they meet Department and FHWA requirements and that they are suitable for bidding;

3. preparing the Proposal for each contract identifying the location, scope and requirements of the contract;

4. reviewing and editing the Special Provisions as necessary for any work, material or method of operation;

5. preparing the Engineer's Estimate;

6. preparing any necessary City/Town Agreements and/or County Resolutions; and

7. performing all necessary administrative work for bid letting.

#### 1.4.4.3 Construction Engineering Services Bureau

#### 1.4.4.4 Contractor Estimate Section

The Contractor Estimate Section processes all contract estimates — both progress and final — for submission to Accounting for payment, including reviewing the final estimates and supporting documentation and submitting the necessary documentation to FHWA to close out completed projects.

#### 1.4.4.5 Change Order and Utilities Section

The Change Order and Utilities Section processes change orders and utility work orders. The Section:

1. maintains files on utility agreements,

2. reviews and processes non-structural-related shop drawings,

3. prepares specifications for the purchase of surveying equipment,

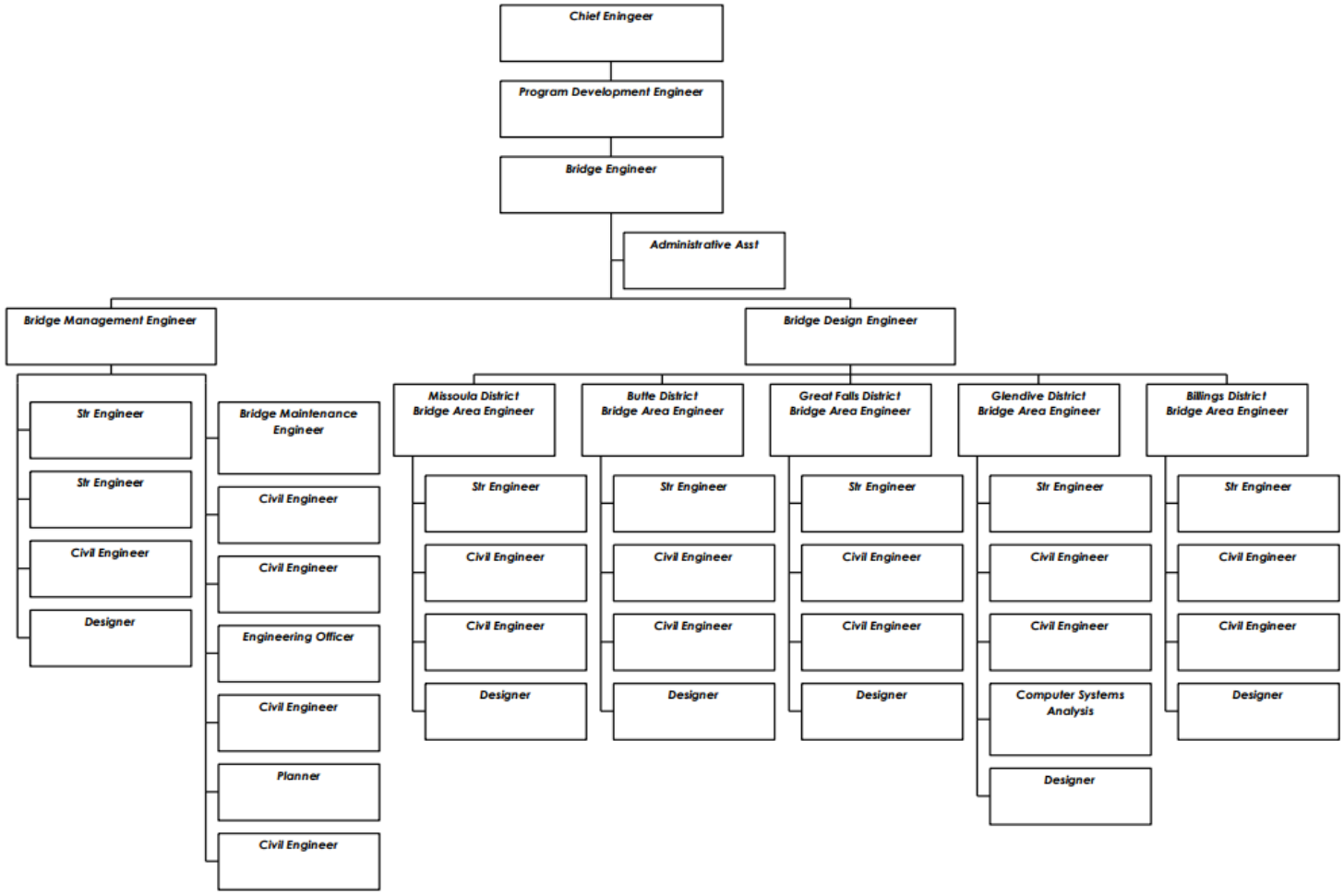
4. arranges for surveying equipment repairs,

5. maintains an inventory of equipment, and

6. supervises the monthly rental of Electronic Distance Measuring (EDM) equipment.

#### 1.4.4.6 Specifications Section

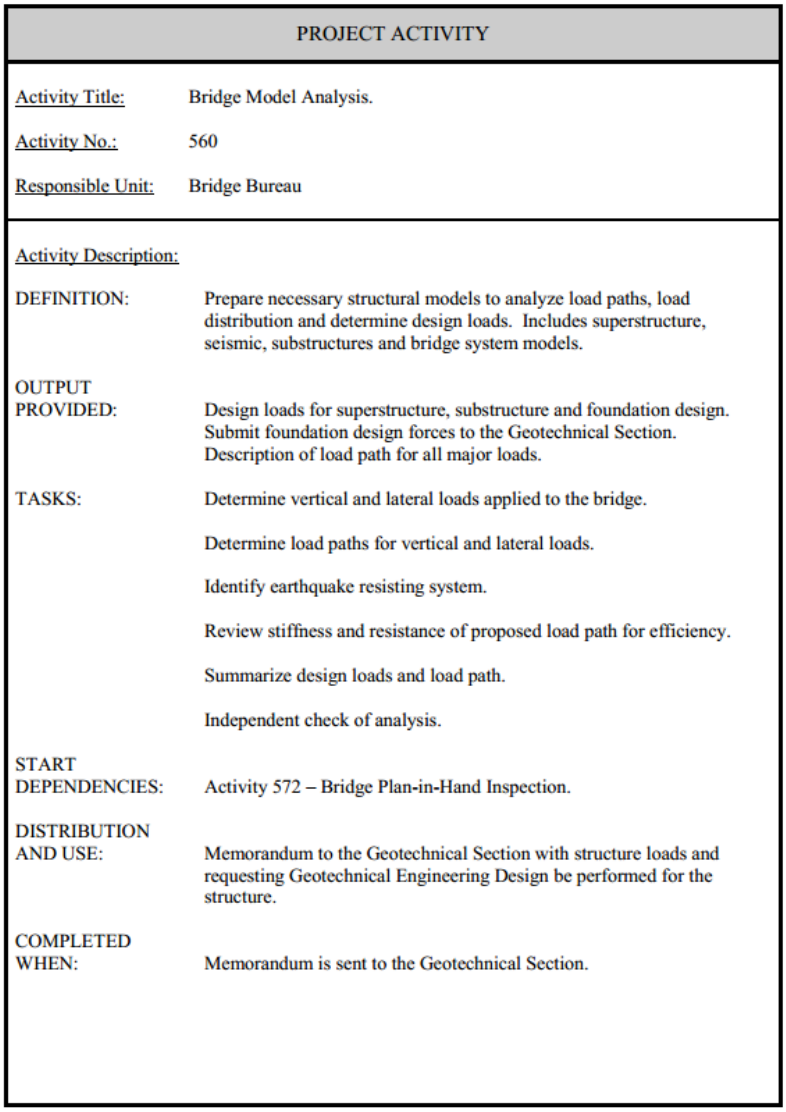
**Figure B-76. Typical format of the text of *Montana Structures Manual-Part I (MDT 2004)***




**MDT BRIDGE BUREAU**

**Figure B-77. Flowchart showing the organizational hierarchy of MDT for Bridge Bureau *(MDT 2004)***

*Montana Structures Manual-Part I* also provides a series of schematics that provide a systematic summary of the methods used to manage projects undergoing the design process (see Figure B-78). Each schematic lists the activity and then gives an overview of the activity, what the desired outcomes are, and what the tasks are, as well as the responsible units. Other parts of the *Montana Structures Manual-Part I* give detailed instructions on what to include in reports and other types of documentation. There are several template documents included to ensure consistency of documentation.



PROJECT ACTIVITY

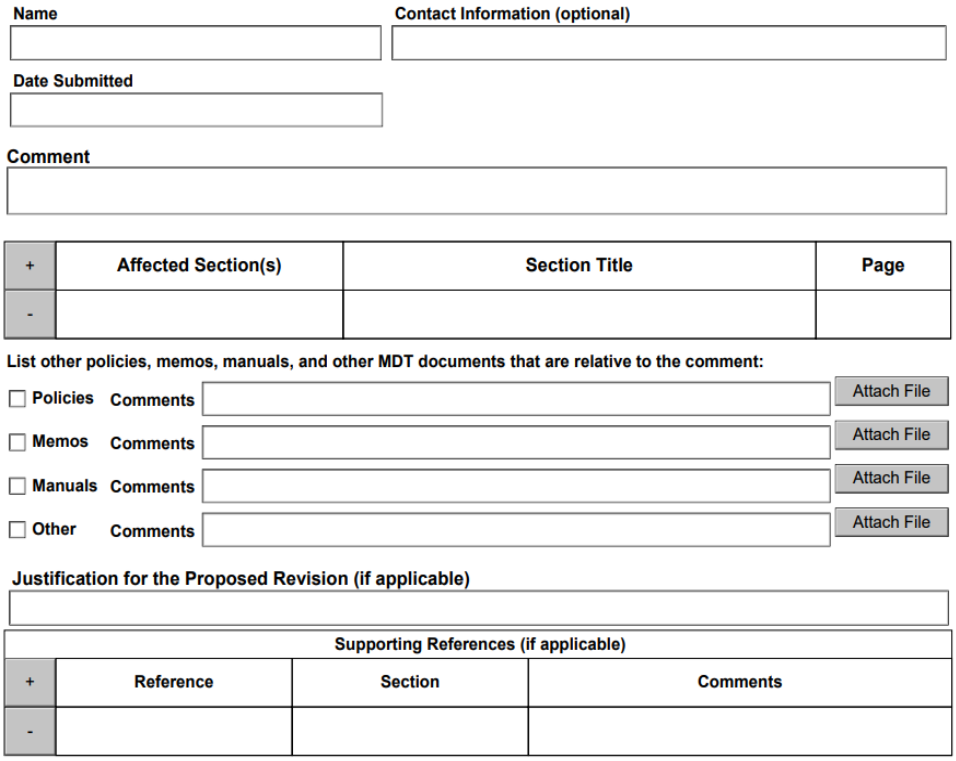
| | |
|---|---|
| Activity Title: | Bridge Model Analysis. |
| Activity No.: | 560 |
| Responsible Unit: | Bridge Bureau |

Activity Description:

| | |
|---|---|
| DEFINITION: | Prepare necessary structural models to analyze load paths, load distribution and determine design loads. Includes superstructure, seismic, substructures and bridge system models. |
| OUTPUT PROVIDED: | Design loads for superstructure, substructure and foundation design. Submit foundation design forces to the Geotechnical Section. Description of load path for all major loads. |
| TASKS: | Determine vertical and lateral loads applied to the bridge. |
| | Determine load paths for vertical and lateral loads. |
| | Identify earthquake resisting system. |
| | Review stiffness and resistance of proposed load path for efficiency. |
| | Summarize design loads and load path. |
| | Independent check of analysis. |
| START DEPENDENCIES: | Activity 572 – Bridge Plan-in-Hand Inspection. |
| DISTRIBUTION AND USE: | Memorandum to the Geotechnical Section with structure loads and requesting Geotechnical Engineering Design be performed for the structure. |
| COMPLETED WHEN: | Memorandum is sent to the Geotechnical Section. |

**Figure B-78. Example of the schematic that shows the bridge project workflow (*(MDT 2004)*)**

In response to the AASHTO Survey, Montana included the *Montana Department of Transportation Road Design Manual Comment Form*. The form is not a bridge design revision form like what several other states have published, however, the *Road Design Manual Comment Form* is similar in that it asks for what comments the user is reporting, what sections of the manual would be affected, and a rationale if the comment suggests a revision (see Figure B-79). Additionally, the form asks for a list of policies, memos, manuals, and other documents that would be affected by comments regarding the manual, as well as any references that support the user's comment (see Figure B-79). While the previously mentioned details are filled out by the user, there is also a section that is completed by the Road Design Manual Committee; this section acts as a record for the meeting where the comments are discussed and documents the date, attendees, the conclusions the meeting drew, and any follow-up actions that are required (see Figure B-80).


Name

Contact Information (optional)

Date Submitted

Comment

| + | Affected Section(s) | Section Title | Page |
|---|---|---|---|
| - | | | |

List other policies, memos, manuals, and other MDT documents that are relative to the comment:

Policies Comments Attach File

Memos Comments Attach File

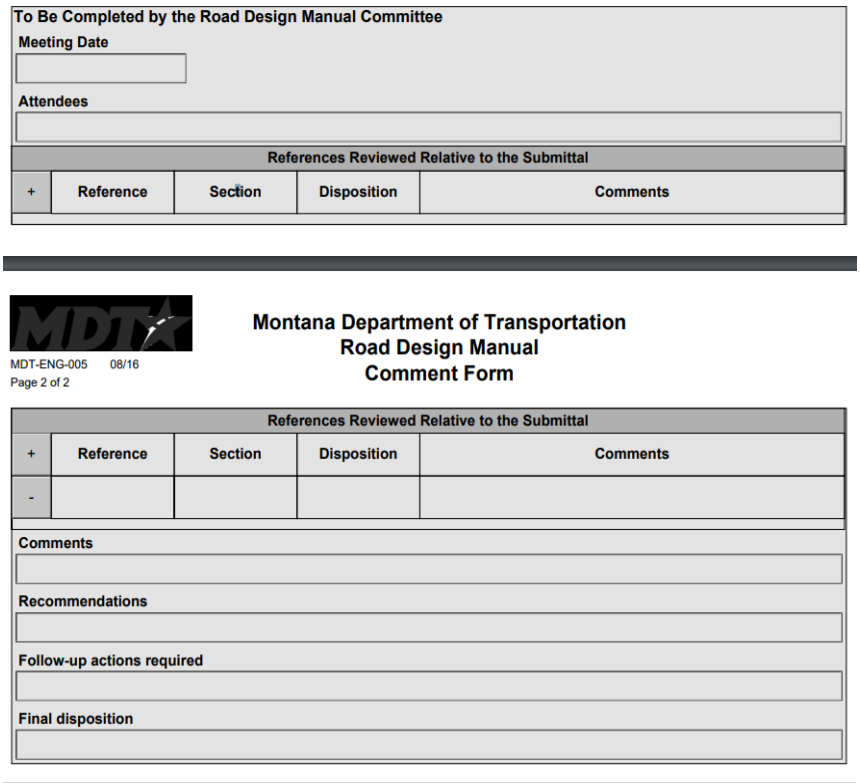
Manuals Comments Attach File

Other Comments Attach File

Justification for the Proposed Revision (if applicable)

| Supporting References (if applicable) | | | |
|---|---|---|---|
| + | Reference | Section | Comments |
| - | | | |

**Figure B-79. The portion of the *Road Design Manual Comment Form* to be filled by the user**



To Be Completed by the Road Design Manual Committee

Meeting Date

Attendees

| References Reviewed Relative to the Submittal | | | | |
|---|---|---|---|---|
| + | Reference | Section | Disposition | Comments |

MDT-ENG-005 08/16
Page 2 of 2

Montana Department of Transportation
Road Design Manual
Comment Form

| References Reviewed Relative to the Submittal | | | | |
|---|---|---|---|---|
| + | Reference | Section | Disposition | Comments |
| - | | | | |

Comments

Recommendations

Follow-up actions required

Final disposition

**Figure B-80. The portion of the Road Design Manual Comment Form that is filled by the Road Design Manual Committee**

## B.11 NEW HAMPSHIRE

New Hampshire Department of Transportation (NHDOT) organizes bridge design policy into the *Bridge Design Manual, Bridge Details, Bridge Detail Sheets*, and *Sample Plans*. The *Bridge Design Manual* contains the design policies while the *Bridge Details* and *Bridge Detail Sheets* include the design standards. The *Sample Plans* consists of documents that serve as guidelines and a self-check during the bridge design process.

### B.11.1 Policy Documentation

NHDOT has published two versions of their *Bridge Design Manual*, the first is a historical version from October 2000 (*Bridge Design Manual v1.0*) and the second is the current version that was published in January 2015 (*Bridge Design Manual 2.0*). While both versions are accessible as compiled PDFs, the newer one is also accessible in individual chapters. However, the *Bridge Design Manual 2.0* is not fully completed, there are completed, partially completed and incomplete chapters (see Figure B-81). Updates to the *Bridge Design Manual* (BDM) take place on an as-needed basis.

## Bridge Design Manual

- **Date Issued :** January 2015
- **Version:** v2.0
- **Full Manual:** Bridge Design Manual (pdf, xx MB) *(not completed)*
- **Individual Chapters:**

| Chapter | Description | Document Size | Revision Date | Revisions Made |
|---|---|---|---|---|
| | Cover | 324 KB | November 2018 | |
| | Table of Contents | 171 KB | November 2018 | |
| | Forward | 178 KB | February 2016 | |
| Chapter 1 | General Information | 6.2 MB | March 2016 | Revision History |
| Chapter 2 | Bridge Selection | 20.2 MB | August 2018 | Revision History |
| Chapter 3 | Preliminary Design Requirements | 1.4 MB | February 2016 | Revision History |
| Chapter 4 | Loads and Load Factors | 1.0 MB | March 2016 | Revision History |
| Chapter 5 | Seismic Design and Retrofit | 945 KB | | |
| Chapter 6 | Substructure | 14.4 MB | March 2016 | Revision History |
| Chapter 7 | Superstructure ***(partially completed)*** | 8.8 MB | November 2018 | Revision History |
| Chapter 8 | Concrete Structures ***(not completed)*** | | | |
| Chapter 9 | Miscellaneous Structures ***(not completed)*** | | | |
| Chapter 10 | Non-Bridge Structures | 10.0 MB | February 2016 | Revision History |
| Chapter 11 | Preparation of Plans | 3.4 MB | February 2016 | Revision History |
| Chapter 12 | Existing Bridges ***(not completed)*** | | | |
| Chapter 13 | Bridge Rating ***(not completed)*** | | | |
| Chapter 14 | Municipal Bridge Program ***(not completed)*** | | | |

- Updates to individual chapters of the Bridge Design Manual will take place as needed.
- **Manual Manager:**
  - Angela Hubbard, Project Engineer, NHDOT Bureau of Bridge Design
    angela.hubbard@dot.nh.gov

**Figure B-81. Status of the *Bridge Design Manual 2.0 (NHDOT 2015a)***

The *Bridge Design Manual* is organized by chapters denoted using a numerical system and these chapters are subdivided into sections following the corresponding chapter numbers (see Figure B-82). The appendices of each chapter are located at the end of each respective chapter. A table of contents for the chapter is given when the individual chapters are opened, no hyperlinks are provided.

## *Chapter 5 Seismic Design and Retrofit*



**Figure B-82. Chapter 5 table of contents *(NHDOT 2015b)***

The manual is written in a textbook-style format with brief paragraphs explaining the reasoning behind policies (see Figure B-83). Small illustrations and equations are provided to supplement the text. Appendices at the end of each chapter include samples of forms and different documents such as flowcharts and tables.

### 5.3 Rehabilitation of Existing Bridges

#### *5.3.1 General*

In general, retrofit work on piers and abutments will not be required. Most retrofit work shall consist of providing lateral restraint at bridge bearings and providing adequate seat width. The Department may require more extensive analysis and retrofit for major bridges, or if a unique situation exists. The decision to include seismic retrofit of piers and abutments will be made on a case-by-case basis by the Department. The level of seismic retrofitting that would be required for a particular rehabilitation or reconstruction project will be dependent on several factors such as ADT, importance of the bridge, age of the bridge, economic considerations, whether the bridge is on the Interstate, State, or Local System, etc.

When options for the designer are limited, providing adequate seat widths for an existing superstructure is a high priority over other potential retrofit measures; it is a key component of the Department's objective to prevent span loss. If attainment of adequate seat widths is not a practical option, using such measures as isolation bearings should be explored. To prevent significant transverse movement of the superstructure, concrete keeper blocks or steel keeper angles may be rigidly attached to the pier or abutment caps between the beams. When evaluating seismic retrofit options, all reasonable measures should be explored for possible implementation.

The following two FHWA reports should be used as guides for seismic retrofit of bridges:

- *Report No. FHWA-IP-87-6, "Seismic Design and Retrofit Manual for Highway Bridges"*
- *Report No. FHWA-RD-94-052, "Seismic Retrofitting Manual for Highway Bridges"*

**Figure B-83. Sample text showing the textbook-style format that includes some background information regarding the policy *(NHDOT 2015b)***

The *Bridge Details* show various standard design details that serve as "examples of items that are often used with very similar application from job to job." *Bridge Detail Sheets* are plan sheets that can be used on different NHDOT bridge projects.

### B.11.2 Rationale Behind Policies

Included in the *Bridge Details*, *Sample Plans*, *Bridge Detail Sheets*, and besides the individual chapters of the *Bridge Design Manual* are chapter revision histories (see Figure B-81). These histories are in a table format and are organized according to the date of revision and section. The table also includes a description of the revision for each revision and sometimes, has the background information on the change that serves as rationale. If a section was updated, then both the original and revised text is shown; the original text is in red and has a strikethrough (see Figure B-84).

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

BUREAU OF BRIDGE DESIGN

**BDM CHAPTER 3 - REVISION HISTORY**

| Date of Revision | Action | Location of Change | Revision Description | Background |
|---|---|---|---|---|
| 2/8/2016 | Appendix 3.2-A1. Replace all pages. | Appendix 3.2-A1, page 3.2-A1-1, 4 | Preliminary General Plan Elevation: Added bullet: "*Summary of Preliminary Bridge Quantities Table*"<br><br>Preliminary Estimate: Deleted bullet: "~~Account for tall abutments using projected quantities.~~" | Preliminary quantities are determined at preliminary plan stage for the preliminary estimate. |
| | Appendix 3.2-B1. Replace all pages. | Appendix 3.2-B1, page 3.2-B1-2 | Preliminary General Plan and Elevation: Added: Summary of Preliminary Bridge Quantities Table | Preliminary quantities are determined at preliminary plan stage for the preliminary estimate. |
| | | | | |

**Figure B-84. Example showing the revision history of a chapter in *Bridge Design Manual 2.0 (NHDOT 2016)***

NHDOT has two types of Design Memorandums: *Active Memorandums* and *Inactive Memorandums*. As shown in Figure B-86, *Active Memorandums* "are issued as interim updates to the Bridge Design Manual" (NHDOT 2015a). "They supersede the contents of the Manual and

will remain in effect until superseded by a chapter revision." (NHDOT 2015a). Inactive Memorandums are updates that have been incorporated into the latest revision of the BDM (see Figure B-87). They are provided to document and clarify the evolution of the Manual. Both types of memorandum are organized by date and record changes made to the *Bridge Design Manual*, *Bridge Details*, and *Bridge Detail Sheets*. A list of memorandums is provided in a tabular format with subject, date of issue, issue number, and a hyperlink to the relevant document (see Figure B-85). The specific parts of each publication that is being modified is listed, following by a summary of what is being changed; the summary includes some rationale as it notes when revisions are made due to NHDOT policies having been changed. The summary is followed by a background information section that provides information to identify the rationale. The memorandums also include copies of the revised design details that show which ones have been changed or are new.

## Design Memorandums

**Active Memorandums**

Design Memorandums are issued as interim updates to the Bridge Design Manual. They supersede the contents of the Manual and will remain in effect until superseded by a chapter revision.

| Number | Date | Subject |
|---|---|---|
| 2018-03 | 5/15/2018 | Temporary Barrier for Bridge Projects |
| 2018-01 | 1/25/2018 | Revised Cast-in-Place Deck Haunch Detail, Prestressed Partial-Depth Concrete Deck Panel |
| 2017-01 | 10/27/2017 | LRFD Design for OHSS, ITS Supports and their Foundations; Straight Anchor Rods for Foundations |
| 2016-01 | 3/14/2016 | Bridge Railing Bending Requirements |
| 2014-02 | 6/12/2014 | Discontinuance of Aluminum Bridge and Approach Rail |
| 2011-01 | 3/2011 | Deck and Box Beams |

**Inactive Memorandums**

These memorandums have been incorporated into the latest revision of the Bridge Design Manual. They are provided to document and clarify the evolution of the Manual.

| Number | Date | Subject |
|---|---|---|
| 2018-02 | 4/4/2018 | Preformed Closed Cell Expansion Joints |
| 2017-02 | 12/12/2017 | Cast-in-Place Deck Haunch Detail, Prestressed Partial-Depth Concrete Deck Panel |
| 2014-02 | 3/04/2014 | Bridge Deck Expansion Joints |
| 2014-01 | 1/21/2014 | Bridge Design Website Changes |
| 2013-01 | 3/20/2014 | Vehicular Collision Pier Protection |
| 2012-01 | 3/20/2014 | Sign Structures |
| | 10/01/2004 | Deflection Notice |

**Figure B-85. Active and inactive design memorandums available on the web *(NHDOT 2015a)***

## STATE OF NEW HAMPSHIRE
**BRIDGE DESIGN MEMORANDUM**



**FROM:** Peter E. Stamnas, PE
Administrator

**DATE:** March 14, 2016
**AT (Office):** Bureau of Bridge Design

**SUBJECT:** **Design Memorandum 2016-01**
**Bridge Railing Bending Requirements**

**TO:** **Bureau of Bridge Design staff, Bridge Design Consultants, FHWA, NHDOT Bureaus**

The Bureau of Bridge Design is updating the Bridge Design Manual. During this process, certain design decisions are being issued for immediate implementation as noted by the following:

**A. 2016 Standard Specifications for Road and Bridge Construction, Section 563 – Bridge Railing:**

The following has been added to the 2016 Standard Specifications:

**3.2 Fabrication.**

**3.2.1** Shop fabrication drawings shall be submitted for approval in accordance with 105.02.

**3.2.1.1** The shop fabrication drawings shall show the lengths of all individual rail sections and locations of all field splices. Rail sections shall be supplied in continuous lengths as shown or specified on the plans. Butt welding of short pieces of rail to form the specified continuous length of rail section will not be permitted. Butt splices, if approved, shall be made in the shop with complete joint penetration (CJP) groove welds and inspected by ultrasonic testing.

**3.2.1.2** Horizontally-curved rail sections shall be shop bent to form a smooth curve, unless approved otherwise. It is required to secure the services of a specialty bend facility to do the work, as necessary, for small radii (e.g., less than 50 feet). Curvatures with radii less than seven feet may be achieved by miter cut and welding the tube in chords lengths appropriate for the bend. A "miter-cut-and-weld" joint, where three sides of a tube are cut, the fourth side bent, and the cut edges welded with a backing bar, is considered to be a CJP. Curvature for T101 bridge rail tubes may be achieved with miter-cut-and-weld joints for radii less than 20 feet, if approved, since the tubes are hidden from view.

**B. Summary:**

The above noted revisions are being implemented to specify the following:

- The steel bridge rail can be bent for radii ≥ 50-ft. by all steel Fabricators.
- If the bridge rail radii is between 7-ft. and 49-ft., it requires the rail to be sent to a specialty shop to be bent. This will require additional cost in which the Contractor should include in the bid price. A note shall be put on the Bridge Rail Layout plan noting, "Shop bend only. No butt splices permitted."
- If the bridge rail radii < 7-ft., the curvature can be obtained by miter-cut-and-welding the tube, if approved by the Design Chief. A miter-cut-and-weld detail should be shown on the plans. Confirm the shop plans show the bridge railing is structural tubing welded together and *not* individual plates welded together to form a tube.
- The Department prefers the bridge rail to be designed for a shop bent smooth curve.
- Since the steel rail Fabricator may not notice the new wording in the 2016 Spec. Book, the Fabricator shop plans should be *carefully* reviewed so that they show what was called for on the plans. If the Contract Plans show a radii between 7 and 49-ft. and the Fabricator shop plans show the tubes with butt splices that weren't called for on the plans, the shop plans should be "marked up" to require the tubes be sent to a specialty shop to be bent (no miter-cut and weld joints). Reference Section 563.3.2 of the 2016 Spec. Book.

## STATE OF NEW HAMPSHIRE
**BRIDGE DESIGN MEMORANDUM**



- No additional wording has been put on the standard plans.
- The T101 rail tubes are hidden from view, so miter-cut and weld joints may be used.

**C. Background:**

This memorandum incorporates the changes to information available at the NHDOT Bridge Design Website in accordance with the changes being made to the Bridge Design Manual.

NHDOT bridge plans have been showing steel rail bend dimensions that cannot be done without sending to a specialty shop. The steel bridge rail shop plans have been showing miter-cut-and-weld joints for the radii because the Contractor was not notified that a specialty shop bend was required. After speaking with steel Fabricators to determine their bending limitations, the specification for bridge railing was updated to note NHDOT's policy. The new wording in the specification provides guidance to the designer and Fabricator.

This Memorandum clarifies NHDOT's policy for the design and fabrication of steel bridge railing that shall be included in the contract plans.

**D. Implementation:**

The update to the Bridge Design Manual shall be implemented as of the date of this memo and shall be used on all applicable projects.

Peter E. Stamnas, PE
Administrator, Bureau of Bridge Design

**Figure B-86. Example of an active design memorandum (*(NHDOT 2015a)*)**

## STATE OF NEW HAMPSHIRE

1 of2

**BRIDGE DESIGN MEMORANDUM**

**FROM:** Mark W. Richardson, PE
Administrator

**DATE:** January 21,2014
**AT (Office):** Bureau of Bridge Design

**SUBJECT:** **Design Memorandum 2014-01**
**NHDOT- Bridge Design Website Changes**

**TO:** **Bureau of Bridge Design staff, Bridge Design Consultants, FHWA, NHDOT Bureaus**

The Bureau of Bridge Design is updating the Bridge Design Manual and web site. During this process, certain completed sections are being issued for immediate implementation. Consequently, the Bridge Design Website has been modified as follows:

**A. Document Library: Bridge Drawings**

- New Bridge Details Sheets
- New Bridge Details
- New Sample Plans

**B. Summary:** The above noted revisions are being

- Bridge Design drawings on NHDOT Br
categories: (I) Bridge Detail Sheets, (2

- **Bridge Detail Sheets:** Bridge Detail S shire DOT for use on NHDOT projects. Oth own risk. The Detail Sheets are backed by engineering analysis, calculations, crash testing, and are approved by NHDOT Administrators and the Federal Highway Administration (FHWA). Only certain details can be modified by designers. As noted on each Detail Sheet, if any modifications are made to details other than those noted, the engineer responsible for the modification becomes the Engineer of Record (EOR) for those details and for all effects the modifications may have on other components within the sheet.

  The Bridge Detail Sheets are located at
  http://www.nh.gov/dot/org/projectdevelopment/bridgedesign/detailsheets/index.htm

- **Bridge Details:** The New Hampshire Department of Transportation (NHDOT) makes these documents available on an "as-is" basis. Bridge Details are considered nothing more than *examples* of items that are often used with very similar application from job to job. The details are intended to be copied to a project and *modified to fit* the particular aspects of the project. They are not intended to be included in a contract plan set without close scrutiny for correct application to the specific bridge or project..

  The Bridge Details are located at
  http://www.nh.gov/dot/org/projectdevelopment/bridgedesign/bridgedetails/index.htm

- **Sample Plans:** The Bureau of Bridge Design has assembled sample bridge plans and bridge plan checklists that can be used as an aide in the preparation of construction plans for bridges. The sample bridge plans and checklists are intended to be used only as a *general guide*, or reminder, to the designer, checker, and reviewer, and are not intended to be a replacement for the user's own professional judgment based on sound engineering principles. It is the responsibility of the designer to provide the details that allow the Contractor to construct the project as intended. The Bureau of Bridge Design makes these documents available on an "as

NHDOT Bridge Design
1/12/2015 9:43:16 AM

Memorandum is **inactive.**
See current NHDOT Bridge Design Manual.

## STATE OF NEW HAMPSHIRE

2 of2

**BRIDGE DESIGN MEMORANDUM**

is" basis. Details and items on the sample plans may be revised/updated overtime, and therefore, should be reviewed frequently. It is the responsibility of the designer to provide the most current details and items on the contract plans.

The Sample Bridge Plans are located at
http://www.nh.gov/dot/org/projectdevelopment/bridgedesign/sampleplans/index.htm

- The Bridge Design drawings will be updated as needed and the latest updated version will be placed on the website with the revision date noted.

**C. Background:**

This memorandum incorporates the changes to information available at the NHDOT Bridge Design Website in accordance with the changes being made to the Bridge Design Manual.

The efforts of the Department are judged to a great extent by the clarity, neatness, and accuracy of its Contract Plans. It is the intent of the Department to require that all drawings meet the NHDOT standards to produce clear, consistent, and effective plan sheets that have uniform appearance and accurate information.

**D. Implementation:**

The update to the NHDOT Bridge Design Website Drawings shall be implemented as of the date of this memo and shall be used on all applicable projects.

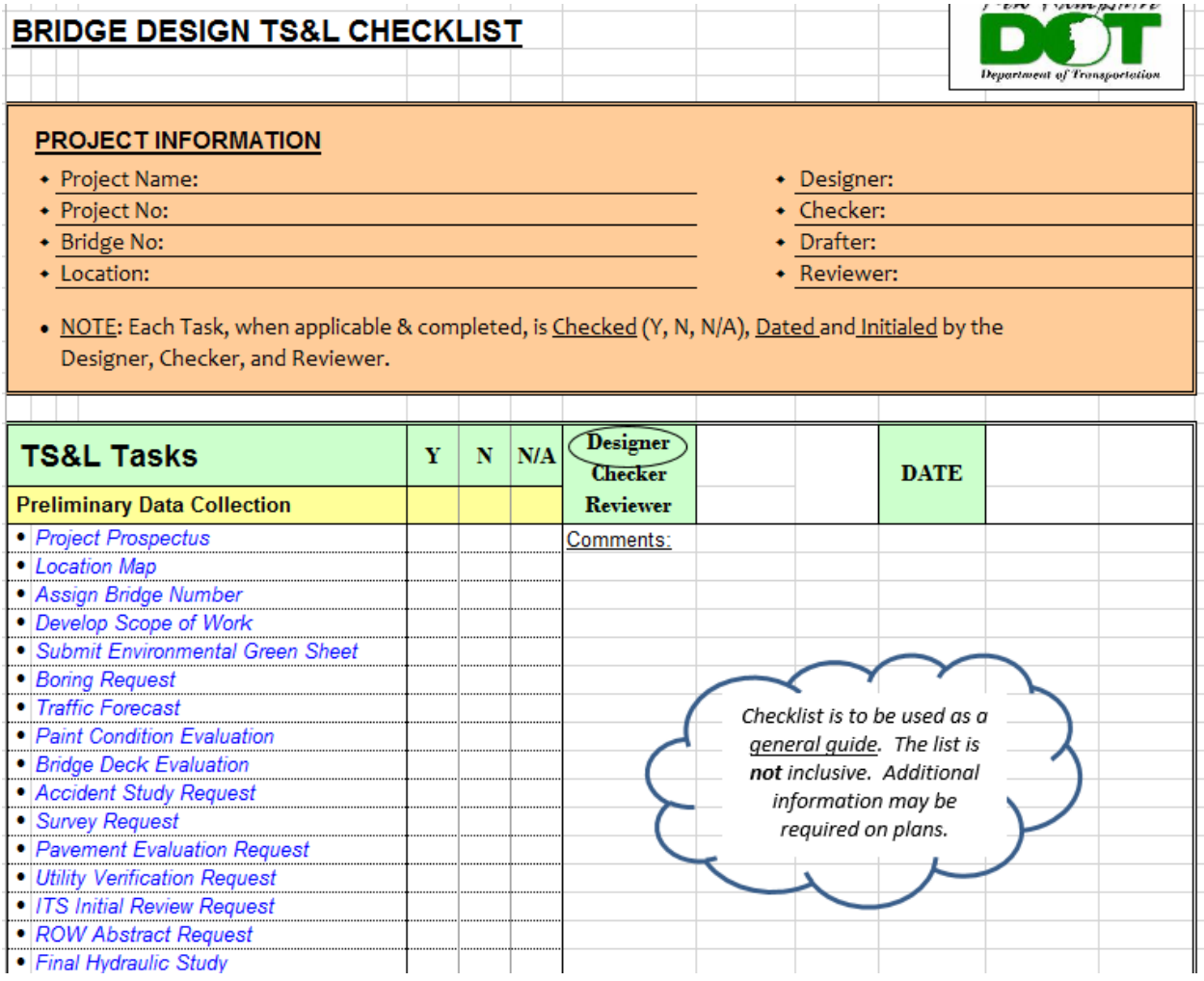
Mark W. Richardson, PE
Administrator, Bureau of Bridge Design

enclosures

**Figure B-87. Example of an inactive design memorandum (*(NHDOT 2015a)*)**

### B.11.3 Policy Implementation Guidelines

The *Sample Plans*, which also include the *Bridge Plan Checklists*, are a set of documents that serve to aid in the bridge project process and act as a system of self-checks for the involved individuals. The checklists are Excel spreadsheets that include lists of general required information for a specific project, as well as the date of completion and space for any comments (see Figure B-88). These spreadsheets allow for a record of a project's process and give a general guide to follow. Other sample documents—such as notes, bridge plans, and design standards—are also included to provide a guide for maintaining consistency.



**BRIDGE DESIGN TS&L CHECKLIST**

DOT Department of Transportation

**PROJECT INFORMATION**

- Project Name:
- Project No:
- Bridge No:
- Location:
- Designer:
- Checker:
- Drafter:
- Reviewer:

- NOTE: Each Task, when applicable & completed, is Checked (Y, N, N/A), Dated and Initialed by the Designer, Checker, and Reviewer.

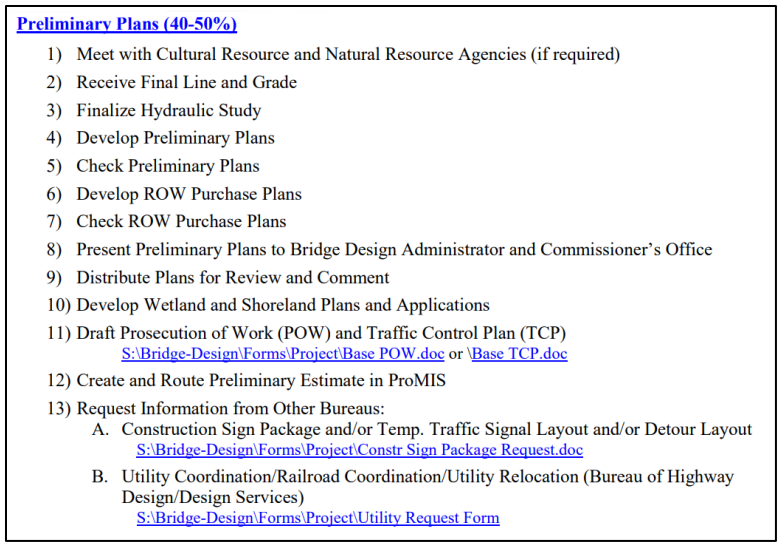
| TS&L Tasks | Y | N | N/A | Designer Checker Reviewer | | DATE | |
|---|---|---|---|---|---|---|---|
| **Preliminary Data Collection** | | | | | | | |
| • Project Prospectus | | | | Comments: | | | |
| • Location Map | | | | | | | |
| • Assign Bridge Number | | | | | | | |
| • Develop Scope of Work | | | | | | | |
| • Submit Environmental Green Sheet | | | | | | | |
| • Boring Request | | | | | | | |
| • Traffic Forecast | | | | | | | |
| • Paint Condition Evaluation | | | | | | | |
| • Bridge Deck Evaluation | | | | | | | |
| • Accident Study Request | | | | | | | |
| • Survey Request | | | | | | | |
| • Pavement Evaluation Request | | | | | | | |
| • Utility Verification Request | | | | | | | |
| • ITS Initial Review Request | | | | | | | |
| • ROW Abstract Request | | | | | | | |
| • Final Hydraulic Study | | | | | | | |

*Checklist is to be used as a general guide. The list is **not** inclusive. Additional information may be required on plans.*

**Figure B-88. Sample checklist (NHDOT 2015c)**

In section 1.2.2, the *Bridge Design Manual* lists each organizational element and design responsibilities. Each group involved in the project, such as the consultant section and the

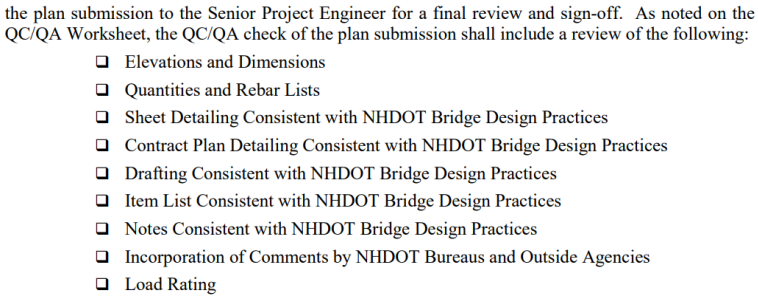
administrator, is listed along with all of their respective responsibilities. Chapter 1 also provides instructions on how to complete various processes, such as contract procedure and QC/QA procedure. The steps for completion are provided as well as the responsible parties. A detailed numbered list of instructions is provided for project development (see Figure B-89). Checklists for reports are also included to ensure consistency of records (see Figure B-90).



**Preliminary Plans (40-50%)**

1) Meet with Cultural Resource and Natural Resource Agencies (if required)
2) Receive Final Line and Grade
3) Finalize Hydraulic Study
4) Develop Preliminary Plans
5) Check Preliminary Plans
6) Develop ROW Purchase Plans
7) Check ROW Purchase Plans
8) Present Preliminary Plans to Bridge Design Administrator and Commissioner's Office
9) Distribute Plans for Review and Comment
10) Develop Wetland and Shoreland Plans and Applications
11) Draft Prosecution of Work (POW) and Traffic Control Plan (TCP)
    S:\Bridge-Design\Forms\Project\Base POW.doc or \Base TCP.doc
12) Create and Route Preliminary Estimate in ProMIS
13) Request Information from Other Bureaus:
    A. Construction Sign Package and/or Temp. Traffic Signal Layout and/or Detour Layout
       S:\Bridge-Design\Forms\Project\Constr Sign Package Request.doc
    B. Utility Coordination/Railroad Coordination/Utility Relocation (Bureau of Highway Design/Design Services)
       S:\Bridge-Design\Forms\Project\Utility Request Form

**Figure B-89. Part of the detailed step-by-step instructions on project development (NHDOT 2015d)**



the plan submission to the Senior Project Engineer for a final review and sign-off. As noted on the QC/QA Worksheet, the QC/QA check of the plan submission shall include a review of the following:

- ❑ Elevations and Dimensions
- ❑ Quantities and Rebar Lists
- ❑ Sheet Detailing Consistent with NHDOT Bridge Design Practices
- ❑ Contract Plan Detailing Consistent with NHDOT Bridge Design Practices
- ❑ Drafting Consistent with NHDOT Bridge Design Practices
- ❑ Item List Consistent with NHDOT Bridge Design Practices
- ❑ Notes Consistent with NHDOT Bridge Design Practices
- ❑ Incorporation of Comments by NHDOT Bureaus and Outside Agencies
- ❑ Load Rating

**Figure B-90. Example of the checklists included within the manual for self-checks (NHDOT 2015d)**

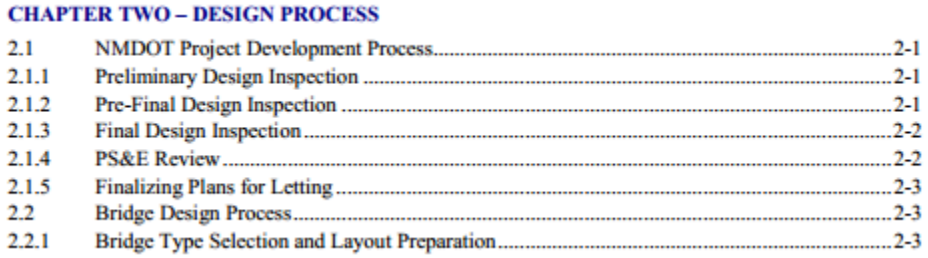
## B.12 NEW MEXICO

The New Mexico Department of Transportation (NMDOT) documents bridge design policy in their *Bridge Procedures and Design Guide*. The bridge design standards are collectively stored as *Standard Specifications for Highway and Bridge Construction*.

