PART X: BRIDGE SURVEYS

Bridge surveys are required at proposed bridge sites or where reconstruction of an existing bridge is planned.

10.1 New Bridge Site

10.1.1 Alignment

Refer to **Part VIII, "Route Surveying"**.

10.1.2 Baselines/Traverses

A baseline shall be established at the proposed bridge location. When appropriate, the baseline should be the legal centerline, i.e. Public Land Survey System (PLSS) lines or previously established legal center lines.. If required, permanent monuments shall be placed on the baseline on both sides of the proposed bridge in areas outside of construction limits. If the base line is the legal centerline, temporary monuments with offsets are permitted for construction purposes. Any such offset scheme must be fully documented and explained in the surveyor's report.

On Railroads, the baseline should be the center line of the mainline tracks. The baseline should be tied to track stationing or railroad mile posts.

Baseline crossings may be required to be established along facilities (cross streets, railroads, major power or communication lines, PLSS lines, etc.) crossing the proposed bridge baseline. If required, permanent marks shall be placed and witnessed at baseline crossings and on points on the alignment of the crossing structure to determine direction and topography of the crossed facility relative to the bridge alignment. Requirements for baseline crossings shall be determined by and coordinated with the MDOT survey project manager.

Particular attention shall be paid to stationing in the proposed bridge area. A station equation must be determined when metric stationing is being correlated with other baselines in English units. All stationing schemes shall be coordinated with the MDOT survey project manager.

If a hydraulic survey is part of the bridge survey refer to **Part XIII, "Hydraulic Surveys"** and

coordinate additional requirements with appropriate personnel.

10.1.3 Benchmarks and Elevation Datum

Elevation datum shall be that used on any existing or proposed facility or project for which the bridge survey is intended to support. Original benchmarks used for the supported project should be recovered if practical and verified and additional benchmarks set as required. Elevation datum shall be coordinated with the MDOT survey project manager and fully explained in the surveyor's report.

Benchmarks shall be fully described and witnessed by station plus and outs and by coordinates.

10.1.4 Cross Sections

Cross sections, from left to right, shall be generated perpendicular to the baseline, at intervals of 50 feet. Irregular terrain may dictate cross sections at shorter intervals. Cross sections shall cover an area of no less than 150 feet, both sides of the bridge reference lines. Exact areas to be cross sectioned approaching and leaving the actual crossing site typically extend 150 feet in both directions, but shall be coordinated with the MDOT survey project.

If a digital terrain model (DTM) is required sufficient horizontal and vertical data shall be collected to allow computer modeling. Refer to **Part XII, "Topographic Surveys"** for appropriate guidance and **Appendix "F"** of this Survey Manual for appropriate CAiCE feature codes.

10.1.5 Structures

Position and elevation of critical objects or structures at or in the vicinity of the proposed bridge shall be located. If required by the scope of work these normally include:

1. Bridge or culvert footings, piers, abutments, walls, decks, sidewalks, catch basins, curbs, gutters, significant vegetation.

2. Bridge under-clearance measurements.

3. Planimetric bridge sketch showing reference lines, reference points, skew angles and super structure components.

Bridges, culverts, retaining walls and other structures require precise relative measurements. All structure dimensions are recorded to the nearest 0.01 foot. Bridge dimensions may be recorded on new field sketches or hand written on copies of construction plans. Elevation view sketches should be included and annotated appropriately. Specific information shall be requested by the Bridge Unit. Photographs of structures will be taken only if requested and labeled with control section, project number, date and content. The project surveyor must insure that all required information is presented in a form easily accessed and understood by the designer.

10.1.6 Utilities

If required by the Scope of Work, all surface manifestations of underground and overhead utilities within the project area shall be located and identified and referenced to the project coordinate system. Approximate heights of overhead utility lines is often useful and if required coordinated with the MDOT survey project manager. Utilities shall be identified by name, entities located by project coordinates with station and offset from the appropriate alignment, and appropriate elevations reported. If required, inverts, flow lines, size, material, elevations on top of pipe, top and bottom of structure shall be obtained.

