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32.1 General

The Regional Office shall determine the utilities that will be affected by the construction of any bridge structure at the earliest possible stage. It shall be their responsibility to deal with these utilities and to provide location plans or any other required sketches for their information. When the utility has to be accommodated on the structure, the Regional Office shall secure approval from the representative of the utility and the Bureau of Structures for the location and method of support.

Due consideration shall be given to the weight of the pipes, ducts, etc. in the design of the beams and diaphragms. To insure that the function, aesthetics, painting and inspection of stringers of a structure are maintained, the following applies to the installation of utilities on structures:

1. Permanent installations, which are to be carried on and parallel to the longitudinal axis of the structure, shall be placed out of sight, between the fascia beams and above the bottom flanges, on the underside of the structure.

2. Conglomeration of utilities in the same bay shall be avoided in order to facilitate maintenance painting and future inspection of girders in a practical manner.

3. In those instances where the proposed type of superstructure is not adaptable to carrying utilities in an out-of-sight location in the underside of the structure, an early determination must be made as to whether or not utilities are to be accommodated and, if so, the type of superstructure must be selected accordingly.

32.2 Plans

Utilities may be supported by a system which requires inserts in the concrete deck slab. They also may be supported directly on structural beams. Utilities shall not be supported by a system that requires drilling into prestressed concrete beams or welding onto structural steel beams.

It shall be the responsibility of the Regional Office to obtain approval of support details from the individual utility companies prior to the final submission.

Preliminary and final general plan and elevation drawings shall show information about all existing and proposed utilities carried under the superstructure or in the vicinity of foundations. Complete information as to the name of owner, size, type, abandonment, proposed relocation, material to be furnished by utility company, etc. shall be noted.

32.3 Department Policy

The following guidance in regard to utility installations on bridges should be followed:

General Considerations

1. In most cases, attachment of utility facilities to highway structures, such as bridges, is a practical arrangement and considered to be in the public interest. However, attaching utility lines to a highway structure can materially affect the structure, the safe operation of traffic, the efficiency of maintenance as well as the appearance and therefore must be provided for during the design stage.

2. Since highway structure designs and site conditions vary, the adoption of a standard method to accommodate utility facilities is not feasible; however, the method employed should conform to logical engineering considerations for preserving the highway, its safe operation, maintenance and appearance. Generally, acceptable utility installations are those which will occupy a position beneath the structure's floor, between the outer girders of beams or within a cell, and at an elevation above low superstructure steel or masonry.

3. The general controls for providing encasement, allied mechanical protection and shut-off valves to pipeline crossings of highways and for restriction against varied use shall be followed for pipeline attachments to bridge structures, except that sleeves are required only through the abutment backwalls. Where a pipeline attachment to a bridge is encased, the casing should be effectively opened or vented at each end to prevent possible buildup of pressure and to detect leakage of gases or fluid.

   Since an encasement is not normally provided for a pipeline attachment to a bridge, additional protective measures shall be taken. Such measures shall employ higher factor of safety in the design, construction, and testing of the pipeline than would normally be required for cased construction.

4. Communication and electric power line attachments shall be suitably insulated, grounded, and carried in protective conduit or pipe from the point of exit from the ground to re-entry. The cable shall be carried to a manhole located beyond the backwall of the structure. Carrier pipe and casing pipe should be suitably insulated from electric power line attachments.

5. Guy wires in support of any utility will never be allowed to attach to a bridge structure.

6. Cell phone or other type antennas shall not be mounted from or on any bridge or sign support structure.

32.4 Pipeline Expansion Joints

Allowances must be made for changes in pipe length due to thermal expansion and alternate contraction. While couplings will take care of the normal amount of expansion and contraction in each length of pipe, expansion joints are required where no flexible joints are used in the pipeline or when the amount of concentrated movement at one point in excess of the amount that can be safely absorbed by the standard coupling.

An expansion joint should be located in the pipeline adjacent to every point where expansion means are provided in the superstructure.

Use couplings to accommodate the differential movement between the structure and the line itself, and to provide flexibility to accommodate vibrations of the structure. Each coupling can safely accommodate up to 3/8 inch longitudinal movement.

Proper alignment is important to insure free and concentric movement of the slip-type expansion joint. Alignment guides should be designed to allow free movement in only one direction along the axis of the pipe and to prevent any horizontal or vertical movement of the pipe. Suitable pipe alignment guides may be obtained from reliable pipe alignment guide manufacturers. Alignment guides should be fastened to some rigid part of the installation, such as the framework of the bridge. Alignment guides should be located as close to the expansion joint as possible, up to a maximum of 4 pipe diameters. The distance from the first pipe guide to the second should not exceed a maximum of 14 pipe diameters from the first guide. Where an anchor is located adjacent to an expansion joint, it too, should be located as close to the expansion joint as possible – to a maximum of 4 pipe diameters from the expansion-joint. Additional pipe supports are usually required. Pipe supports should not be substituted for alignment guides.

The main pipe anchors must be designed to withstand the full thrust resulting from internal line pressure; also, the force required to collapse the slip pipe, and the frictional forces due to guides and supports.

32.5 Lighting

When lighting conduits are used in a bridge use an approved expansion fitting at each semi expansion or expansion joint.

Use bolted option on all bridges with X-frame and lower laterals. Do not use bolted option when channel diaphragms are used.

There is some flexibility in placing light standards. Whenever possible, place all light standards at the piers instead of in the spans for both aesthetics and vibration problems. Place 4' from pier if there is an expansion joint at the pier. WisDOT has experienced mast arm failures due to vibration on poles placed further from the pier.

With poles set in the center of the spans on bridges the heavy luminaire tends to stand still as the bridge deflects due to traffic. The pole shaft is too stiff to deflect much so the pole arm takes all the movement.