### B.12.1 Policy Documentation

The *Bridge Procedures and Design Guide* has a table of contents organized by chapter and subsections that extend up to two levels (see Figure B-91). Appendices, a list of tables, and a list

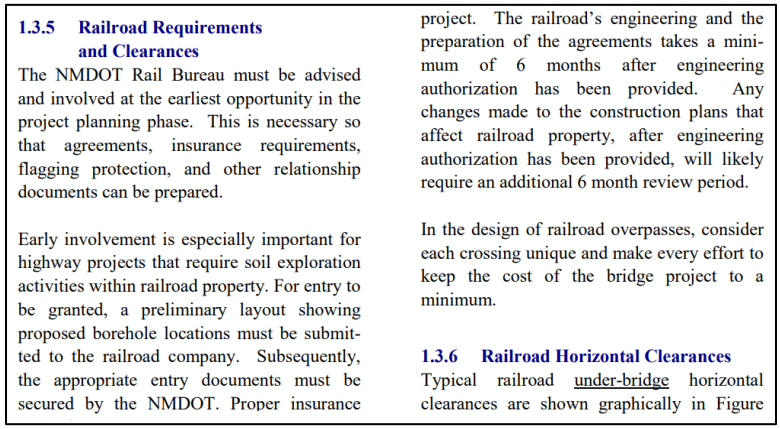
of figures are also included. Tabbing is not used to differentiate the levels of organization, making the table of contents hard to read. There are also no hyperlinks in the table of contents. The text is written in a two-column format with subsections divided by a blue, bolded heading (see Figure B-92). For many of the policies, a brief background is provided to explain the subject matter.



**CHAPTER TWO – DESIGN PROCESS**



**Figure B-91. Excerpt of the table of contents showing the organization (NMDOT 2018)**



**1.3.5 Railroad Requirements and Clearances**

The NMDOT Rail Bureau must be advised and involved at the earliest opportunity in the project planning phase. This is necessary so that agreements, insurance requirements, flagging protection, and other relationship documents can be prepared.

Early involvement is especially important for highway projects that require soil exploration activities within railroad property. For entry to be granted, a preliminary layout showing proposed borehole locations must be submitted to the railroad company. Subsequently, the appropriate entry documents must be secured by the NMDOT. Proper insurance project. The railroad's engineering and the preparation of the agreements takes a minimum of 6 months after engineering authorization has been provided. Any changes made to the construction plans that affect railroad property, after engineering authorization has been provided, will likely require an additional 6 month review period.

In the design of railroad overpasses, consider each crossing unique and make every effort to keep the cost of the bridge project to a minimum.

**1.3.6 Railroad Horizontal Clearances**

Typical railroad under-bridge horizontal clearances are shown graphically in Figure

**Figure B-92. Example of the organization of the text within the *Bridge Procedures and Design Guide* (NMDOT 2018)**

The *Standard Specifications for Highway and Bridge Construction* contains both the "Standard Specifications", the "Standard Drawings" and the "Bridge Design Standards and Criteria" (see Figure B-93). Two versions of "Standard Specifications" are provided: *2014 Specs for Highway and Bridge Construction* and *2007 Specs for Highway and Bridge Construction*. The "Standard Drawings" are grouped by Division and are all in PDF format; a collective list of all the active drawings is also available and categorized based on the division and then by section number (see Figure B-94). The "Bridge Design Standards and Criteria" has drawings that are not grouped and are available in both PDF and DWG formats.

| Standard Drawings | |
|---|---|
| Active Standard Drawings List | pdf |
| Division 200 | 203.pdf \| 206.pdf \| 210.pdf |
| Division 400 | 450.pdf |
| Division 500 | 511-1.pdf \| 511-2.pdf \| 514.pdf<br>515.pdf \| 516.pdf \| 533.pdf<br>543.pdf \| 562.pdf \| 564.pdf \| 570.pdf |
| Division 600 | 602.pdf \| 603.pdf \| 605.pdf<br>606.pdf \| 607.pdf \| 608.pdf<br>609.pdf \| 610.pdf \| 619.pdf<br>622.pdf \| 623.pdf \| 631.pdf<br>662.pdf \| 667.pdf |
| Division 700 | 701.pdf \| 702.pdf \| 703.pdf<br>704.pdf \| 706.pdf \| 707.pdf<br>708.pdf \| 710.pdf \| 713.pdf<br>715.pdf \| 750.pdf |
| Division 800 | 801.pdf |

| Bridge Design Standards and Criteria | | |
|---|---|---|
| Prestressed Concrete Bridge Member Type 36 | PDF | DWG |
| Prestressed Concrete Bridge Member Type 45 | PDF | DWG |
| Prestressed Concrete Bridge Member Type 54 | PDF | DWG |
| Blockout Through Girder Top | PDF | DWG |
| Prestressed Concrete Bridge Member Type 63 | PDF | DWG |

**Figure B-93. The "Standard Drawings" and" Bridge Design Standards and Criteria" (NMDOT 2012)**

| LISTING OF CONTENTS | |
|---|---|
| **SECTION NUMBER** | **SECTION TITLE AND SUBTOPICS** |
| | **DIVISION 200 - EARTHWORK** |
| **203** | **EXCAVATION, BORROW, AND EMBANKMENT** |
| **206** | **EXCAVATION AND BACKFILL FOR CULVERTS AND MINOR STRUCTURES** |
| | Bedding and Backfill |
| | Maximum and Minimum Covers for Corrugated Metal and Structural Plate Pipe |
| | Plastic Culvert |
| **210** | **EXCAVATION AND BACKFILL FOR MAJOR STRUCTURES** |
| | **DIVISION 400 - SURFACE TREATMENTS AND PAVEMENTS** |
| **450** | **PORTLAND CEMENT CONCRETE PAVEMENT (PCCP) (QLA)** |
| | Pavement Joint Details |
| | **DIVISION 500 - STRUCTURES** |
| **511** | **CONCRETE STRUCTURES** |
| | Cattle Passes |
| | Culvert Headwalls and Endwalls |
| | Bridge Slope Pavement |

**Figure B-94. Summary of the active drawings list (NMDOT 2012)**

## B.12.2 Rationale Behind Policies

Revision history and the rationale behind policies are not included in the *Bridge Procedures and Design Guide*. However, summaries of the revised drawings are listed based on the revision date (see Figure B-95)

**Dated: June 8, 2018 (→: Indicates revised drawings for date listed)**

- This listing includes the completed new standard drawings with numbers that correlate to their standard sections of the current standard specifications. Standard drawing are to be referenced in the index of plan sheets with appropriate drawing title, date, and new section drawing number
- This list also includes standard drawings, which have not been renumbered. These standard drawings are currently being reformatted or redesigned and the appropriate old drawing title and date with appropriate old drawing designation is to be referenced in the index of plan sheets.

| | NEW SECTION DRAWING NUMBER | NEW SECTION DRAWING DATE | OLD DRAWING DESIGNATION AND DATE (English) | DRAWING TITLE | |
|---|---|---|---|---|---|
| → | 511-51-1/2 | 06/1/18 | NEW | Metal End Section with Safety Grates for Metal Pipes (Circular and Arches) | ®B |
| | | | | | |
| → | 511-51-2/2 | 06/1/18 | NEW | Metal End Section with Safety Grates for Metal Pipes (Circular and Arches) | ®B |
| | | | | | |
| | | | | ***BARRIER POST ANCHORAGE BLOCK*** | |
| | ~~511-54-1/2~~ | ~~5/08/13~~ | ~~BPAB-001 06/02/94~~ | ~~Barrier Post Anchorage Block for Existing and New CBC Construction~~ | ~~®B~~ |
| | | | | (See 606-GR31-16/20, 606-15-7/7 and 606-17-7/7 for possible solutions) | |
| | | | | | |
| | ~~511-54-2/2~~ | ~~5/08/13~~ | ~~BPAB-002 08/19/88~~ | ~~Barrier Post Anchorage Block for Existing and New CBC Construction~~ | ~~®B~~ |
| | | | | (See 606-GR31-16/20, 606-15-7/7 and 606-17-7/7 for possible solutions) | |
| | | | | | |
| | | | | ***CONCRETE BOX CULVERTS*** | |
| | 511-59-1/2 | 04/09/07 | | Concrete Box Culvert Index of Sheets Explanation of Use of Drawings | |
| | | | | | |
| | 511-59-2/2 | 04/09/07 | | Concrete Box Culvert Example of Use of Drawings | |

**Figure B-95. Revision history of active drawings (NMDOT 2012)**

## B.12.3 Policy Implementation Guidelines

Diagrams, equations, lists, and tables in the *Bridge Procedures and Design Guide* provide parameters and specifics for scenarios. In Appendix B, two flowcharts are given that outline the workflow of Structural/Bridge Bureau Submittals (see Figure B-96).

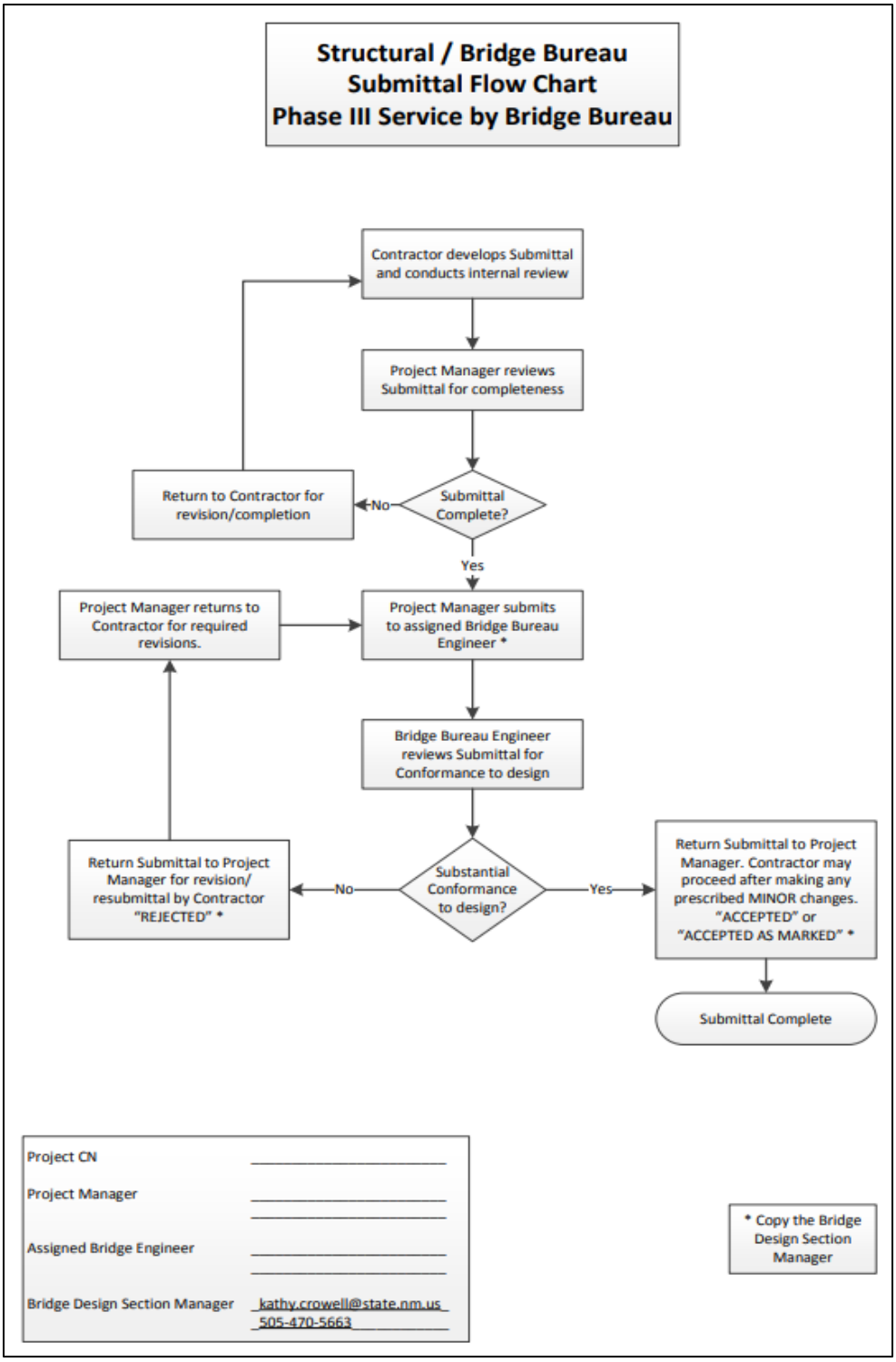



**Figure B-96. Flowchart outlining the workflow involved in Structural/Bridge Bureau Submittals (NMDOT 2018)**

## B.13 NEW YORK

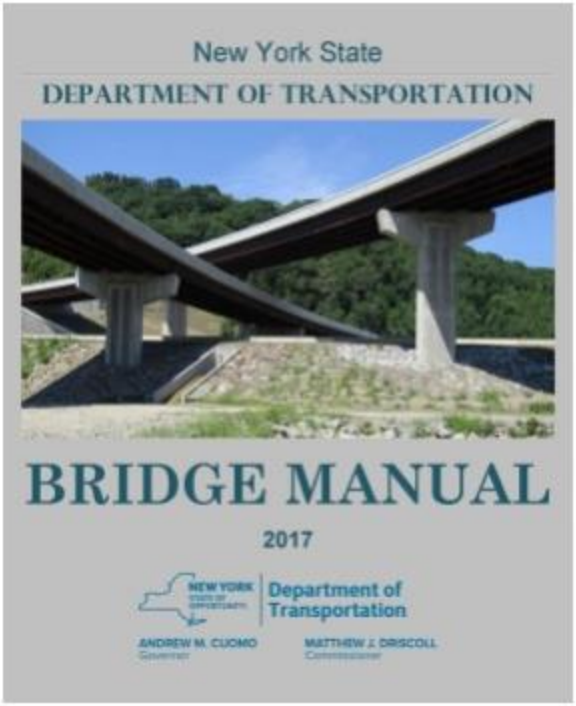
The New York Department of Transportation (NYSDOT) offers the bridge design manual in US customary units as well as metric units. Bridge detail sheets are also provided in these two unit systems. Only the US customary unit version was reviewed for this study. Besides the bridge detail sheets, an additional set of standard design details is provided as "Emergency Bridge Contract Drawings".

### B.13.1 Policy Documentation

Hyperlinks are provided to access the standards and policies. The updated or published date is listed next to the hyperlinks (see Figure B-97). The bridge design manual webpage shows a table with a revision history that includes the dates of revision along with an extremely brief summary of the changes (see Figure B-98). While the manual is presented as a single PDF, electronic forms included in the appendices are also given as separate, fillable Word documents.

| Structures Design Quality Bureau | |
|---|---|
| **Standards and Policies** | |
| Bridge Detail (BD) Sheets - English - USC | Last Updated<br>February 2017 |
| Bridge Manual - US Customary | 2017 Edition,<br>Last Updated August 2017 |
| Seismic References in Article A3.10 of the LRFD Blue Pages<br>(NYCDOT Seismic Design Guidelines for Bridges in Downstate Region) | Posted July 2016 |
| Overhead Sign Structures<br>Design Manual | Last Updated May 2008 |
| Overhead Sign Structures<br>Blue Pages | Last Updated March 2007 |
| Emergency Bridge Contract Drawings | Last Updated November 2014 |
| Bridge Manual - Metric Edition (For Reference Only) | 4th Edition, Addendum #1<br>Last Updated January 2008 |
| Bridge Detail (BD) Sheets - Metric - SI (For Reference Only) | Last Updated<br>June 2010 |

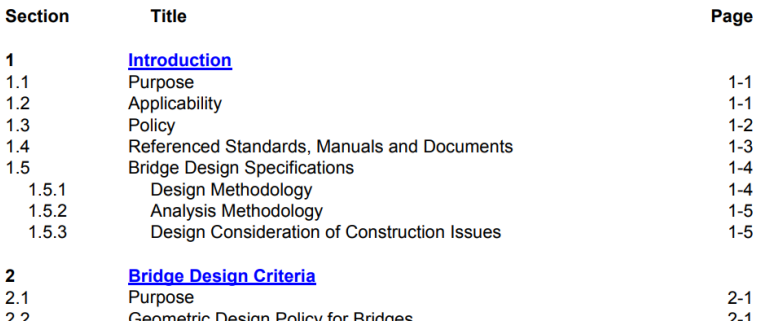
**Figure B-97. Hyperlinks on NYSDOT webpage leading to various manuals, detail sheets, and other documents (NYDOT n.d.)**




| | |
|---|---|
| This Bridge Manual has been prepared to provide policies, guidance and procedures for bridge project development and design for the New York State Department of Transportation. This manual is intended to provide guidance for decisions in the bridge project process, to document or reference policies and standards that need to be considered and to provide a commentary discussing good bridge engineering practice. | |
| **Revision History:** | Last Revised, August 2017<br>Previous Editions:<br>January 2008, 1st Edition<br>April 2010, Addendum #1<br>May 2011, Addendum #2<br>April 2014, Addendum #3 |
| **Contact:** | Standards and Policies<br>(518) 485-1148 |
| **Email:** | **Questions or Comments:**<br>dot.sm.mo.BridgeManual@dot.ny.gov |
| **Available At:** | Download |

**Figure B-98. NYSDOT webpage showing the bridge design manual and a brief revision history (NYDOT n.d.)**

The *Bridge Manual* opens with a table of contents that is organized by chapter. There are no subsections listed to specify content. Hyperlinks are provided to access each chapter. Detailed tables of contents for individual chapters is provided at the beginning of each chapter (see Figure B-99). Hyperlinks are still provided for the chapter headings, but not for the specific subheadings. In addition to the Table of Content, List of Figures and List of Tables are provided with their page numbers.



| Section | Title | Page |
|---|---|---|
| **1** | **Introduction** | |
| 1.1 | Purpose | 1-1 |
| 1.2 | Applicability | 1-1 |
| 1.3 | Policy | 1-2 |
| 1.4 | Referenced Standards, Manuals and Documents | 1-3 |
| 1.5 | Bridge Design Specifications | 1-4 |
| 1.5.1 | Design Methodology | 1-4 |
| 1.5.2 | Analysis Methodology | 1-5 |
| 1.5.3 | Design Consideration of Construction Issues | 1-5 |
| **2** | **Bridge Design Criteria** | |
| 2.1 | Purpose | 2-1 |
| 2.2 | Geometric Design Policy for Bridges | 2-1 |

**Figure B-99. Part of the detailed table of contents showing multiple layers of subheadings (NYSDOT 2017)**

The policies within the manual are written in a textbook-format; for each policy, background information in paragraph form is given regarding the nature of the policy. The details and criteria for some of the longer policies are given in a bulleted list format, this distinguishes it from the rest of the information making it easier to read and comprehend (see Figure B-100). Hyperlinks to other sections of the manual and external sources are provided within the text. Small figures are provided in the background information parts of the manual to help illustrate various concepts.

## Appendix 2B
## One-Lane Bridge Policy

**A.** **Objective**: This policy sets forth criteria used to determine where it would be acceptable to replace an existing one-lane bridge by another one-lane bridge.

When an existing one-lane bridge has deteriorated beyond a point where rehabilitation is appropriate, an evaluation shall be made to determine whether closure of the road or removal of the bridge is an acceptable solution. If that evaluation indicates that the bridge is deserving of replacement, then a determination must be made of the number of traffic lanes to be carried by the proposed bridge. The objective of this policy is to govern that decision.

**B.** **Definitions**:

**Existing One-lane Bridge**: One upon which two vehicles, traveling in the same or opposite direction, will not normally attempt to pass one another. The bridge may or may not be signed as a "One-lane Bridge". In the absence of recorded or observed experience, any bridge less than 16 ft. wide, curb to curb or rail to rail, shall be considered as a one-lane bridge. A ramp bridge, carrying traffic in only one direction, is not a one-lane bridge for the purpose of this definition.

**Existing One-lane Road**: One upon which two vehicles, traveling in the same or opposite direction, will pass one another only with care, usually by the slowing or stopping of one or both vehicles, and perhaps by the movement of one or both vehicles partially off the pavement surface, often accomplished at intermittent widenings which may occur naturally or which may be developed deliberately to facilitate such passing. In the absence of recorded or observed experience, any road measuring less than 16 ft. wide, edge to edge of roadway (including pavement plus graded shoulders), shall be considered as a one-lane road, unless it carries traffic in only one direction.

**C.** **Requirements**: An existing one-lane bridge may be replaced by another one-lane bridge if each of the following requirements are met:

1. The project shall meet the requirements of Table 5-11 of AASHTO's *A Policy on Geometric Design of Highways and Streets - 2011*.
2. The current two-way ADT must be less than 350, and the predicted ADT for the 30th year after completion of the project must be less than 500.
3. The current and anticipated future operating speeds must be not greater than 40 mph.
4. An analysis of the three-year crash experience must reveal no more than one reported crash, with no crash being reported during that same period as being directly attributable to the narrowness of the existing one-lane bridge.
5. The replacement bridge and its approaches must be signed as a "One-lane Bridge" in accordance with the MUTCD.
6. Horizontal and vertical sight distances must be provided to allow approaching motorists to safely observe an opposing vehicle on the bridge or its far approaches.

**Figure B-100. Format of the manual content (NYSDOT 2017)**

The *Bridge Detail Sheets* are organized using a letter-number system: the first two letters are always BD for bridge design, followed by two letters that group sheets with a similar theme (for example; AB for abutment), then by a number that organizes the sheets sequentially, and finally by a suffix (R#) that indicated how many times the sheet has been revised. These sheets are arranged under the relevant bridge element group assigned with a group ID (for example; for

Abutments, the group ID is AB-E) as seen in Figure B-101. Sheets that have been revised within the past 12 months are highlighted yellow in the listing.

| GROUP ID | BRIDGE ELEMENT | LAST UPDATED |
|---|---|---|
| AB-E | Abutments | 12/20/16 |
| AD-E | Approach Drainage | 12/17/13 |
| BG-E | Bearings | 10/08/14 |
| CB-E | Precast Culverts | 7/14/16 |
| EE-E | Excavation and Embankment | 09/22/17 |

**Figure B-101. Bridge detail table of contents where the sheets are grouped by general topic (NYSDOT n.d.)**

The initial webpage includes hyperlinks that group the detail sheets by group, along with the last date of revision besides them (see Figure B-101). When a group is opened, it shows the hyperlinks to individual bridge detail sheets along with their date of issuance (see Figure B-102). However, the detail sheets do not indicate what changes have been made.

## Abutments - USC

| BD NO. | DRAWING NAME | EI/EB NO. | ISSUED |
|---|---|---|---|
| BD-AB1E R1 | Abutment Plan & Elevation For U-Wingwall Structure (For Skews Under 30 Degrees) | EB 16-050 | 12/20/2016 |
| BD-AB2E R1 | Abutment Plan & Elevation For U-Wingwall Structure (For Skews 30 Degrees And Over) | EB 16-050 | 12/20/2016 |
| BD-AB3E R1 | Abutment Plan & Elevation With Flared And In-line Wingwalls | EB 16-050 | 12/20/2016 |
| BD-AB4E R1 | Example Of Pile Layout And Footing Reinforcement Plan | EB 16-050 | 12/20/2016 |
| BD-AB5E R1 | Example Of Reinforcement Details For Stem, Backwalls, Headers And Pedestals | EB 16-050 | 12/20/2016 |
| BD-AB6E R1 | Abutment Sections And Concrete Keyway Details (Pile Foundation Shown) | EB 16-050 | 12/20/2016 |
| BD-AB7E R1 | Wingwall Sections (Pile Foundation Shown) | EB 16-050 | 12/20/2016 |
| BD-AB8E R1 | Miscellaneous Abutment Details | EB 16-050 | 12/20/2016 |
| BD-AB9E R1 | Stone Veneer Panel Details | EB 16-050 | 12/20/2016 |
| *The document links found within this table require Adobe Acrobat Reader* | | | |

**Figure B-102. Individual bridge detail sheets listed under the relevant group showing the detailed letter-number system used to organize them (NYSDOT n.d.)**

### B.13.2 Rational Behind Policies

NYSDOT provides a separate document that summarizes revisions to the bridge manual made in the previous year. A copy of the first edition bridge manual is also provided for historical reference. Within the revisions document, there is no mention of the specific revision dates nor of the rationale behind changes. The changes are organized by chapter and a summary of the change is listed under the chapter heading with no reference to policy numbers or other types of subheadings within a chapter (see Figure B-103). The changes are not separated from one another making them hard to read. This poses a challenge because as the list of changes become longer, the list of revisions will become cluttered making it hard to locate a specific change if needed.

**TECHNICAL INFORMATION:**

- The Bridge Manual August 2017 replaces the Bridge Manual, US Customary Edition, in its entirety, including the addenda.
- No cost impact is anticipated.
- The wording has been changed to make it compatible with design-build projects.
- References throughout the Manual have been updated.
- This is an extensive rewrite. The most significant changes are listed below, but many other changes have been made.

**Significant Changes**

1 **Introduction**
Bridge Manual is now a required design document
Bridge Manual now applies to all Federal Aid Local Projects and is recommended for all other bridges Approving authority for noncompliant features now defined
LRFR factor changed from 1.0 to 1.2
New section – bridge design methodology - moved from section 8. Use of NYSDOT Standard Specifications for Highway Bridges requires DCES approval for rehabs

2 **Bridge Design Criteria**
Broadened purpose to include all geometric design criteria. Document noncompliance and nonconformance
Curved alignments updated
Glossary has been moved to the Glossary section
Hydraulic design criteria moved to Chapter 3
Profile section updated

3 **Project Scoping and Preliminary Plan Development**
The scoping section has been expanded to provide stronger guidance.
Bridge Rehabilitation Report has been added to DAD formats

**Figure B-103. Part of the manual revisions showing the organization of the content (NYSDOT 2017)**

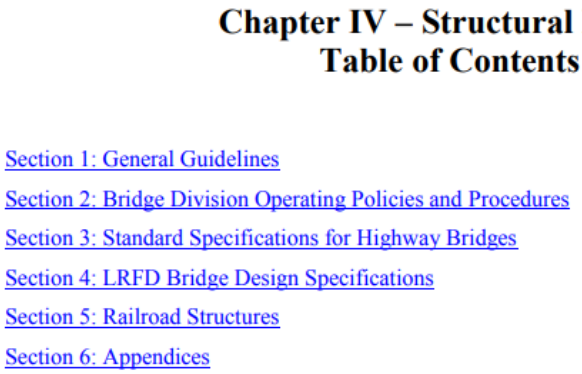
Several tables and equations listed within the bridge design manual provide specific parameters needed for calculations. However, not many policy implementation guidelines are provided.

## B.14 NORTH DAKOTA

North Dakota Department of Transportation (NDDOT) has multiple bridge design publications. The design policies are in the *Design Manual*, design standards are in the *Standard Drawings*, and revisions and updates are in the *Recent Revisions, Corrections and Updates*. Supplemental information is included in *Preliminary Engineering* and *Plan Review* which provides a table of responsibilities for every involved party in the *Design Guidelines, Reference and Forms,* and *Plan Preparation Guide*.

### B.14.1 Policy Documentation

The *Design Manual* is offered in chapters (Chapter I -VII), a PDF of the entire manual is not available. Each chapter starts with a table of contents that provides hyperlinks to each section within the chapter. Specific policy numbers are not given, only the general subject matter (see Figure B-104).



**Chapter IV – Structural Design**
**Table of Contents**

Section 1: General Guidelines
Section 2: Bridge Division Operating Policies and Procedures
Section 3: Standard Specifications for Highway Bridges
Section 4: LRFD Bridge Design Specifications
Section 5: Railroad Structures
Section 6: Appendices

**Figure B-104. Example of the table of contents with specific sections and their hyperlinks (NDDOT n.d.)**

The manual is organized in a paragraph format with each policy divided by a bolded heading and policy number (see Figure B-105). There is no background or rationale provided for the policies. There are several small diagrams to supplement the text. The appendices for each section are located after their respective section (see Figure B-104) and vary greatly in content; most include diagrams, maps, and other information that supplement the chapter contents.

**IV-02.03.07 Pile Spacing**

To facilitate pile-driving operations, the minimum center-to-center pile spacing is 2'-6" with a 3'-0" minimum preferred. It may be necessary to increase the plan dimensions of a footing or pile cap when using battered piles. The standard embedment into a pier or abutment footing for a driven pile is 1'-0" and shall be dimensioned in the plans.

**IV-02.03.08 Footings**

Any footings or foundations with a thickness of 5'-0" or greater shall be treated as mass concrete. This may require the Contractor to modify the concrete mix and/or to instrument the concrete member and take action to ensure that the temperature differential between the inside and outside of the member is small enough to minimize the potential for cracking.

**Figure B-105. Example of text within the manual, it is formatted into paragraphs with bold headings (NDDOT n.d.)**

The *Standard Drawings* are separate from the *Design Manual* and are organized into a table by number, title, and revision date. The drawings that were added or revised within the last year are highlighted in yellow in the table. An option is available to search for a particular drawing using its title (see Figure B-106).

Title: Search... Clear Search

Note: If you experience issues opening any documents, please review the Document View and Download Instructions page.

Click column headings to sort.

| Standard No | Standard Title | Revision Date |
|---|---|---|
| D101-01 PDF | NDDOT Abbreviations | 9/20/2018 |
| D101-02 PDF | NDDOT Abbreviations | 4/23/2018 |
| D101-03 PDF | NDDOT Abbreviations | 4/23/2018 |
| D101-10 PDF | NDDOT Utility Company and Organization Abbreviations | 9/20/2018 |
| D101-20 PDF | Line Styles | 9/23/2016 |
| D101-21 PDF | Line Styles | 9/23/2016 |
| D101-30 PDF | Symbols | 7/1/2014 |

**Figure B-106. Sample list of standard drawings with highlights to distinguish the recently revised or added drawings (NDDOT 2018a)**

## B.14.2 Rationale Behind Policies

All changes to the design manual, references, and forms are recorded in *Recent Revisions, Corrections and Updates*. The information is organized into tables with the revisions to the *Design Manual* separate from those to the references and forms. The tables of changes to the *Design Manual* are split according to year. For each year, the revisions are organized by date, chapter,

and section (see Figure B-107). For each revision, there is a brief description of the change, but no rationale is provided.

**CHANGES TO DESIGN MANUAL - 2018**

| Date | Chapter | Section | Description |
|---|---|---|---|
| 1/25/2018 | 1 | 2 | Added milestone activity and description for Endangered Species Act Consultation (ESACO). Revised milestone activity description for Biological Assessment (BIOAS). |
| 1/25/2018 | 2 | 4 (Section 1) | -Added direction to clip wetlands off of the existing inslope when determining wetland impacts<br>-Removed Stream order Systems<br>-Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 2) | Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 3) | -Added what is expected in a conceptual mitigation plan<br>-Added culvert sinking criteria based on 2017 revised 404 Nation Wide Permit Regional Conditions<br>-Added 408 Permission and Outgrant information.<br>-Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 4) | Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 5) | -Added detail to what is needed in conduction annual mitigation bank monitoring.<br>-Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 6) | -Added detail to what is needed in conduction annual onsite mitigation monitoring.<br>-Minor edits that expanded or clarified existing text. |
| 1/25/2018 | 2 | 4 (Section 7) | -Deleted section 7 Mitigation Tracking<br>-Added more detail to Section 9 Woody Vegetation Mitigation |

**Figure B-107. Revisions and other changes to the *Design Manual* in 2018 (NDDOT 2018b)**

The table for the references and forms is not split but has subheadings to differentiate different documents (see Figure B-108). The revisions are organized by date and include a one or two-line summary of the change, however, no rationale is provided.

**CHANGES TO DESIGN MANUAL REFERENCE AND FORMS**

| Date | Description |
|---|---|
| **Design Exception Form** | |
| 7/31/2015 | Updated form to be consistent with Stewardship agreement. |
| 11/7/2012 | Modified for to be DOT form. Changed footer. |
| 2/27/2008 | Added Minor Rehabilitation to the note at the bottom of the first page. |
| 11/14/2007 | Revised threshold for full FHWA involvement from $3 million to $5 million. |
| 5/10/2007 | Added electronic distribution statement. |
| 3/29/2007 | Updated Work Type on first page. Added Basis for Recommendation on last page. |
| 12/7/2006 | Corrected typo on page 2, note 4, bride to bridge. |
| **Legal Display Advertisements and Press Releases** | |
| 12/3/2015 | Updated all Press Releases and also Public Hearing Advertisement. |
| 12/10/2014 | Updated the Public Participation Survey and Instructions. |
| 3/11/2013 | Updated the Public Participation Survey and Instructions. |
| 12/5/2012 | Updated the Instructions for Public Participation Surveys. |
| 11/7/2012 | Add link for Stormwater Poster. |
| 7/23/2012 | Updated all public meeting advertisments and press releases. Added sign in sheet, participation survey, instructions, and codes. |
| 4/18/2011 | Revised the Public Meeting Sign-In Sheet |

**Figure B-108. Changes to other documents besides the *Design Manual* (NDDOT 2018b)**

### B.14.3 Policy Implementation Guidelines

Two documents, *Preliminary Engineering* and *Plan Review*, provide a way of determining what parties are involved in each step of the bridge design process. Both documents consist of tables that document the level of involvement that each party has for each step of the process, making it easier to assign responsibility and improve intra-organizational communication (see Figure B-109).

| Representative | Preliminary Plan Review | | PS&E Plan Review | | Final Office Plan Review | |
|---|---|---|---|---|---|---|
| | Invite | Attend | Invite | Attend | Invite | Attend |
| Lead Designer or Technical Support Person | SOI | Yes | SOI | Yes | SOI | Yes |
| Director - Office of Project Development | No | No | S or U | O | S or U | S* or U* |
| District Engineer | Yes | Yes | Yes | Yes | F | No |
| District - Assistant Engineer | Yes | Yes | Yes | Yes | F | No |
| Bridge Division Engineer | No | No | No | No | B | B* |
| Bridge - Design Section | Yes | O | Yes | O | B or F | B |
| Bridge - Hydraulics Section | Yes | O | Yes | O | No | No |
| Construction Services - Assistant Engineer | Yes | O | Yes | O | No | No |
| Construction Services - Environmental Section | Yes | O | Yes | O | No | No |
| Design Division Engineer | No | No | Yes | O | D | D* |
| Design - Program Manager for Roadway Design (Design Division and Bridge Division Projects Only) | Yes | Yes | Yes | Yes | Yes | Yes |
| Design - Program Manager for Technical Support (District and Consultant Projects Only) | Yes | Yes | Yes | Yes | Yes | Yes |
| Design - Traffic Section | Yes | O | Yes | O | Yes | O |
| ETS - Program Manager | Yes | O | Yes | O | No | No |
| ETS - Consultant Admin. Section (Consultant Projects Only) | No | No | Yes | No | No | No |
| ETS - Cultural Resources Section (Appropriate State-System Manager or Off-System Manager) | O | O | O | O | No | No |
| ETS - Environmental Section | Yes | O | Yes | O | No | No |
| ETS - Environmental Section - Appropriate Liaison Person | Yes | O | Yes | O | No | No |
| ETS - Technical Services Section | Yes | O | Yes | O | No | No |
| ETS - Permitting Engineer | Yes | O | Yes | O | No | No |
| Local Government Engineer | U | O | U | O | U | U |
| Local Government - Assistant Engineer | U | O | U | O | U | U |
| Maintenance Division Engineer | Yes | O | Yes | O | No | No |
| Maintenance Division - Assistant Engineer | Yes | O | Yes | O | No | No |
| Maintenance Division - ITS Engineer | ITS | O | ITS | O | No | No |
| Maintenance Division - Signing Manager | Yes | O | Yes | O | No | No |
| **-Grp-DOT Materials & Research Review** | Yes | O | Yes | O | No | No |
| Planning/Asset Management - Traffic Data Section | WIM, ATR | O | WIM, ATR | O | No | No |
| Planning/Asset Management - RR Crossing Programs Section | RR | O | RR | O | No | No |
| Programming Division Engineer | No | No | Yes | No | No | No |
| Programming - Assistant Engineer | No | No | Yes | No | No | No |
| Programming - Traffic Operations Section | No | No | Yes | O | No | No |
| City | C or U | O | C or U | O | No | No |
| FHWA – PROJECTS OF DIVISION INTEREST ONLY (PODI) | FTP | O | FTP | O | No | No |

**SYMBOL LEGEND**

| | | | |
|---|---|---|---|
| B | Bridge Division projects only. | C | If the city has cost participation. |
| F | Only forward the electronic final plans prior to Final Office Review for informational purposes for the District or Bridge Division. | D | Design Division projects only. |
| FTP | Only forward the invite and electronic plans to your Division's Administrative Assistant for coordination with FHWA through their FTP website. | ITS | Only projects that involve ITS items. |
| O | Optional or as Appropriate. | RR | Only projects with at-grade rail crossings. |
| S | Strategic Projects only. | SOI | Send out invitations and organize meeting. |
| U | Urban Regional Projects (cities greater than 5,000) or ND Street Projects. | * | Signature of final plans. |
| WIM, ATR | Only projects with Weigh-in-Motion or Automated-Traffic-Recorders. | | |

**Figure B-109. The *Plan Review* showing the responsibilities of staff and units involved in the plan review process (NDDOT 2018c)**

NDDOT also provides a few other supplementary documents: *Design Guidelines, Reference and Forms,* and *Plan Preparation Guide*. The *Design Guidelines* includes an overview of NDDOT's philosophy through sections such as the Design Philosophy, Investment Strategies, and Design Guidelines (see Figure B-110). The *Reference and Forms* link contains resource files that are

organized into a table by name, category, division, and revision date (see Figure B-111). Files that have been updated and/or added in the last 90 days are highlighted in yellow within the table. Options to search for a form within this table by title and to view the available forms based on its title or category are available. The *Plan Preparation Guide* includes a collection of reoccurring plan sheets and notes for the Design Section and the Bridge Section (see Figure B-112). The notes provide the information on the latest construction practices of NDDOT.

**I-06.01 Design Philosophy**

The basic philosophy to consider when designing new or existing roadway facilities is to do so in accordance with AASHTO A Policy on Geometric Design of Highways and Streets, 6th edition, 2011; hereinafter referred to as *A POLICY*. In using *A POLICY*, generally start with the minimum values provided and then adjust them as the need would dictate. There may be circumstances where it may be in the best interest to use the minimum or desirable values. There may be circumstances where it may not be in the best interest to use the values in *A POLICY*. In those instances, it would be necessary to develop different values and process a design exception. Design exceptions are defined in more detail in Section I-06.04 of the Design Manual.

**Figure B-110. Example of the *Design Guidelines* content (NDDOT 2017)**

Search... Search Clear

**Note:** If you experience issues opening any documents, please review the **Document View and Download Instructions** page.

View By Title | View By Category

Click column headings to sort.

| Resource Files | Category | Division | Revision Date | File Size |
|---|---|---|---|---|
| Design Exception Form | Design Exception Form | Design | 01/09/2017 | 252.42KB |
| Public Informational Meeting Advertisement | Legal Display Advertisements and Press Releases | Environmental and Transportation Services | 07/09/2014 | 36.86KB |
| Public Informational Meeting Press Release | Legal Display Advertisements and Press Releases | Environmental and Transportation Services | 12/01/2015 | 33.28KB |
| Public Input Meeting Advertisement | Legal Display Advertisements and Press Releases | Environmental and Transportation Services | 07/09/2014 | 37.89KB |
| Public Input Meeting Press Release | Legal Display Advertisements and Press Releases | Environmental and Transportation Services | 12/03/2015 | 34.82KB |

**Figure B-111. Example of the *References and Forms* table sorted by title (NDDOT 2018d)**

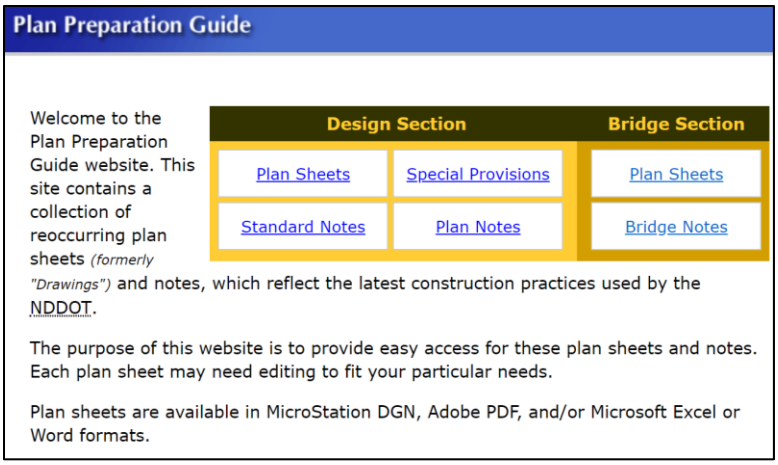



**Figure B-112. The webpage for the *Plan Preparation Guide* that provides hyperlinks to the plan sheets and bridge notes (NDDOT 2018e)**

There are various workflow diagrams detailing the process for specific projects (see Figure B-113). Design Guidelines for specified projects are also provided in tables, highlighting the sources for relevant parameters and information. Within the main text of the manual, there are equations, commonly used parameters, and variable definitions.