Utility location shall be coordinated with the owner of that specific utility whose name, address and point of contact shall be identified.

10.1.7 Drainage

If required, existing drainage patterns may need to be ascertained. Extent shall be defined in the Scope of Work and coordinated with the MDOT survey project manager.

10.2 Major Bridge Repair

Major bridge repair will generally fall under one of three categories: full structure replacement, super structure repair and/or replacement, deck replacement and/or repair. The degree of survey support and specific data required are functions of the scope of the project and the needs of the design engineer. Critical to the success of an existing bridge survey is the degree of coordination effected between the individual responsible for conducting the survey and the MDOT survey project manager. Described below are general requirements of most existing bridge surveys.

10.2.1 Horizontal Control

A closed traverse having an unadjusted ratio of precision of 1:20,000 or better shall be established. The traverse shall incorporate no less than two project monuments approved by the MDOT survey project manager, relate to a horizontal datum approved by the MDOT survey project manager, and include all proposed data collection points and the appropriate centerline alignment. Traverse points shall be not less than 450 feet or more than 1800 feet distant from each other.

Random horizontal error shall be distributed using a properly weighted, least squares adjustment routine.

10.2.2 Vertical Control

Unless otherwise directed, vertical control used for the original bridge construction should be recovered. If existing plans are available, bridge seat elevations are a potential source of project elevations. A benchmark is required on both sides of the structure outside of the proposed limits of construction. Vertical datum to be used must be coordinated with and approved by the MDOT survey project manager.

A minimum of two benchmarks placed on both sides of the structure outside of proposed construction limits shall be established. Elevations shall be determined to an accuracy standard of 0.06 ft times the square root of the distance in miles. Random error shall be distributed using a properly weighted, least squares adjustment routine. Exceptions to the standard shall be determined by the MDOT survey project manager.

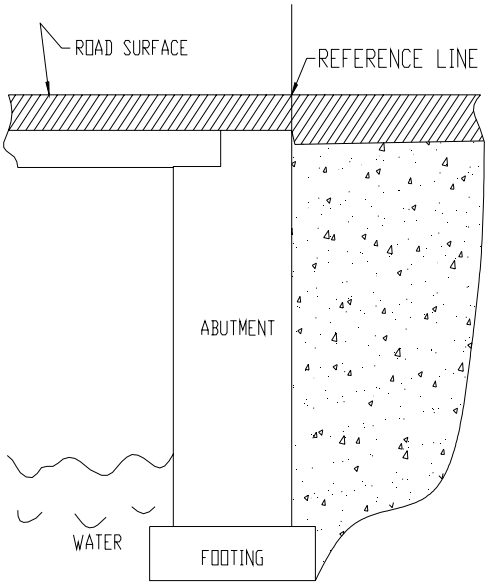
10.2.3 Alignment

Legal Alignment is that centerline from which easements, rights of way or fee titles are described. Right of way plans, previous construction plans, documents of record such as plats or certificates of survey, existing monuments, physical evidence, are used as guides in determining legal alignment.

Plan Alignment is that shown on the bridge plans. It is usually the legal alignment.

Structure Alignment is determined from the "as-built" center line of the bridge. Bridge reference points are established on bridge reference lines at the backs of the bridge abutments at the physical center of the bridge. The "as-built" centerline is determined by splitting walks, edges of decks or other appropriate members on opposite sides of the structure, recreating the most probable location of the original bridge alignment. If the bridge were built along a tangent, this is a straight line. If the bridge is curved, this

Figure 10.1
Bridge Reference Lines



defines the chord. If the bridge structure has been altered since original construction the surveyor should be aware of the possibility of the alignment being offset.

