

BRIDGE DESIGN MANUAL

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**MICHIGAN DESIGN MANUAL
BRIDGE DESIGN**

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CHAPTER 1 • INTRODUCTION

1.00 INTRODUCTION

The Bridge Design Manual addresses the procedures involved in preparing plans of bridges and other major structures on the interstate/freeway, arterial, collector and local road system governed by the Michigan Department of Transportation (MDOT). Incorporation of or connectivity to other modes of transportation (pedestrian, bicycle, multi-use paths, etc.) must be considered.

In this manual a bridge is defined by the National Bridge Inspection Standards Federal Code of Regulations (23 CFR 650) as a structure that spans over a waterway, highway, or railway with an opening measured along the center of roadway of more than 20 ft. Structures that span distances under 20 ft. are considered culverts.

In compiling these procedures, an effort was made to include all information related to plan preparation. The major portion of the manual is devoted to design criteria and the presentation of plan information. But other chapters deal with the routines of processing the work, the source material supporting design considerations, and the involvement of other agencies affected by the project. In general, the Bridge Design Manual is intended to be a single source reference for the MDOT Design Engineers and consultants assigned the responsibility of producing bridge plans. It is assumed that this manual is to be used in conjunction with the MDOT Road Design Manual. The Road Design Manual contains relative/pertinent information and procedures for both road designers and bridge designers. In general, the Bridge Design Manual is intended to be a reference for the MDOT Design Engineers and consultants assigned the responsibility of producing bridge plans of the requirements specific to structure design beyond those detailed in the Road Design Manual.

Much of the information presented originates from the Bridge Squad Leaders' Notes, for many years the reference manual for the MDOT Bridge Engineer. These notes were updated and rearranged to comprise several chapters of the volume. This was expanded with input from other MDOT divisions and outside agencies, the policies of which influence the design and geometry of bridges. Some contributions resulted from experience in fabricating, constructing, and maintaining bridges.

The design of highway bridges in Michigan is based on the ***Standard Specifications for Highway Bridges*** and ***LRFD Bridge Design Specifications*** published by the American Association of State Highway and Transportation Officials (AASHTO). Repetition of any of these specifications would be unnecessary and was avoided in preparing this manual. In some cases, however, the AASHTO specifications are vague or leave a decision to the judgment of the Engineer.

LRFD Guide Specifications for the Design of Pedestrian Bridges and ***Guide for the Development of Bicycle Facilities*** will aid in the design of other modes of transportation.

Guidelines in the Bridge Design Manual are provided as clarification and thus supplement the provisions of AASHTO. Some minimum requirements in the AASHTO specifications have been found through experience to be insufficient. In these instances, the Design Manual supersedes AASHTO with more rigorous controls.

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Procedures and guidelines continually change. The material in the Bridge Design Manual is continually updated and every attempt is made to keep the Manual as current as possible. When the need for an addition or change arises, the Manual is updated on a monthly basis. These updates will describe the revision, explain the reason, serve as a commentary, and assign the date of its implementation. The most recent revision date is included with each section or subsection. If there is no date with a section of the manual, this means that the section has not been revised since it was originally created. (12-16-2019)

It is expected that many of the changes will be additions prompted by comments from those using the Manual. While considerable effort was made to compile all information that should be required to prepare plans, some points no doubt have been overlooked. For this reason, any questions or suggestions regarding the text of the Bridge Design Manual should be sent to the MDOT Standards Unit at MDOT-Bridge-Design-Standards@michigan.gov.

Many different resources are available for designing and detailing of bridges, structures, and all modes of transportation. These include plan sheet examples, drafting details and practices, and various types of specifications. A summary and link location to these is described in the subsequent sections.

See [BDM Section 1.05](#) for a list of commonly used abbreviations and acronyms used throughout the BDM and the civil engineering and construction industry in general.

See [BDM Section 1.06](#) for a list of publications from MDOT, FHWA, and other sources that are referenced throughout the BDM.

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1.01 MDOT DEVELOPMENT GUIDE

The Development Guide is a collection of guidance, design submittal requirements, best practices & workflows, training, sample plans, software configurations, and other helpful resources related to the development process, for MDOT staff and consultant partners. The Development Guide is published by the [Design Services Section](#).

The MDOT Development Guide is currently available only on the State of Michigan (SOM) SharePoint Site which is open to all SOM Employees. However, external access for design engineers that are not SOM Employees but are responsible for producing road or bridge plans in Michigan is available. Consultants should contact MDOT Engineering Support at MDOT-EngineeringSupportTraining@michigan.gov for instructions on how to create and maintain a SOM M365 guest account to receive access.