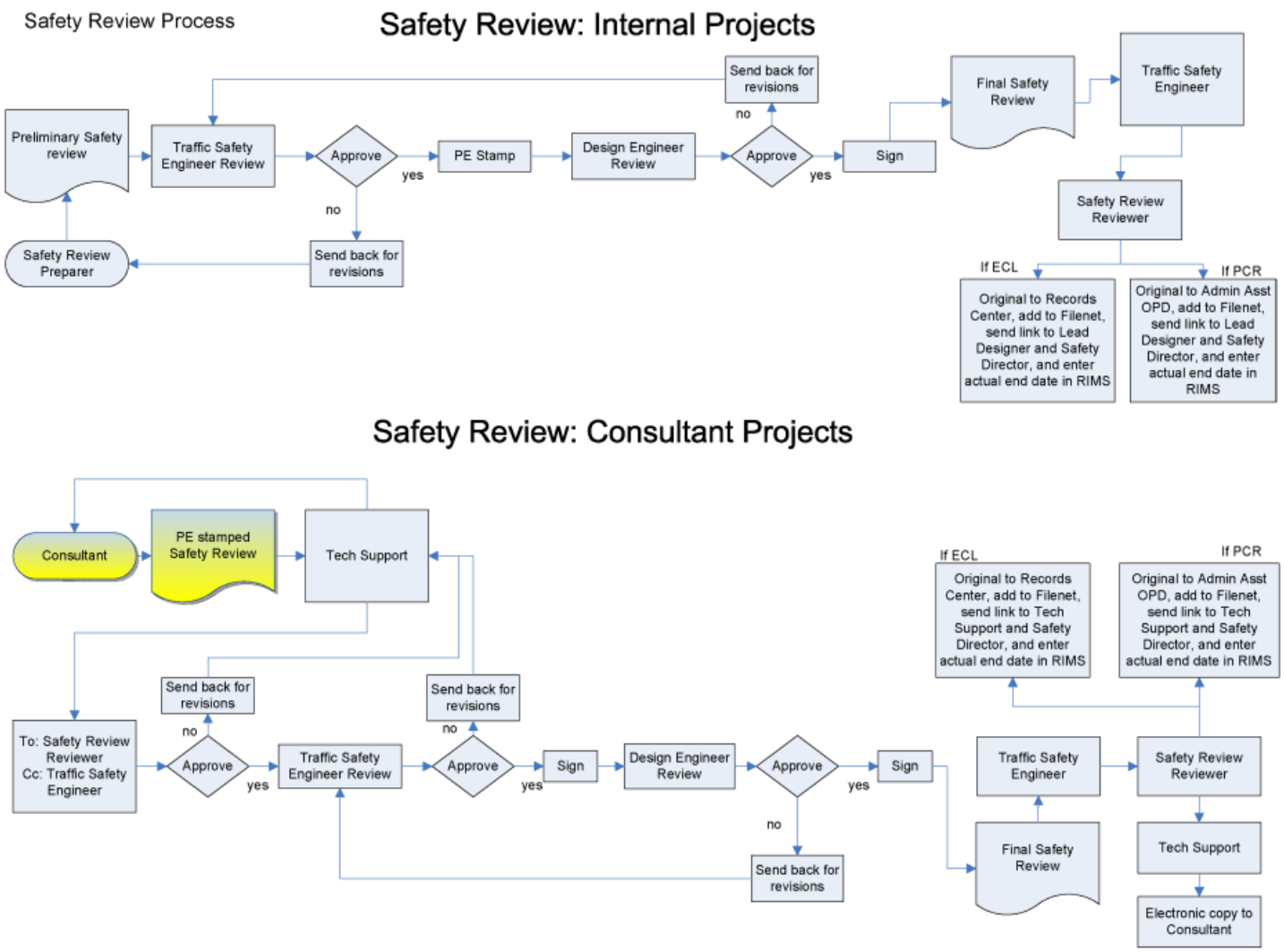


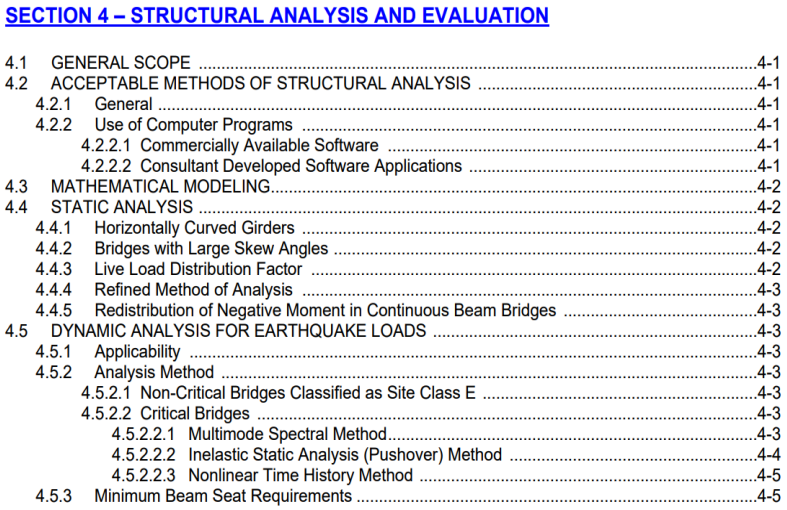

**Figure B-113. Workflow examples (NDDOT n.d.)**

## B.15 RHODE ISLAND

Rhode Island Department of Transportation (RIDOT) presents bridge design policies using the *Bridge Design Manual* and the *Bridge Design Standard Details*.

### B.15.1 Policy Documentation

The *Bridge Design Manual* contains a detailed table of contents that is organized by chapter, and subsections that extend up to three levels. Only the chapter headings are hyperlinked (see Figure B-114).

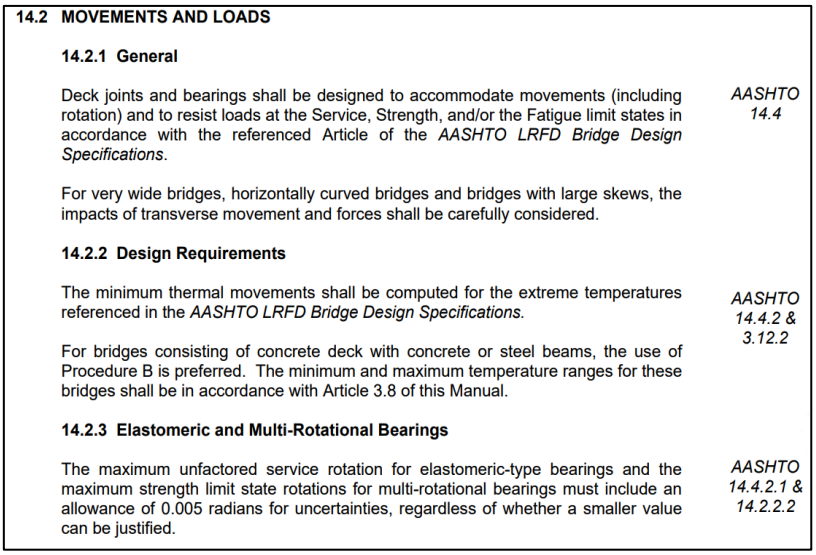


SECTION 4 – STRUCTURAL ANALYSIS AND EVALUATION



**Figure B-114. Excerpt from the table of contents showing the detailed organization and the hyperlink for the chapter heading (RIDOT 2007)**

Within the *Bridge Design Manual*, the text is organized into a paragraph format that is divided using bolded headings (see Figure B-115). In some sections, there are bullet points used to break up the text, making it easier to read. AASHTO is referenced numerous times and each time it is referenced, a citation to the specific article of AASHTO is included to the right of the paragraph (see Figure B-115).



**14.2 MOVEMENTS AND LOADS**

**14.2.1 General**

Deck joints and bearings shall be designed to accommodate movements (including rotation) and to resist loads at the Service, Strength, and/or the Fatigue limit states in accordance with the referenced Article of the *AASHTO LRFD Bridge Design Specifications*. — *AASHTO 14.4*

For very wide bridges, horizontally curved bridges and bridges with large skews, the impacts of transverse movement and forces shall be carefully considered.

**14.2.2 Design Requirements**

The minimum thermal movements shall be computed for the extreme temperatures referenced in the *AASHTO LRFD Bridge Design Specifications.* — *AASHTO 14.4.2 & 3.12.2*

For bridges consisting of concrete deck with concrete or steel beams, the use of Procedure B is preferred. The minimum and maximum temperature ranges for these bridges shall be in accordance with Article 3.8 of this Manual.

**14.2.3 Elastomeric and Multi-Rotational Bearings**

The maximum unfactored service rotation for elastomeric-type bearings and the maximum strength limit state rotations for multi-rotational bearings must include an allowance of 0.005 radians for uncertainties, regardless of whether a smaller value can be justified. — *AASHTO 14.4.2.1 & 14.2.2.2*

**Figure B-115. Example of the organization of the text within the manual with references to AASHTO (RIDOT 2007)**

The *Bridge Design Standard Details* are provided in a single PDF. While there is a table of contents, there are no hyperlinks, which make it difficult to navigate through the file. The file size is at 28.6 MB and users may have difficulty loading and scrolling through the document.

### B.15.2 Rationale Behind Policies

Neither revision history nor rationale behind changes were found.

### B.15.3 Policy Implementation Guidelines

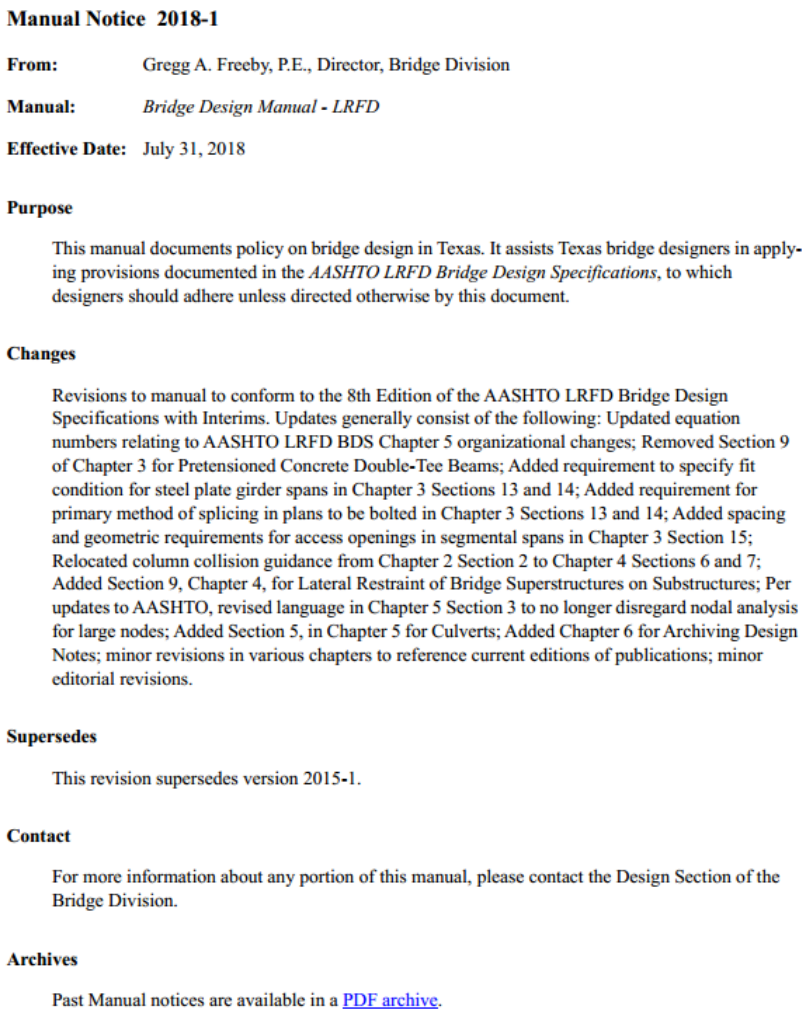
Tables and graphs provide parameters and additional information pertaining to specific scenarios however, unlike the manuals from other states, detailed examples are not provided.

## B.16 TEXAS

The Texas Department of Transportation (TxDOT) provides three primary documents: a *Bridge Design Manual*, a *Project Management Guide*, and a *Best Practices Workbook*. The *Bridge Design Manual* provides information on policies relevant to TxDOT projects, the *Project Management Guide* contains descriptions of the processes and procedures that are needed to successfully complete a project, and the *Best Practices Workbook* contains documents to help with monitoring and recording progress on a project. TxDOT also gives access to *Bridge Design Standards*, as well as memorandums documenting their revision histories and a guide that serves as a quick-reference for information regarding the standards. The *Communications Manual* provides users with guidelines for proper communication in areas such as structured writing and business communications.

### B.16.1 Policy Documentation

TxDOT only provides access to the most recent version of the LRFD *Bridge Design Manual*. The second page of the manual presents the latest date of revision, the version that the current version supersedes, and a brief overview of the updates/revisions in the current version (see Figure B-116). There is also a table summarizing the changes since 2005 (see Figure B-117). A vertical blue line along the right edge and a different font type are used to highlight the subsections with changes/revisions (see Figure B-118).



**Manual Notice 2018-1**

**From:** Gregg A. Freeby, P.E., Director, Bridge Division

**Manual:** *Bridge Design Manual - LRFD*

**Effective Date:** July 31, 2018

**Purpose**

This manual documents policy on bridge design in Texas. It assists Texas bridge designers in applying provisions documented in the *AASHTO LRFD Bridge Design Specifications*, to which designers should adhere unless directed otherwise by this document.

**Changes**

Revisions to manual to conform to the 8th Edition of the AASHTO LRFD Bridge Design Specifications with Interims. Updates generally consist of the following: Updated equation numbers relating to AASHTO LRFD BDS Chapter 5 organizational changes; Removed Section 9 of Chapter 3 for Pretensioned Concrete Double-Tee Beams; Added requirement to specify fit condition for steel plate girder spans in Chapter 3 Sections 13 and 14; Added requirement for primary method of splicing in plans to be bolted in Chapter 3 Sections 13 and 14; Added spacing and geometric requirements for access openings in segmental spans in Chapter 3 Section 15; Relocated column collision guidance from Chapter 2 Section 2 to Chapter 4 Sections 6 and 7; Added Section 9, Chapter 4, for Lateral Restraint of Bridge Superstructures on Substructures; Per updates to AASHTO, revised language in Chapter 5 Section 3 to no longer disregard nodal analysis for large nodes; Added Section 5, in Chapter 5 for Culverts; Added Chapter 6 for Archiving Design Notes; minor revisions in various chapters to reference current editions of publications; minor editorial revisions.

**Supersedes**

This revision supersedes version 2015-1.

**Contact**

For more information about any portion of this manual, please contact the Design Section of the Bridge Division.

**Archives**

Past Manual notices are available in a PDF archive.

**Figure B-116. Example of a revision notice that includes the revision date, a summary of the changes, and the version that the current *Bridge Design Manual* l supersedes (TxDOT 2018a)**

**Manual Revision History**

| Version | Publication Date | Summary of Changes |
|---|---|---|
| 2005-1 | July 2005 | New manual |
| 2005-2 | September 2005 | Revision adding information on deck slabs on slab beams, double-tee beams, and box beams. Also added information on prestressed slab beams, prestressed concrete double-tee beams, prestressed concrete box beams, and cast-in-place concrete slab and girder spans (pan forms). |
| 2006-1 | June 2006 | Revision adding information on cast-in-place concrete spans, straight plate girders, and curved plate girders. |
| 2006-2 | July 2006 | Revision adding information in Chapter 3 on prestressed concrete U beams (types U40 and U54) and on concrete deck slabs on U beams (types U40 and U54), and making minor adjustments to references in the Chapter 3 section on geometric constraints for steel-reinforced elastomeric bearings and to the Chapter 4 sections on design criteria for abutments and design criteria for inverted tee reinforced concrete bent caps. |

**Figure B-117. Part of the table showing a summary of the changes made to the *Bridge Design Manual* since 2005 (TxDOT 2018a)**

## Table of Contents

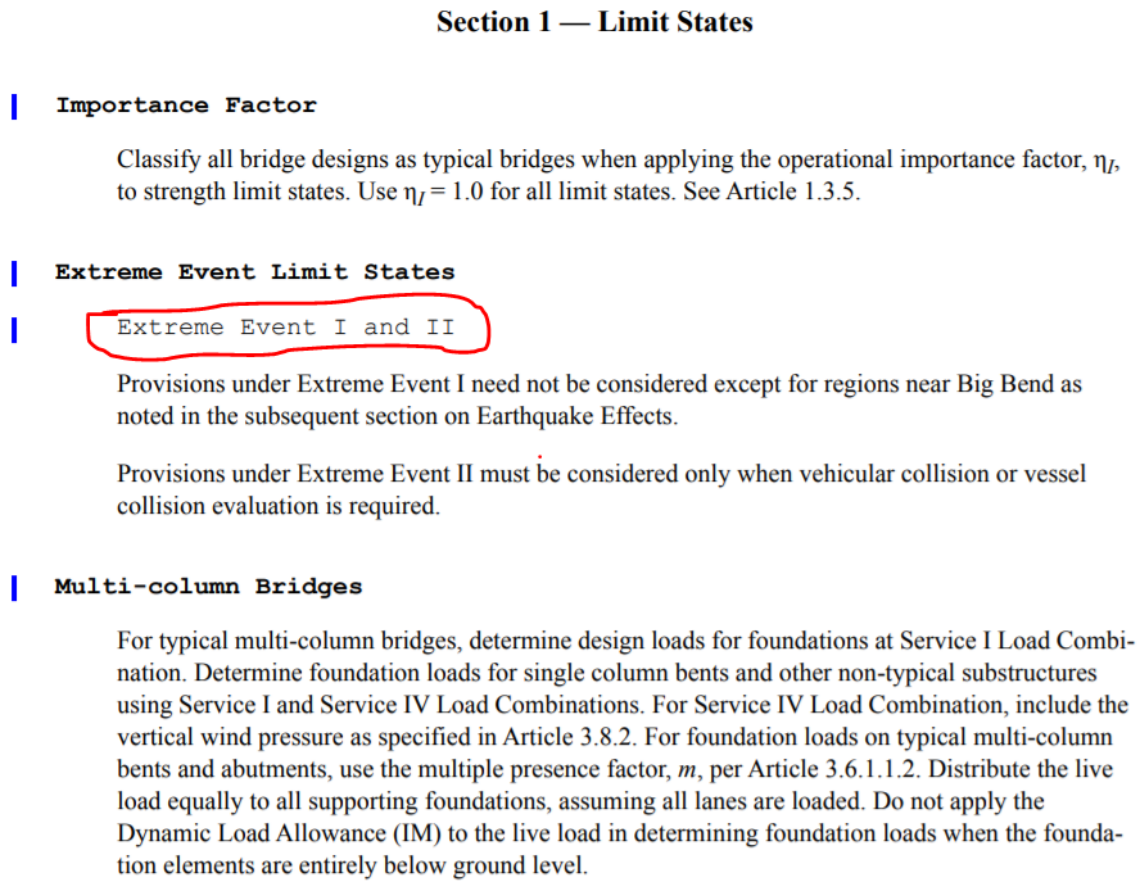


**Figure B-118. Format of the table of contents of the *Bridge Design Manual* (TxDOT 2018a)**

The manual is not organized numerically; rather the sections are divided by topic, and then by subsections that explain aspects of that topic (see Figure B-118). Each section and subsection listed in the table of contents are hyperlinked to allow for easy navigation. The lack of numerical identification for policies may confuse users as it creates a challenge when referring to a specific policy elsewhere. While the entire table of contents is at the beginning of the manual, at the beginning of each chapter, there is a table of contents detailing the subsections for that specific chapter.

The manual content is presented in a single column format. The revisions/updates are indicated by placing a blue line along the left margin and, sometimes, by using a different font type (see

Figure B-119). It is challenging to identify all the updates/revisions since they are not consistently presented with the specific font type.



**Section 1 — Limit States**

**Importance Factor**

Classify all bridge designs as typical bridges when applying the operational importance factor, $\eta_I$, to strength limit states. Use $\eta_I = 1.0$ for all limit states. See Article 1.3.5.

**Extreme Event Limit States**

Extreme Event I and II

Provisions under Extreme Event I need not be considered except for regions near Big Bend as noted in the subsequent section on Earthquake Effects.

Provisions under Extreme Event II must be considered only when vehicular collision or vessel collision evaluation is required.

**Multi-column Bridges**

For typical multi-column bridges, determine design loads for foundations at Service I Load Combination. Determine foundation loads for single column bents and other non-typical substructures using Service I and Service IV Load Combinations. For Service IV Load Combination, include the vertical wind pressure as specified in Article 3.8.2. For foundation loads on typical multi-column bents and abutments, use the multiple presence factor, *m*, per Article 3.6.1.1.2. Distribute the live load equally to all supporting foundations, assuming all lanes are loaded. Do not apply the Dynamic Load Allowance (IM) to the live load in determining foundation loads when the foundation elements are entirely below ground level.

**Figure B-119. Format of the Bridge Design Manual content (TxDOT 2018a)**

The policies do not provide much background information or explanation but instead, provide straightforward instructions, the majority of which are formatted into a bulleted list (see Figure B-120). The way each policy is divided into subsections allows for a clear overview of the policy and eases user understanding.

TxDOT *Bridge Standards* are organized by general topic area and are available as PDF and DGN files. Within the general topic areas, the standards are organized by revision date, standard name, and a description (see Figure B-121).

**Materials**

Use Class S concrete ($f_c'$ = 4.0 ksi). Refer to district-specific corrosion protection requirements for regions where bridge decks are exposed to de-icing agents and/or saltwater spray with regularity. If thus required, use Class S (HPC) concrete.

Use Grade 60 reinforcing steel or deformed welded wire reinforcement (WWR) meeting the requirements of ASTM A1064. Refer to district-specific corrosion protection requirements for regions where bridge decks are exposed to de-icing agents and/or saltwater spray with regularity. If thus required, use one of the following types of corrosion resistant reinforcement (refer also to Item 440):

- Epoxy-Coated Reinforcing Steel meeting the requirements of ASTM A775 or A934
- Epoxy-Coated WWR meeting the requirements of ASTM A884 Class A or B
- Hot-Dip Galvanized Reinforcing Steel
- Glass Fiber Reinforced Polymer (GFRP) Bars; The design for GFRP reinforcement in bridge decks must adhere to the AASHTO LRFD Guide Specifications for GFRP-Reinforced Concrete Bridge Decks and Traffic Railings.
- Dual Coated Reinforcing Steel meeting the requirements of ASTM A1055
- Low Carbon/Chromium Reinforcing Steel meeting the requirements of ASTM A1035 Gr 100 Ty CS
- Stainless Reinforcing Steel meeting the requirements of ASTM A955 Ty 316LN, XM-28, 2205, or 2304; Use only for extreme chloride exposure in coastal areas.

**Figure B-120. Example of how the manual is written; it shows the bulleted list format as well as the straightforward writing that lacks any background information (TxDOT 2018a)**

**PRESTRESSED CONCRETE X-BEAMS**

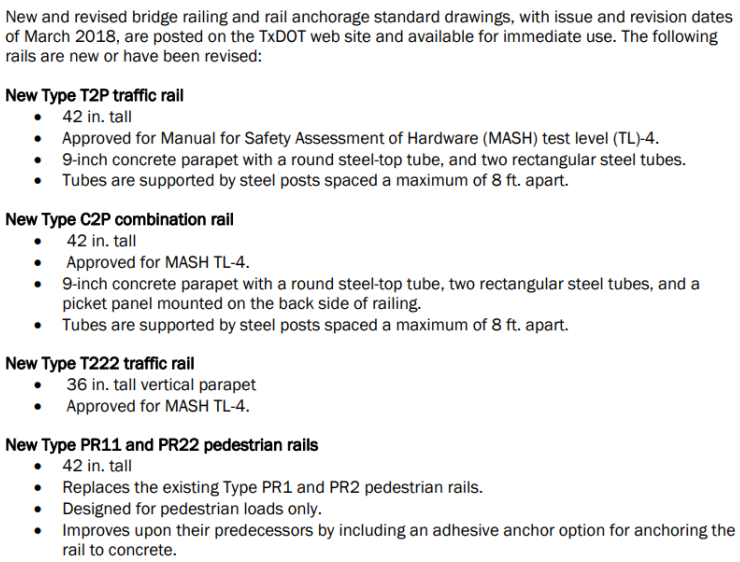
| Rev Date | Std Name | Description | File Name |
|---|---|---|---|
| 01-16 | | Index sht of Prestr X-Beam Standards | table15e.dgn |
| | | ***PRESTRESSED CONCRETE X-BEAM DETAILS*** | |
| **Rev Date** | **Std Name** | **Description** | **File Name** |
| 06-11 | XB20 | Prestressed Concrete X-Beam Details,Ty XB20 | xbstds01.dgn |
| 06-11 | XB28 | Prestressed Concrete X-Beam Details,Ty XB28 | xbstds02.dgn |
| 06-11 | XB34 | Prestressed Concrete X-Beam Details,Ty XB34 | xbstds03.dgn |
| 06-11 | XB40 | Prestressed Concrete X-Beam Details,Ty XB40 | xbstds04.dgn |
| 06-11 | XBBR-MS | Erect Bracing Req w/Miscellaneous Slab Det | xbstds05.dgn |
| 06-11 | XBCS | X-Beam Continuous Slab Details | xbstde06.dgn |
| 06-11 | XBEB | X-Beam Elastomeric Bearing Details | xbstde07.dgn |
| 01-16 | XBND | Prestressed Conc X-Bm Non-Standard Designs | xbstds08.dgn |
| 04-13 | XBSK | Shear Key Details for 5XB X-Beams | xbstds92.dgn |
| 06-11 | XBTS | X-Beam Thickened Slab End Details | xbstde09.dgn |
| | | ***PRESTRESSED CONCRETE X-BEAM 32' ROADWAY DETAILS*** | |

**Figure B-121. List of Bridge Standards (TxDOT 2018a)**

### B.16.2 Rationale Behind Policies

While no rationale is provided, TxDOT does allow access to past revision notices through a hyperlink located on the second page of the manual (see Figure B-122). The revisions do not have a set period of time between them. Each revision notice includes a brief overview of the changes made, as well as the revision date and the version used prior to the revision. There is no access to the previous versions of the manual which may pose a problem if one was attempting to see any prior revisions.

The webpage containing hyperlinks for the *Bridge Standards* also includes a list of *Memorandums of Issued/Revised Standards From September 2000 to Present*. Older memos are also available and can be seen by accessing the hyperlink named "Show Previous Memos". The memos contain a detailed description of the changes made to various standards however, they do not contain any rationale for the changes (see Figure B-123).



New and revised bridge railing and rail anchorage standard drawings, with issue and revision dates of March 2018, are posted on the TxDOT web site and available for immediate use. The following rails are new or have been revised:

**New Type T2P traffic rail**

- 42 in. tall
- Approved for Manual for Safety Assessment of Hardware (MASH) test level (TL)-4.
- 9-inch concrete parapet with a round steel-top tube, and two rectangular steel tubes.
- Tubes are supported by steel posts spaced a maximum of 8 ft. apart.

**New Type C2P combination rail**

- 42 in. tall
- Approved for MASH TL-4.
- 9-inch concrete parapet with a round steel-top tube, two rectangular steel tubes, and a picket panel mounted on the back side of railing.
- Tubes are supported by steel posts spaced a maximum of 8 ft. apart.

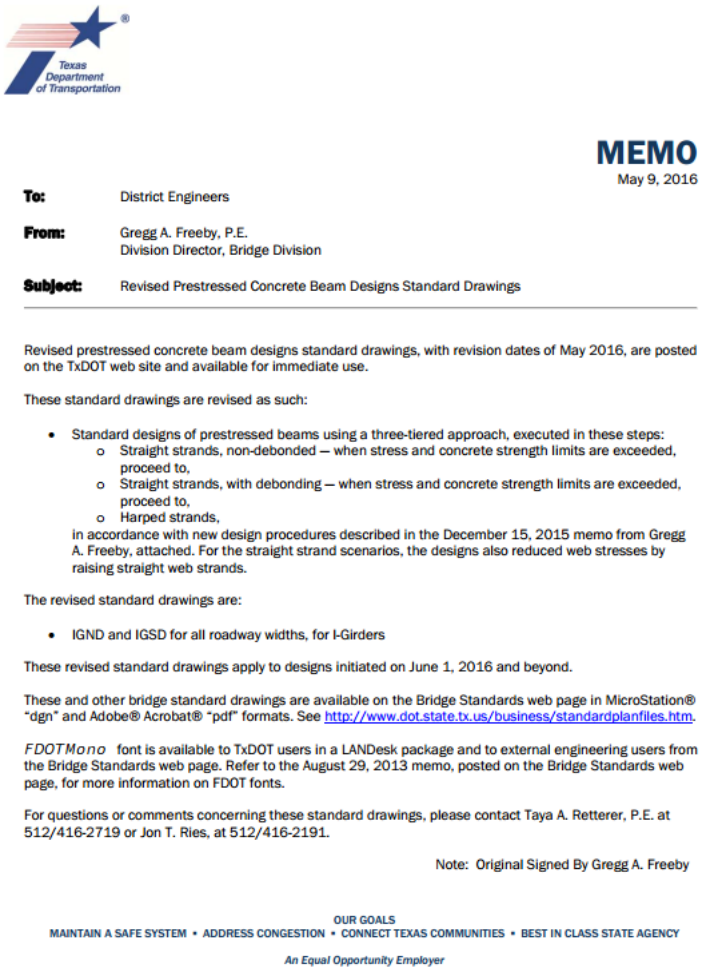
**New Type T222 traffic rail**

- 36 in. tall vertical parapet
- Approved for MASH TL-4.

**New Type PR11 and PR22 pedestrian rails**

- 42 in. tall
- Replaces the existing Type PR1 and PR2 pedestrian rails.
- Designed for pedestrian loads only.
- Improves upon their predecessors by including an adhesive anchor option for anchoring the rail to concrete.

**Figure B-122. Example of the memorandums detailing changes to the *Bridge Standards*.**



Texas Department of Transportation

**MEMO**

May 9, 2016

**To:** District Engineers

**From:** Gregg A. Freeby, P.E.
Division Director, Bridge Division

**Subject:** Revised Prestressed Concrete Beam Designs Standard Drawings

Revised prestressed concrete beam designs standard drawings, with revision dates of May 2016, are posted on the TxDOT web site and available for immediate use.

These standard drawings are revised as such:

- Standard designs of prestressed beams using a three-tiered approach, executed in these steps:
  - Straight strands, non-debonded — when stress and concrete strength limits are exceeded, proceed to,
  - Straight strands, with debonding — when stress and concrete strength limits are exceeded, proceed to,
  - Harped strands,

  in accordance with new design procedures described in the December 15, 2015 memo from Gregg A. Freeby, attached. For the straight strand scenarios, the designs also reduced web stresses by raising straight web strands.

The revised standard drawings are:

- IGND and IGSD for all roadway widths, for I-Girders

These revised standard drawings apply to designs initiated on June 1, 2016 and beyond.

These and other bridge standard drawings are available on the Bridge Standards web page in MicroStation® "dgn" and Adobe® Acrobat® "pdf" formats. See http://www.dot.state.tx.us/business/standardplanfiles.htm.

*FDOTMono* font is available to TxDOT users in a LANDesk package and to external engineering users from the Bridge Standards web page. Refer to the August 29, 2013 memo, posted on the Bridge Standards web page, for more information on FDOT fonts.

For questions or comments concerning these standard drawings, please contact Taya A. Retterer, P.E. at 512/416-2719 or Jon T. Ries, at 512/416-2191.

Note: Original Signed By Gregg A. Freeby

OUR GOALS
MAINTAIN A SAFE SYSTEM • ADDRESS CONGESTION • CONNECT TEXAS COMMUNITIES • BEST IN CLASS STATE AGENCY

*An Equal Opportunity Employer*

**Figure B-123. A memorandum issued regarding the *Revised Prestressed Concrete Beam Designs Standard Drawings* (TXDOT 2018b)**

In response to the *AASHTO Survey*, TxDOT has outlined the workflow of the revision and publication process for their online manuals. The workflow shows each step of the process and the members involved in the workflow (Figure B-124).

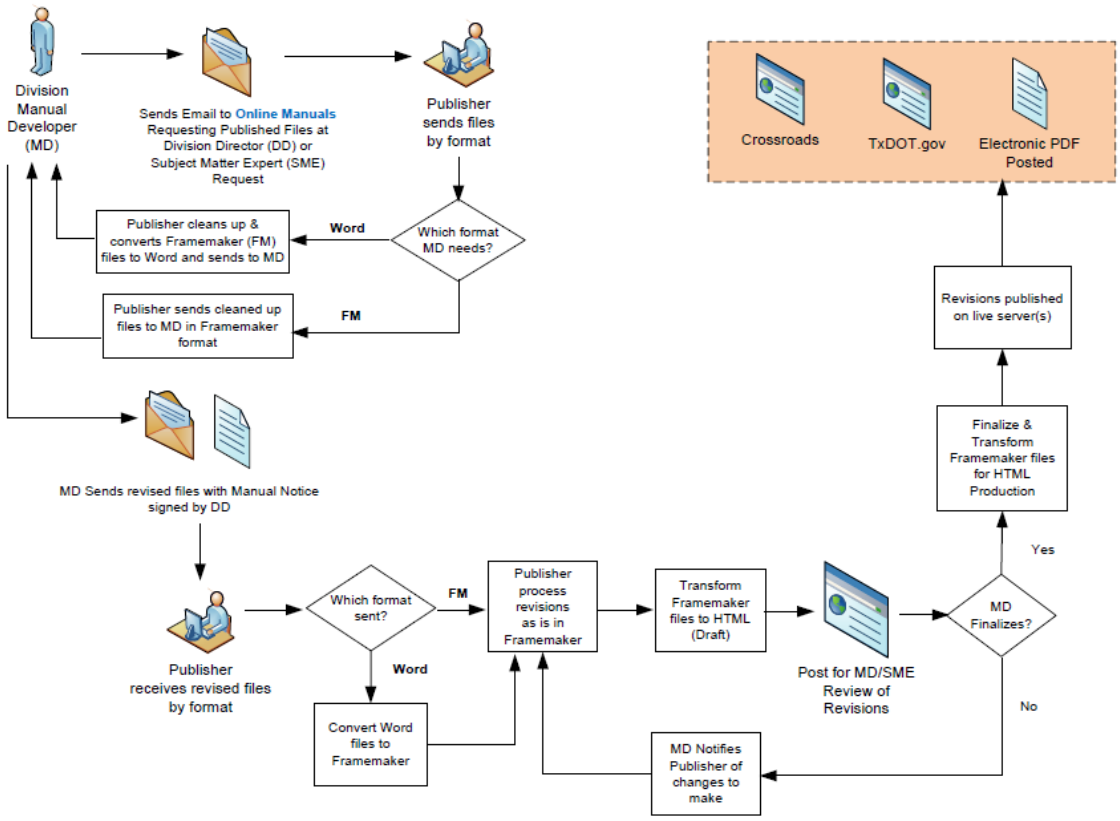



**Figure B-124. The online manual revision and publication workflow (AASHTO 2014)**

## B.16.3 Policy Implementation Guidelines

For policies, the manual includes various constraints, equations, and parameters for use in specific scenarios (see Figure B-125).

- Determine interface shear transfer in accordance with Article 5.8.4. Take cohesion and friction factors as provided in Article 5.8.4.3 as follows:

  $c = 0.28$ ksi

  $\mu = 1.0$

  $K_1 = 0.3$

  $K_2 = 1.8$ ksi

**Figure B-125. Example of the parameters given within the manual for specific situations**

The *Guide to Bridge Standard Drawings* is a quick-reference guide for bridge designers to gather information regarding bridge standards. The document contains a revision history on the first page with the latest changes being distinguished using green fonts. The guide contains tables with background information on the bridge design components contained in the standards. The tables discuss the advantages and usefulness of each component, as well as the standard drawing features, restriction regarding the use of the standards, and other topics (see Figure B-126).

| | |
|---|---|
| **Advantages/ Usefulness** | ▪ Pretensioned concrete X-beams are useful for bridges requiring shallow superstructures and where future widening is anticipated.<br>▪ Pretensioned concrete X-beam bridges are predicted to cost more than pretensioned concrete I-Girder bridges but less than conventional pretensioned concrete box beam bridges.<br>▪ Construction is similar to pretensioned concrete I-Girder bridges. |
| **Standard Drawing Location** | ▪ XB prefixes.<br>▪ Web site:<br>http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm#XBeams |
| **Standard Drawing Features** | ▪ Designed for HL93 live load in accordance with *AASHTO LRFD Bridge Design Specifications*.<br>▪ Drawings Accommodate:<br>– Four beam depths (20-, 28-, 34-, and 40-in.), each in two nominal widths (4-ft. and 5-ft.). Only 5-ft. wide beams are used with the standard roadway widths.<br>– 32-, 38-, 40-, and 44-ft. roadway widths<br>– 0-, 15-, and 30-degree skew angles.<br>– Span lengths of 40-ft. through 110-ft., in 5-ft. increments. Not all beam types accommodate all span lengths.<br>– Abutment header slopes of 2:1 and 3:1.<br>– Most standard rail types.<br>▪ Roadway surface is a cast-in-place concrete slab with 8-inch depth.<br>▪ Details are provided to construct 2- or 3-span units with slabs continuous over interior bents. Using units reduces the number of expansion joints.<br>▪ Drawings support these foundation options:<br>– Drilled shafts (36-in)<br>– Multi-pile footings<br>– Prestressed concrete piling (16-, 18-, 20-,24-in)<br>– Steel H-piling (14x73, 14x117, 18x135)<br>▪ Nine standard drawings are provided to use with customized bridge plans. |
| **Standard Drawings Needed for Bridge Details** | ▪ XBSD – Roadway-specific Prestressed Concrete X-Beam Standard Design standard drawing |

**Figure B-126. Sample page from the Guide to Bridge Standards showing the table of information regarding types of bridge design components**

The *Local Government Projects Best Practices Workbook* guides users through the process of completing a project, starting with the project initiation and ending with project close-out and maintenance. The book contains many forms in a workbook-style format that team members can fill out to track the process of the project (Figure B-127). These forms also provide a good record of lessons learned during each of these projects.

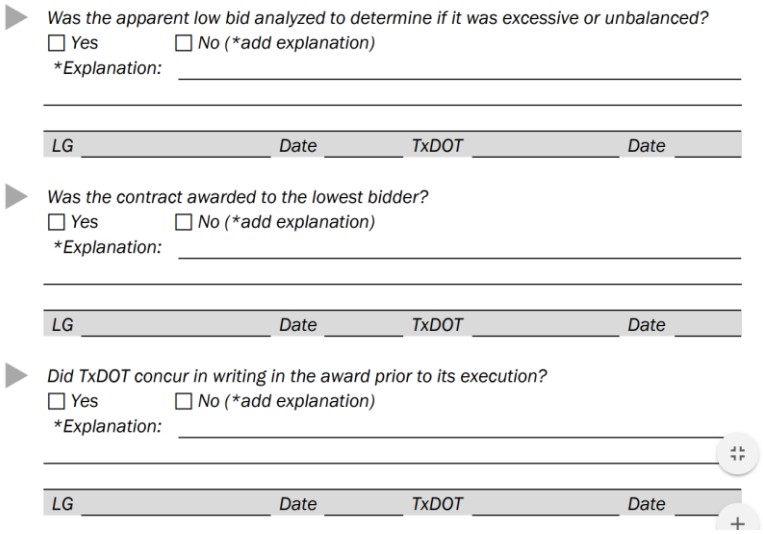



**Figure B-127. Example of the worksheet-style forms found in the Best Practices Workbook (TxDOT 2015a)**

The *Local Government Project Maintenance Guide* also guides users through the project process similar to the *Best Practices Workbook*, starting at the project initiation and ending with the project close-out and maintenance. It also includes various flowcharts to guide users through the activities of a project (see Figure B-128), as well as a list of abbreviations for different organizations and transportation-related projects.

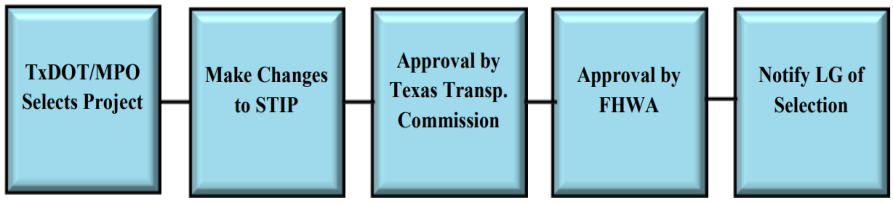
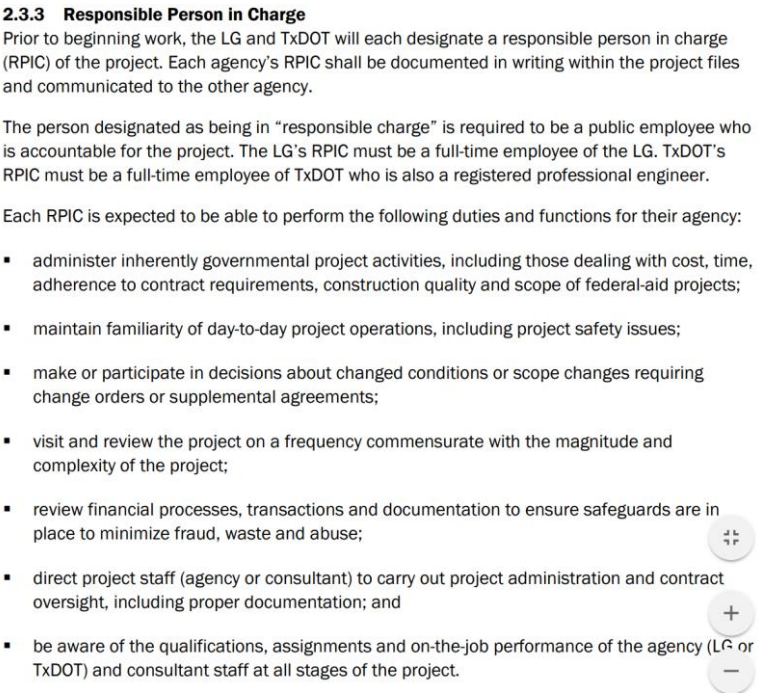



**Figure B-128. Example of the workflow diagrams found in the Project Maintenance Guide (TxDOT 2015b)**

While this guide does not include worksheets to fill out, it includes detailed instructions on how parts of a project should be executed, including the different groups who are involved and specific actions that need to be completed in order to complete that stage of the process (see Figure B-129).



**2.3.3 Responsible Person in Charge**

Prior to beginning work, the LG and TxDOT will each designate a responsible person in charge (RPIC) of the project. Each agency's RPIC shall be documented in writing within the project files and communicated to the other agency.

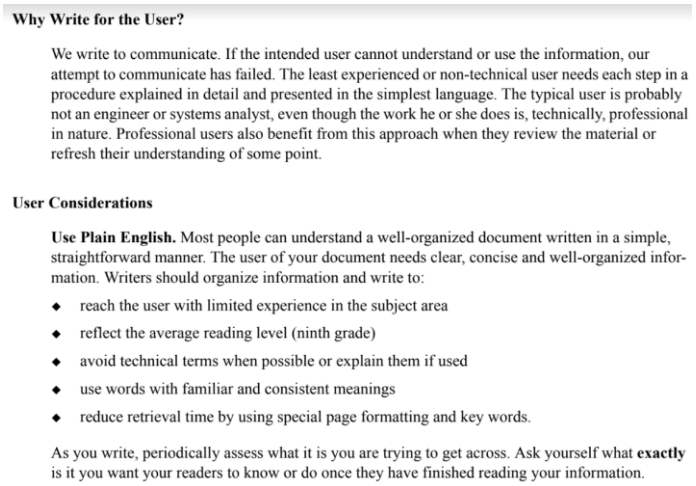
The person designated as being in "responsible charge" is required to be a public employee who is accountable for the project. The LG's RPIC must be a full-time employee of the LG. TxDOT's RPIC must be a full-time employee of TxDOT who is also a registered professional engineer.

Each RPIC is expected to be able to perform the following duties and functions for their agency:

- administer inherently governmental project activities, including those dealing with cost, time, adherence to contract requirements, construction quality and scope of federal-aid projects;
- maintain familiarity of day-to-day project operations, including project safety issues;
- make or participate in decisions about changed conditions or scope changes requiring change orders or supplemental agreements;
- visit and review the project on a frequency commensurate with the magnitude and complexity of the project;
- review financial processes, transactions and documentation to ensure safeguards are in place to minimize fraud, waste and abuse;
- direct project staff (agency or consultant) to carry out project administration and contract oversight, including proper documentation; and
- be aware of the qualifications, assignments and on-the-job performance of the agency (LG or TxDOT) and consultant staff at all stages of the project.

**Figure B-129. Example of the detailed instructions found in the Project Maintenance Guide that help identify the responsibilities of different units involved with a project (TxDOT 2015b)**

The TxDOT *Communications Manual* documents the recommended guidelines for communication matters such as writing structure, business communications, and manual standards. The manual is structured like a textbook with lessons and examples on how to write effectively; it serves to ensure consistency and proper communication amongst all responsible parties of projects (see Figure B-130).



**Why Write for the User?**

We write to communicate. If the intended user cannot understand or use the information, our attempt to communicate has failed. The least experienced or non-technical user needs each step in a procedure explained in detail and presented in the simplest language. The typical user is probably not an engineer or systems analyst, even though the work he or she does is, technically, professional in nature. Professional users also benefit from this approach when they review the material or refresh their understanding of some point.

**User Considerations**

**Use Plain English.** Most people can understand a well-organized document written in a simple, straightforward manner. The user of your document needs clear, concise and well-organized information. Writers should organize information and write to:

- reach the user with limited experience in the subject area
- reflect the average reading level (ninth grade)
- avoid technical terms when possible or explain them if used
- use words with familiar and consistent meanings
- reduce retrieval time by using special page formatting and key words.

As you write, periodically assess what it is you are trying to get across. Ask yourself what **exactly** is it you want your readers to know or do once they have finished reading your information.

**Figure B-130. Example of writing guidelines located in the Communications Manual**

## B.17 WISCONSIN

The Wisconsin Department of Transportation (WisDOT) organizes their information into three publications: *Bridge Manual*, *Standard Drawings*, and *Update Archives*. The *Bridge Manual* contain the bridge design policies as well as background information concerning the policy. The *Standard Drawings* contain the design guides and details. The *Update Archives* contain a summary of the changes that took place, as well as copies of the standards and manuals from a six-month period.