With a constant wind velocity the poles will vibrate. If they are placed too far into the span, deflections from traffic will induce further erratic vibrations. While single arm brackets are aesthetically appealing they are more prone to fatigue failures than the double arm brackets. Some single arm brackets have been replaced this way.

The resonant frequency of most poles is quite low (5 to 10 cycles per second). Therefore low wind velocities can excite these poles if they are not damped. In most cases the arm and luminaire do some of this. One case where this didn't work was corrected by putting vermiculite in the pole.

Some pole vibrations cause the bulbs to unscrew and fall out. This is corrected by attaching a clamp over the end of the bulb.

55 foot long poles with 20 foot mast arms can have a noticeable bend in the pole due to the dead load of the luminaire and mast arm up to approximately 12 inches.

The pole manufacturers suggest that the poles be manufactured with a curve so that the dead load of the arm and luminaire cause the centerline of the pole to approximate a straight line. They did not want to increase the pole cost by using more material. A fair tolerance should be allowed on the prescribed shape of the pole.

For high mast lighting questions, please contact the BOS ancillary structures maintenance engineer.

32.6 Conduit Systems

Structures may require conduit systems when lighting, signals and other services are located on or adjacent to structures. These systems typically include conduit, conduit boxes (junction boxes and/or pull boxes), and conduit fittings. Preferably, these conduit system are embedded in concrete elements for protective and aesthetic reasons. In some cases, externally mounted systems may be warranted when concrete embedment is not practical or economical.

Rigid nonmetallic conduit, also referred to as PVC (polyvinyl chloride) conduit, is commonly used throughout structures due to its low costs and ease of installation. At joint locations with fittings, rigid metallic conduit (RMC) is recommended on both sides of the joint for a rigid and durable connection. RMC shall be galvanized per the specifications. Use of reinforced thermosetting resin conduit (RTRC), also referred to as fiberglass conduit, has been limited on projects due to its high costs and durability concerns when embedded in concrete. Use of liquid-tight flexible metal conduit (LFMC) may be considered at large expansion joints or when anticipated movements exceed standard fitting allowances. Use of PVC coated RMC is currently not being used on structures.

For long conduit runs, junction boxes are required to facilitate wire installations, to allow for future access, and for grounding purposes. The maximum run of 2-inch conduit, without a junction box, is 190 feet. Junction boxes can only be used with 2-inch diameter conduit. The maximum run of 3-inch conduit is 190 feet and junction boxes are not allowed to accommodate longer runs. Junction boxes should be used near expansion joints for grounding purposes. Additionally, all expansion fittings are to be wrapped and include a bonding jumper. Pull boxes, similar to junction boxes, are located off of structures and facilitate roadway conduit requirements and details. Typically, these items are addressed in the roadway plans.

See Standards for Light Standard and Junction Box for Parapets and Conduit Details and Notes for additional information. Refer to Chapter 39 for conduit systems servicing sign structures.

Conduit systems for structures should also consider the following items:

- Plans shall specify type, size and location for all conduit, junction boxes, and fittings necessary to accommodate services on structures. Typically, all other electrical requirements such as wiring diagrams, grounding conductors, etc. should be provided in the roadway plans. Additional details and notes may be required for some services, such as conduit systems for navigation lighting.

- Conduit type (coordinate with the Regional electrical engineer):

    - Concrete embedment: 2-inch PVC - schedule 40

    - Concrete embedment at expansion fittings: RMC (3’-0” minimum on each side of fitting)

    - Structure mounted - underdeck lighting: 1-inch RTRC. Refer to Roadway Standards for additional underdeck light details.

    - Structure mounted - Other: 1-inch PVC - schedule 80 (preferred). RTRC, RMC or LFMC may also be considered.

- The maximum allowable conduits that can be placed in concrete parapets is two 2-inch diameter conduits with junction boxes and two 3-inch diameter conduits without junction boxes. Conduit runs exceeding two 2-inch diameter conduits, as shown in the Bridge Standards and Insert Sheets, shall be determined on a case-by-case basis with conduit fittings adequately spaced and detailed at joint openings.

- Future conduit runs should not be placed unless future services are highly probable. Conduit systems are expensive and are routinely addressed by maintenance.

- All conduit runs shall have a limited number of bends. The sum of the individual conduit bends on a single run between boxes (pull or junction) shall not exceed 360 degrees, preferably not to exceed 270 degrees. No individual bend shall be greater than 90 degrees. Use two 45 degree bends in lieu of a 90 degree bend when space allows.

- Bends shall not be less than the minimum radius as specified by the National Electrical Code. For layout purposes, all bends shall have a minimum bend radius no less than 6 times the nominal diameter.

- Provide 3'-0" minimum RMC conduit on each side of semi-expansion joint fittings. For expansion joints, provide 3'-0" minimum RMC conduit on one side and extend the other side to a junction box. All semi-expansion and expansion joints with RMC conduit and fittings should be wrapped and bonded, as shown or noted in the Standards.

- For large movements or when joints exceed standard fitting allowances consider using a LFMC system. The specified LFMC conduit length should be at least 2 times the anticipated movements.

- Extend conduit a minimum of 2 inches above concrete surfaces and extend a minimum of 6 inches for buried applications. Provide temporary end caps, unless conduit terminates in a pull box.

- Provide 2'-0" minimum conduit cover when installed below roadways, 1'-6" minimum otherwise. Conduit cover should not exceed 3'-0". Provide 2-inch PVC - schedule 40 for buried applications, unless directed otherwise. Provide 2" minimum concrete cover when embedding in concrete.

- Conduit systems and light spacing requirements should be coordinated with the roadway engineer and the Regional electrical engineer.