The bridge reference line having the lowest station designation is Bridge Reference Line "A". The bridge reference line have the highest station designation is Bridge Reference Line "B". Note that in some instances, the back of the abutment may be notched to support a pavement approach slab. Care should be taken to insure that the back of the abutment and not the notch is being used as the reference line. Hand digging is usually required.

Center lines or chords are extended in both directions and permanently marked outside of the proposed limits of construction.

If intermediate piers are present, the center line of the pier is its reference line. Pier reference lines are numbered beginning with reference line one at the pier with the lowest stationing. Reference line numbers increase to accommodate the number of piers. The angle formed by the intersection of a pier or abutment reference line with the bridge alignment is a *skew angle.*

In the case of a road widening and/or new bridge, there may be a new *Construction Alignment*. If additional right of way is acquired based on this new alignment, then it becomes a legal alignment, the plan alignment and ideally, the new structure alignment.

It is essential that the alignment or alignments required as well as the stationing scheme be clearly

identified in the scope of work and thoroughly coordinated.

10.2.4 Elevations and Benchmarks

Vertical control used for the original bridge construction should be recovered if possible and used with additional benchmarks being established as necessary. Datum should coordinated with the MDOT survey project manager. Critical elevations shall be determined by the design engineer, normally but not necessarily restricted to those identified on existing plans. The surveyor shall take a number of test observations of elevations throughout the existing structure to insure agreement and co-relation among original and new vertical data sets. A minimum of two benchmarks, one in the vicinity of the near stream side and one in the vicinity of the far stream side shall be established, witnessed and referenced to the surveyed alignment.

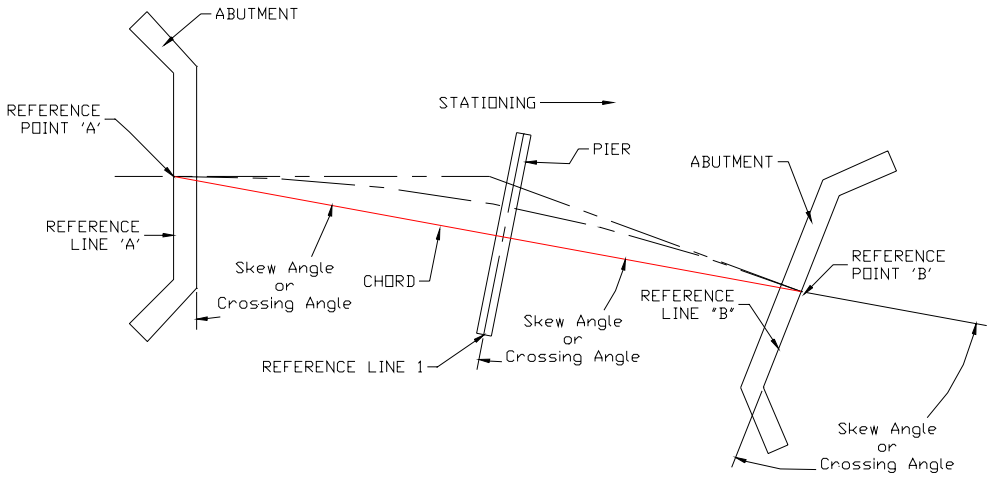
10. 3 Mapping

10.3.1 Planimetric Detail

The following planimetric detail is generally required.

Detailed as-built bridge structure sketch or schematic depicting the current structure size, location,

Figure 10.2
Bridge Reference Lines (Curved Bridge)



elevation. Include reference point stationing coordinates and elevations and crossing angles.

Bridge structure measured in total. Sketches of near sides and far sides, side views, end views and plan views. Both substructure and superstructure elements must be shown.

Length, width, thickness and spacing of beams, if required.

Abutments and piers referenced to appropriate alignment(s).

10.3.2 Elevations

The following are typical minimum requirements: Footings, tops of abutments, bridge seats, reference points, cross sections at reference lines.

When the bridge crosses a highway: Under-clearance at centerline, edge of metal, edge of shoulder, on both sides of bridge, shall be measured. Under-clearance is a measured distance, defined as the difference in elevation from the afore mentioned roadway locations to the bottom of the beams directly above those points. The actual elevations at all locations are generally required.