### B.17.1 Policy Documentation

The manual can be accessed as individual chapters, two discrete volumes, or a single file that combines volume 1 and 2 (see Figure B-131). Each chapter has a table of contents that is organized numerically with section and subsections, as seen in Figure B-132. Each section/subsection in the table of contents is hyperlinked. The table uses a single column format to present the content. Within the chapter, policies are separated from the text by placing them in a textbox and titling them as a "WisDOT policy item:", as shown in Figure B-133. While this creates an effective way of identifying a policy and understanding the reasoning behind the policy, it might complicate navigation if a user is just trying to find a specific policy due to the lack of granularity.

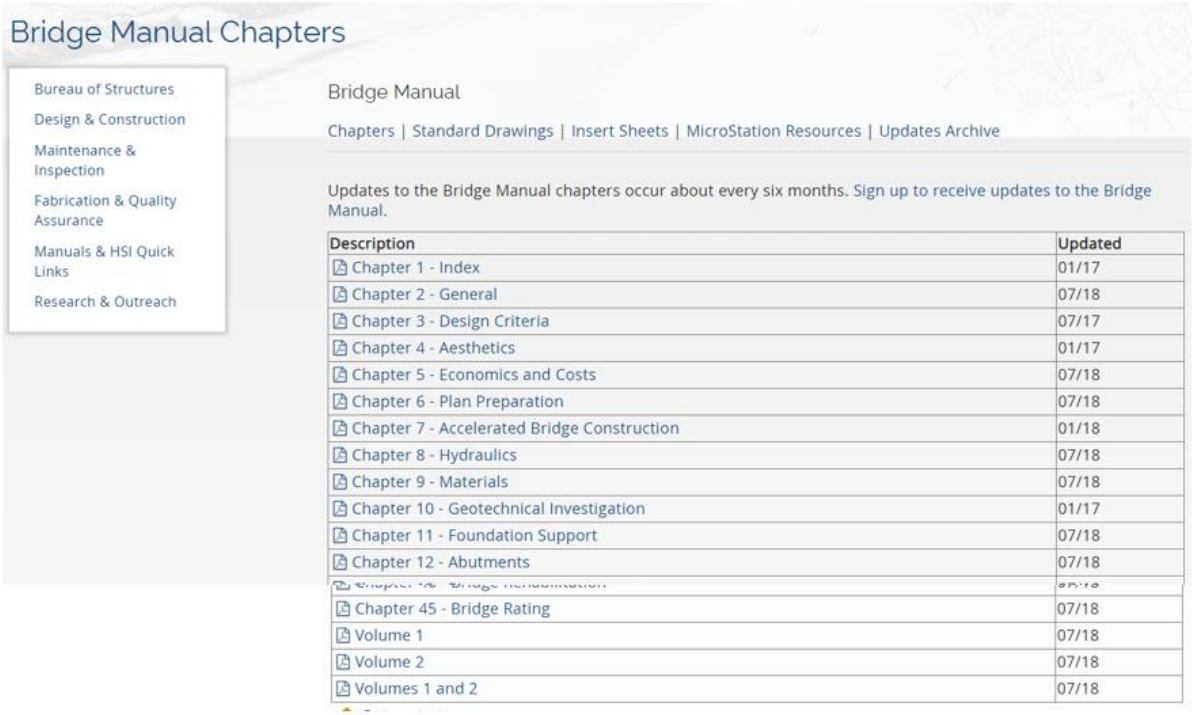



**Figure B-131. WisDOT website showing Bridge Manual chapters and related information (WisDOT 2018)**

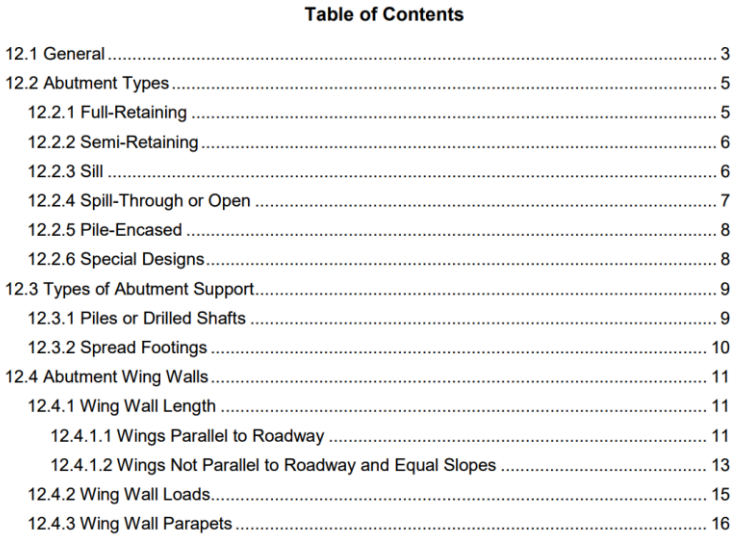
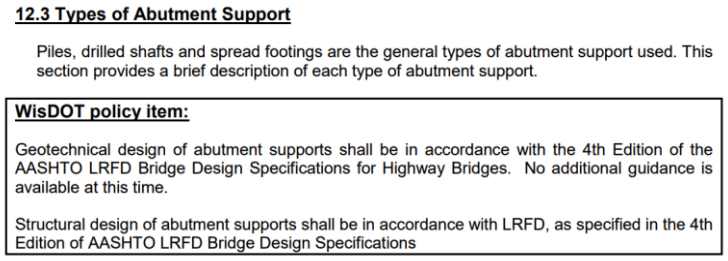


Table of Contents



**Figure B-132. Organization of information in the table of contents of the *Bridge Manual* (WisDOT 2018)**



**12.3 Types of Abutment Support**

Piles, drilled shafts and spread footings are the general types of abutment support used. This section provides a brief description of each type of abutment support.

**WisDOT policy item:**

Geotechnical design of abutment supports shall be in accordance with the 4th Edition of the AASHTO LRFD Bridge Design Specifications for Highway Bridges. No additional guidance is available at this time.

Structural design of abutment supports shall be in accordance with LRFD, as specified in the 4th Edition of AASHTO LRFD Bridge Design Specifications

**Figure B-133. Example of a WisDOT policy within the *Bridge Manual* (WisDOT 2018)**

The manuals are updated about every six months, the most recently updated date is listed next to the chapter link. References to outside material is cited throughout the manual however, no hyperlinks are given to direct the user to those references.

The bridge design guides are listed separately as *Standard Drawings*. These are also organized by chapter title and then by section titles, as seen from Figure B-134. The design guides also include the most recent date of revision.

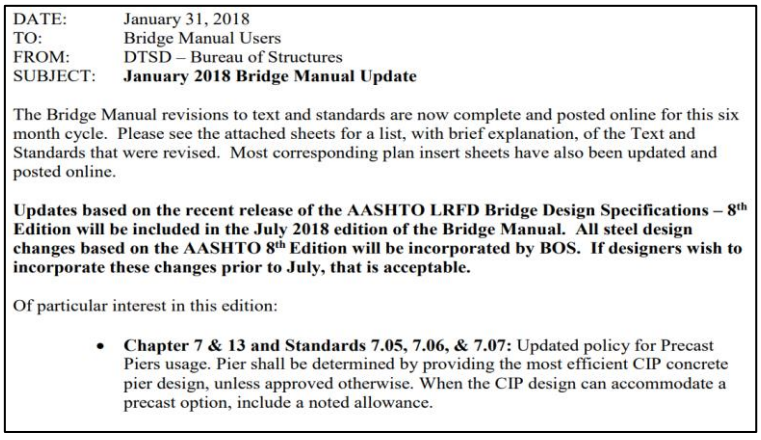
| Description | Updated |
|---|---|
| Chapter 4 - Aesthetics | |
| 4.01 - Formliner Details | 07/16 |
| 4.02 - Aesthetic Concepts Without Pedestrian Accommodations | 07/15 |
| 4.03 - Aesthetic Concepts With Pedestrian Accommodations | 07/15 |
| 4.04 - Wing & Parapet Aesthetic Details | 01/18 |
| 4.05 - Multi-Columned Pier Aesthetic Details | 07/15 |
| All - All Chapter 4 Standards | 01/18 |

**Figure B-134. Organization of topics in the table of contents in the *Standard Drawings* (WisDOT 2018)**

### B.17.2 Rationale Behind Policies

The textbook format of the bridge design manual provides a thorough explanation of the various concepts and background needed to understand the policy. Various diagrams that illustrate specific concepts support the text.

Changes to both the design manuals and guides are listed in the *Updates Archive*. These updates are also published on a six-month time period, once in January and once in July, and are organized by month and year. The specific date that the update was published is also provided alongside the title. This method of presenting the changes is good as long as the user does not need a timeline of changes for a specific section; in that case, they would have to go through each individual update to compose such a list. Within the updates, the most important revisions are first listed by general chapter number for the design manuals and by specific number for the standard drawings, as seen in Figure B-135. Under that, the updates of the text within the manual are organized by chapter number and page number, along with a summary of the change, as shown in Figure B-136. Due to the lack of a date associated with the change, this method may be ineffective if a chronological list of changes to a section is needed. A detailed report of the changes to the standard drawings is also included, showing each standard drawing along with any changes made, see Figure B-137. The *Updates Archive* provides access to copies of previous versions of the standards.



DATE: January 31, 2018
TO: Bridge Manual Users
FROM: DTSD – Bureau of Structures
SUBJECT: **January 2018 Bridge Manual Update**

The Bridge Manual revisions to text and standards are now complete and posted online for this six month cycle. Please see the attached sheets for a list, with brief explanation, of the Text and Standards that were revised. Most corresponding plan insert sheets have also been updated and posted online.

**Updates based on the recent release of the AASHTO LRFD Bridge Design Specifications – 8th Edition will be included in the July 2018 edition of the Bridge Manual. All steel design changes based on the AASHTO 8th Edition will be incorporated by BOS. If designers wish to incorporate these changes prior to July, that is acceptable.**

Of particular interest in this edition:

- **Chapter 7 & 13 and Standards 7.05, 7.06, & 7.07:** Updated policy for Precast Piers usage. Pier shall be determined by providing the most efficient CIP concrete pier design, unless approved otherwise. When the CIP design can accommodate a precast option, include a noted allowance.

**Figure B-135. Example of a Memo in the *Update Archive* (WisDOT 2018)**

**January 2018 Bridge Manual Text Update Summary**

| Chapter | Page Number(s) | Change |
|---|---|---|
| 6 | 15,27,29 | Added labeling guidance for new and rehab projects. |
| | 42 | Added HMA and PMA overlay guidance for estimating quantities. |
| 7 | 8 | Updated Policy Item for precast pier usage. Pier configurations shall be determined by providing the most efficient CIP concrete pier design, unless approved otherwise. When the CIP concrete design can accommodate a precast option, include a noted allowance. |
| 9 | 4 | Removed A4 abutment reference. Clarified epoxy coated bar usage. |
| | 6, 20 | Added figure for typical development lengths for standard hooks in tension |
| | 6-8, 20-23 | Re-numbered figures |
| | 27 | Updated Policy Item for the implementation of revised tension development and lap lengths. Changed implementation date from July of 2018 to January of 2019. |
| 11 | 34 | Removed A4 abutment reference. |

**Figure B-136. Example of the detailed changes to the text of the *Bridge Manual***

**January 2018 Standard Details Update Summary**

**Chapter 4**

- Std 4.01 ■ No revisions.
- Std 4.02 ■ No revisions.
- Std 4.03 ■ No revisions.
- Std 4.04 ■ Revised parapet width (missed in last update)
- Std 4.05 ■ No revisions.

**Chapter 7**

- Std 7.01 ■ No revisions.
- Std 7.02 ■ Added "Section Thru Abutment for Girders"
  - ■ Updated reinforcement spacing below and behind abutments
- Std 7.03 ■ Revised boxed note for optional precast pier usage. See 7.1.4.1.2 for updates.
- Std 7.04 ■ No revisions.
- Std 7.05 ■ Removed boxed note for optional precast pier usage. See 7.1.4.1.2 for updates.
- Std 7.06 ■ Removed boxed note for optional precast pier usage. See 7.1.4.1.2 for updates.
- Std 7.07 ■ Removed boxed note for optional precast pier usage. See 7.1.4.1.2 for updates.

**Figure B-137. Example of the detailed changes to the *Standard Drawings***

### B.17.3 Policy Implementation Guidelines

A limited amount of resources is provided within the manual, a few of which can be seen in Figure B-138. Example calculations and templates are not provided.

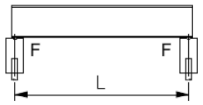
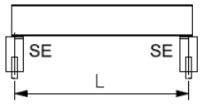
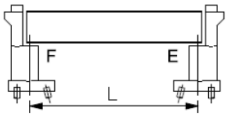
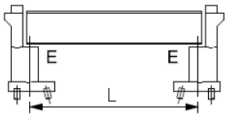
| Abutment Arrangements | Superstructures | | |
|---|---|---|---|
| | Concrete Slab Spans | Prestressed Girders | Steel Girders |
| Type A1 (F-F)<br>  | a.<br>L ≤ 150'<br>S ≤ 30°<br>AL ≤ 50' | a.<br>L ≤ 150'<br>S ≤ 15°<br>AL ≤ 50' | a.<br>L ≤ 150'<br>S ≤ 15°<br>AL ≤ 50' |
| Type A1 (SE-SE)<br>  | a.<br>L ≤ 300'<br>S ≤ 30°<br>AL > 50' | a.<br>L ≤ 300'<br>S ≤ 40° | a.<br>L ≤ 150'<br>S ≤ 40° |
| Type A3 (F-E)<br>  | Not used | Single span and (S > 40°) | Single span and (L > 150' or S > 40°) |
| Type A3 (E-E)<br>  | b.<br>L >300' and S ≤ 30° with rigid piers | L>300' or (S > 40° and multi-span) | Multi-span and (L>150' or S > 40°) with rigid piers |

**Figure B-138. An example of the scenario-specific guidelines given in the *Bridge Manual* (WisDOT 2018)**

**Table B.1. Links to State DOT Manuals and Guides**

| DOT | Documentation | Weblink |
|---|---|---|
| Alabama | Structural Design Manual | https://www.dot.state.al.us/brweb/. |
| | Bridge Special Project Drawings | |
| Alaska | Bridges and Structures Manual | http://www.dot.state.ak.us/stwddes/desbridge/bridgemanual.shtml |
| | Bridges and Structures Manual | http://www.dot.state.ak.us/stwddes/dcsprecon/stddwgspages/bridge_eng.shtml |
| Florida | Structural Manual | http://www.fdot.gov/structures/StructuresManual/CurrentRelease/StructuresManual.shtm |
| | Structures Design Office Design Standards Details & Data Tables | http://www.fdot.gov/structures/cadd/standards/standards.shtm |
| | Archived Publications | http://www.fdot.gov/structures/DocsandPubs.shtm |
| | Current Bulletins/Memorandums | http://www.fdot.gov/structures/Memos/currentbulletins.shtm |
| | Archived Bulletins | http://www.fdot.gov/structures/Memos/archivedbulletins.shtm |
| Georgia | Bridge and Structures Design Manual | http://www.dot.ga.gov/PartnerSmart/DesignManuals/BridgeandStructure/GDOT_Bridge_and_Structures_Policy_Manual.pdf |
| | Bridge Design Basic Drawings | http://www.dot.ga.gov/PartnerSmart/DesignSoftware/Pages/Bridge.aspx#tab-1 |
| Idaho | Bridge Design Manual | https://itd.idaho.gov/bridge/ |
| Iowa | LRFD Design Manual | https://iowadot.gov/bridge/design-policies/bridge-design-manual |
| | Bridge Standards | https://iowadot.gov/bridge/bridge-and-culvert-standards/bridge-standards |
| | Checklists | https://iowadot.gov/bridge/design-policies/bridge-and-culvert-plan-checklist |
| Michigan | Bridge Design Manual | https://mdotcf.state.mi.us/public/design/englishbridgemanual/ |
| | Bridge Design Guides | https://mdotcf.state.mi.us/public/design/englishbridgeguides/ |
| Minnesota | Bridge Design Manual | https://www.dot.state.mn.us/bridge/pdf/lrfdmanual/lrfdbridgedesignmanual.pdf |
| | Bridge Details Manual | https://www.dot.state.mn.us/bridge/pdf/cadd/files/bdetailspart1/bridge-details-manual-part-1.pdf |
| Mississippi | Bridge Design Manual | http://mdot.ms.gov/documents/bridge/Manuals/MDOT%20Bridge%20Design%20Manual.pdf |
| | Standards | http://mdot.ms.gov/portal/bridge.aspx |

| | | |
|---|---|---|
| Montana | Montana Structures Manual | https://www.mdt.mt.gov/publications/manuals.shtml |
| | Bridge Design Standards | |
| New Hampshire | Bridge Design Manual | https://www.nh.gov/dot/org/projectdevelopment/bridgedesign/documents.html |
| New Mexico | Bridge Procedures and Design Guide | http://dot.state.nm.us/content/nmdot/en/Engineering_Support.html#b |
| | Standard Specifications for Highway and Bridge Construction | |
| New York | Bridge Manual | https://www.dot.ny.gov/divisions/engineering/structures/manuals/bridge-manual-usc |
| | Bridge Detail Sheets | https://www.dot.ny.gov/main/business-center/engineering/cadd-info/drawings/bridge-detail-sheets-usc |
| | Emergency Bridge Contract Drawings | https://www.dot.ny.gov/divisions//engineering/structures/repository/files/emergency_contract_dwgs.pdf |
| North Dakota | Bridge Design Manual | https://www.dot.nd.gov/manuals/design/designmanual/designmanual.htm# |
| Rhode Island | Bridge Design Manual | http://www.dot.ri.gov/documents/doingbusiness/RILRFDBridgeManual.pdf |
| | Bridge Design Standard Details | http://www.dot.ri.gov/documents/doingbusiness/RIDOT_Bridge_Standards.pdf |
| Texas | Bridge Design Manual | http://onlinemanuals.txdot.gov/txdotmanuals/lrf/lrf.pdf |
| | Best Practices Workbook | http://ftp.dot.state.tx.us/pub/txdot/lgp/procedures/workbook.pdf |
| | Project Management Guide | http://ftp.dot.state.tx.us/pub/txdot/lgp/procedures/guide.pdf |
| | Standards | https://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm |
| Wisconsin | Bridge Manual | https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/bridge-manual.aspx |
| | Standard Drawings | https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/bridge-manual-standards.aspx |
| | Update Archives | https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/bm-updates.aspx |

For single box cross-sections, the superstructure may be analyzed as a spine beam for both flexural and torsional effects. A steel box should not be considered to be torsionally rigid unless internal bracing is provided to maintain the box cross-section. The transverse position of bearings shall be modeled.

Commentary on side - in separate column

**4.6.3.5—Truss Bridges**

**C4.6.3.5**

A refined plane frame or space frame analysis shall include consideration for the following:

- Composite action with the deck or deck system;
- Continuity among the components;
- Force effects due to self-weight of components, change in geometry due to deformation, and axial offset at panel points; and
- In-plane and out-of-plane buckling of components including original out-of-straightness, continuity among the components and the effect axial forces present in those components.

Out-of-plane buckling of the upper chords of pony truss bridges shall be investigated. If the truss derives its lateral stability from transverse frames, of which the floorbeams are a part, the deformation of the floorbeams due to vehicular loading shall be considered.

Load applied to deck or floorbeams instead of to truss joints will yield results that more completely quantify out-of-plane actions.

Experience has shown that dead load force effects calculated using either plane frame or space frame analysis in a truss with properly cambered primary and secondary members and detailed to minimize eccentricity at joints, will be quite close to those calculated by the conventional approximations. In many cases, a complete three-dimensional frame analysis may be the only way to accurately calculate forces in secondary members, particularly live load force effects.

**4.6.3.6—Arch Bridges**

**C4.6.3.6**

The provisions of Article 4.6.3.5 shall apply where applicable.

The effect of the extension of cable hangers shall be considered in the analysis of an arch tie.

Where not controlled through proper detailing, rib shortening should be investigated.

The use of large deflection analysis of arches of longer spans should be considered in lieu of the moment magnification correction as specified in Article 4.5.3.2.2c.

Rib shortening and arch design and construction are discussed by Nettleton (1977).

Any single-step correction factor cannot be expected to accurately model deflection effects over a wide range of stiffnesses.

If a hinge is provided at the crown of the rib in addition to hinges at the abutment, the arch becomes statically determinate, and stresses due to change of temperature and rib shortening are essentially eliminated.

Arches may be analyzed, designed, and constructed as hinged under dead load or portions of dead load and as fixed at some hinged locations for the remaining design loads.

When the distribution of stresses between the top and bottom chords of trussed arches is dependent on the manner of erection, the manner of erection shall be indicated in the contract documents.

In trussed arches, considerable latitude is available in design for distribution of stresses between the top and bottom chords dependent on the manner of erection. In such cases, the manner of erection should be indicated in the contract documents.

AOCS Standards



Official methods and recommended practices of the American Oil Chemists' Society 1998.

see Notes, 6). Swirl to dispense thoroughly and let stand for 10 min in cold water bath to completely precipitate the polyethylene.

11. Weigh accurately two pieces of 7.0-cm moisture-free glass-fiber filter paper and place them along with the size 1 retainer ring in the California State modified Buchner funnel. Place the funnel on a 1-L filtration flask and, with gentle suction, filter the solution from Procedure, 10. Using a wash bottle, wash the flask, retainer ring and paper four times with 20-mL portions of cold methanol.
12. Pull air through the glass-fiber paper for 2 min. Carefully remove the paper from the funnel and dry in an oven at 105°C to constant weight. Ten min drying time should be sufficient. Cool in a desiccator and reweigh the paper and contents to constant weight.

## CALCULATIONS

1. Calculate the ppm (mg/kg) polyethylene in the samples as follows:

$$\text{Polyethylene, ppm} = \frac{\text{mass of precipitate, g}}{\text{mass of sample, g}} \times 10^6$$

## PRECISION

1. The probable accuracy (based on the previous version of this AOCS method) is ± 10 ppm for values in the range of 50 to 500 ppm (see Notes, 7). International Union of Pure and Applied Chemistry Method 2.606, published in 1987, notes a standard deviation of 20 mg/kg (ppm) at a level of 200 mg/kg (ppm) of polyethylene. The probable reproducibility of the method (based on International Organization for Standardization/British Standards Institution Method BS 3919, published in 1976) is a coefficient of variation of about 15% up to 100 mg/kg (ppm) and about 10% in the range of 100–400 mg/kg (ppm).
2. Details of an interlaboratory test on the precision of the method are summarized in Table 1 (1). The values derived from this interlaboratory test may not be applicable to concentration ranges and matrices other than those given. These values indicate a higher degree of variation than previously calculated. See Notes, 7.

**Table 1**
**Interlaboratory test results.**

| | Tallow 1 | Tallow 2 |
|---|---|---|
| Number of laboratories retained after eliminating outliers | 10 | 9 |
| Mean, mg/kg | 41 | 184 |
| Standard deviation of repeatability ($s_r$), mg/kg | 8 | 15 |
| Coefficient of variation of repeatability, % | 20 | 8.4 |
| Repeatability limit ($r$) ($2.83 \times s_r$), mg/kg | 23 | 24 |
| Standard deviation of reproducibility ($s_R$), mg/kg | 14 | 33 |
| Coefficient of variation of reproducibility, % | 34 | 18 |
| Reproducibility limit ($R$) ($2.83 \times s_R$), mg/kg | 39 | 92 |

## NOTES

Notes at end of relevant section

*Caution*

A fume hood must be used for the entire analysis.

Chloroform is a known carcinogen. It is toxic by inhalation and has anesthetic properties. Avoid contact with the skin. Prolonged inhalation or ingestion can lead to liver and kidney damage and may be fatal. It is nonflammable, but will burn on prolonged exposure to flame or high temperature. The TLC is 10 ppm in air. A fume hood should be used at all times when using chloroform.

Tetrachloroethylene (perchloroethylene) is an irritant to eyes and skin. The TLC is 50 ppm in air.

Ethyl alcohol (ethanol) is flammable. Use a properly operating fume hood when heating or evaporating.

Methyl alcohol (methanol) is flammable and toxic. Avoid contact with eyes. Avoid breathing vapors. Use effective fume-removal device. Can react vigorously with sodium hydroxide + chloroform, potassium hydroxide + chloroform and perchloric acid.

Acetone is a flammable solvent. It should not be used near an open flame. The use of a fume hood is recommended when using this solvent.

Sulfuric acid is a strong acid and will cause severe burns. Protective clothing should be worn when working with this acid. It is a dehydrating agent and should not be stored in the vicinity of organic materials. Use great caution in mixing with water due to heat evolution that can cause explosive spattering. Always add the acid to the water, never the reverse.

Additional technical notes are numbered in this example.

## NUMBERED NOTES

1. 95% ethyl alcohol (ethanol) may be replaced by industrial methyl alcohol.
2. For samples expected to contain more than 400 mg/kg (ppm) plastic polymer, the sample weight may be reduced to 25 g.
3. The glass-fiber paper is very rapid and extremely retentive, but it is delicate and must be handled with care.
4. The filtering flask (500 mL) used in Procedure, 7–10 should be thoroughly cleaned of any residual polyethylene film after each completed analysis. A strong, hot caustic solution is adequate for this purpose. Observe proper caution in handling strong caustic solutions.
5. Procedure, 9 requires complete and thorough washing. The tetrachloroethylene must be kept at near boiling at all times.
6. The methanol used in Procedure, 10 and 11 should be precooled below 10°C by refrigeration or cold water bath to ensure complete and rapid precipitation.
7. The probable accuracy is thought to be due to the inherently nonuniform nature of materials in the samples. It represents the approximate agreement that is attainable. It is recommended that the analyst become familiar with the procedure on trial samples to be able to recognize or anticipate difficulties.

## REFERENCES

1. ISO 6656 Animal and Vegetable Fats and Oils—Determination of polyethylene-type polymers.

References can be linked to original documents in PW

National Electrical Code - Notes at end of relevant section, smaller font



NFPA 70

## National Electrical Code

2017 Edition

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This 2017 edition includes the following usability features as aids to the user. Changes other than editorial are indicated with gray shading within sections. An entire figure caption with gray shading indicates a change to an existing figure. New sections, tables, and figures are indicated by a bold, italic *N* in a gray box to the left of the new material. An *N* next to an Article title indicates that the entire Article is new. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

# ARTICLE 90
# Introduction

### 90.1 Purpose.

**(A) Practical Safeguarding.** The purpose of this *Code* is the practical safeguarding of persons and property from hazards arising from the use of electricity. This *Code* is not intended as a design specification or an instruction manual for untrained persons.

**(B) Adequacy.** This *Code* contains provisions that are considered necessary for safety. Compliance therewith and proper maintenance result in an installation that is essentially free from hazard but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.

Informational Note: Hazards often occur because of overloading of wiring systems by methods or usage not in conformity with this *Code*. This occurs because initial wiring did not provide for increases in the use of electricity. An initial adequate installation and reasonable provisions for system changes provide for future increases in the use of electricity.

**(C) Relation to Other International Standards.** The requirements in this *Code* address the fundamental principles of protection for safety contained in Section 131 of International Electrotechnical Commission Standard 60364-1, *Electrical Installations of Buildings*.

Informational Note: IEC 60364-1, Section 131, contains fundamental principles of protection for safety that encompass protection against electric shock, protection against thermal effects, protection against overcurrent, protection against fault currents, and protection against overvoltage. All of these potential hazards are addressed by the requirements in this *Code*.

### 90.2 Scope.

**(A) Covered.** This *Code* covers the installation and removal of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways for the following:

(1) Public and private premises, including buildings, structures, mobile homes, recreational vehicles, and floating buildings
(2) Yards, lots, parking lots, carnivals, and industrial substations
(3) Installations of conductors and equipment that connect to the supply of electricity
(4) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings, that are not an integral part of a generating plant, substation, or control center

**(B) Not Covered.** This *Code* does not cover the following:

(1) Installations in ships, watercraft other than floating buildings, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles

Informational Note: Although the scope of this *Code* indicates that the *Code* does not cover installations in ships, portions of this *Code* are incorporated by reference into Title 46, Code of Federal Regulations, Parts 110–113.

(2) Installations underground in mines and self-propelled mobile surface mining machinery and its attendant electrical trailing cable
(3) Installations of railways for generation, transformation, transmission, energy storage, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communications purposes
(4) Installations of communications equipment under the exclusive control of communications utilities located outdoors or in building spaces used exclusively for such installations
(5) Installations under the exclusive control of an electric utility where such installations
   a. Consist of service drops or service laterals, and associated metering, or
   b. Are on property owned or leased by the electric utility for the purpose of communications, metering, generation, control, transformation, transmission, energy storage, or distribution of electric energy, or
   c. Are located in legally established easements or rights-of-way, or



Notes at end of relevant section - named "Informational Note" - in smaller font to set off

Commentaries/rationale combined into an appendix or separate section at end of book. Everything in order - relevant sections marked with manual section number. Can be easily revised and republished in PDF or HTML.

# 1996 Commentary to Standard Specifications for Highway Bridges

## INTRODUCTION

**Note:** The 16th Edition of *Standard Specifications of Highway Bridges* includes a Commentary to offer further explanation of the revisions provided in 1996.

## DIVISION I

### C5.2.1.4 MSE Walls

The existing specification is restrictive because it refers only to modular precast facing. The proposed wording allows the use of other kinds of facings which are available today.

### C5.2.2.3 Overall Stability

The existing specification implies that it is acceptable to proceed with a wall design without soil/rock data by using a slightly higher factor of safety. It is clearly unacceptable and dangerous to proceed with a wall design without adequate data; and, it conflicts with minimum standards of safety for site investigations already contained in AASHTO Bridge Specifications. The proposed revision requires that site data be obtained for all wall designs, but still distinguishes between normal wall installations and those supporting bridge abutments, buildings or critical utilities.

### C5.5.5 Structure Dimensions and External Stability

Existing Article 5.5.5 requires the same factor of safety for seismic loads as for static loads. However, Article 5.8.10.1 allows a reduced factor of safety for seismic loads. It is reasonable to use a lower factor of safety for seismic loads because it is an infrequent and temporary load. For static loads, we reserve some capacity for unknown loads, fabrication, and workmanship. The proposed revision allows the designer to use judgment for the specific site and also brings this article in line with MSE wall criteria.

### C5.6.2 Earth Pressure and Surcharge Loading

This revision is to correct an error in the formula for embedment in rock in Figure 5.6.2A.

### C5.8.1 Structure Dimensions

The existing specifications regarding embedment depth are based on latent physical characteristics of the ground. Because of this, most cases are overly conservative, but extreme cases could be equally unconservative. Embedment depths should be based on engineering calculations for stability, bearing capacity, and settlement. Frost heave, scour and proximity to slopes are special considerations.

### C5.8.2 External Stability and Figure 5.8.4.1A

The existing specification requires the designer to use Equation (5.8.2.1) to determine the lateral earth pressure coefficient needed for external stability calculations for MSE walls. However, for all other gravity walls, the designer is required to use Figure 5.5.2B. Since the lateral earth pressure coefficient is not dependent on wall type, there should not be two methods in the specification. In addition, for current practice, it is generally assumed that no wall friction is generated at the back of the wall for overturning and sliding calculations for MSE walls. This can be easily accommodated by setting $\delta = \beta$. This proposal eliminates Equation (5.8.2.1) and requires the use of Figure 5.5.2.B.

Additional revisions in this Article include the elimination of the reference to 0.7 as the minimum reinforcement ratio in the fifth paragraph and in Figures 5.8.2A, 5.8.2B, and 5.8.2C. Also revised is Figure 5.8.4.1A for the same reason.

In Figure 5.8.2A, the term V2, which is the weight of the traffic surcharge above the reinforced soil mass, conflicts with V2, as defined in the Notations Section, which is the weight of the sloping soil surcharge on top of the reinforced soil mass. Rather than introduce another V term, it is believed that the "q" load symbol above the reinforced soil mass is adequate to give direction to the designers. Also revised is the formula for factor of safety against sliding, which should not include the traffic surcharge above the reinforced soil mass since this would provide a higher factor of safety than is realistic. It should include the traffic surcharge behind the soil mass.

*See also C5.8.2 (1998).*

### C2.3.4 Fire Retardant Treatment

Fire retardant treatments are proprietary and chemical formulations vary between manufacturers. The fire retardant treatment manufacturers have established design values for wood products treated with their commercial formulations. It should be noted that use of individual company design value recommendations for fire retardant treated wood products is subject to approval of the authority having jurisdiction.

### C2.3.5 Format Conversion Factor, $K_F$ (LRFD Only)

Format conversion factors convert reference design values (allowable stress design values based on normal load duration) to *LRFD reference resistances* as described in ASTM D5457 (17). Specified format conversion factors, $K_F$, in NDS Table 2.3.5 and Applicability of Adjustment Factor Tables in Chapters 4, 5, 6, 7, 8, 9, and 10 and Appendix Table N1 are based on similar factors contained in ASTM D5457.

The *LRFD reference resistance* is a strength level design value for short term loading conditions. Consequently, the format conversion factor includes: 1) a conversion factor to adjust an allowable design value to a higher strength-level design value, 2) a conversion factor to adjust from a 10-year to a 10-minute (short-term) load basis, and 3) a conversion factor to adjust for a specified resistance factor, $\phi$.

The term, *LRFD reference resistance*, is not specifically defined or calculated in the Specification but is included as part of the LRFD adjusted design value which includes all applicable adjustments to the reference design sion factor, $K_F$, for each material property in lieu of the equation format of $K_F$ (i.e., $K_F$ = constant/$\phi$) used in prior editions of the Specification.

### C2.3.6 Resistance Factor, $\phi$ (LRFD Only)

Specified resistance factors, $\phi$, in NDS Table 2.3.6 and Appendix N, Table N2 are based on resistance factors defined in ASTM D5457 (17). Resistance factors are assigned to various wood properties with only one factor assigned to each stress mode (i.e., bending, shear, compression, tension, and stability). In general, the magnitude of the resistance factor is considered to, in part, reflect relative variability of wood product properties. Actual differences in product variability are accounted for in the derivation of reference design values.

### C2.3.7 Time Effect Factor, $\lambda$ (LRFD Only)

The time effect factor, $\lambda$ (LRFD counterpart to the ASD load duration factor, $C_D$), varies by load combination and is intended to establish a consistent target reliability index for load scenarios represented by applicable load combinations. With the exception of the load combination for dead load only, each load combination can be viewed as addressing load scenarios involving peak values of one or more "primary" loads in combination with other transient loads. Specific time effect factors for various *ASCE 7* (3) load combinations are largely dependent on the magnitude, duration, and variation of the primary load in each combination. For example, a time-effect factor of 0.8 is associated with the load combination 1.2D + 1.6 ($L_r$ or S

Commentaries/rationale combined into an appendix or separate section at end of book. Everything in order - relevant sections marked with manual section number. Can be easily revised and republished in PDF or HTML.

# APPENDIX C: SURVEY OF STATE DOTS

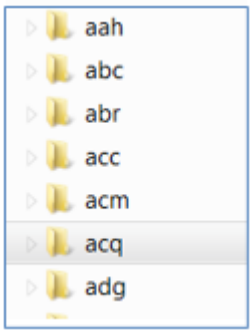
# Texas DOT Response

The Michigan Department of Transportation (MDOT) will be implementing a new *Knowledge Management System* framework that responds to all the needs of the users and developers as well provides a secure environment to maintain the integrity of the Bridge Design Manual (BDM), Guides (BDG), Standard Plans, and Policy Documentation. Through our review of DOT practices reported with the survey on Engineering Policy Guides, conducted by the Missouri DOT in 2016, we noticed that your agency implemented some unique practices. It is greatly appreciated if you could respond to the following questionnaire and provide weblinks or access to relevant documentation.

***Structured Framemaker related questions:***

- In your opinion what are the advantages of Structured Framemaker to create/edit manuals and export to other formats when compared to other word processing programs?
  - Adobe Framemaker's structured authoring enforces a set hierarchy and rules for the flow of content; when exported as XML, this hierarchy is maintained for import into other tools.
  - Framemaker can handle and manipulate the modification and relocation of content, regardless of the size of the document, through its structure tree view. Microsoft Word will have difficulty handling multiple pages/chapters, when it goes beyond +200 pages.
  - Framemaker's huge advantage is the book file that assembles the components of the manuals by referencing; this same book file can also modify attributes all at a high level to affect the rest in the collection.
- Can you share the number of staff members required (assigned) for maintaining document management system, including members with IT background and other staff members?
  - At the current time, there is only two: a publisher and a publishing technical support. The pub tech support is the only one with a full IT background. At one point, we used to have a staff of four: three publishers and one pub tech support.
- In your estimation, what is the percentage of the content pieces (sections, sub-sections, and drawings) of individual manuals reused in other manuals and documents?
  - Less than 10%.
- Would you be able to share a copy of your Document Type Definition (DTD) for reference?
  - Yes, please see attachment file TxDOTdtdV5.dtd (text file).
- Are images stored in SVG file format? If yes, what kind of information do you frequently search for in SVG files and what tool is used to facilitate the search?
  - No. We have images stored as PNG, JPEG, or GIF. Why? Majority of the images that we receive from our engineering groups have already been converted to one of the aforementioned image formats.

- Are Dynamic Content Filters used with the Document Information Typing Architecture (DITA) to create personalized content experiences for your end users?
  - Since we have a set structure that was developed in the early 2000's, there is no need for us to use DITA. The reason for this is that the content that we receive from our subject matter experts (SME) about 80% of the time is already styled and formatted to the structure that resides in Framemaker with only minor adjustments.
- How are metadata, indexing, keywords, etc., handled?
  - Our structure has attributes at the section, chapter, and book level that will appear as metatags in the HTML. At the level of subheadings, unique IDs are implemented.
- With the Structured Framemaker implemented, what is the location of physical storage and organization of the documents?
  - The final published versions are posted on two separate servers: intranet and a subset on the Internet.
  - Online Manuals is the keepers of the finalized product kept in its Framemaker source format **.fm*. These source files along with their PDFs and images are retained on a drive hosted on one of our work servers. When SMEs request an update to their publication, we provide them with clean (revision and track changes removed) files in either as Framemaker files or in Word using custom macros that emulate the identical styles in Framemaker.
  - Documents are organized by book using a unique three character identifier—e.g., *Right of Way Manual Vol. 2 – Acquisition* has the identifier *acq*. This identifier system is for our internal use only.




***Workflow related questions:***

- Can you describe your internal workflow process for creating and revising policy documents/manuals?
  - Yes, please reference attachment file *RevisionProcess.pdf*.
  - Once the manual developer has their requested files, edits are made and a manual notice (MN) is drafted summarizing the purpose or changes in the manual.
  - Drafts are submitted to Audit and General Counsel through their director requesting a review for legal compliance and internal control checks.

- Upon return of documents division addresses any GC/AUD comments with their SMEs.
- Director signs the MN and updated files are submitted for publication.

- Does every participant (user) responsible for aspects of the workflow have equal privileges (access control)?
  - Our workflow is not truly automated. There is still some human interaction and communication.
- Is the workflow process serial or have parallel activities?
  - Majority of our workflow is serial. Parallel activities occur at the time of publication where the PDF, internal, and external HTML are produced.
- Is there a process for sending reminders for outstanding activities?
  - Communication via Outlook
- What is the software used to create and edit the documents?
  - Adobe Framemaker 2015
- What formats are used to store the documents (PDF, XML, MS Word?)
  - Source files are stored in Framemaker format (*.fm).
- What are the published document formats (web/HTML, wiki, PDF)?
  - web/HTML and PDF

***Questions related to updates/versioning:***

- How are revisions and updates handled?
  - SMEs send a request via Outlook to our publisher; publisher returns files in either Framemaker or in our customized macro-enabled Word docs. (please see *RevisionProcess.pdf* & answer above )
- Do you have a specified frequency for publishing updates (annually, monthly, or ad hoc)?
  - Right now, they are either ad hoc or based upon the business unit's re-verify process so it varies by division. Bridge Division reviews and updates on a two year cycle, unless major changes are needed off-cycle.
- Do you have a specified frequency for updating manuals, guides, and policies?
  - Not at this time; however, our compliance unit is in process of recommending guidelines/policies to that end. We will be moving toward annual review of each published manual.
- Do you have a specific employee for the revisions and edits of manuals and documents? If so, can you share the qualifications for the position?
  - Yes, we do. On the publication side basic qualification is knowledge of HTML and PDF authoring and some technical writing skills or experience; the rest is done via one-on-one training to learn Framemaker or via an approved training vendor.

***Questions related to the reasoning behind specific policy:*** *(Select all that apply)*

- The reasoning is embedded as commentary
- The reasoning is hyperlinked within the manuals ***X***
- The reasoning documents are stored and accessed separately

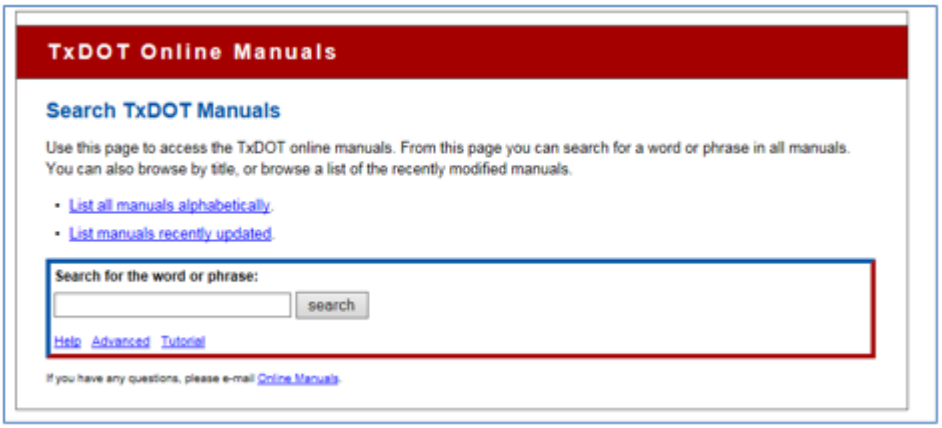
- by the internal staff without restriction X
- by the internal staff through a designated staff member
- by external users through a specific request to administration
- through hyperlinks provided within the web X
- as appendices X
- using "See also" references X
- through layers in the final document

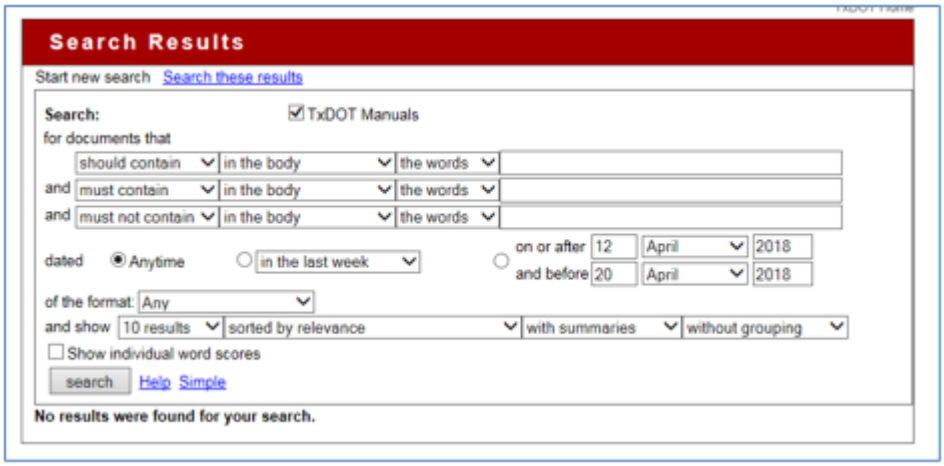
● If commentary is accessible via layers,

- the commentary layers can be accessed by a designated staff member
- the commentary layers can be accessed by all internal staff
- the commentary layers can be accessed by all users
- internal users can switch on and off the display of commentary layers
- external users can switch on and off the display of commentary layers

***Other questions:***

- Are there design examples that are accessible to users?
  - We refer users to look at existing manuals to give an idea of the look, feel, and structure of the published content.
- How is search and retrieval handled both internally and externally (the public)?
  - Both the internal and external manual collections have a search box with advanced features.






- What is the archival process?
  - Though not set in stone, at the opportunity of the publisher, folders are zipped and moved to a specific location on our local work server; only finalized source files, PDFs, and images are retained with at least one N-1 revision included.

- Do you have a content strategy document that you would be willing to share with us?
  - Yes, we do. The publication is in process to be rewritten to reflect our current business environment, but we can share what was relevant at one time. Please see the *Communications Manual* (com.pdf).