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1.02 PLAN SHEET EXAMPLES

Plan sheet examples can be found at [Guidelines for Bridge Plan Preparation \(MDOT Sample Plans Bridge\)](#). The document presents samples of detail sheets that can be used as guides in preparing plans of highway bridges. The samples were selected and tailored to provide as much reference data as possible on a limited number of sheets. Each of the detail sheets of a typical set of plans is represented. At the same time, detailing procedures for a variety of bridge types are illustrated. Commentary is provided for more clarity and background on guidelines and detailing procedures. Also included are abbreviations, symbols and naming conventions for files.

In general, adherence to these guides is recommended. Many of them result from past construction experience, and while other methods of presenting structural details may be equally effective, it is possible that they would create problems. The format shown is preferred if for no other reason than the familiarity that the state contractors have developed following it on previous jobs. On rare occasions, the guides may not be appropriate, but before electing to deviate, drafting personnel should be sure there is ample justification.

Additional information and Archived Bridge Sample Plans are available online from the [MDOT Development Guide](#).

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1.03 DRAFTING DETAILS AND PRACTICES

Drafting details and practices, cell libraries and other miscellaneous files can be found on the [MDOT Development Guide](#) and [MDOT Design Services Website](#).

Various details have been standardized and appear on specific sheets. See [Guidelines For Bridge Plan Preparation](#) (MDOT Sample Plans Bridge) and the [Bridge Support Resources](#) section of the [MDOT Development Guide](#) for various details, practices and sample plan sheets. It also contains drafting degrees of accuracy, abbreviations and symbols used on plans.

For naming convention of files see [Base File Name Conventions](#) of the MDOT Development Guide (CAD Standards).

Structure designations and additional bridge/structure information is available in the [Michigan Structure Inventory and Appraisal Coding Guide](#).

Checking all detail drawings must be done to ensure the accuracy of the plans. The drawings shall comply with the design calculations, existing design guides, and the practices listed in [Guidelines For Bridge Plan Preparation](#).

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1.04 SPECIFICATIONS

Specifications are to accompany the plans as part of the contract documents. They establish how the work is to be done, the materials and equipment that are to be used, and the method of measurement and payment for the work. It is the Design Engineer's responsibility to see that all relevant specifications are included in the contract.

Three types of specifications exist, all accomplishing the purposes stated above. These are [Standard Specifications for Construction](#), [Supplemental Specifications](#), and special provisions (including [The Frequently Used Special Provisions](#)).

For more detailed information on specifications including Special Provisions, supplemental specifications and proprietary items see [Chapter 11](#) of the Road Design Manual.

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1.05 ABBREVIATIONS AND ACRONYMS

The following is a list of abbreviations and acronyms found throughout the Michigan Bridge Design Manual. An abbreviation or acronym is written out the first time it is used in a Chapter, but the abbreviation or acronym will be used for the remainder of the Chapter.

The exception is for the following MDOT publications:

- Bridge Design Manual (BDM)
- Road Design Manual (RDM)
- Bridge Design Guide (BDG)

These will be referenced throughout the manual in acronym format followed by the chapter and section number or BDG number that is being referenced.

3R – Resurfacing, Restoration, and Rehabilitation for bridge work.

4R – New Construction and Reconstruction.

AASHTO – American Association of State Highway and Transportation Officials.

ABC – Accelerated Bridge Construction

ACI – American Concrete Institute

ADA – Americans with Disabilities Act

ADT – Average Daily Traffic

ADTT – Average Daily Truck Traffic

AGL – Above Ground Level

AISC – American Institute of Steel Construction

AMSL – Above Mean Sea Level

AREMA – American Railway Engineering and Maintenance-of-Way Association

ASD – Allowable Stress Design

ASTM - American Society for Testing and Materials

AWS – American Welding Society

BDG – Bridge Design Guide

BFS – MDOT Bridge Field Services

BOBS – MDOT Bureau of Bridges and Structures

BOD – MDOT Bureau of Development

C&T Div – MDOT Construction and Technology Division

CADD – Computer Aided Drafting Design

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CE – Categorical Exclusion

CFR – Code of Federal Regulations

CFT – Cubic feet

CIP – Cast-in-Place

Conc. – Concrete

CPM – Capital Preventative Maintenance

CSM – Capital Scheduled Maintenance

D.L. – Dead Load

DBE – Disadvantaged Business Enterprise

DE – Design Exception

DEIS – Draft Environmental Impact Statement

Dia. – Diameter

DV – Design Variance

EA – Environmental Assessment

EGLE – Michigan Department of Environment, Great Lakes, and Energy

EGLE/WMD – The Materials Management Division of EGLE

EIS – Environmental Impact Statement

EJ - Expansion Joint

EI. – Elevation

EOD – End of Drive

EOR – Engineer of Record

EPDM rubber – Ethylene Propylene Diene Monomer rubber, a synthetic rubber material