When bridge crosses water: The elevation of the bottom of stringers and water surface elevation.

Cross section intervals shall be determined by the scope of the project, the needs of the design engineer and the instructions of the Supervising Surveyor, Design Surveys. If EDMI is used, sufficient data will be observed to allow computer modeling of the above stated requirements.

If a Digital Terrain Model of the topography is required, bridge structure will not be included. See **Part XIII**.

10.3.3 Utilities

If required by the Scope of Work, all surface manifestations of underground and overhead utilities within the project area shall be located and identified and referenced to the project coordinate system. Utilities shall be identified by name, entities located by project coordinates with station and offset from the appropriate alignment, and appropriate elevations reported. If required, inverts, flow lines, size, material, elevations on top of pipe, top and bottom of structure shall be obtained.

10.3.4 Drainage

If required, existing drainage patterns may need to be ascertained. Extent shall be defined in the Scope of Work and coordinated with the MDOT survey project manager.

10.3.5 Photographs

Photographs are a valuable aid in interpreting data at the bridge site. If requested, Polaroid, 35mm, digital or equivalent formats are acceptable as well as video. A level rod should be included in the photograph to aid in determining scale. Photographs are meant to complement, not substitute, properly prepared field notes

10.4 Deliverables

10.4.1 Portfolios

Each bridge survey must be packaged in a separate divided portfolio or portfolios being 10" (254 mm) by 12" (305mm) in size with a flap cover. If the bridge survey is part of a larger road project, control and mapping data in the area of the bridge shall be duplicated in the bridge survey portfolio. Each portfolio shall be labeled on the outside using the following format.

Bridge Survey Notes for:
Route [ ]
Location and Project Limits [ ]

Control Section [ ] Job Number [ ] Date of Submittal [ ]
By [*Name of Firm*]
Michigan Professional Surveyor [ ]

10.4.2 Sections

Each submittal shall contain six separate sections: **Administrative, Control, Alignment, Property, Mapping,** and **Miscellaneous**. Sections may not be combined.

A. Administrative.

The administrative section contains the survey order or letter, MDOT Form 222 "Survey Notes, Receipt and Transmittal", survey scope, surveyor's project report, written minutes of meetings and where applicable any information requested by the prime consultant.

B. Control

The control section contains data collected and copies of all research documents used to establish the horizontal and vertical reference systems for the project, including a thoroughly written explanation of how the systems were established.

C. Alignment

The alignment section contains witnesses and stationing of alignment points set or found, an explanation of how the alignment was determined, and all supporting documentation.

D. Property

The property section contains all information that may be required regarding the real property affected by the project and all required property ties. This may include copies of all land corner recordation certificates for all government corners used or reestablished, recorded plats, recorded surveys, tax maps, tax descriptions and riparian ownership.

E. Mapping

The mapping section contains all survey notes, research documents and collected data used to plot the maps necessary for the project. All plots for topography, elevations, utilities and drainage are to be placed in this section.

F. Miscellaneous

The miscellaneous section contains any information not included in the previous sections. The surveyor's project report should specify any items included in this section.

10.4.3 Data Formats

All paper sheets in the portfolio shall be marked with the control section, job number, section number and page number.

All diskettes shall be labeled with the control section, job number, data type and file names.

The following information shall be submitted on 3.5" (88.9mm) HD diskettes:

Text files in ASCII format containing the witness lists for the horizontal alignment ties, bench marks and government corners.

Any other text files are to be in either ASCII or Rich Text Format (RTF).

Paper documents are submitted as follows:

All recorded instruments on 8.5" X 11" sheets.

All text files on 8.5" X 11" sheets.

All recorded plats and condominiums on 18" X 24" sheets.

All plots on 24" X 36" sheets.

All documents and plots are to be legibly printed or reproduced on white paper.