## Ohio DOT Response

The Michigan Department of Transportation (MDOT) will be implementing a new *Knowledge Management System* framework that responds to all the needs of the users and developers as well provides a secure environment to maintain the integrity of the Bridge Design Manual (BDM), Guides (BDG), Standard Plans, and Policy Documentation. Through our review of DOT practices reported with the survey on Engineering Policy Guides, conducted by the Missouri DOT in 2016, we noticed that your agency implemented some unique practices. It is greatly appreciated if you could respond to the following questionnaire and provide weblinks or access to relevant documentation.

***SiteCore DMS related questions:***

- What was the need for migrating from SharePoint DMS to SiteCore DMS in 2016-17?
- How has the manual delivery (internal and external user access) scheme changed as a result of this implementation?
- Who performed the migration work (staff, consultant or both)?
- Were there challenges with the migration process you would like to share?
- Do you have documents describing the migration (ex. a "content strategy" document) that you can share?
- Do you experience any limitations when handling different file types with SiteCore?
- Do you experience any limitations when handling metadata, indexing and version control?

***Workflow related questions:***

- Can you describe your internal workflow process for creating and revising policy documents/manuals?
    - We are updating the manual in sections instead of all at once. In doing so, we are able to break up the sections into manageable parts.
    - Each part has a working group consisting of bridge designers and planners. The working group responsibility is to produce a final draft of the part in Microsoft Word.
    - Each working group has a leader that is a member of our Central Office – Office of Structural Engineering. The leader is responsible for managing all tasks necessary to complete the development of the part on schedule.
    - The work for each group is reviewed by the Bridge Standards Engineer to ensure that the content, format, etc. is consistent throughout the publication. This individual is also available to provide context and historical background regarding current provisions.
    - The State Bridge Engineer has approval authority for the content.

    - The format for the new manual will be two columns with the requirements in the left column and commentary in the right column. This is similar to the AASHTO LRFD Bridge Design Specifications.
    - Two sections of our current Bridge Design Manual are critical to releasing a new update. Section 100 provides general information including how to use the manual and the role it plays in design contracts. This absolutely needs to be available first in order to introduce and implement our new two column format. Section 400 provides information for rehabilitation of bridges and structures. The release of this section will finally require designers to use the AASHTO LRFD Bridge Design Specifications instead of the AASTHO Standard Specifications for Bridges and Structures.
- Does every participant (user) responsible for aspects of the workflow have equal privileges (access control)?
    - Only the working group leaders and the Bridge Standards Engineer will have privileges for the draft version of each part. Group members have access to a central network file directory to provide or review information.
- Is the workflow process serial or have parallel activities?
    - The workflow process has parallel activities. It is the responsibility of the Bridge Standards Engineer to ensure consistency between these activities.
- Is there a process for sending reminders for outstanding activities?
    - The working group leaders use Microsoft Outlook and Skype for Business.
- Do you use any other software to create and edit documents other than SiteCore? If yes, please list the software and the type of documents.
    - Our primary software for document development is MS Word.
    - Final documents made available to end users will be created with Adobe Acrobat Pro DC in PDF format.
    - MS Excel is used to create some figures and printed to PDF format.
    - Bentley MicroStation is used to create some figures and printed to PDF format.
- What formats are used to store the documents (PDF, XML, MS Word?)
    - The final complete document will be PDF.
    - The development files are MS Word.
    - Figures will be Excel or MicroStation
- What are the published document formats (web/HTML, wiki, PDF)?
    - PDF
- Are the files stored in a back-end database, in Network File System or in both places? *Please state file organization and location of physical storage.*
    - All files are stored in a network file system available with read only access within the Department. Full access is only available to the Bridge Standards Engineer.
    - Until SiteCore is implemented, published files will be available on SharePoint.

***Questions related to updates/versioning:***

- How are revisions and updates handled?
    - ODOT currently publishes updates to design publications twice per year on the third Friday in January and July. The process for publication development is defined in ODOT Policy 16-004(P) and ODOT Procedure 122-004(SP).
    - The working group leader will produce the final draft of the parts. The Bridge Standard Engineer will consolidate, review, publish and submit to the publication development committee noted above for review.
    - Upon approval of the specifications committee, the Standard Engineer will publish the manual on the internet in pdf format.
- Do you have a specified frequency for publishing updates (annually, monthly, or ad hoc)? .
    - Department publications are updated 4 times per year – January, April, July & October. Engineering publications are updated two times per year – January & July, to reduce the amount of information consumed by our customers.
- Do you have a specified frequency for updating manuals, guides, and policies?
    - Same as above
- Do you have a specific employee for the revisions and edits of manuals and documents? If so, can you share the qualifications for the position?
    - The Engineering publications are published by the Standards Engineer. For structural publications, the Bridge Standards Engineer performs this duty. The Bridge Standards Engineer is a senior bridge engineer with 10+ years of experience.

***Questions related to the reasoning behind specific policy/change/update:*** *(Select all that apply)*

- The reasoning is embedded as commentary **Yes**
- The reasoning is hyperlinked within the manuals **No**
- The reasoning documents are stored and accessed separately
    - by the internal staff without restriction **Yes**
    - by the internal staff through a designated staff member **No**
    - by external users through a specific request to administration **No**
    - through hyperlinks provided within the web **No**
    - as appendices **No**
    - using “See also” references **Yes**
    - through layers in the final document **No**
- If commentary is accessible via layers,
    - the commentary layers can be accessed by a designated staff member
    - the commentary layers can be accessed by all internal staff
    - the commentary layers can be accessed by all users
    - internal users can switch on and off the display of commentary layers

- external users can switch on and off the display of commentary layers

***Other questions:***

- Are there design examples that are accessible to users?
  - There are currently no design examples in the Bridge Design Manual
- How is search and retrieval handled both internally and externally (the public)?
  - Key word search available in PDF format.
- What is the archival process?
  - Each time a manual is published, the previous edition is archived by the date it was first approved. This is necessary to determine the edition applicable at the time of contract signings.

# RE: Ohio Bridge Design Manual Questions

I followed up with our Office of Communications after receiving your email. Below is their response:

*Here's my stab at some answers. Feel free to forward this along and/or have them reach out to me directly for more details. I started with a generalized overview of our efforts and situation, and attempted to touch on each question individually in what follows.*

*Technically, we're still keeping SharePoint as an option for a good deal of our document hosting and access, depending on quantity and audience (the Extranet and Intranet site are/will be SharePoint). Sitecore (as we'll be using it, at least at first) is not really an enterprise-level Document Management Solution (DMS) for the department, it's intended to be a Content Management Solution (CMS) that happens to host some of the departments' key documents.*

*The distinction between CMS and DMS may or may not be critical in this survey and line of questioning. When I hear DMS, I think more of a customized department/enterprise-wide document storage and archiving system/solution. Like a true point of record/resource for all documents, we here at ODOT have and continue to traditionally use our mapped "O: Drive," or other file-folder based network storage shares, as the true internal "record" for current and archived versions of our documents. We are not there yet toward a web-based DMS, and this website redesign project does not begin to tackle all of those system challenges and nuances.*

*The main ODOT Sitecore site will be where only the current documents, and a limited (agreed-upon and codified in governance individually by each business unit/publishing office) archive of necessary or relevant earlier versions of documents will be made publicly available freely without stipulation. We've run into a glut of overlapping, and potentially contradictory, archival sets of documents in our current public SharePoint CMS system that we do not wish to duplicate or migrate (we have upwards of 100,000+ files/versions that were never centrally managed or indexed very well, so search results can and do turn up the wrong iterations of files (especially those out of our control by outside services such as Google).*

*Full-on file and Document Management Systems are truly tricky and complicated business systems (with the potential for complex workflows for versioning, reviewing, approvals, histories, record-retention scheduling, publishing and auto expiration, etc.) that are much more robust and tailored to handle all current, future and past documents, both internally and externally. That is beyond the scope of what we want, need or are able to address for this project at this stage.*

*Our new public Sitecore Content Management System is intended and being built to be leaner and less*
*exhaustively complete as a point of record and more of a point of introduction and baseline availability. That is, it's intended to just scratch surface of document delivery by offering a limited set of files while offering a contextual contact points or processes to those visitors who may want or need access to anything beyond the current (or limited historical) versions of our*

*primary resources. It has very hard and fast limitations in terms of file size and file types. Individual files larger than 16 Mb are a challenge to host directly (storage involves complicated and 'expensive' SQL databases rather than inexpensive traditional file storage) , and we're still not sure if/how larger files can be managed, some may have to be split or resaved in compressed formats if possible. As far as file types, we are able to host most common formats – PDFs primarily for longer-form and specially formatted materials, but no real support for multipage TIFFs, Flash, MR SID and/or other plug-in dependent materials.*

*A robust ability to support metadata, tagging and ODOT-specific taxonomy in Sitecore is in place and is intended to help with a much better indexing and search functionality across the site, but we will not be using it for systematic versioning and archiving at this time.*

*We plan on migrating full record sets for certain documents from our public SharePoint site (with currently offer open anonymous access) to comparable but authenticated SharePoint Extranet sites for certain business units. If these areas are comfortable sharing their archived files to their managed audience(s). This explicitly helps provide a common understanding between the visitor and the department that such access is semi-restricted for a reason, and that reason is to provide greater context and control over such archival information. (like using a Library Card or resource room in a gallery/museum or library where the material is kept in storage until request and access is granted only on-site and with caveats.)*

*Our interpretation and implementation document sharing on our public site to this point has been to put it all out there (again and again and again) and let everyone come wherever and however they please to retrieve any resource or document that's available. We've tried our best to curate and cull (but it's been inconsistently meted and often active links are updated, but outdated files are not deleted or made otherwise unavailable to the public. Technically, public-records can (and should) be offered only on request and with some stipulations to ensure that wrong or outdated information is not mistaken or presented as current and accurate due to a lack of understanding and context.*

Standard Procedure - 122-04(SP)
Effective: June 1, 2012
Responsible Office: Construction
Management, Engineering, Planning
Supersedes Standard Procedure 122-004(SP)
dated September 18, 2002 and 510-005(SP)
dated December 1, 2004

# DEVELOPMENT OF STANDARDS AND SPECIFICATIONS

## PROCEDURAL STATEMENT:

These standard procedures are for the development, approval, distribution and implementation of all new and revised Standards and Specifications as listed under *Definitions.*

## AUTHORITY:

*Ohio Revised Code, Sections 5501.02, 5501.03 and 5501.31*.

*Code of Federal Regulations 23 CFR 625*

## REFERENCES:

Development of Standards and Specifications (Policy No. 16-004(P))

## SCOPE:

These standard procedures are applicable to the design industry, contracting industry, FHWA, and any affected department employee who may develop or request revisions to Standards or Specifications.

## BACKGROUND & PURPOSE:

The Department had a standard procedure for distribution of design standards and a standard procedure for development of construction specifications.

This standard procedure is the merger of two former standard procedures; 122-004(SP) dated September 18, 2002 and 510-005(SP) dated December 1, 2004, and the Administrative Ruling for Specification Committee Supplemental Instructions dated December 9, 2005. This document allows for more thorough and consistent development of new design standards and construction specifications. By having a construction perspective on design standards and a design perspective on construction specifications, it will ensure all perspectives are considered and eliminate potential conflicts when implemented.

**DEFINITIONS:**

Construction and Material Specifications Book (C&MS): A published bound book that contains detailed provisions, together with the Plans and the Proposal, constitute the Contract for the performance of required work. It is an official legal and technical document by which the Department bids and constructs highway projects.

Design Manuals: A document that contains design criteria and describes plan content associated with various design specialty areas.

Proposal Notes: Published proposal notes contain a wide variety of legal and technical requirements necessary for the proper bidding and sale of an individual project. These notes override all other requirements in the Plans, C&MS, Supplemental Specifications, and Standard Construction Drawings

Publication Owner: The office that authors a Standard or Specification

Specifications: Contract documents used to issue instructions to contractors. For the purposes of this procedure, Specifications will include: the C&MS, Supplemental Specifications, Supplements, and Proposal Notes.

Standards and Specification Committee (Committee): Working committees, formed around specific design tasks, construction tasks or materials, and composed of ODOT district and central office staff, representatives from the Federal Highway Administration and industry trade
groups.

Standards and Specifications Committee Chairperson (Chairperson): The individual assigned by the Division of Construction Management Deputy Director with the responsibility to manage the standards and specification development process consistent with this standard procedure.

Specifications Coordinator: The individual assigned by the Division of Construction Management Deputy Director with the responsibility to perform the functions described in Section VII of this procedure.

Standards: Documents related to design of an improvement. For the purposes of this procedure, Standards will include Design Manuals and Standard Drawings.

Standard Drawings: Detail drawings furnished by ODOT describing items which are frequently used in plans and would otherwise require a plan detail. Standard Drawings require pre-approval for general use.

Supplemental Specifications: Individually numbered documents describing the construction and material specifications for new items of Work.

Supplements: Individually numbered documents describing necessary information such as

laboratory methods of test, and certification or pre-qualification procedures for materials.

**PROCEDURE STATEMENT**

I. GENERAL:

A. All requests to add, revise or delete Standards and Specifications must be submitted in writing to the appropriate Publication Owner.

B. Contractors, producers, suppliers and consultants should submit their requests through their association.

C. FHWA may submit their request directly to the appropriate Publication Owner.

D. Department staff must submit their request through their Administrator.

E. All initial submissions for inclusion into the Standard or Specifications must include or reference the following topics:

1. Standards:

a. Description;
b. Manual or Drawing;
c. Design Considerations (i.e. applicability to various project types and conditions);
d. Method of calculation (if required);
e. Method of payment (if required);
f. Implementation procedure;
g. Review requirements for new/revised items; and
h. List of specifications or other standards that may be impacted by the revision.

2. Specifications:

a. Description;
b. Materials;
c. Construction requirements;
d. Method of measurement;
e. Basis of payment; and
f. Designer note to address conditions under which the Specification will be used on construction projects (if required).

II. COMMITTEES

A. The Administrators of Construction Administration, Roadway Engineering, Structural Engineering, Pavement Engineering, Traffic Engineering, Geotechnical Engineering, Environmental Services and Hydraulic Engineering will assign standards and specifications to the following committees:

1. Contract Administration Committee;
2. Geotechnical Committee;
3. Pavement Committee
4. Structures Committee;
5. Hydraulics and Environmental Committee; and
6. Traffic and Roadway Committee.

B. See Attachment B for typical committee membership

III. PUBLICATION OWNER'S TASKS

A. Review requests to add, revise or delete existing Standards and Specifications, as needed;

B. Each Publication Owner is in responsible charge of their designated Standard or Specification (Attachment C) and shall:

1. Receive all proposed requests for inclusion into the publication;
2. Review the proposed request. If it has merit, prepare the initial draft and submit it to the appropriate Standards and Specifications Committee Chairperson;
3. In collaboration with Committee Chairperson, reconcile all comments received during reviews until recommended final draft is achieved
4. Submit the final draft Standard or Specification for quality control as described in this standard procedure;
5. Forward final draft Standard or Specification to Specification Coordinator for final review and formal review, respectively, and approval;
6. Reconcile all quality control comments received from FHWA or the Executive Committee. The Publication Owner will have ten days to resolve quality control comments and produce a final draft specification;
    a. Non-substantive Comments: At the discretion of the Publication Owner, reconciliation of the non-substantive quality control comments can be accomplished through written communication.
    b. Substantive Comments: Any substantive or content changes to the document recommended by either quality control reviewer will require that Publication Owner reconvene with the Committee to address the recommended changes.
    c. Quality Control Comment Reconciliation Validation: The Publication Owner will validate that the quality control comments have been satisfactorily addressed.

## IV. COMMITTEE CHAIRPERSON'S TASKS

A. The Deputy Director of Construction shall assign one chairperson to each committee. The Chairperson acts as the liaison between the Department, FHWA and the industry.

B. The Chairperson will assemble approved committee members as designated in Attachment B.

C. The Chairperson shall:

1. Distribute the initial draft to committee members electronically for review and comment;
2. Allow committee members to review the initial draft and return written comments to the Chairperson within 21 days of receipt;
3. Schedule and conduct a committee meeting each quarter, if necessary. The purpose of this meeting is to thoroughly discuss the merits of the initial draft Standard or Specification.
4. Return the initial draft and comments to the Publication Owner;
5. Collaborate with the Publication Owner and recommend a final draft Standard or Specification.

## V. COMMITTEES' TASKS

A. General:

1. Attend committee meetings;
2. Review and update existing Standards and Specifications, as needed;
3. Remove obsolete Standards and Specifications
4. Review proposed Standards and Specifications;
5. Write all proposed Standards and Specifications to conform with the appropriate Quality Control Checklist (attachment D or E);
6. Circulate draft Standards and Specifications for review by non-committee members and other industry people as needed;
7. Assist the Committee Chairperson in providing documentation needed for the distribution of new and revised Standards and Specifications; and
8. Ensure compliance with the applicable state and federal regulations, policies and standard procedures.

## VI. STANDARDS AND SPECIFICATIONS QUALITY CONTROL TASKS

A. Provide Standards quality control in accordance with Standards Quality Control Checklist (attachment E).

B. Provide Specifications quality control in accordance with Specification

Quality Control Checklist (attachment D).

C. Collaborate with FHWA quality control review to ensure compliance with applicable laws, policies and standard procedures.

## VII. SPECIFICATION COORDINATOR TASKS

A. These tasks will be performed by the Specification Coordinator (Division of Construction Management).

1. Log final draft Standards and Specifications recommended by the Committee;
2. Forward final draft Standards and Specifications to Executive Committee for final approval;
3. Return non-approved final draft Standards and Specifications and written comments received to the Publication Owner. Repeat steps 1 and 2 until Executive Committee final approval is obtained;
4. Log and forward the final draft Standards and Specifications approved by Executive Committee to FHWA.
5. Return non-approved final draft Standards and Specifications and written comments received to the Publication Owner. Repeat steps 2, 3, and 4 until formal approval is obtained;
6. Publish and distribute approved Standards and Specifications, designer notes, and other written guidance, to all interested parties including the FHWA and ODOT;
7. Notify Publication Owner of approval and publication of Standards and Specifications; and
8. Maintain a record of all Standards and Specifications and correspondence for tracking and historical purposes;

## VIII. EXECUTIVE COMMITTEE

A. The Executive Committee is responsible for final approval of all Standards and Specifications on behalf of the Department.

B. Members of the Executive Committee are as follows:

1. Deputy Director Division of Engineering;
2. Deputy Director Division of Construction Management;
3. Deputy Director Division of Planning;
4. Deputy Director Division of Operations; and
5. District Deputy Directors (or designee)

C. In the event of a tie, the Assistant Director for Transportation Policy will make the final determination.

D. The Executive Committee will provide formal approval or non-approval in writing of all proposed Standard and Specifications with 14 days of receipt.

IX. FHWA

A. The FHWA will provide oversight of the Standards and Specification process and interact with the committees during Standard and Specification development.
B. FHWA defers development reviews to the Department for Standards and Specifications that are only editorial in nature.
C. The FHWA will provide formal approval in writing of all proposed Standard and Specifications with 14 days of receipt.
D. Formal FHWA approval is not required for Proposal Notes numbered below 100.

X. DISTRIBUTION

A. All new and revised Standards shall be published quarterly on the Design Reference Resource Center (DRRC) webpage (http://www.dot.state.oh.us/drrc/). All new and revised Specifications shall be published quarterly on the Construction Reference Resource Center (CRRC) webpage (http://www.dot.state.oh.us/crrc/ ).
B. The quarterly dates shall be the third (3rd) Friday of January, April, July, and October.
C. Exceptions to the quarterly release date will be considered provided the Deputy Director over the Publication Owner responsible for the revision demonstrates a safety or significant cost impact.
D. Each Division's webpage manager will maintain the DDRC webpage and CRRC webpage. Notification of changes shall be sent to the webpage manager two (2) weeks prior to the quarterly release date.
E. Notification of changes on the DRRC or CRRC webpage will be by email to a distribution list. Registration to the distribution list will be available to all internal and external customers.
F. All scope documents for LPA/Consultant Contracts shall require parties to incorporate revisions noted on the DRRC or CRRC webpage to Design Manuals, Proposal Notes, Standard Drawings, Construction and Material Specifications and Supplemental Specifications into Construction Plans.
G. All Standards and Specifications shall be available in Adobe Acrobat (.pdf) or TIF format.

**TRAINING**

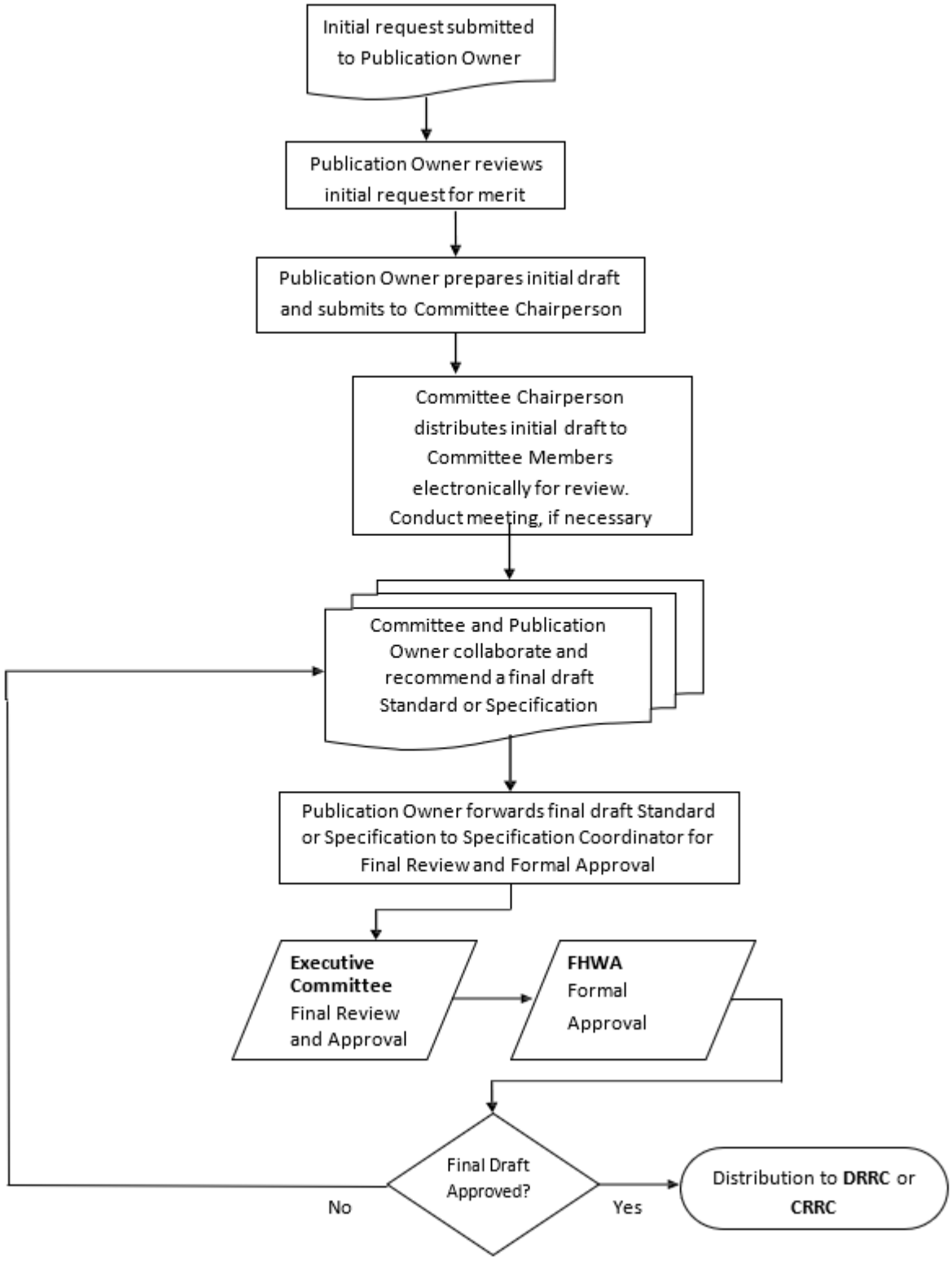
The Committee Chairperson must complete a course on writing Specifications in the Active Voice/Imperative Mood style.

**FISCAL ANALYSIS**

Implementation of this standard procedure will provide cost savings to the Department. Construction personnel will have input in design standards and design personnel will

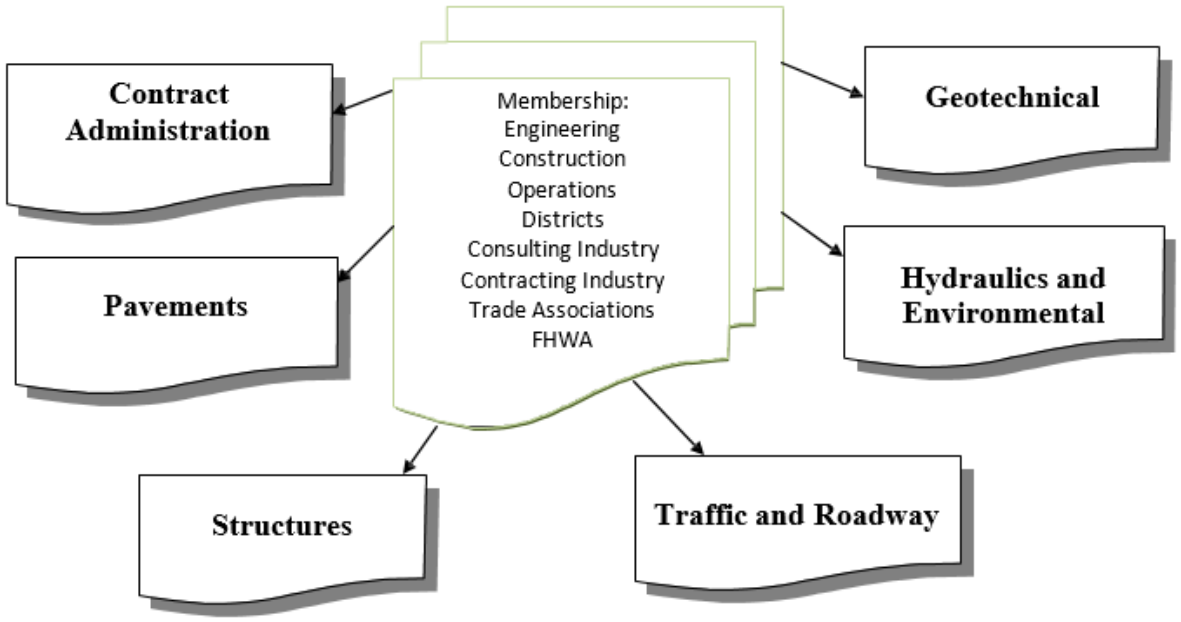
have input in construction specifications. This allows for more thorough and consistent development of standards and specifications prior to their implementation and provides a feedback opportunity to incorporate lessons learned into contract documents through this continuous quality improvement process. Distribution of all standards and specifications are electronic in lieu of hard copy. Costs for paper, print, binders, and postage will be reduced considerably.

Attachment A



Attachment B

## Standards and Specifications Committees




| CONTRACT ADMINISTRATION COMMITTEE |
|---|
| **Committee Chairperson:** from Construction Administration |
| Specification Sections: 100, 619, 624<br>Standards: Innovative Contracting Manual, CADD Engineering Standards Manual, Design Build Scope Manual, Real Estate Policies and Procedures Manual, Project Development Process Manual |
| Contract Sales Section |
| Office of Materials Management |
| Office of Construction Administration |
| Office of Real Estate |
| Office of Aerial Engineering |
| Office of Estimating (as needed) |
| Office of Environmental Services (as needed) |
| District Representatives (two for design and two for construction) |
| Federal Highway Administration |
| Ohio Contractors Association |
| Contractors (two chosen by Ohio Contractors Association) |
| American Council of Engineering Companies of Ohio (two member representatives) |

| GEOTECHNICAL COMMITTEE |
|---|
| **Committee Chairperson:** from Construction Administration |
| Specification Sections: 200, 304, 410, 411, 617, 651, 652, 653, 654 and pertinent 700 sections.<br>Standards: Geotechnical Bulletins, Specifications for Geotechnical Explorations, Manual for Abandoned Underground Mines - Inventory and Risk Assessment, Survey and Mapping Specification |
| Office of Materials Management |
| Office of Construction Administration |
| Office of Pavement Engineering |
| Office of Geotechnical Engineering |
| Office of Aerial Engineering |
| Office of Environmental Services |
| District Representatives (two for design and two for construction) |
| Federal Highway Administration |
| Ohio Contractors Association |
| Contractors (two chosen by Ohio Contractors Association) |
| American Council of Engineering Companies of Ohio (two member representatives) |
| Ohio Aggregates & Industrial Minerals Association |

| PAVEMENT COMMITTEE | |
|---|---|
| **Committee Chairperson**: from Construction Administration | |
| **Concrete** sub-committee:<br>Specification Sections: 255, 256, 257, 258, 305, 320, 321, 450, 608, 609, and pertinent 700 sections<br>Standards: Sections of Location and Design Manual - Volume 3, Pavement Standard Drawings | **Asphalt** sub-committee:<br>Specification Sections: 251, 252, 253, 254, 301, 302, 400 (except 410 and 411), 615, 618, and pertinent 700 sections<br>Standards: Sections of Location and Design Manual - Volume 3, Pavement Standard Drawings |
| Office of Construction Administration | Office of Construction Administration |
| Office of Materials Management | Office of Materials Management |
| Office of Pavement Engineering | Office of Pavement Engineering |
| Office of Geotechnical Engineering | Office of Geotechnical Engineering |
| District Representatives (one for design and one for construction) | District Representatives (one for design and one for construction) |
| Federal Highway Administration | Federal Highway Administration |
| Ohio Contractors Association | Ohio Contractors Association |
| Contractor (chosen by Ohio Contractors Association) | Contractor (chosen by Ohio Contractors Association) |
| American Council of Engineering Companies of Ohio– member representative | American Council of Engineering Companies of Ohio – member representative |
| American Concrete Pavement Association | Flexible Pavements of Ohio |
| Ohio Aggregates & Industrial Minerals Association | Ohio Aggregates & Industrial Minerals Association |
| Ohio Ready Mix Concrete Association | |

| STRUCTURES COMMITTEE |
|---|
| **Committee Chairperson:** from Construction Administration |
| Specification Sections: 500, 610 and pertinent 700 sections<br>Standards: Bridge Design Manual, Bridge Standard Drawings |
| Office of Construction Administration |
| Office of Materials Management |
| Office of Structural Engineering |
| Office of Geotechnical Engineering |
| District Representatives (two for design and two for construction) |
| Federal Highway Administration |
| Ohio Contractors Association |
| Contractors (two chosen by Ohio Contractors Association) |
| Ohio Ready Mix Concrete Association |
| American Council of Engineering Companies of Ohio (two member representatives) |

| HYDRAULICS and ENVIRONMENTAL COMMITTEE |
|---|
| **Committee Chairperson:** from Construction Administration |
| Specification Sections: 601, 602, 603, 604, 605, 613, 616, 638, 659, 660, 670, 671 and pertinent 700 sections.<br>Standards: Location and Design Manual - Volume 2 - Drainage Design, Sections of Location and Design Manual - Volume 3, Hydraulic Standard Drawings, Waterway Permit Manual |
| Office of Construction Administration |
| Office of Materials Management |
| Office of Structural Engineering |
| Office of Hydraulic Engineering |
| Office of Roadway Engineering |
| Office of Environmental Services (as needed) |
| District Representatives (two for design and two for construction) |
| Federal Highway Administration |
| Ohio Contractors Association (if needed) |
| Contractors (two chosen by Ohio Contractors Association) |
| American Council of Engineering Companies of Ohio (two member representatives) |
| Ohio Aggregates & Industrial Minerals Association |

| TRAFFIC AND ROADWAY COMMITTEE |
| --- |
| **Committee Chairperson:** from Construction Administration |
| Specification Sections: 606, 607, 614, 620- 622, 625-633, 640, 656, 657, 658, 661- 666 and pertinent 700 sections.<br>Standards: Location and Design Manual - Volume 1 - Roadway Design, Traffic Engineering Manual, Roadway Standard Drawings, Traffic Standard Drawings |
| Office of Construction Administration |
| Office of Materials Management |
| Contract Sales Section |
| Office of Traffic Engineering |
| Office of Roadway Engineering |
| District Representatives (two for design and two for construction) |
| Federal Highway Administration |
| Ohio Contractors Association |
| Contractors (two chosen by Ohio Contractors Association) |
| Institute of Traffic Engineers (ITE) or |
| American Council of Engineering Companies of Ohio (member representative) |

Attachment C

# Publication Owners

## Standards:

| | |
|---|---|
| Bridge Design Manual | Office of Structural Engineering |
| CADD Engineering Standards Manual | Office of Aerial Engineering |
| Design Build Scope Manual | Office of Construction Administration |
| Geotechnical Bulletins | Office of Geotechnical Engineering |
| Innovative Contracting Manual | Office of Construction Administration |
| Location and Design Manual - Volume 1 - Roadway Design | Office of Roadway Engineering Services |
| Location and Design Manual - Volume 2 - Drainage Design | Office of Hydraulics |
| Location and Design Manual - Volume 3 - Highway Plans and associated Sample Plan Sheets | Office of Roadway Engineering |
| Manual for Abandoned Underground Mines - Inventory and Risk Assessment | Office of Geotechnical Engineering |
| Survey and Mapping Specification | Office of Aerial Engineering |
| Pavement Design and Rehabilitation Manual | Office of Pavement Engineering |
| Project Development Process Manual | Office of Environmental Services |
| Real Estate Policies and Procedures Manual | |
| Right of Way Plan Manual | Office of Real Estate |
| Utilities | Office of Real Estate |
| Railroad Coordination | Office of Real Estate |
| Specifications for Geotechnical Explorations | Office of Geotechnical Engineering |
| Traffic Engineering Manual | Office of Traffic Engineering |
| ODOT Standard Construction Drawings & Plan Insert Sheets | |
| Roadway | Office of Roadway Engineering Services |
| Bridges | Office of Structural Engineering |
| Traffic | Office of Traffic Engineering |
| Hydraulic | Office of Hydraulics |
| Pavement | Office of Pavement Engineering |

## Specifications:

| | |
|---|---|
| Construction & Material Specifications | Office of Construction Administration |
| Supplemental Specifications | Office of Construction Administration |
| Supplements | Office of Materials Management or Office of Construction Administration |
| Proposal Notes | Office of Construction Administration |

Attachment D

# ODOT Specification Quality Control Checklist

| **Specification Number:** | **Revision Date:** |
|---|---|
| **Submitted By/Date:** | **Reviewed By/Date:** |

| **Check-off or Comment** | **Quality Control Point:** |
|---|---|
| | Active Voice, Imperative Mood |
| | Spelling re-checked |
| | Cross references checked |
| | Designers note or usage instructions included |
| | Standard formatting followed: Times New Roman, 12 pt, as per C&MS |
| | Standard section numbering and bullets followed |
| | Computer file in MS Word, with revision tracking turned on, and edits shown from original document |
| | Punctuation re-checked |
| | English (Metric) units order checked |
| | Comments from committee members included as hidden comments in the MS Word file |
| | Specification concepts reviewed for conformance to applicable laws, regulations, policies, and procedures |

This checklist is to be completed by the Specification Coordinator for each revised, or new Specification. The Specification Coordinator will send a completed copy to the Committee Chairperson and the FHWA when the QC check is completed.

Attachment E

# ODOT Standards Quality Control Checklist

| **Standard:** | **Revision Date:** |
|---|---|
| **Submitted By/Date:** | **Reviewed By/Date:** |

| **Check-off or Comment** | **Quality Control Point:** |
|---|---|
| | Description; |
| | Manual or Drawing; |
| | Design Considerations (i.e. applicability to various project types and conditions); |
| | Method of calculation (if required); |
| | Method of payment (if required); |
| | Implementation procedure; |
| | Review requirements for new/revised items; |
| | List of specifications or other standards that may be impacted by the revision |
| | Spelling re-checked |
| | Cross references checked |
| | Standard formatting followed |
| | Punctuation re-checked |
| | English (Metric) units order checked |
| | Comments from committee members |
| | Standards concepts reviewed for conformance to applicable laws, regulations, policies, and procedures |

This checklist is to be completed by the Publication Owner for each revised, or new Standard. The Publication Owner will send a completed copy to the Committee Chairperson and the FHWA when the QC check is completed.

## Attachment F

TITLE 23--HIGHWAYS

CHAPTER I--FEDERAL HIGHWAY ADMINISTRATION, DEPARTMENT OF TRANSPORTATION

PART 625_DESIGN STANDARDS FOR HIGHWAYS



Sec. 625.4 Standards, policies, and standard specifications.

The documents listed in this section are incorporated by reference with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51 and are on file at the Office of the Federal Register in Washington, DC. They are available as noted in paragraph (d) of this section. The other CFR references listed in this section are included for cross-reference purposes only.

(a) Roadway and appurtenances. (1) A Policy on Geometric Design of Highways and Streets, AASHTO 2001. [See Sec. 625.4(d)(1)]

(2) A Policy on Design Standards Interstate System, AASHTO, January 2005. [See Sec. 625.4(d)(1)]

(3) The geometric design standards for resurfacing, restoration, and rehabilitation (RRR) projects on NHS highways other than freeways shall be the procedures and the design or design criteria established for individual projects, groups of projects, or all nonfreeway RRR projects in a State, and as approved by the FHWA. The other geometric design standards in this section do not apply to RRR projects on NHS highways other than freeways, except as adopted on an individual State basis. The RRR design standards shall reflect the consideration of the traffic, safety, economic, physical, community, and environmental needs of the projects.

(4) Erosion and Sediment Control on Highway Construction Projects, refer to 23 CFR part 650, subpart B.

(5) Location and Hydraulic Design of Encroachments on Flood Plains, refer to 23 CFR part 650, subpart A.

(6) Procedures for Abatement of Highway Traffic Noise and Construction Noise, refer to 23 CFR part 772.

(7) Accommodation of Utilities, refer to 23 CFR part 645, subpart B.

(8) Pavement Design, refer to 23 CFR part 626.

(b) Bridges and structures. (1) Standard Specifications for Highway Bridges, Fifteenth Edition, AASHTO 1992. [See Sec. 625.4(d)(1)]

(2) Interim Specifications--Bridges, AASHTO 1993. [See Sec. 625.4(d)(1)]

(3) Interim Specifications--Bridges, AASHTO 1994. [See Sec. 625.4(d)(1)]

(4) Interim Specifications--Bridges, AASHTO 1995. [See Sec. 625.4(d)(1)]

(5) AASHTO LRFD Bridge Design Specifications, First Edition, AASHTO 1994 (U.S. Units). [See Sec. 625.4(d)(1)]

(6) AASHTO LRFD Bridge Design Specifications, First Edition, AASHTO

1994 (SI Units). [See Sec. 625.4(d)(1)]

(7) Standard Specifications for Movable Highway Bridges, AASHTO 1988. [See Sec. 625.4(d)(1)]

(8) Bridge Welding Code, ANSI/AASHTO/AWS D1.5-95, AASHTO. [See Sec. 625.4(d) (1) and (2)]

(9) Structural Welding Code--Reinforcing Steel, ANSI/AWS D1.4-92, 1992. [See Sec. 625.4(d)(2)]

(10) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, AASHTO 1994. [See Sec. 625.4(d)(1)]

(11) Navigational Clearances for Bridges, refer to 23 CFR part 650, subpart H.

(c) Materials. (1) General Materials Requirements, refer to 23 CFR part 635, subpart D.

(2) Standard Specifications for Transportation Materials and Methods of Sampling and Testing, parts I and II, AASHTO 1995. [See Sec. 625.4(d)(1)]

(3) Sampling and Testing of Materials and Construction, refer to 23 CFR part 637, subpart B.

(d) Availability of documents incorporated by reference. The documents listed in Sec. 625.4 are incorporated by reference and are on file and available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: http://www.archives.gov/federal--register/code--of--federal--regulations/ibr--locations.html. These documents may also be reviewed at the Department of Transportation Library, 400 Seventh Street, SW., Washington, DC, in Room 2200. These documents are also available for inspection and copying as provided in 49 CFR part 7, appendix D. Copies of these documents may be obtained from the following organizations:

(1) American Association of State Highway and Transportation Officials (AASHTO), Suite 249, 444 North Capitol Street, NW., Washington, DC 20001.

(2) American Welding Society (AWS), 2501 Northwest Seventh Street, Miami, FL 33125.