FAA – Federal Aviation Administration

Fdn – Foundation

FHWA – Federal Highway Administration

FIES – Final Environmental Impact Statement

FONSI – Finding of No Significant Impact

FPC – Final Project Coordination

FRP – Fiber Reinforced Polymer

Ft. – Feet

FT/S – Feet per Second

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F_y – Yield Stress

GRS-IBS – Geosynthetic Reinforced Soil – Integral Bridge System

HEC – Hydraulic Engineering Circular

HEC-RAS – Hydraulic Engineering Center – River Analysis System

HL-93 Mod – Highway Load – 93 Modified

HMA – Hot-Mix Asphalt

HSM – Highway Safety Manual

I.D. – Inside Diameter

In. – Inches

in³ – inches cubed, measure of volume

k/ft – Kip per feet, measure of pressure

Kft – Kip-Feet, measure of moment

Kip – Kilo-Pounds

Ksi – kips per square inch

L.L. – Live Load

Lb(s) – Pounds

LFD – Load Factor Design

LM – Latex Modified

LOP – Letter of Permission

LRFD – Load and Resistance Factor Design

MASH – Manual for Assessing Safety Hardware

MDNR – Michigan Department of Natural Resources

MDOT – Michigan Department of Transportation

MDX – a steel girder bridge analysis and rating software

Min. – Minimum

MITS – Michigan Intelligent Transportation System

MSE – Mechanically Stabilized Earth

NAD 83 – 1983 North American Datum

NCHRP 350 - National Cooperative Highway Research Program Report 350

NEPA – National Environmental Policy Act

NHS – National Highway System

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NPDES – National Pollutant Discharge Elimination System

O.D. – Outer Diameter

OE/AAA – Obstruction Evaluation/Airport Airspace Analysis

OEC – Omissions and Errors Check

OGDC – Open Graded Drainage Course

OHWM – Ordinary High-Water Mark

PBES – Prefabricated Bridge Elements & Systems

PCI – Prestressed Concrete Institute

PDA testing – Pile Driver Analyzer testing

PE – Professional Engineer

PIC – Proprietary Item Certification

PIF – Public Interest Finding

PLQA – Program Level Quality Assurance

PM – Preventative Maintenance

PPD – MDOT Preconstruction Process Documentation

Psf – pounds per square foot

Psi – pounds per square inch

PVC – polyvinyl Chloride (a type of plastic)

QA – Quality Assurance

QC – Quality Control

RBPI S&O – Risk Based Project Involvement Stewardship and Oversight

RFP – Request for Proposal

RID – Reference Information Document

ROD – Record of Decision

ROW – Right-of-Way

RQD – Rock Quality Designation

RSA – Road Safety Audit

SBAT - State Bridge Alignment Team

SDDCTEA – Surface Deployment and Distribution Command Transportation Engineering Agency

SESC – Soil Erosion and Sedimentation Control

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Sft; SQ.Ft. – Square feet

SHA – State Highway Agency

SMS – Surface-water Modeling System

SPMT – Self-Propelled Modular Transport

SPT – Standard Penetration Test

ST – Shelby Tube

TSC – MDOT Transportation Service Center

URTS – Utility Relocation Tracking System

USGS – United States Geological Survey

Veh – vehicle

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1.06 REFERENCES

The references listed below are a non-comprehensive list mentioned throughout the BDM chapters. Designers and Technicians are encouraged to use these documents along with the BDM when designing bridge projects in the State of Michigan.

- AASHTO LRFD Bridge Design Specifications, 9th and 10th Edition
- ACI 318 – Building Code Requirements for Structural Concrete, Current Edition
- AISC Code of Standard Practice (AISC 303), Current Publication
- AISC Steel Construction Manual, Current Edition
- AWS D1.5 – Bridge Welding Code (American Welding Society), Current Publication
- FHWA NHI-15-047: Load & Resistance Factor Design (LRFD) for Highway Bridge Superstructures
- Geometric Design Guides – MDOT Design Division
- Guidelines for Plan Preparation – MDOT Design Division
- Michigan Manual on Uniform Traffic Control Devices, Current Edition
- PCI Bridge Design Manual, Current Edition
- Standard Plans and Special Details – MDOT Design Division
- Standard Specifications for Construction, Current Edition

Existing plans for a recent project, similar in nature to the proposed project, are an excellent reference.