# APPENDIX D: MDOT HISTORICAL POLICY DOCUMENTATION

# BRIDGE POLICY DOCUMENTATION

**LOCATION, NOTATION, FILE NAMING CONVENTION**

# Index

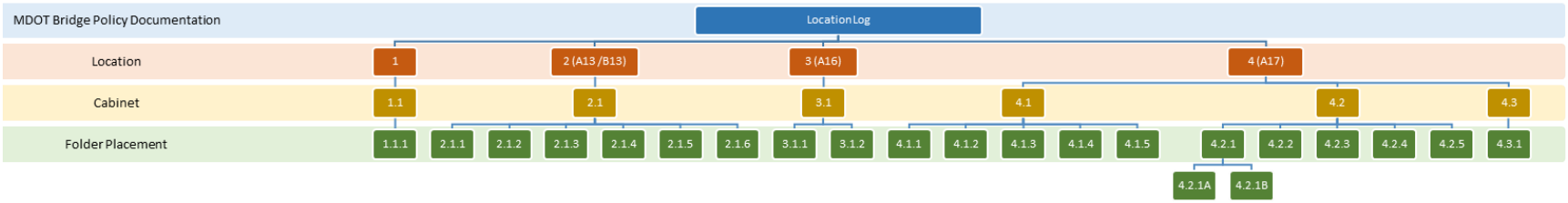



**Figure D-1 . Folder/document location log**

## HARD-COPY DOCUMENTATION

### Location 2: Filing Cabinets – Column A13-B13


**Figure D-2. Location 2: File cabinet located between column A13 and B13**


**Figure D-3. Location 2 filing cabinet**

*Table D-1. Location 2 Shown in Figure D-2 and Figure D-3*

| Folder Name Based on Location | Folder Name Based on Folder/ Document Title | Notes | Action |
|---|---|---|---|
| 2.1.1 BDM 1987, 1988 & 1992 | Bridge Design Manual (05/26/1987 Version) | Scan only the pages before Ch. 1 | Scanned |
| | Bridge Design Manual (12/07/1987 Reformatted Version) | | |
| | Bridge Design Manual (09/01/1988 Version) | | |
| | Bridge Design Manual (08/06/1992 Version) | | |
| | Computer Seminar Structural Steel Design and PC Box Beam | | |
| 2.1.2 BDM Update | Bridge Design Manual Update | Scan all | |
| 2.1.3 Crash Test Railing | Crash Test Railing 1 | | |
| | Crash Test Railing 2 | | |
| | Bridge Railings | | |
| 2.1.4 Squad Leader Notes | Squad Leader Notes 1 | | |
| | Squad Leader Notes 2 | | |
| | Squad Leader Notes 3 | | |
| | Squad Leader Notes 4 | | |
| | Squad Leader Notes 5 | | |
| 2.1.5 BDG | Bridge Design Guide | Already Scanned | Reviewed and verified the content |
| 2.1.6 Bridge Specs | Bridge Design Specifications 1901-1936 | Scan all | Scanned |

## Location 3: Filing Cabinets – Column A16

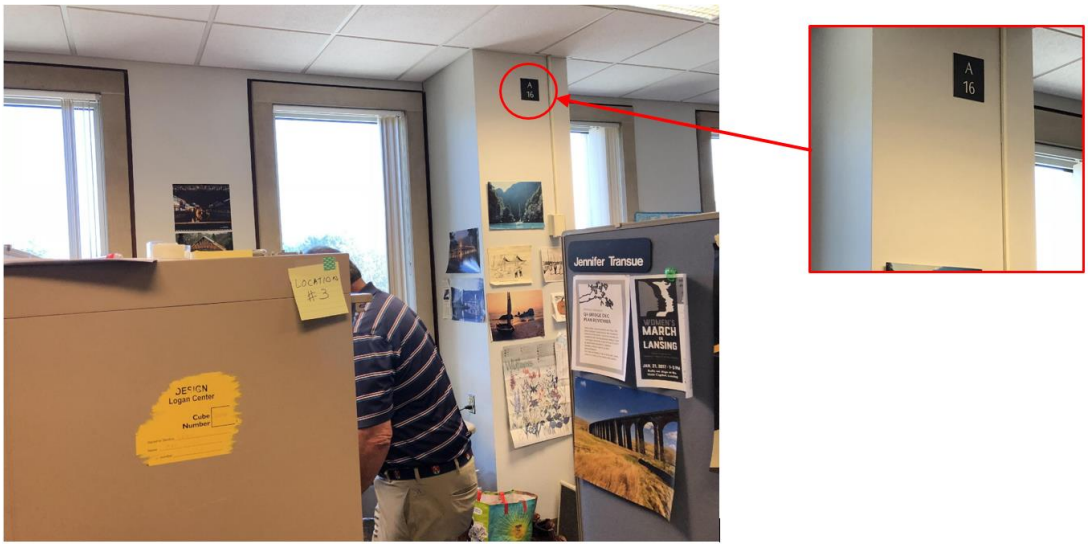



**Figure D-4. Location 3: File cabinet is located adjacent to column A16**

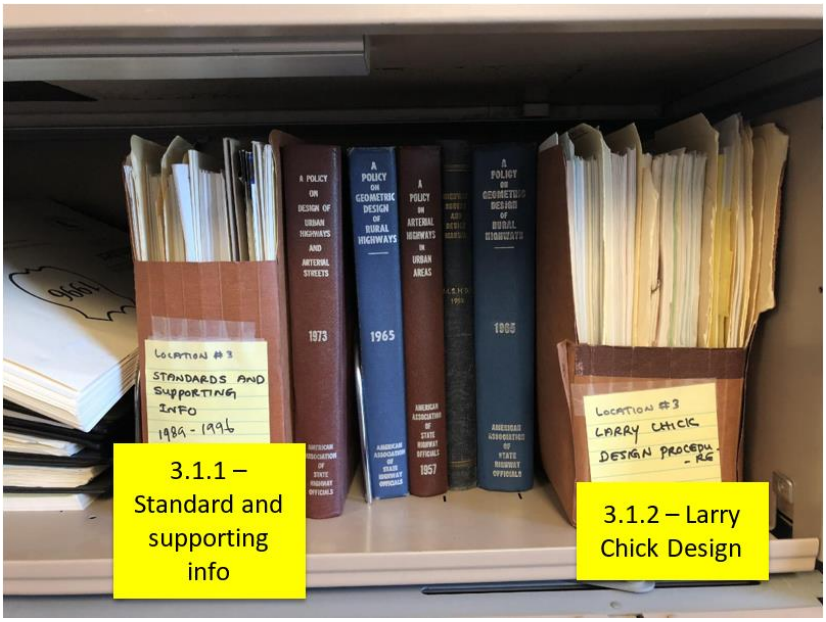



**Figure D-5. Location 3 filing cabinet**

**Table D-2. Location 3 Shown in Figure D-4 and Figure D-5**

| Folder Name Based on Location | Folder Name Based on Folder/ Document Title | Notes | Action |
|---|---|---|---|
| 3.1.1 Standard and supporting info | Standard and Supporting Information 1989 - 1996 | | Scanned |
| 3.1.2 Larry Chick Design | Larry Chick Design Procedure | | |

## Location 4: Filing Cabinets – Column A17

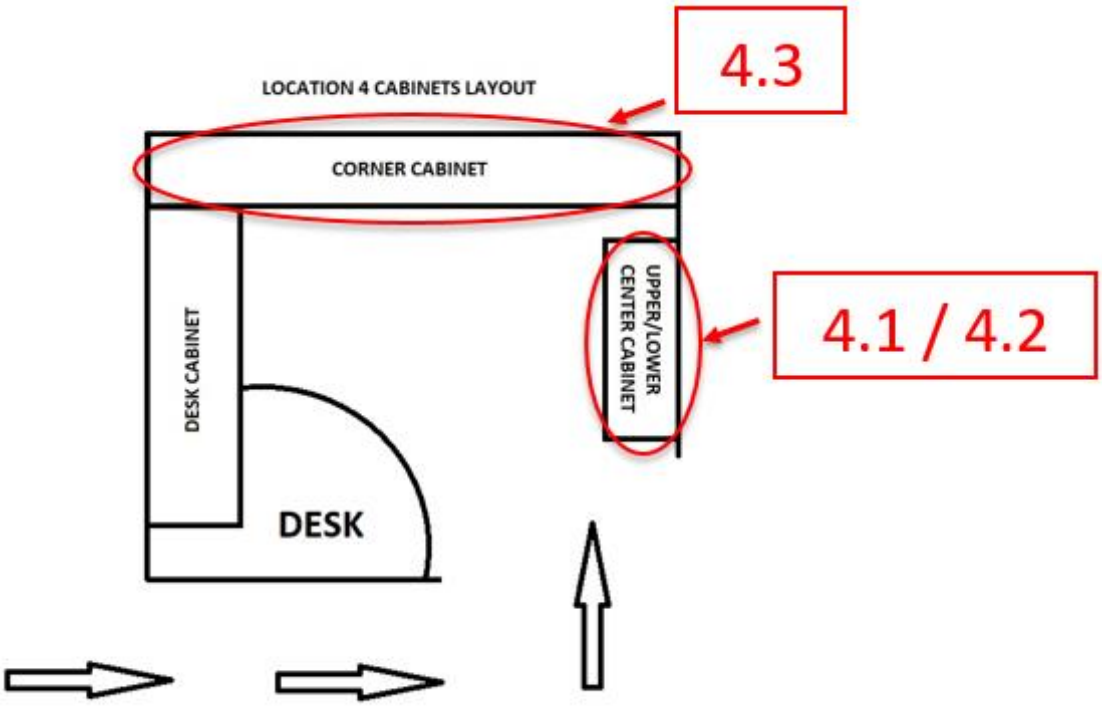



**Figure D-6. Location 4 filing cabinet arrangement in the cubicle**

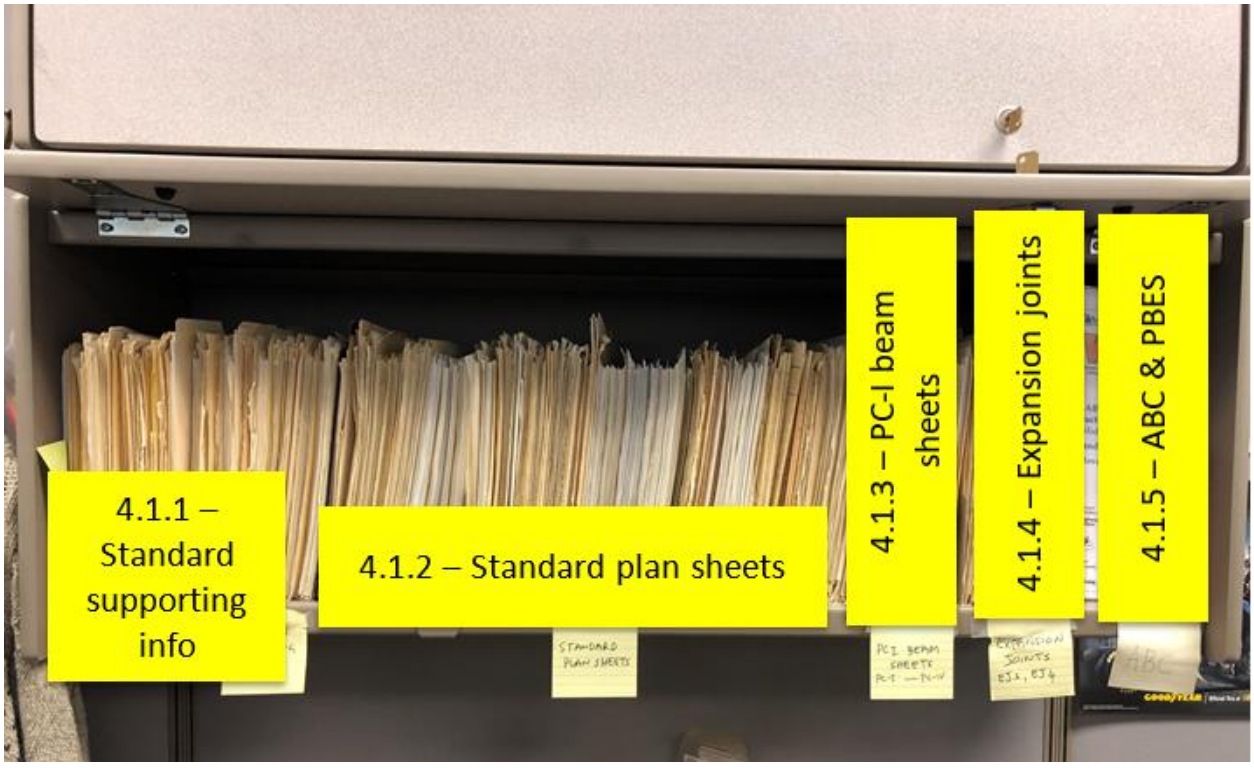



**Figure D-7. Upper shelf of the center cabinet**

**Table D-3: Location 4 Shown in Figure D-6 and Figure D-7**

| Folder Name Based on Location | Folder Name Based on Folder/ Document Title | Notes | Action |
|---|---|---|---|
| 4.1.1 Standard Supporting Info | Standard Supporting Information | | Scanned |
| 4.1.2 Standard Plan Sheet | Standard Plan Sheet | | |
| 4.1.3 PC-I Beam Sheet | PC-I Beam Sheet | | |
| | PC-IV Beam Sheet | | |
| 4.1.4 Expansion Joints | Expansion Joints EJ-3 | | |
| | Expansion Joints EJ-4 | | |
| 4.1.5 ABC & PBES | Accelerated Bridge Construction and Prefabricated/Precast Bridge Element and System | | |

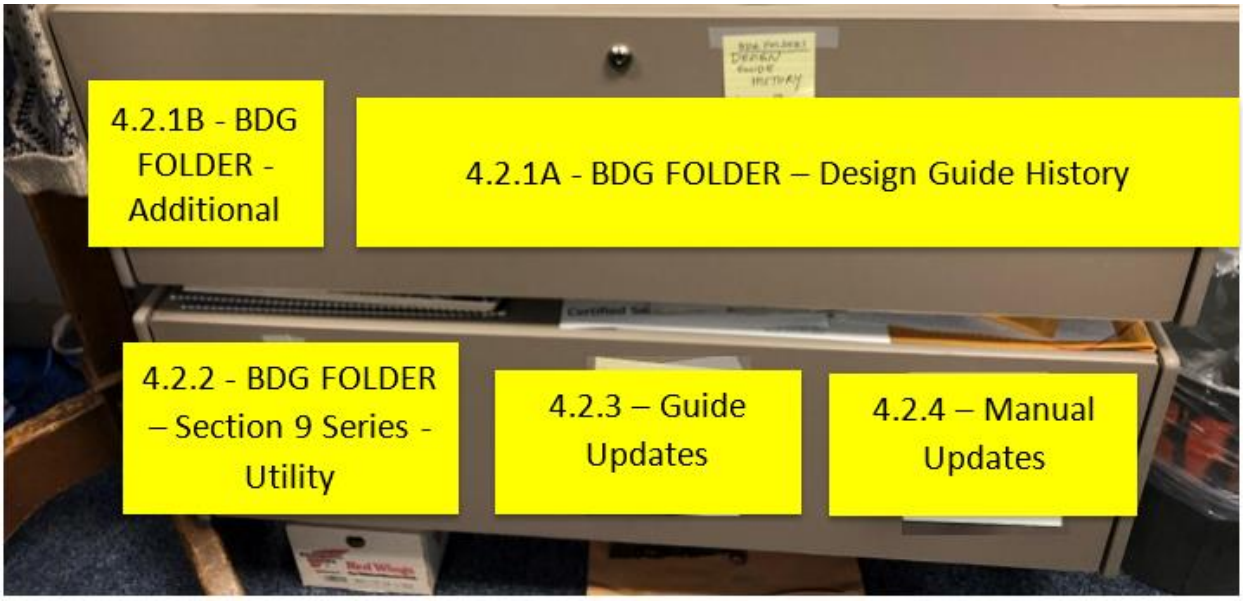



**Figure D-8. Lower shelves of the center cabinet**

**Table D-4: Location 4 Shown in Figure D-6 and Figure D-8**

| Folder Name Based on Location | Folder Name Based on Folder/ Document Title | Notes | Action |
|---|---|---|---|
| 4.2.1A BDG Folders | BDG Folder - Design History Chapter 1 | | Scanned |
| | BDG Folder - Design History Chapter 2 | | |
| | BDG Folder - Design History Chapter 3 | | |
| | BDG Folder - Design History Chapter 4 | | |
| | BDG Folder - Design History Chapter 5 | | |
| | BDG Folder - Design History Chapter 6 | | |
| | BDG Folder - Design History Chapter 7 | | |
| | BDG Folder - Design History Chapter 8 | | |
| | BDG Folder - Design History Chapter 9 | | |
| 4.2.1B BDG Folders (Additional) | BDG Folder – Additional Materials | Additional Materials need to be sorted and combined to appropriate Folder | |
| 4.2.2 Section 9 – Utility | Section 9 Series - Utility | | |
| 4.2.3 Guide update | Guide Update | | |
| 4.2.4 Manual update | Manual Update | | |
| 4.2.5 Future BDG Updates | BDG – Future Updates | Folder was on the desk and need to determine the final location for these hardcopies. | |

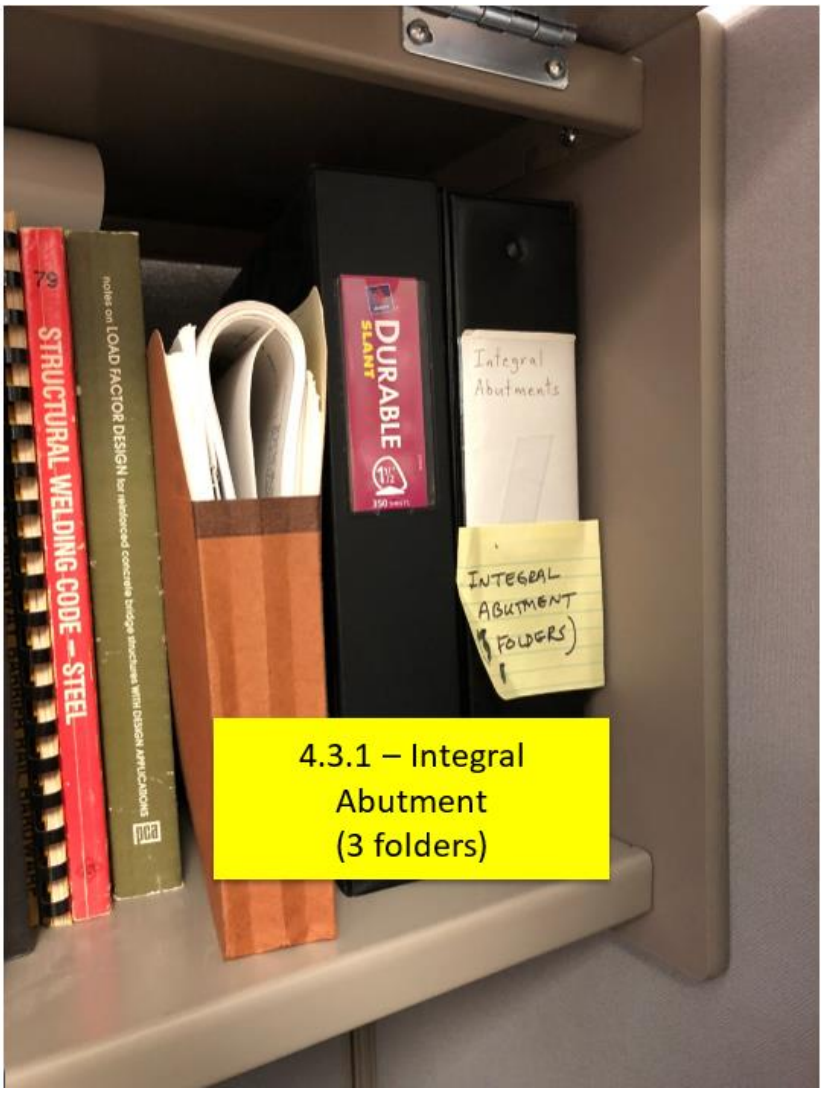


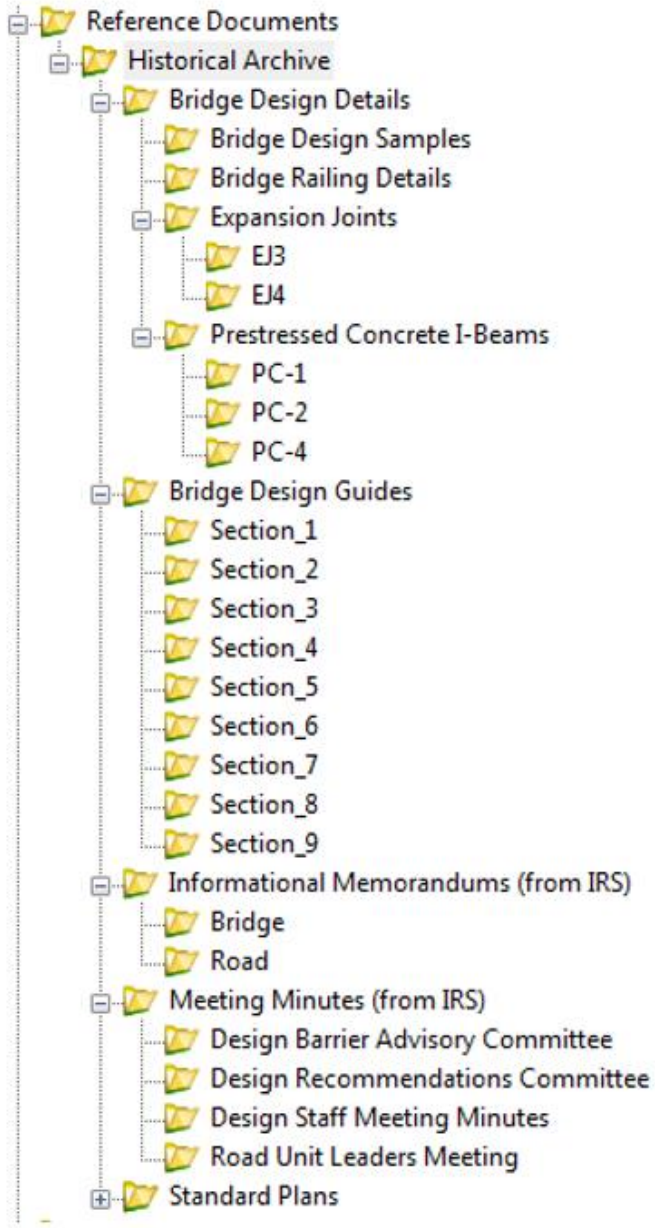

**Figure D-9. Top shelf of the corner cabinet**

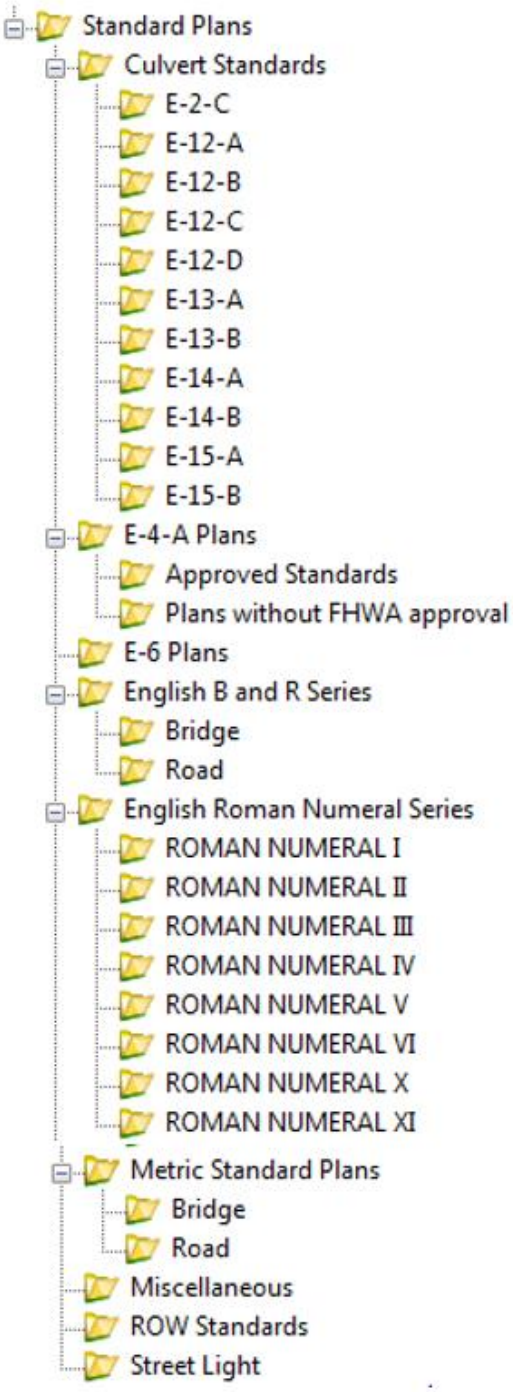
**Table D-5: Location 4 Shown in Figure D-6 and Figure D-9**

| Folder Name Based on Location | Folder Name Based on Folder/ Document Title | Notes | Action |
|---|---|---|---|
| 4.3.1 Int Abut | Integral Abutment 1 | | Scanned |
| | Integral Abutment 2 | | |
| | Integral Abutment 3 | | |

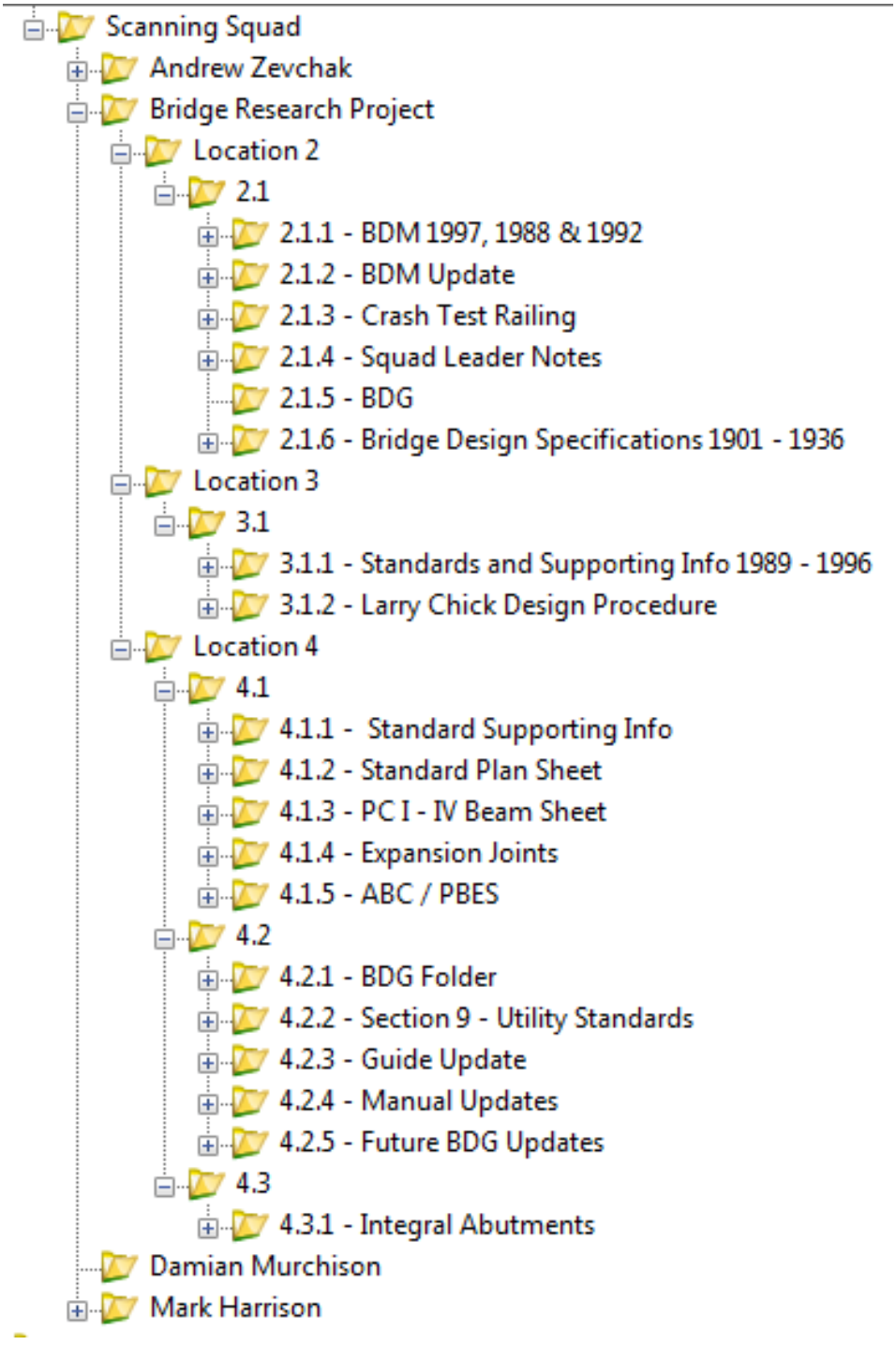
# Folder Arrangement in ProjectWise

## MDOT Historical Archive

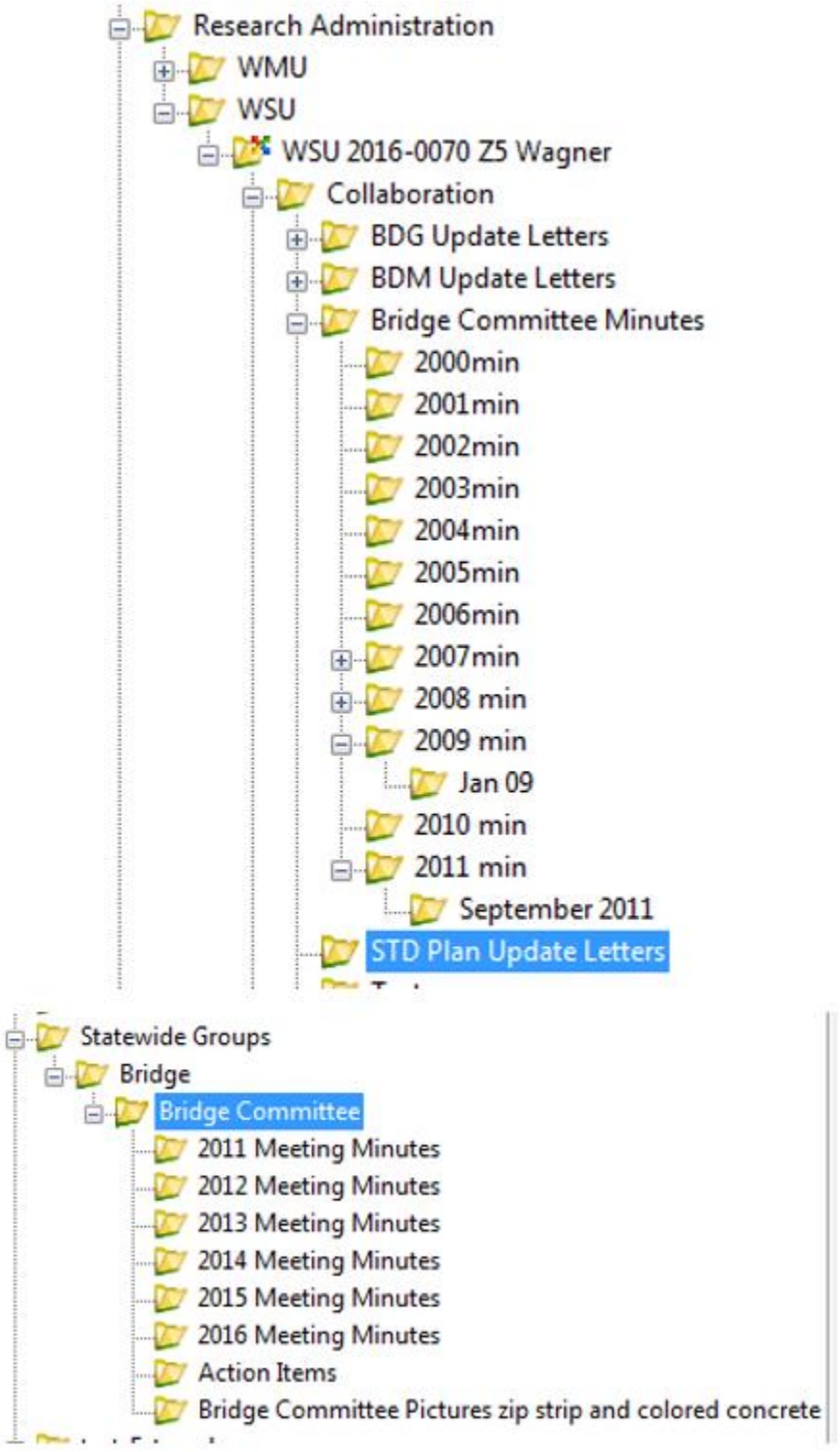


## Scanned Historical Records



## Bridge Committee Meeting Notes



# APPENDIX E: FOLDER STRUCTURE FOR DOCUMENT MANAGEMENT

Figure E-1 shows the folder structure developed for organizing the documents in *Historical Archive* and *Bridge Research Project* folders. This folder structure has five primary folders: *Bridge Design Guides*, *Informational Memorandums (from IRS)*, *Bridge Design Manuals*, *Standard Plans*, and *Other*. All the folders, other than the *Informational Memorandums (from IRS)* folder, contain subfolders.

Figure E-2 shows the BDG folder and file structure. The *Bridge Design Guides* folder contains 11 subfolders: *BDG Updates*, *Miscellaneous*, and *Section 1* to *Section 9*. Also, this main folder contains a README and four log files. Figure E-3 shows the arrangement of *Bridge Design Guides* folders and documents in a File Explorer window. In order to maintain an audit trail, the original location of the source files that are moved into each folder is listed next to the respective folder, as shown in Figure E-2. Additional information is provided in the respective log files and the README file. Figure E-4 to Figure E-13 show the folder and file structure in the rest of the four primary folders. Log and README files provided in these folders describe the folder and file organization as well as the source file locations. The meticulous process followed in this project allows finding the source location and the final destination of any folder or file. A similar process was implemented to develop a document management structure and the details are presented in Appendix E.

In order to make this process effective, the significance of the documents need to be prioritized and considered for disposal if they are no longer necessary or have no historical value to MDOT. During the process of reorganizing the documents into the new folder structure shown in Figure E-1, documents that require a special review by MDOT were moved into folders *Miscellaneous* and *Other*. Hence, the content of the documents in these folders need MDOT review.

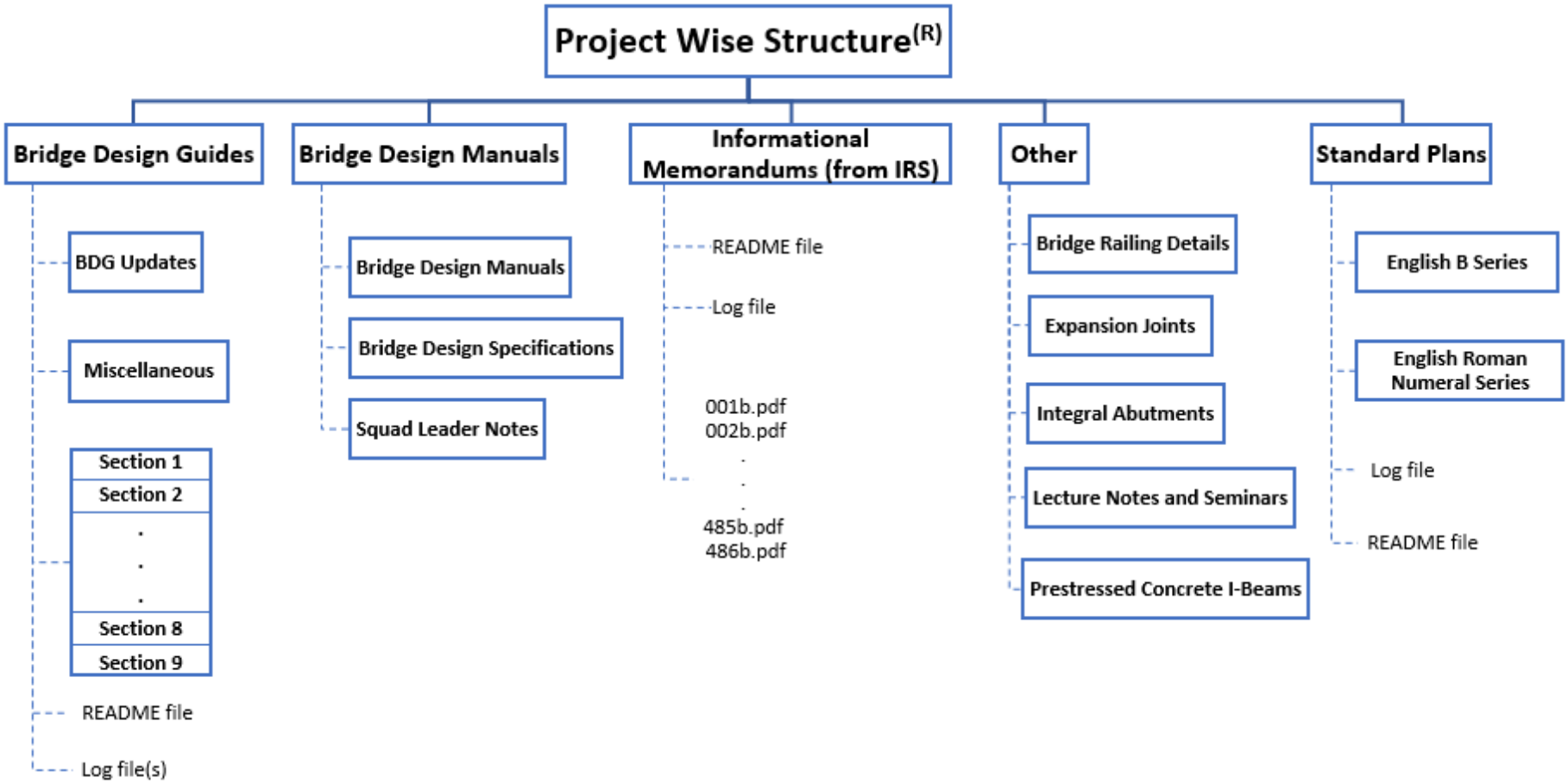



**Figure E-1. Folder structure for organizing *Historical Archive* and *Bridge Research Project* folder content**

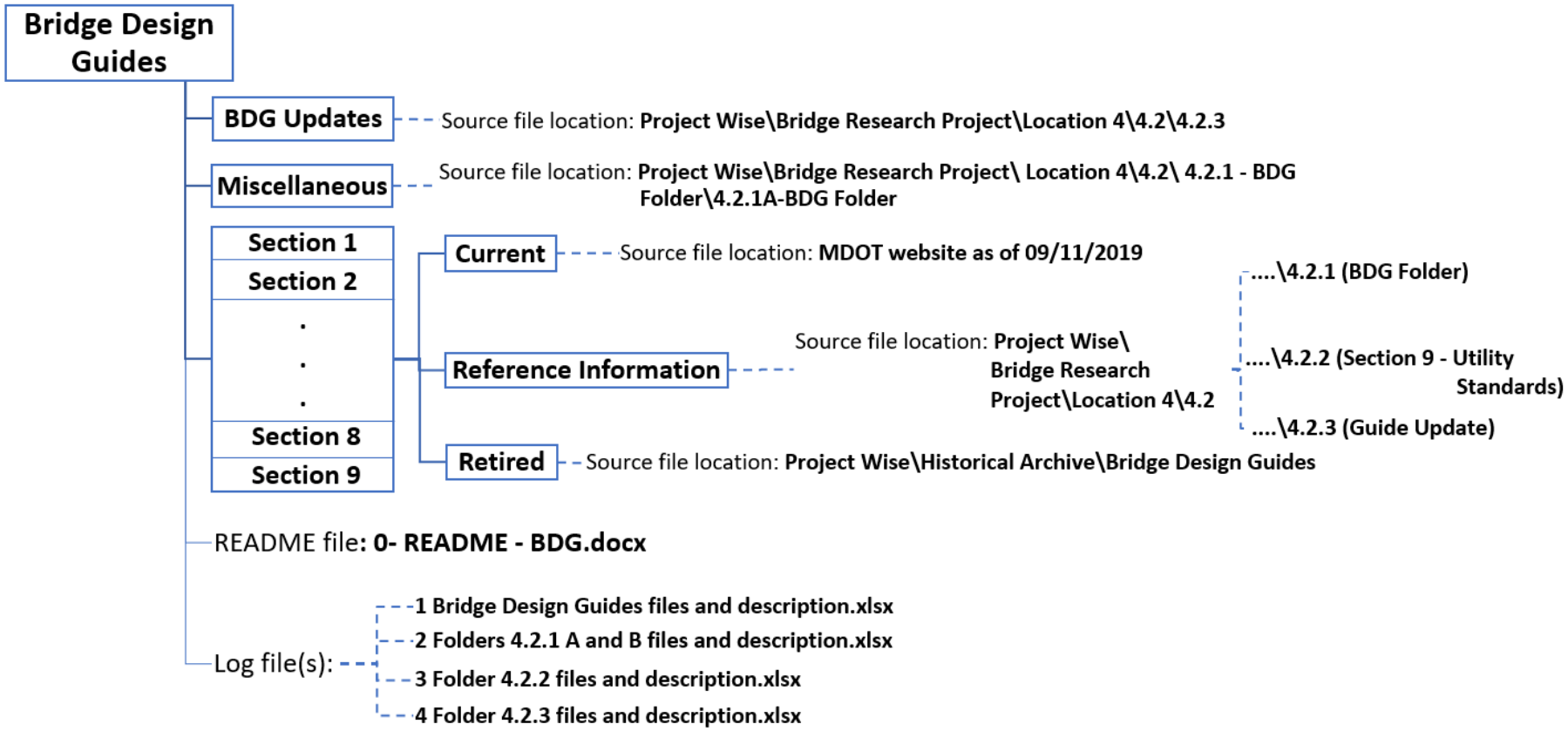



**Figure E-2.** ***Bridge Design Guides*** **folder and file structure**

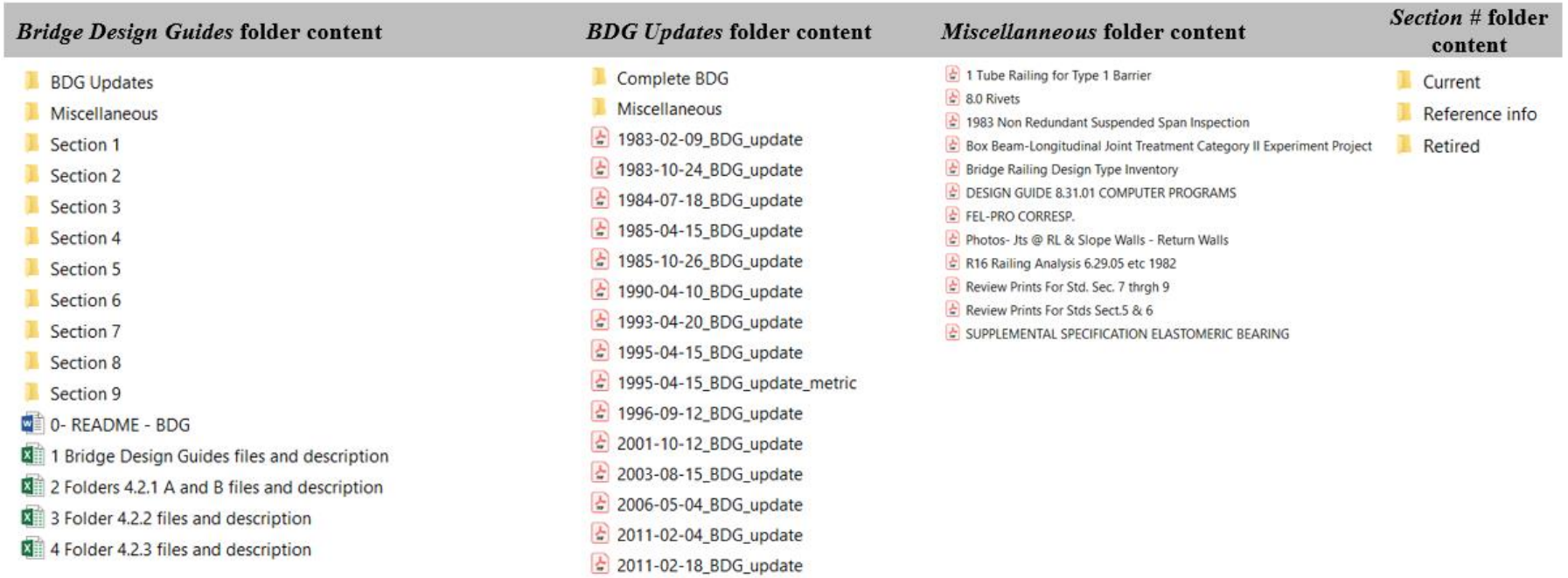



**Figure E-3. Graphical representation of *Bridge Design Guides* folder and file structure in a File Explorer window**

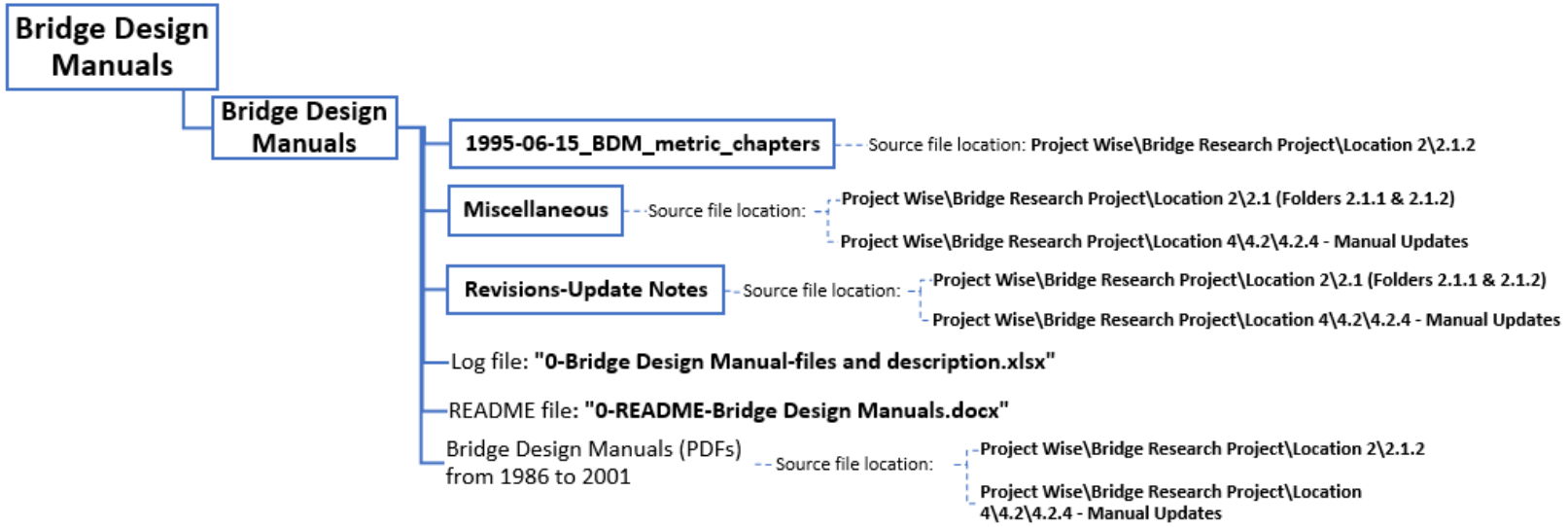



**Figure E-4. *Bridge Design Manuals* folder and file structure**

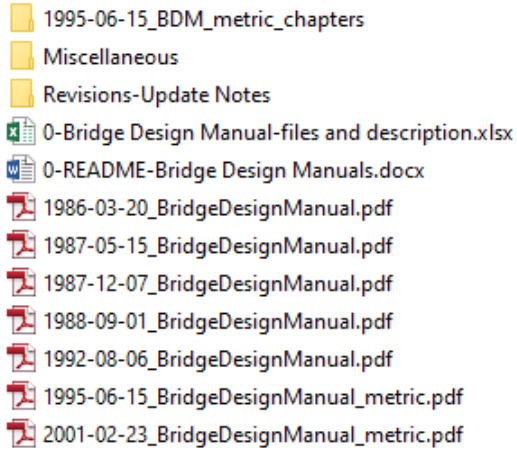



**Figure E-5. Graphical representation of *Bridge Design Manuals* folder and file structure in a File Explorer window**

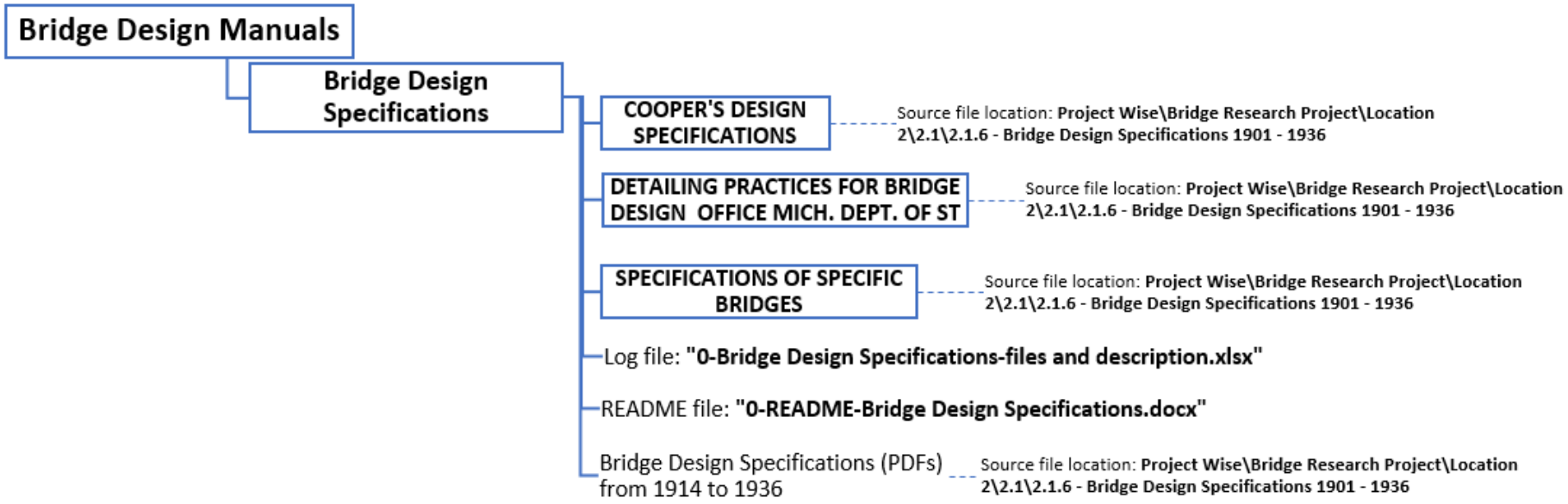



**Figure E-6.** ***Bridge Design Specifications*** **folder and file structure**


**Figure E-7. Graphical representation of** ***Bridge Design Specifications*** **folder and file structure in a File Explorer window**

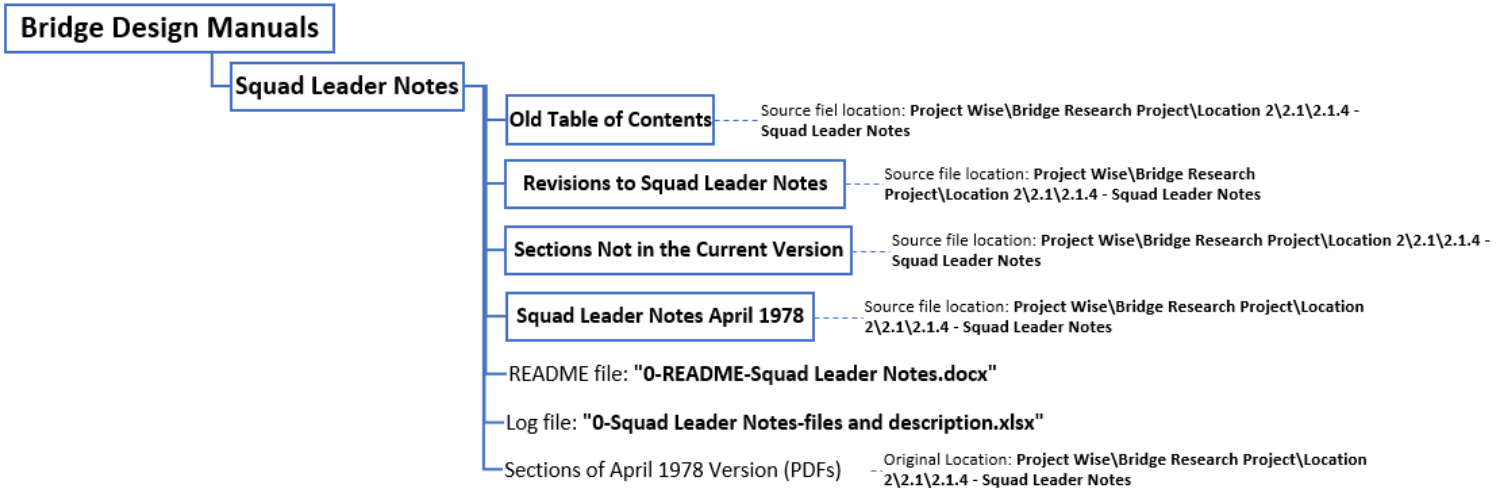



**Figure E-8. *Squad Leader Notes* folder and file structure**

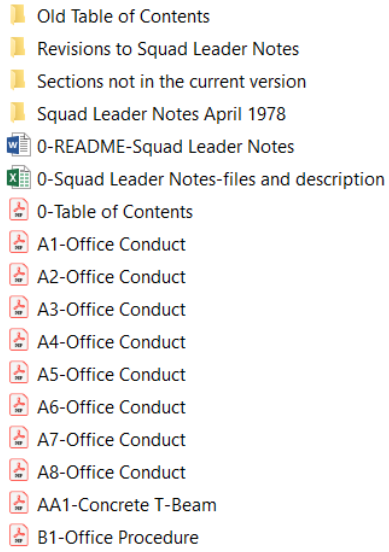



**Figure E-9. Graphical representation of *Squad Leader Notes* folder and file structure in a File Explorer window**

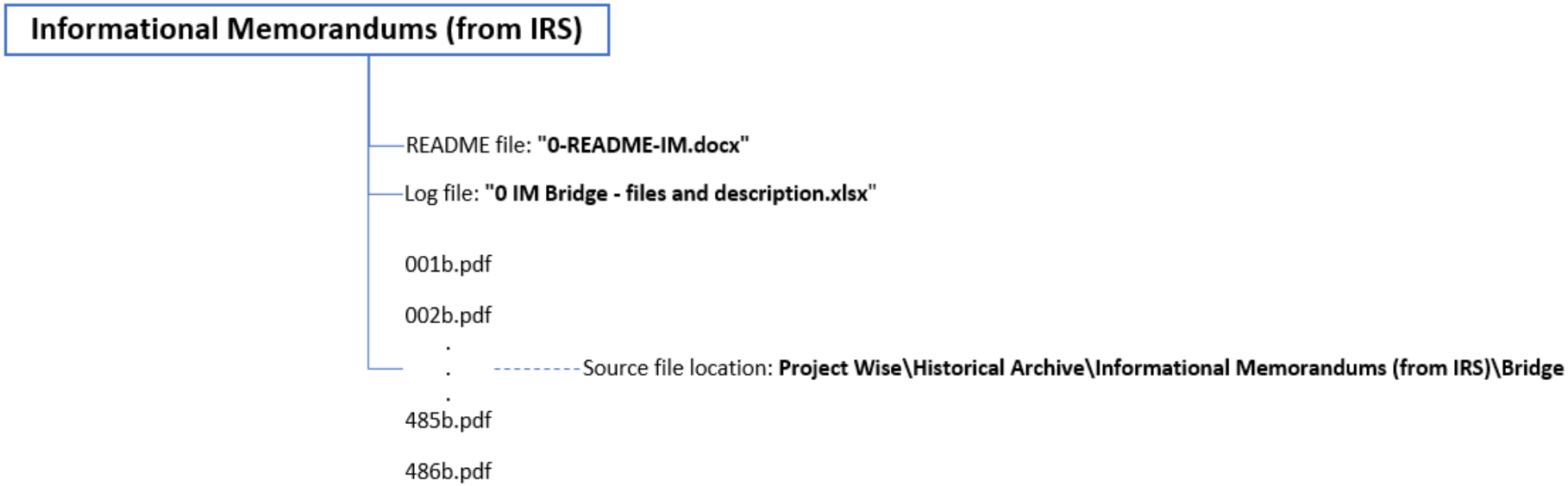



**Figure E-10.** ***Informational Memorandums*** **file structure**

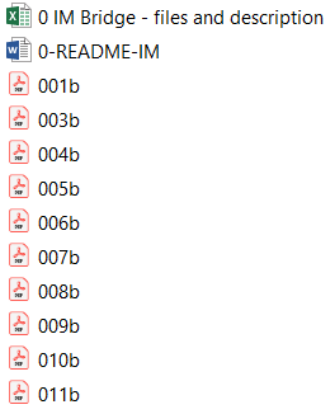



**Figure E-11. Graphical representation of** ***Informational Memorandums*** **file structure in a File Explorer window**

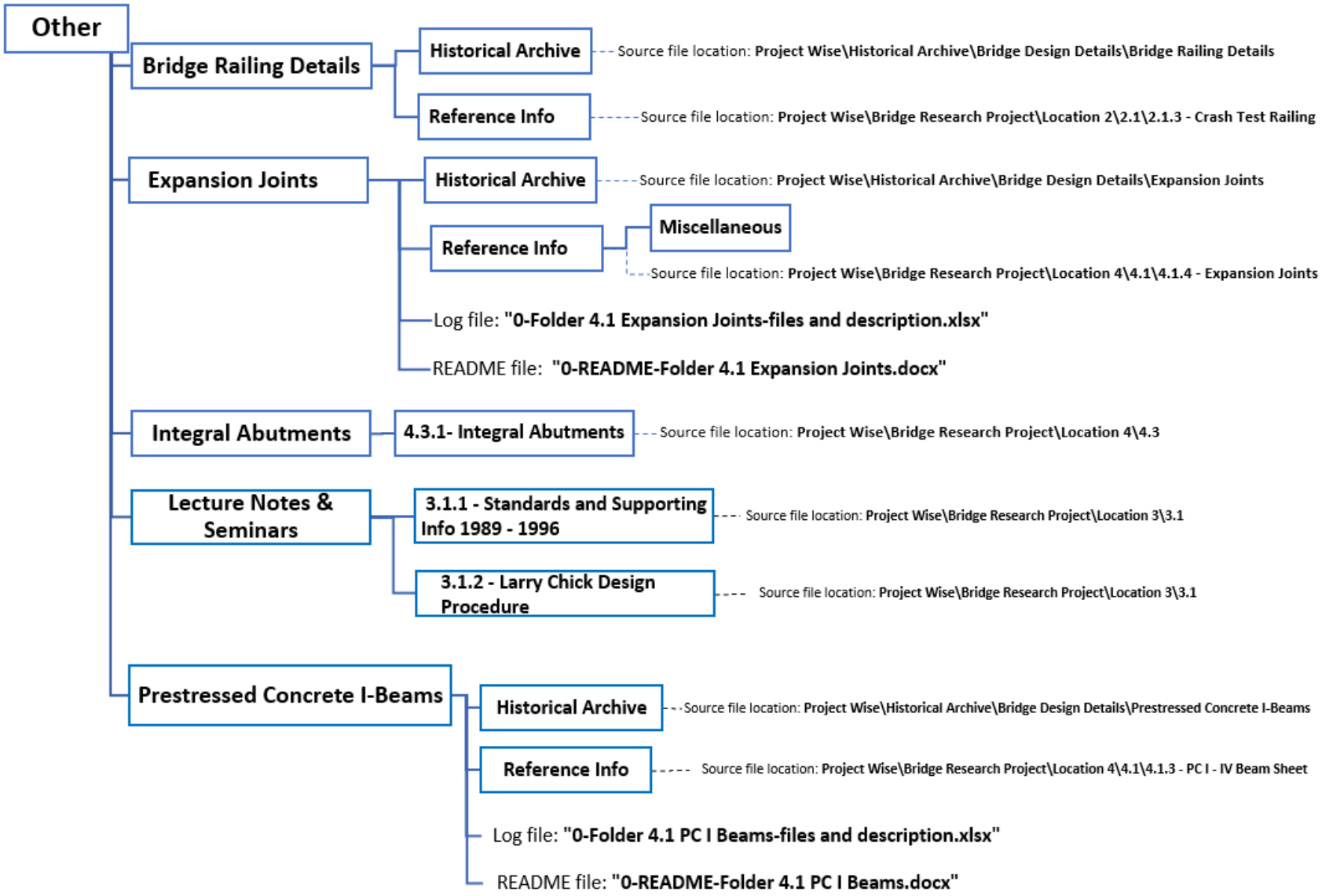



**Figure E-12. File and folder structure in the '*Other*' folder**

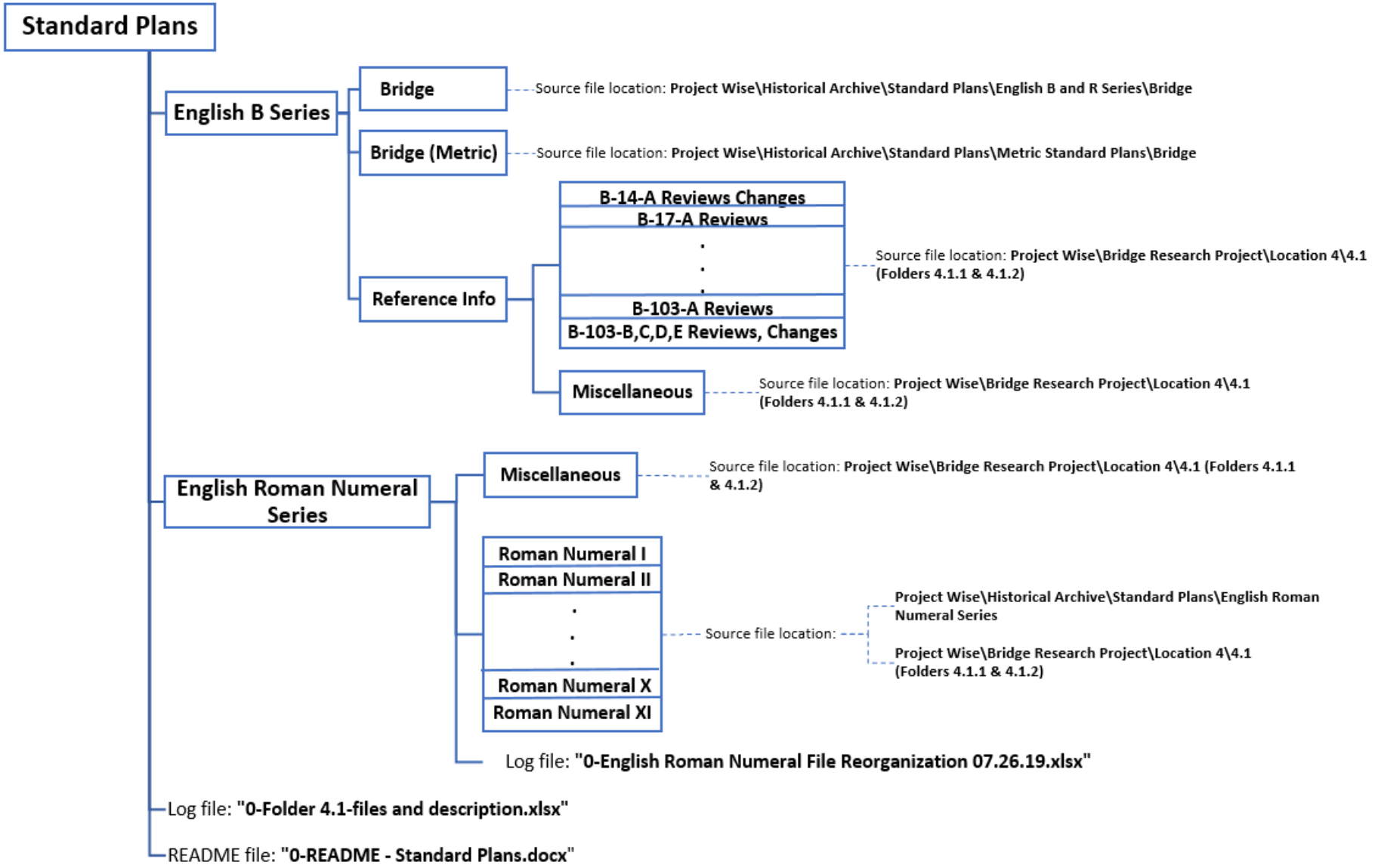



**Figure E-13.** ***Standard Plans*** **folder and file structure**

# APPENDIX F: COMPILED BDM/BDG REVISIONS/UPDATES FROM *MONTHLY UPDATE*

## Bridge Design Guide Update History

'Guide Update History' spreadsheet contains 8 sheets representing all sections of the *Bridge Design Guide* as of ***September 30, 2019***. The Guide does not have Section 2 (Figure F-1). As shown in Figure F-2, each sheet contains columns representing Ref. No., Section Number, Guide Section Name, Issue and Supersede dates, Revision Summary, and Reference.


**Figure F-1. Bridge Design Guide sections and content format**

| Ref. No | Section Number | Guide Section | Issue Date | Supersedes Date | Revision Summary | Reference |
|---|---|---|---|---|---|---|
| 1 | 6.05 | **6.05** | | | | |
| 2 | 6.05.01 | 6.05.01 | 00/00/000 | 00/00/000 | Deleted guide. Guide 6.05.01 A is now in effect. Two lane freeway shoulders shall be 14'-10". | MU-05-2014 |
| 3 | 6.05.01. A | 6.05.01A Bridge Cross Sections New Construction/Reconstruction | 2/14/2011 | 00/00/000 | Guide is now in effect (Post 2013 status is now permanent). Two lane freeway shoulders shall be 14'-10". | MU-05-2014 |
| 4 | 6.05.02 | 6.05.02 Bridge Cross Sections Trunkline, County & City Bridges | 8/21/2017 | 3/17/2014 | Updated note for shoulder widths with reference to Bridge Design Manual Chapter 7 and AASHTO, "A Policy on Geometric Design of Highways and Streets". | MU-03-2014 |
| 5 | 6.05.03 | 6.05.03 Bridge Ramp and U-Turn Cross Sections | 12/22/2011 | 2/14/2011 | Added note to "match bridge shoulder slope and direction with adjacent thru lane". The "Two Lane Ramp" detail is clarified to apply to single crown ramps only. It does not imply that single crown is used exclusively. | MU-12-2011 |
| 6 | 6.06 | **6.06** | | | | |
| 7 | 6.06.01 | 6.06.01 Substructure Clearances Rural State Trunklines | 8/15/2003 | 11/27/2001 | | |
| 8 | 6.06.02 | 6.06.02 Substructure Clearances Rural State Trunklines | 2/14/2011 | 8/15/2003 | | |
| 9 | 6.06.03 | 6.06.03 Substructure Clearances Urban State Trunklines | 8/15/2003 | 11/27/2001 | | |
| 10 | 6.06.04 | 6.06.04 Substructure Clearances County Road and City Street Under | 8/15/2003 | 11/27/2001 | | |
| 11 | 6.06.05 | 6.06.05 Clear Zone Distance (Lc) labeled Clear Zone Chart in MU | 11/21/2013 | 8/15/2003 | For design speeds of 40 mph or less and cut slopes 1:4 or flatter, the clear zone distances for ADTs of 750 or greater were revised to meet the 2011 Roadside Design Guide. | MU-11-2013 |
| 12 | 6.05.05. A | 6.06.05A Curve Correction Factors (Kcz) labeled Curve correction factors table in MU | 11/23/2015 | 11/21/2013 | The table was revised to meet the 2011 Roadside Design Guide. (Most Radii values were revised with minor changes to the values in the 65 mph and 70 mph Design Speeds.) | MU-11-2013 |
| 13 | 6.05.05. A | 6.06.05A Curve Correction Factors (Kcz) labeled Curve correction factors table in MU | 11/23/2015 | 11/21/2013 | Updated note. | MU-11-2015 |

**Figure F-2. Layout of the spreadsheet that summarizes BDG updates/revisions**

**Ref. No.** – This is used to give each line an identity. This column is used to reset the spreadsheet to its original format after sorting information based on a defined criterion.

**Section Number** – Represents Bridge Design Guide section number.

**Guide Section** – Represents guide section number and title.

**Issue Date** – Represents the publication date of the previous guide.

**Supersedes Date** – Represents the latest publication date.

**Revision Summary** – Description of the changes or update to the specific guide.

**Reference** – The *Monthly Update* that published the relevant update/revision.

*Note:*

When the Issue and/or Supersedes Date of certain guides are not available, 00/00/0000 is used to represent the Issue Date and/or Supersedes Date. This date format is used to avoid any sorting issues.

*The spreadsheet is provided as a separate file.*

## Bridge Design Manual Update History

"Manual Update History" spreadsheet contains 16 sheets representing all the chapters of the *Bridge Design Manual* as of ***September 30, 2019***, except chapter 1. The spreadsheet includes separate sheets for Chapters 7 and 8 representing LRFD and LFD design policies (Figure E-3). As shown in Figure E-4, columns in each sheet represent Ref. No., Section Number, Manual Section Name, Revision Date, Revision Summary, and Reference. Revision summary is taken from the *Monthly Update* that were published between ***November 2011*** and ***September 30, 2019***.


**Figure F-3. MDOT webpage showing manual chapters and links for accessing *Monthly Update***

| Ref. No | Section Number | Manual Section | Revision Date | Revision Summary | Reference |
|---|---|---|---|---|---|
| 1 | **7.01** | **7.01 GENERAL** | | | |
| 2 | 7.01.01 | 7.01.01 Design Specifications | 8/20/2009 | Prior to 11/2011 | |
| 3 | 7.01.02 | 7.01.02 Design Method | 8/20/2009 | Prior to 11/2011 | |
| 4 | 7.01.03 | 7.01.03 Design Stresses | 1/29/2018 | Added Grade S2M, P1M and DM concrete. Use note with Special Provision for Grade S2M, P1M & DM concretes. | MU-01-2018 |
| 5 | 7.01.03 | 7.01.03 Design Stresses | 10/17/2016 | Updated designation for pre-stressing strand tensile strength to $f_{pu}$ from $f's$. | MU – 10 - 2016 |
| 6 | 7.01.03 | 7.01.03 Design Stresses | 11/24/2014 | Increased prestressed concrete strengths and introduced release strengths (7000 psi max) for concrete beams. | MU – 11 - 2014 |

**Figure F-4. Layout of the spreadsheet that summarizes BDM updates/revisions**

**Ref. No.** – This is used to give each line an identity. This column is used to reset the spreadsheet to its original format after sorting information based on a defined criterion.

**Section Number** – Represents Bridge Design Manual section number or policy number.

**Manual Section** – Represents manual section number and title.

**Revision Date** – Represents the approved date of update or revision to a policy.

**Revision Summary** – Describes the revisions or update to a policy introduced between ***November 2011*** and ***September 2019***.

**Reference** – The *Monthly Update* that published the relevant update/revision.

*Note:*

Since the revision summary is taken from the *Monthly Update*, the Revision Summary column includes a statement "Prior to 11/2011" when the policies were revised/updated prior to November 2011.

The Revision Summary column also includes a statement "Not referenced in MU" when a revision date between ***November 2011*** and ***September 2019*** is stated in the *Bridge Design Manual* but no information found in the corresponding *Monthly Update*.

*The spreadsheet is provided as a separate file.*

# APPENDIX G: COMPILED INFORMATION FROM *UPDATE LETTERS* AND *OFFICE MEMORANDUMS*

## BDG Update Letters

*BDG Update Letters* are archived in ProjectWise (PW) as shown in Figure G-1. This particular folder contains three subfolders with 40 documents.

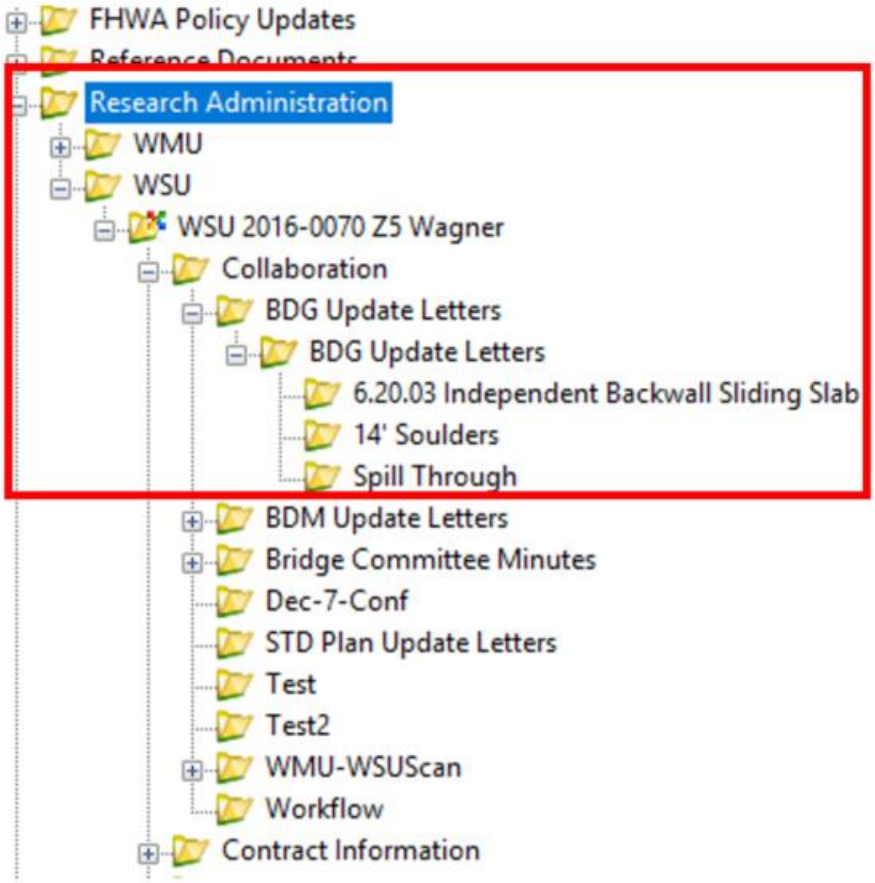



**Figure G-1. BDG Update Letters archived in ProjectWise**

Every single file from the *BDG Update Letters* folder and subfolders are listed in the 'BDG Update Letters' spreadsheet (Figure G-2). The spreadsheet contains the name of the folder or subfolder PW, file name, comments (brief description of the content of the file), status (explained in red box below), and other references. The other references primarily represent *Monthly Update* newsletters that documented the revisions/updates to the BDG.

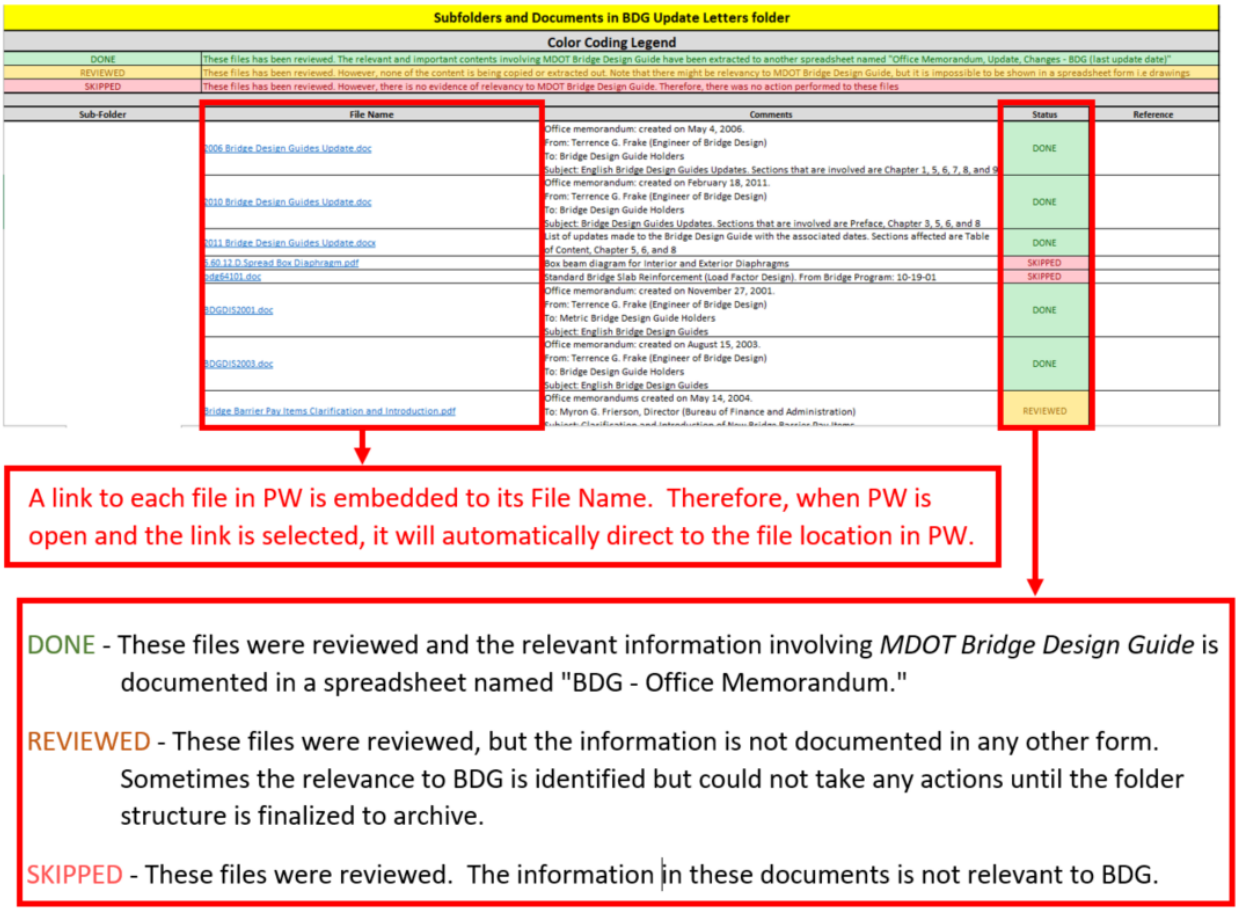


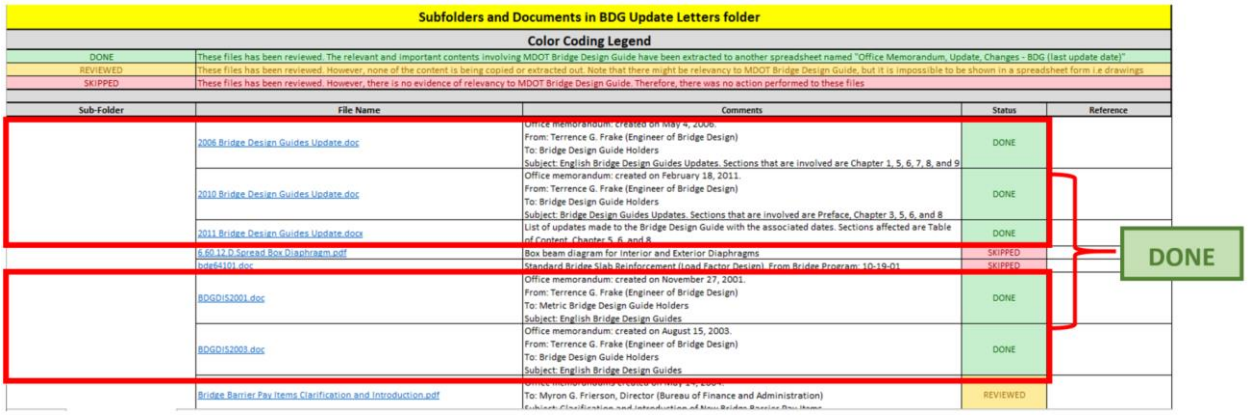

**Figure G-2. *BDG Update Letters* spreadsheet**

Note:

*Spreadsheet is provided as a separate file.*

## BDG – Office Memorandum

Figure G-3 shows the *BDG Update Letters* spreadsheet. The items with status *'DONE'* are reviewed and relevant information is documented in *BDG – Office Memorandum* spreadsheet shown in Figure G-4. Links to the parent files in PW are provided. The spreadsheet contains the section number, the updates made to the section, revision date, parent file (file in PW), and comment. Certain sections of the BDG has been delete or no longer exist. If this is the case, a remark such as *'These pages do not exist'* is included in the 'Comment' cell.



| Subfolders and Documents in BDG Update Letters folder | | | | |
|---|---|---|---|---|
| Color Coding Legend | | | | |
| DONE | These files has been reviewed. The relevant and important contents involving MDOT Bridge Design Guide have been extracted to another spreadsheet named "Office Memorandum, Update, Changes - BDG (last update date)" | | | |
| REVIEWED | These files has been reviewed. However, none of the content is being copied or extracted out. Note that there might be relevancy to MDOT Bridge Design Guide, but it is impossible to be shown in a spreadsheet form i.e drawings | | | |
| SKIPPED | These files has been reviewed. However, there is no evidence of relevancy to MDOT Bridge Design Guide. Therefore, there was no action performed to these files | | | |
| Sub-Folder | File Name | Comments | Status | Reference |
| | 2006 Bridge Design Guides Update.doc | Office memorandum: created on May 4, 2006.<br>From: Terrence G. Frake (Engineer of Bridge Design)<br>To: Bridge Design Guide Holders<br>Subject: English Bridge Design Guides Updates. Sections that are involved are Chapter 1, 5, 6, 7, 8, and 9 | DONE | |
| | 2010 Bridge Design Guides Update.doc | Office memorandum: created on February 18, 2011.<br>From: Terrence G. Frake (Engineer of Bridge Design)<br>To: Bridge Design Guide Holders<br>Subject: Bridge Design Guides Updates. Sections that are involved are Preface, Chapter 3, 5, 6, and 8 | DONE | |
| | 2011 Bridge Design Guides Update.docx | List of updates made to the Bridge Design Guide with the associated dates. Sections affected are Table of Content, Chapter 5, 6, and 8 | DONE | |
| | 6.60.12.D.Spread Box Diaphragm.pdf | Box beam diagram for Interior and Exterior Diaphragms | SKIPPED | |
| | bde64101.doc | Standard Bridge Slab Reinforcement (Load Factor Design). From Bridge Program: 10-19-01 | SKIPPED | |
| | BDGDIS2001.doc | Office memorandum: created on November 27, 2001.<br>From: Terrence G. Frake (Engineer of Bridge Design)<br>To: Metric Bridge Design Guide Holders<br>Subject: English Bridge Design Guides | DONE | |
| | BDGDIS2003.doc | Office memorandum: created on August 15, 2003.<br>From: Terrence G. Frake (Engineer of Bridge Design)<br>To: Bridge Design Guide Holders<br>Subject: English Bridge Design Guides | DONE | |
| | Bridge Barrier Pay Items Clarification and Introduction.pdf | Office memorandum: created on May 26, 2004.<br>To: Myron G. Frierson, Director (Bureau of Finance and Administration)<br>Subject: Clarification and introduction of New Bridge Barrier Pay Items | REVIEWED | |

DONE

**Figure G-3. *BDG Update Letters* spreadsheet**

| Office Memorandum - Bridge Design Guide | | | | | |
|---|---|---|---|---|---|
| No. | Section | Update | Date | Parent File | Comment |
| 1 | 1.00.02 | Guide designation updated to include Guide 5.46.06, Structure Backfill and Foundation Excavation - Abutments and Guide 6.11.02, Straight Line Superelevation | 05/04/06 | 2006 Bridge Design Guides Update.doc | These pages do not exist |
| 2 | 1.00.04 | Guide 8.11.04 updated with "30° to 45°". | 05/04/06 | 2006 Bridge Design Guides Update.doc | These pages do not exist |
| 3 | 1.00.05 | Guide 9.12.01 updated Mass to Weight, Guides 9.21.03, 9.21.04 and 9.33.01 deleted Ameritech due to frequent name changes, Guide 9.40.02 updated to Consumers Energy, and Guide 9.40.03 updated to DTE Energy. | 05/04/06 | 2006 Bridge Design Guides Update.doc | These pages do not exist |
| 4 | 5.16.01 | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc | |
| 5 | 5.06.01A | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc | These pages do not exist |
| 6 | 5.18.01 | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc | |
| 7 | 5.18.01. A | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc | |
| 8 | 5.24.01 | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc | |
| 9 | 6.20.03 | Wall bars changed to epoxy coated. | 05/04/06 | 2006 Bridge Design Guides Update.doc | |
| 10 | 5.20.01 | Preformed Waterproofing Membrane changed to Preformed Joint Waterproofing. | 05/04/06 | 2006 Bridge Design Guides Update.doc | |
| 11 | 5.27.03 | Cap bars changed to epoxy coated | 05/04/06 | 2006 Bridge Design Guides Update.doc | |
| 12 | 6.05.01 | Updated auxiliary lane sections, specifically when gore is on structure. | 05/04/06 | 2006 Bridge Design Guides Update.doc | These pages do not exist |
| 13 | 6.05.03 | Delete designation for urban and rural ramps (details are equal). Two guides combined into one (6.05.04 deleted). Updated for auxiliary lane sections, specifically when gore is on structure. | 05/04/06 | 2006 Bridge Design Guides Update.doc | |
| 14 | 6.05.04 | Delete designation for urban and rural ramps (details are equal). Two guides combined into one (6.05.04 deleted). Updated for auxiliary lane sections, specifically when gore is on structure. | 05/04/06 | 2006 Bridge Design Guides Update.doc | These pages do not exist |

**Figure G-4. *BDG – Office Memorandum* spreadsheet**

**No** – This is used to give each line an identity. This column is used to reset the spreadsheet to its original format after sorting information based on a defined criterion.

**Section Number** – Represents Bridge Design Guide section number.

**Updates** – Shows a summary of revisions/updates to each guide.

**Date** – Represents the approved date of the revision/update.

**Parent File** – The source file in PW.

**Comment** – Necessary remarks for the corresponding BDG section.

Note: *Spreadsheet is provided as a separate file.*

## BDM Update Letters Spreadsheet

*BDM Update Letters* are archived in ProjectWise (PW) as shown in Figure G-5. This particular folder contains a large number of subfolders and documents.

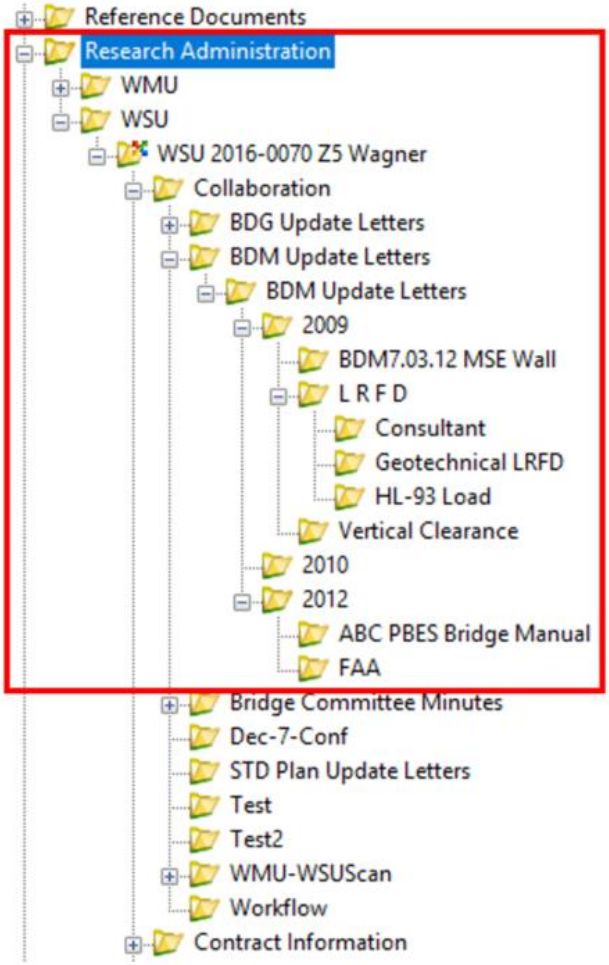



**Figure G-5. BDM Update Letters archived in ProjectWise**

Every single file from the *BDM Update Letters* folder and subfolders are listed in the 'BDM Update Letters' spreadsheet (Figure G-6). The spreadsheet contains the name of the subfolder and sub-subfolders in PW, file name, comments (brief description of the content of the file), status, and other reference. The other reference primarily represents *Monthly Update* newsletters that documented the revisions/updates to the BDM.

| Subfolders and Documents in BDM Update Letters folder | | | | | | |
|---|---|---|---|---|---|---|
| **Color Coding Legend** | | | | | | |
| DONE | These files has been reviewed. The relevant and imporant contents involving MDOT Bridge Design Manual have been extracted to another spreadsheet named "Office Memorandum, Update, Changes - BDM (last update date)" | | | | | |
| REVIEWED | These files has been reviewed. However, none of the content is being copied or extracted out. Note that there might be relevancy to MDOT Bridge Design Manual, but it is impossible to be shown in a spreadsheet form i.e drawings | | | | | |
| SKIPPED | These files has been reviewed. However, there is no evidence of relevancy to MDOT Bridge Design Manual. Therefore, there was no action performed to these files | | | | | |
| **Subfolder** | **Sub-Subfolder** | | **File Name** | **Comments** | **Status** | **Other Reference** |
| | | | BDM Update 2001.docx | Office memorandum: created on October 24, 2001.<br>From: Terrence G. Frake (Engineer of Bridge Design)<br>To: Metric Bridge Design Manual Holders<br>Subject: English Bridge Design Manual | DONE | |
| | | | BDM Updates 1995 2001.pdf | Office memorandum: created on Feburary 23, 2001.<br>From: Mark A. VanPortFleet (Engineer of Bridge Design)<br>To: Metric Bridge Design Manual Holders<br>Subject: Chapter 5 and 6 of Bridge Design Manual | DONE | |
| | | | | Office memorandum: created on May 1, 2000.<br>From: Mark A. VanPortFleet (Engineer of Bridge Design)<br>To: Metric Bridge Design Manual Holders<br>Subject: Chapter 3, 4, 5, 7, 8, 9, 10, 12, and 14 of Bridge Design Manual | DONE | |
| | | | | Office memorandum: created on February 7, 2000.<br>From: Mark A. VanPortFleet (Engineer of Bridge Design)<br>To: Bridge Design Guide Holders<br>Subject: Chapter 2, 5, 10, 11, and 13 of Bridge Design Manual | DONE | |
| | | | | Office memorandum: created on August 20, 1999.<br>From: Mark A. VanPortFleet (Engineer of Bridge Design)<br>To: Metric Bridge Design Manual Holders<br>Subject: Chapter 1, 3, 8, 9, 14, and 15 of Bridge Design Manual | DONE | |
| | | | | Office memorandum: created on August 20, 1999.<br>From: Mark A. VanPortFleet (Engineer of Bridge Design)<br>To: Metric Bridge Design Manual Holders<br>Subject: Chapter 7 of Bridge Design Manual. | DONE | |

**Figure G-6. *BDM Update Letters* spreadsheet**

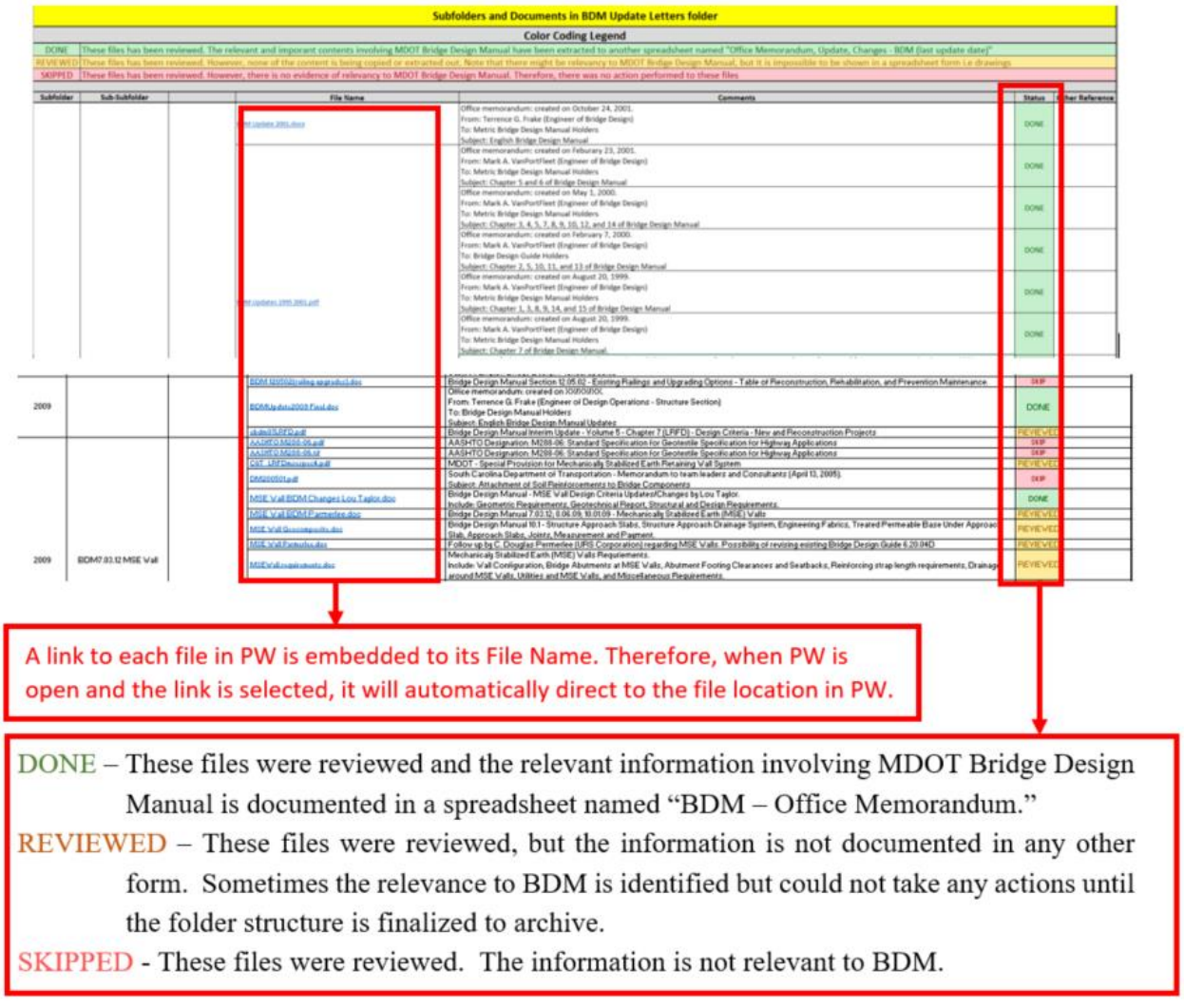



**Figure G-7. *BDM Update Letters* spreadsheet with content description**

Note: *Spreadsheet is provided as a separate file.*

## BDM – Office Memorandum

Figure G-8 shows the *BDM Update Letters* and *BDM-Office Memorandum* spreadsheets. The items with status *'DONE'* in the *BDM Update Letters* spreadsheet are reviewed and relevant information is documented in *BDM – Office Memorandum* spreadsheet. Links to the parent files in PW are provided. The spreadsheet contains No., section, updates, date, and parent file. In this spreadsheet, a color coding is utilized to differentiate the chapters. Each chapter and appendix has a unique color. This color coding is used to eliminate any possible issues with sorting the information according to the section number.

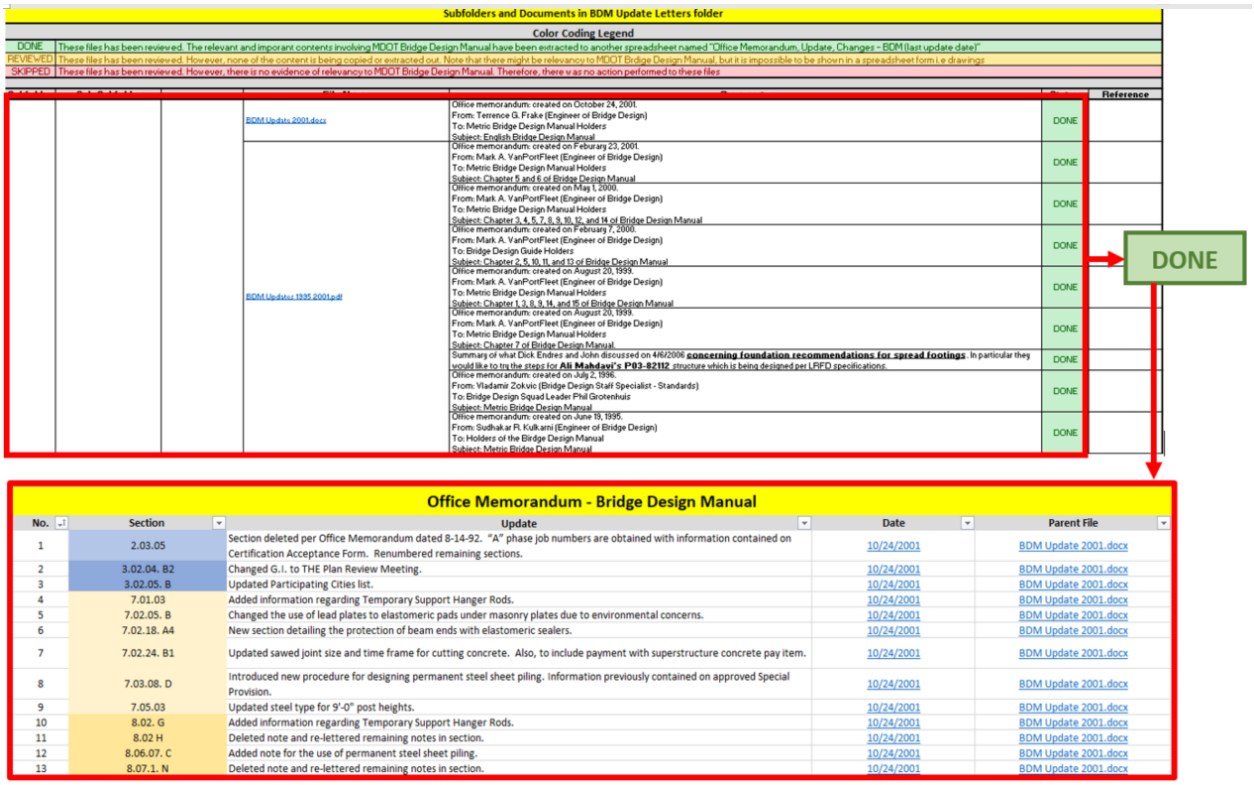



**Figure G-8.** ***BDM Update Letters*** **and** ***BDM-Office Memorandum*** **spreadsheets**

**No** – This is used to give each line an identity. This column is used to reset the spreadsheet to its original format after sorting information based on a defined criterion.

**Section** – Represents Bridge Design Manual section number.

**Updates** – Shows a summary of revisions/updates to each section/policy.

**Date** – Represents the approved date of the revision/update.

**Parent File** – The source file in PW.

Figure G-9 shows the assigned colors to each chapter and appendix. Section 1 is assigned light blue color while Section 3 is assigned a darker blue color. Similarly, Section 4 is assigned light green and Section 6 is assigned a darker green. The sections are initially sorted using color coding. After that the sorting is performed using section numbers and date.

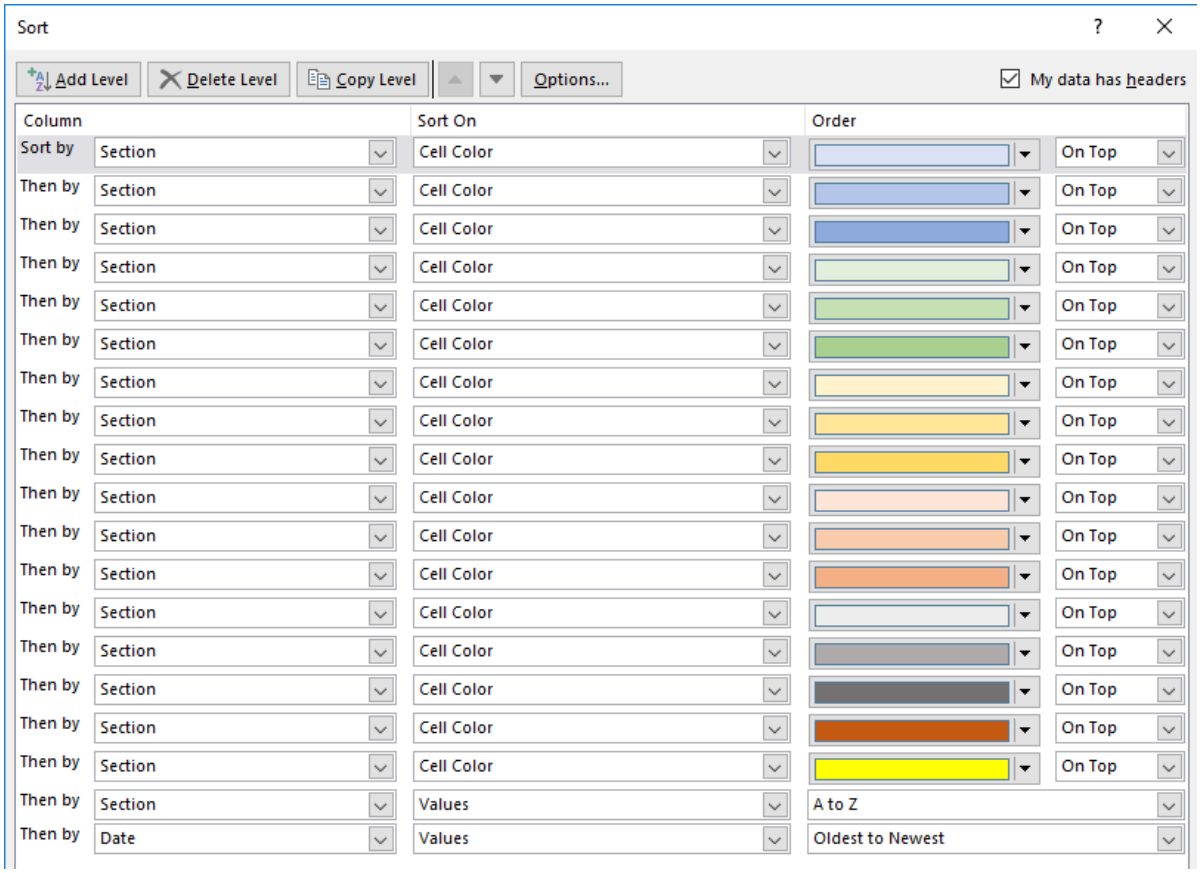
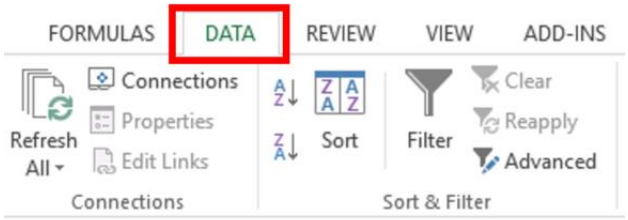


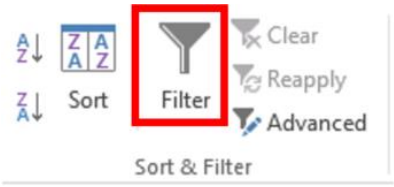

**Figure G-9. Color coding used in the spreadsheet**

The following steps are followed to sort the information in the spreadsheet:

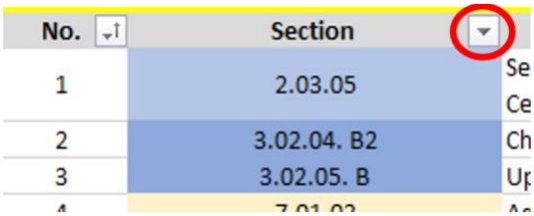
1. Select “DATA” from the ribbon



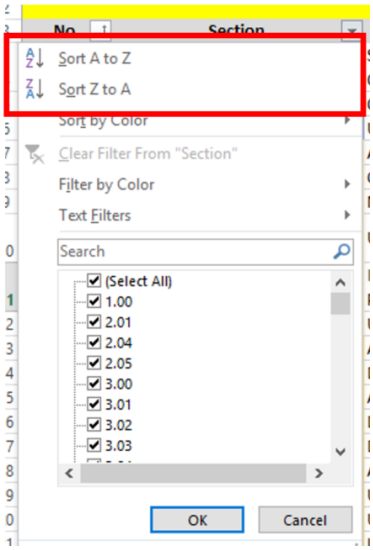

2. In the “Sort & Filter” tabs, select *filter*




3. Filter Arrow will appear in the heading cells




4. To sort the spreadsheet according to Section Number, click on the dropdown arrow shown in the ‘Section Number’ heading cell. Select *Sort A to Z* to sort from Smallest to Largest or select *Sort Z to A* to sort from Largest to Smaller using the options in the pop-up window.

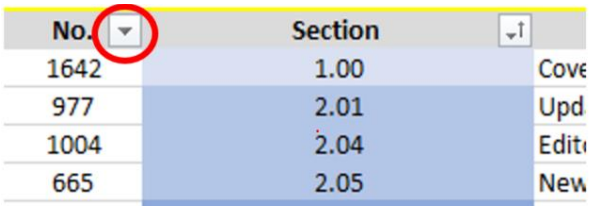


5. Once the sorting is completed, the content will be displayed as shown below.

**Office Memorandum - Bridge Design Manual**

| No. | Section | Update | Date | Parent File |
|---|---|---|---|---|
| 1642 | 1.00 | Covered in first paragraph 'other major structures' | 2/6/2006 | MSE Wall BDM Changes Lou Taylor.doc |
| 977 | 2.01 | Updated programming responsibilities | 2/7/2000 | BDM Updates 1995 2001.pdf |
| 1004 | 2.04 | Editorial/grammatical changes to notes. | 2/7/2000 | BDM Updates 1995 2001.pdf |
| 665 | 2.05 | New section for Bridge Design Quality Assurance & Quality Control. | 5/23/2016 | BDMUpdate2012.doc |
| 188 | 3.00 | Added information regarding 3R vs. 4R projects and the fact that work category determination is based upon which type of work is more than 50%. Definition of reconstruction added. | 8/20/2009 | BDMUpdate2009 Final.doc |
| 493 | 3.00 | Added criteria for 3R/4R project classifications. Cross road over bridges are to be treated as individual segments as they relate to work type and standards. | 2/27/2012 | BDMUpdate2010.doc |
| 659 | 3.00 | Updated standards and design criteria governing 3R and 4R projects when there is a combination of work types (3R, 4R or other work type) within the same project. | 8/22/2016 | BDMUpdate2012.doc |
| 833 | 3.00 | Added criteria for 3R/4R project classifications. Cross road over bridges are to be treated as individual segments as they relate to work type and standards. | 2/27/2012 | BDMUpdate2012.doc |
| 40 | 3.01 | "Exempt" to "oversight" update. | 12/5/2005 | BDMUpdate2005.doc |
| 189 | 3.01 | Updated Grading/Drainage and Consultant Contracting Unit (G/DCCU) to Geotechnical Services Section. No date of update is issued. | 8/20/2009 | BDMUpdate2009 Final.doc |
| 881 | 3.01 | Changed the contaminated site coordination from the Project Planning Division to the Project Manager. | 5/1/2000 | BDM Updates 1995 2001.pdf |

6. To reset the spread to its original version, follow the same steps described above. This time, the drop down arrow at the 'No.' column is used.




7. On the pop-up window, select *Sort A to Z* to sort from Smallest to Largest.

Note:

*Spreadsheet is provided as a separate file.*

# APPENDIX H: COMPILED INFORMATION FROM *BRIDGE COMMITTEE MEETING MINUTES*

## Bridge Design Policy Information In Bridge Committee Meeting Minutes

The spreadsheet summarizes bridge design policy related information in bridge committee meeting minutes. As shown in Figure H-1, bridge committee meeting minutes are stored at two locations within ProjectWise.

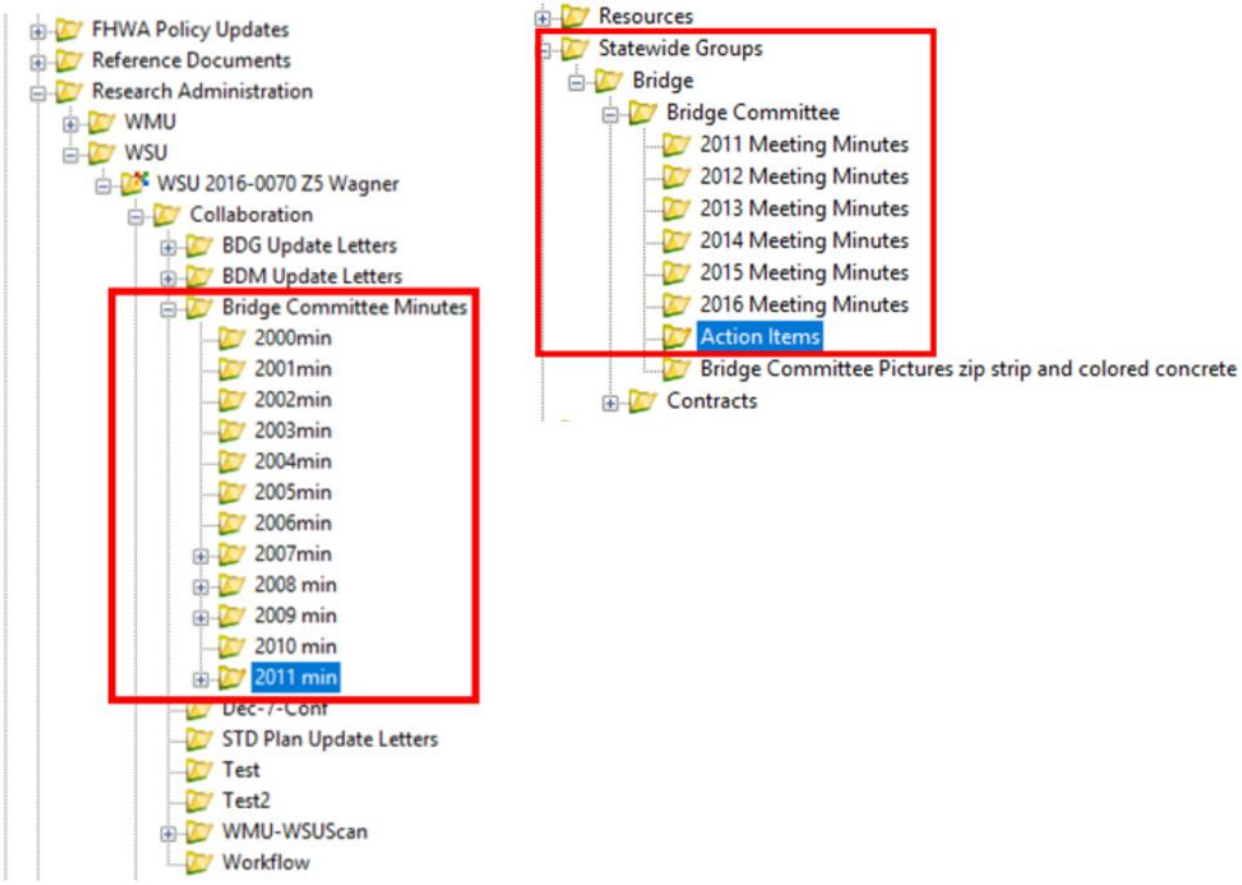



**Figure H-1: Folder structure in ProjectWise**

The 'Bridge Committee Meeting Minutes' spreadsheet was developed after reviewing the meeting minutes from 2016 to 2011. As shown in Figure H-2, the items that share a similar topic are grouped under one color. The items that are listed either in white or grey color cells are the ones that do not belong to a common topic. The color coding does not have a meaning; it is used as a visual aid to separate one topic from another. The spreadsheet is not organized in a particular order but it can be sorted according to "Date". In order to reset the spreadsheet back to its original layout, the numbers in column A "No." can be sorted in an ascending order.

| No. | Title | Bridge Committee Meeting Minute | Date | Action Item | Comments |
|---|---|---|---|---|---|
| 1 | Epoxy Overlay Warranty Update | Three draft special provisions are being developed and will be submitted for review by FHWA, MITA and the suppliers. The "Special Provision for Thin Epoxy Polymer Bridge Deck Overlay, Warranty" is similar to the existing special provision except for that "Warranty" is added to the description and pay item with minor changes. The "Special Provision for A-Q" states that the contract shall not be awarded solely on price, but it will be awarded to the Contractor whose bid represents the best value to MDOT considering price and length of warranty also known as A + Q. This special provision also details the requirements for preparation of the bids and consideration of the bids. In this case, the contractor would be providing a 5, 10, or 15 year warranty for the epoxy overlay. The "Special Provision for Performance Warranty for Epoxy Overlay" includes the warranty bond, terms and conditions of the | 06-2011 | - | |
| 2 | Low Temperature Epoxy Overlay | Maintenance will be monitoring the performance of the overlay. If successful, the product may lower the minimum temperature requirements for the placement of overlays and may allow for additional placement of overlays in early spring and late fall with lower temperatures. | 06-2011 | Maintenance will be monitoring the performance of the overlay. If successful, the product may lower the minimum temperature requirements for the placement of overlays and may allow for additional placement of overlays in early spring and late fall with lower temperatures. | |
| 3 | T-18 Bridge Deck Overlay | Discussed advantages (wide temperature range and fast curing) and disadvantages (costs compared to other thin overlays) of the fast thin curing overlay. | 03-2011 | Further investigation is required. Corey to send Dave copies of overlay product information. | |
| 4 | Performance Based Epoxy Overlay candidate projects | To address MDOT leadership's request to develop a performance based epoxy overlay specification and apply it to candidate projects, an MDOT specific performance specification was developed, and sent out to MITA and industry for comment. Currently there are 3 bridges identified in Bay Region that will use this performance specification. More discussion will take place at the next Bridge Committee meeting once industry comments are received. | 02-2012 | Receive and review industry comments<br>Identification of ownership and finalization of specification, then implementation - to be discussed at next meeting. | |
| 5 | Performance Based Epoxy Overlay candidate projects | Based on industry comments against the performance specification with 10 - 15 year warranty, Corey Rogers revised the specs for a 5 year warranty. The new specifications are currently being reviewed, and once approved will be piloted on a Bay Region project in the June 2012 letting. | 03-2012 | - | |
| 6 | Night Casting for Deep Concrete Overlays | On a project currently being designed, the Region had asked for night pours on a bridge deck overlay project for similar reasons night pours are required for superstructure concrete deck pours. Temperature has fewer impacts on Silica Fume Modified Concrete than it does on Concrete Grade D. Proper application of water (fogging), and wet burlap is critical on deep overlays to prevent the surface from cracking. There is no current requirement to perform this work at night. Should the Regions request the work be done at night to account for staging or adherence to the MDOT mobility policy, the designers should make this accommodation. This will most likely have little impact on the plans, as the project Progress Clause will address work and time restrictions. | 02-2012 | - | |
| 7 | Bridge Preservation Guide | Dave discussed epoxy overlay white paper written by Corey Rogers and the Region Structures Support group. This is to be included in an overall scoping manual, and on the material website. Dave would like to create an MDOT Bridge Preservation Manual. This will be discussed further at subsequent Bridge Committee meetings. | 03-2012 | Develop an MDOT Bridge Preservation Manual | |
| 8 | Review of open action items - All | 12-12: Committee discussed what format a MDOT bridge preservation manual should be in. Corey Rogers said new guides are being prepared. The committee agreed that a bound manual is not needed, and the guides will be placed on the MDOT Bridge Operations website as they are developed. Responsibility has been transferred to Corey Rogers. Action item is to propose or develop location on MDOT web page for placement of preservation guides. | 06-2012 | | |
| 9 | Overlay | 13-8, Vlad working on language with Corey Rogers and Tim Stallard. This has since been completed and issued on January 20, 2015. Sections 12.04. & 12.04.06 B. of the Bridge Design Manual. | 11-2014 | - | |
| 10 | HMA Overlays and Membrane alternatives - Rogers | The use of HMA overlays with or without waterproofing membranes has been limited in Michigan. Most applications are utilized to maintain a suitable ride quality on a poor bridge deck until the deck can get rehabilitated or replaced. With the development of new waterproofing membranes (i.e. spray applied), the committee wanted to reevaluate MDOT's unwritten policy on the use of HMA overlays on bridge decks. Mike Halloran shared that the Parkview bridge HMA overlay needs to be replaced already after 8 years. This is not necessarily due to a failure in the membrane, but the HMA is at the end of its service life. Due to limited service life (less than epoxy overlays) and risk of trapping moisture on the deck, MDOT will continue to limit the use of HMA overlays on bridge decks. MDOT will investigate spray applied membranes for use on those bridges that need the ride quality improvements. | 08-2015 | | Added |
| 11 | Design Requirements for Box Culverts (HL-93 Modified) | Discussed design requirements for box culverts less than 20'. Further discussion is required. | 04-2011 | - | |
| 12 | HL-93 Modified and the Impact on Short Span (Culvert) Structures | Discussed design issues for the 10' to 20' culverts. Current design uses ASTM design tables. Future design would require calculations or a revised table in order to meet the requirements for the HL-93 Modified Load Rating. | 08-2011 | Further investigation required. | |
| 13 | HL-93 Modified and the Impact on Short Span (Culvert) Structures | Load rating of the culverts is being conducted using 2-30 kip axles versus 1-60 kip axles. | 03-2011 | Further investigation is required. MDOT to meet and partner with industry to develop design tables. | |
| 14 | HL-93 modified for Culverts - Jansson/Wagner | A meeting is set up with industry for January 23 to discuss loading analyses, and design loads proposed by industry. There is still a desire from both MDOT and industry to develop standardized tables for moment and shear for design of culvert sections. Concerns still exist over what industry is proposing, and shear deficiencies for spans approaching and greater than 20'. The current procedure is to use HL-93 modified, or the single 60 kip axle load, which the industry feels is too conservative. There are also concerns on MDOT's behalf on changing the design loads at this point when there is ongoing research on this topic. It was decided that when meeting with industry on January 23, we agree to the development of design tables for loading to take into account our current design standards and the 20 overload vehicles. | 11-2012 | - | |
| 15 | HL-93 Modified tables for culverts, issue resolved - Jansson | It doesn't appear that industry will be pursuing the tables at this time. BOXCAR allows the user to use different slab thicknesses, different concrete strengths, etc., and fabricators have different preferences and different forms, coming up with standard dimensions and layout for a given span/rise is not feasible. | 02-2015 | | Added |
| 16 | Presentation of Strand Debonding Research | Dr. Burgueno presented the Strand Debonding Research Report regarding "Effects of Debonded Strands on the Production and Performance of Prestressed Concrete Beams". The report highlighted the performance effects of the split sheathing verses preformed tubular sheathing. | 04-2011 | Recommend incorporating into the results into the Bridge Design Manual. | |
| 17 | Debonding Strands | Fully debonded strands cast in to bridge beams need approval and require oversize debonding. | 05-2011 | Add the special provision, spec book, and plan notes. | |
| 18 | Haunch reinforcement requirements | Although not referenced in MDOT Bridge Design Manual or Bridge Design Guides, it is general MDOT practice to provide additional reinforcement in the form of W-bars when the haunch thickness exceeds 6". Guidance should be provided on this issue. | 02-2012 | Matt and Vlad to review existing guidance relative to haunch reinforcement, and develop guidance language, and details for<br>Possibly note haunch depths (max and min) on plans. | |
| 19 | Setting haunch grades and screed rails from ground | At the MITA conference, some contractors questioned the possibility of setting the screed rail on the fascia beams when the beams are on the ground as opposed to when they are erected. The committee agreed this would be permitted if all self weight and form deflections can be simulated on the ground, and the beam sit on their bearings as they would in the erected state. There may also be issues if the | 02-2012 | | |
| 62 | Bridge Repair Work involving Epoxy Coated Steel Reinforcement | Discussed requirements for bridge repair. Recommend using galvanic anodes in conjunction with epoxy coated steel reinforcement. | 2011-04 | - | |
| 63 | Expansion joint/construction joint policy - Chynoweth | Grand Region had a project were the contractor stated someone from MDOT said all construction joints are to be replaced with expansion joints during rehab projects. This is not MDOT policy. If a structure is determined to need additional articulation as a result of an analysis, a construction joint may be removed and replaced with an expansion joint. Past practice has proven that a compression seal is not an adequate | 2012-06 | - | |
| 64 | Calibration of Expansion Joint openings - Rogers | Many states calibrate the setting of bridge expansion joints to 60°, just like the procedure for resetting rocker bearings. The expansion joints come to the site as a unit, with the rails bolted together, and the joint is typically "cut" upon installation. This typically means the opening is not calibrated given the temperature at the time of installation, and in warmer temperatures, the joint does not have the necessary movement capacity. It was decided that the joint installation should be calibrated per the temperature at the time of installation by setting the joint in place, cutting the rails free, then tieing the rail studs to the existing deck rebar as appropriate for the required opening. Also, there have been instances where the deck sidewalk concrete has been sufficiently removed (1'-6" from the center of the joint), however the barrier was not removed past the expansion joint ending, and the remaining barrier remains in contact. It was decided that the entire barrier should be removed the same 1'-6" from the center of the expansion joint to ensure the new installed expansion joint is allowed the appropriate thermal gradient | 2012-11 | Corey and Vlad will work together on updating the required notes in the Bridge Design Manual, and standard MicroStation joint replacement details to accommodate these changes. | |
| 65 | High Skew Link Slab | 12-33, high skew link slab. Based upon research project, link slabs used for greater than 30 degrees. What is limit for shear studs? General questions. Use same criteria for other link slabs. The committee recommends 30 degrees. It was noted that the I-675 Henry Marsh bridge has many link slabs. | 2014-11 | Beckie will develop a method to track link slabs within inventory.<br>Brad Wagner will ask bridge designers to share with Vlad link slab details.<br>Beckie will have Ron track link slabs when he reviews and inventories SIA data for bridge projects.<br>Steve will review performance of existing link slab details and report to the Bridge Committee. | |
| 66 | Fascia Beam Painting | Eric discussed the difficulty the Statewide Bridge Crew experiences when repairing fascia beams that are coated with lead paint. In some instances the outside fascia side only of the fascia beam was cleaned and coated, while the interior face is still coated with lead. | 2012-01 | Recommend changes to MDOT Bridge Design Manual to include language that cleaning and coating the fascia side of the fascia beam is no longer permitted, and the entire fascia beam must be coated. | |
| 67 | Design of stay in place metal deck forms | The 2003 Standard Specifications for construction note the inclusion of a 50 lb/sft construction loading that must be taken into account in the strength design of the stay in place forms. This loading is not included in the maximum deflection calculations of ¼" or 1/180 of the form span length. The 2012 specification as written seems to include the construction loads in the deflection consideration, however, the maximum deflection criteria is still ¼" or 1/180 of the form span length. This is not consistent with the AASHTO specifications, and designs of stay in place metal forms could significantly change as a result of this. | 2012-02 | Pete will review previous Bridge Committee notes and calculations that lead to the development of the current standards, and draft up language to address this. To be discussed at next Bridge Committee meeting. | |

**Figure H-2. Organization of the content in the spreadsheet**

In addition to the meeting minutes from 2011 to 2016, the documents in the *Action Items* folder shown in Figure H-1 were reviewed. A few items were identified from those documents and included in the spreadsheet. The comment "Added" is included in the spreadsheet to identify those items (Figure H-3).

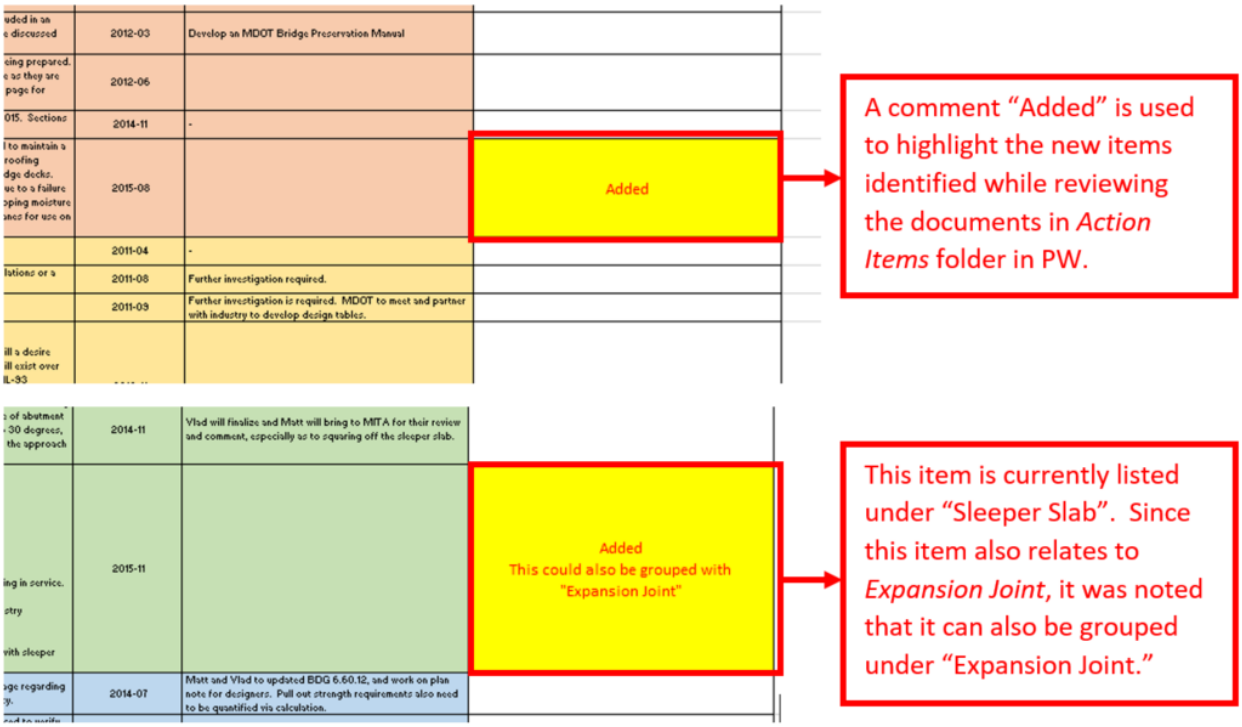



**Figure H-3. Organization of the spreadsheet and significance of the comments**

Note:

*Spreadsheet is provided as a separate file.*

# APPENDIX I: COMPILED LIST OF BRIDGE COMMITTEE ACTION ITEMS

# Bridge Committee Action Items

MDOT maintains a separate spreadsheet with a list of action items developed by the bridge committee. The list includes action items for bridge design policy revisions/updates as well as for other activities. Project manager shared the latest version of the spreadsheet in **August 2018**. Also, the research team identified the previous versions of action item spreadsheets in the Bridge Committee Meeting Minutes folders from **March 2012** to **February 2013**. All these versions were reviewed and a complete list of action items was developed. As shown in Figure I-1, the spreadsheet with this list includes multiple columns representing No., Item No., Meeting Date, Action Item, Member(s) Responsible, Resolved, Resolution Date, Description of Resolution, and Reference to Bridge Committee Meeting. The first column represents the row numbers. The last two columns (BCM and BCM title) document the meeting date when the specific action item was discussed and the title of the relevant notes in the meeting minutes. Documenting such information is needed to develop the rationale behind bridge design policy revisions/updates. The items that were resolved are highlighted in gray.

| MDOT Bridge Committee Action Items | | | | | | | | Reference to Bridge Committee Meeting | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Item No. | Meeting Date | Action item | Member (s) Responsible | Resolved | Resolution Date | Description of Resolution | BCM | BCM title |
| 1 | 13-10 | October-13 | Bulb T beam action items per the EOC approved Bulb T white paper | All | | | Committee needs to decide on skewed ends, shear reinforcement, sole plates, clipping of top flange, skewing of ends of beams, top 6 inches of top flange debonded. Need to develop SP. Ongoing as of June 2015. Pete to consolidate and distribute the SP's for review. Matt Filcek to provide guidance on skew angle limitations and necessary reinforcement scheme. 45 degree starting point on skew limits. 20 degree and greater need reinforcement. (starting points) Vlad, Dave and Brad met and working on developing guidance. Planning to meet with Indiana to assist in the spec development. | Nov-14 | Bridge Unit Leader Concerns |
| 2 | 13-14 | November-13 | Develop MSE wall Inspection and maintenance criteria for incorporation into bridge inspector training and NBI elements | Andrew Bouvy | | | Eric Burns and Andrew Bouvy are contacting other states to see what they are doing. Eric would eventually like to get MSE walls into MiBridge. MDOT should also be monitoring future Federal requirements as the next highway bill may include new requirements. Eric surveyed other states and found that 14 other states are also evaulating the need for inspection processes. Research project in 2016 to assist in creating guidance. RFP is out. | | |
| 3 | 14-4 | June-14 | Create sub group of bridge committee to educate Surclean on industry, and business process. Corey Rogers will be the point of contact for MDOT | Corey Rogers | | | Surclean presented to MITA, June 2015. Development of a prototype ongoing. MDOT prepared to assist in field demo ASAP. | | |
| 4 | 15-3 | May-15 | Draft guidance for when a bridge demolition plan stamped by a PE is required by the contractor for review by the department. | Corey Rogers | | | Corey part of National subcommittee of AASHTO T4 investigating best practices and approaches to specifying bridge demolition. | | |
| 5 | 15-4 | June-15 | High skew link slab pilot project search and evaulation | Brad Wagner | | | Committee recommends evaluating current link slab performance for future recommendations to committee. Review research guide for next committee meeting. | | |
| 6 | 15-6 | June-15 | Corrosion Resistance reinforcement in concrete beams | Steve Kahl | | | Design to develop standard for the use of corrosion resistance reinforcement in concrete beam ends. Agenda item for MITA Bridge Ops. | | |
| 16 | 11-1 | October-11 | HL-93 Modified for Box Culverts - Draft Bridge Advisory notifying bridge owners of change, and update Bridge Design Manual | Dave Juntunen Creightyn McMunn | Y | Jan-15 | Per discussions with industry, no changes will be proposed. Industry uses BOXCAR program, which allows different slab thicknesses, concrete strengths, etc., which does not require standard designs. Also, fabricators have different preferences for forms, so standard dimensions and layout for a given span/rise is not feasible | | |
| 17 | 11-2 | October-11 | Draft Bridge Committee Guidance Document | Matt Chynoweth | Y | February-12 | Bridge Committee Guidance document complete, will present to April 2011 EOC for approval | | |
| 18 | 11-3 | December-12 | Identify strategy for ABC/PBES implementation. Developed guidelines and decision matrix for use. | All | Y | March-12 | Draft Policy document complete, will be presented to EOC in August 2012 | | |
| 19 | 11-4 | December-12 | Retrofit of BOS-49022 due to excessive deflection issues | Eric Burns | Y | July-12 | Region Support and Superior Region crews designed and installed retrofit | | |
| 20 | 11-5 | December-12 | CFRP implementation - document challenges to large scale production design using materials, maintenance issues, coping, etc. | Matt Chynoweth | Y | February-12 | Challenges document complete inclusive of bridge committee members comments. Submitted to Mark Chaput and Director. | | |

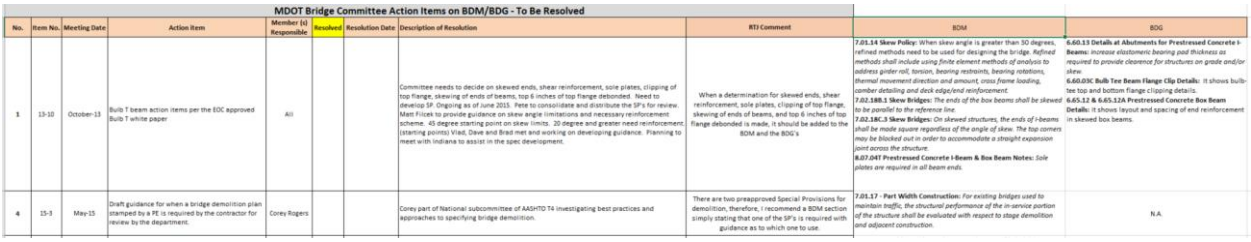
**Figure I-1. MDOT Bridge Committee Action Items spreadsheet**

Note:

*Spreadsheet is provided as a separate file.*

## Action Items - To Be Resolved With BDM-BDG Sections

The "MDOT Bridge Committee Action Items" spreadsheet includes action items for bridge design policy revisions/updates as well as for other activities. Hence, a separate spreadsheet was developed only for the bridge design policy revisions/updates related action items that are to be resolved. As shown in Figure I-2, the first eight columns of this spreadsheet as well as the "MDOT Bridge Committee Action Items" spreadsheet are similar. The last three column titles are RTJ Comment, BDM, and BDG. RTJ Comment column includes feedback from our consultant Mr. Raja Jildeh. BDM column includes the relevant policies in the *Bridge Design Manual* (as of November 14, 2018). BDG column includes relevant Bridge Design Guides (as of November 14, 2018).



MDOT Bridge Committee Action Items on BDM/BDG - To Be Resolved

| No. | Item No. | Meeting Date | Action Item | Member (s) Responsible | Resolved | Resolution Date | Description of Resolution | RTJ Comment | BDM | BDG |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 13-10 | October-13 | Bulb T beam action items per the EOC approved Bulb T white paper | All | | | Committee needs to decide on skewed ends, shear reinforcement, sole plates, clipping of top flange, skewing of ends of beams, top 6 inches of top flange debonded. Need to develop SP. Ongoing as of June 2015. Pete to consolidate and distribute the SP's for review. Matt Filces to provide guidance on skew angle limitations and necessary reinforcement scheme. 45 degree starting point on skew limits. 20 degree and greater need reinforcement. (starting points) Vlad, Dave and Brad met and working on developing guidance. Planning to meet with Indiana to assist in the spec development. | When a determination for skewed ends, shear reinforcement, sole plates, clipping of top flange, skewing of ends of beams, and top 6 inches of top flange debonded is made, it should be added to the BDM and the BDG's | **7.01.14 Skew Policy:** When skew angle is greater than 30 degrees, refined methods need to be used for designing the bridge. *Refined methods shall include using finite element methods of analysis to address girder roll, torsion, bearing restraints, bearing rotations, thermal movement direction and amount, cross frame loading, camber detailing and deck edge/end reinforcement.* **7.02.18B.1 Skew Bridges:** *The ends of the box beams shall be skewed to be parallel to the reference line.* **7.02.18C.3 Skew Bridges:** *On skewed structures, the ends of I-beams shall be made square regardless of the angle of skew. The top corners may be blocked out in order to accommodate a straight expansion joint across the structure.* **8.07.04T Prestressed Concrete I-Beam & Box Beam Notes:** *Sole plates are required in all beam ends.* | **6.60.13 Details at Abutments for Prestressed Concrete I-Beams:** *Increase elastomeric bearing pad thickness as required to provide clearance for structures on grade and/or skew.* **6.60.03C Bulb Tee Beam Flange Clip Details:** It shows bulb-tee top and bottom flange clipping details. **6.65.12 & 6.65.12A Prestressed Concrete Box Beam Details:** It shows layout and spacing of end reinforcement in skewed box beams. |
| 4 | 15-3 | May-15 | Draft guidance for when a bridge demolition plan stamped by a PE is required by the contractor for review by the department. | Corey Rogers | | | Corey part of National subcommittee of AASHTO T4 investigating best practices and approaches to specifying bridge demolition. | There are two preapproved Special Provisions for demolition, therefore, I recommend a BDM section simply stating that one of the SP's is required with guidance as to which one to use. | **7.01.17 - Part Width Construction:** *For existing bridges used to maintain traffic, the structural performance of the in-service portion of the structure shall be evaluated with respect to stage demolition and adjacent construction.* | N.A. |

**Figure I-2. Action items to be resolved**

Note:

*Spreadsheet is provided as a separate file.*