STEEL FABRICATION SHOP DESIGN INSPECTION (LAYDOWN INSPECTION)

GENERAL

This Instructional Memorandum shall be used by the DOT steel plant inspector to carry out one of the phases of structural steel inspection referred to as Design Inspection or Laydown Inspection in the fabrication shop. Assuming that other areas of inspection have been made on an ongoing basis and that any discrepancies found have been corrected, this memorandum essentially covers preparation for laydown inspections, laydown inspection (members in assembly), post laydown inspection and laydown inspection (for members not in assembly).

SECTION 1: PREPARATION

A. DESIGN DRAWINGS, SPECIAL PROVISIONS, APPROVED SHOP DRAWINGS

The inspector should study the **design drawings** to acquaint himself/herself with the design of the superstructure so that he/she can mentally build the structural steel portion of the bridge. The design drawings should be studied for specific specifications and notes.

Special provisions should be studied as part of the preparation for laydown inspections. As with the design drawings, the special provisions may contain specific items that may require special inspection procedures or techniques during the laydown inspection.

Approved shop drawings are used before and during laydown inspections. They are used before the laydown inspection to prepare check off lists such as camber, sweep, shear stud location, and for the locations of the various detail items. These check-off sheets are used to facilitate a quick and more thorough laydown inspection than if only the shop drawings were used. They are also used to have a ready summary of the inspection results; in other words, they form a part of the documentation of the inspections.

B. PREPARATION OF CHECK OFF SHEETS

Camber, sweep, detail locations and shear studs.

The shop inspector and/or their supervisor do the preparation of the various check-off sheets. The accuracy of the check off sheets should be maintained during preparation by means of rechecking or, when possible, crosschecking dimensions. It has not been a practice to have the check off sheets officially checked by anyone in the bridge design department. One built-in check for accuracy is when a discrepancy is apparently discovered during a laydown inspection, it can and should be verified by cross checking using the actual approved shop drawings.

The items to be included in the check off lists have been outlined in the Instructional Memorandum Shop Documentation IM 565 and no attempt will be made here for the outlining of specific forms to be used.

It is desirable that in the preparation of the detail location check off list an adding machine that reads feet, inches and fractions of an inch be used.

SECTION 2: LAYDOWN INSPECTION (MEMBERS ASSEMBLED TO OTHER MEMBERS)

The laydown inspection of any given set of main members, which have been assembled into a line for the purpose of drilling the field bolted splice connections, begins with a check of the items listed previously in IM 563 as prerequisites for a laydown inspection. If these items are found to be satisfactory, the inspection is continued.

The following items then shall be checked:

A. IDENTIFICATION NUMBER OF THE GIRDERS

1. The number of the members assembled

2. The number on the girder as shown on the erection drawing is at the correct end of the member.

B. CAMBER & SWEEP INSPECTION

1. Camber inspection may be made using a laser, a stringline, or a transit as a baseline.

   The tension on the stringline must be such that camber offset readings can be made horizontally to the outside of the member at approximately the web to flange line.

   If a transit is used and it is placed where it must be flipped to shoot both ends of the line, it must be checked to ensure that it maintains a straight sight line. Camber offset dimension readings when taken using a transit shall also be taken to points on the outside of the members along the web to flange line.

   The reason for taking the readings along the web to flange line is that if the flange to which the measurement is made has any warp or flange to web tilt, an erroneous reading would be made if it were not taken along this line.

   The tolerance for camber offset dimensions is normally ± 0 at the bearing points and ± 1/2 in. (± 13 mm) anywhere else along the entire line. Tolerances may be changed for specific bridges.

2. Sweep blocking inspection: For straight lines (no sweep), visual "eyeballing" for proper blocking is satisfactory. The members must be properly blocked to give a straight web to flange line especially across the splices.

When lines with sweep are checked, it is done using offset readings taken with an instrument called a level. Normally readings are taken at splice points and bearing points. Sweep blocking should normally be close to that shown on the shop drawings but the tolerance for deviation from theoretical can be taken as ± 1/2 in. (± 13 mm).

For Horizontally curved bridges, blocking inspection shall be performed in accordance with the instructions from the Structural Materials Engineer.

The method of recording the camber and sweep is outlined in IM 565, Shop Documentation.

C. DETAIL LOCATION INSPECTION

The detail location check off sheet is used to locate and record the positions of the bearing points, all splice points (bolted or welded), stiffeners, gusset plates, hole locations, cover plate ends and drain connecting holes.

Since the various items on the list are given with accumulated measurements, the actual checking should be done with a long steel tape, which is clamped tightly onto the line of beams or girders. It is desirable, but not necessary, to have a tape as long as the line in laydown. Tapes used for this process shall be calibrated annually. Amount of tension applied on these tapes shall be determined by calibration. The inspector may at his / her discretion require a copy of the calibration records. The use of total station for inspection will be at the engineer's discretion. A procedure for the process may be required. It is also very desirable to have the tape calibrated. If the tape is calibrated, the same tape should be used for all the laydown inspections on any specific contract and it should be tensioned using a scale. An arbitrary tension of 15 lbs. (7 kg) is suggested. Whatever the tension (whether determined from calibration or if chosen arbitrarily for a non-calibrated tape), it should be used in all laydowns to maintain consistency of measurements from one line to another.

When the dimensional location of the various items is found to be within tolerance of the computed dimension, it is noted with a check mark on the check off sheet. When differences between the computed dimensions and the actual dimensions exist, the difference between the readings is recorded along with an arrow, which shows if the difference is toward or away from the zero reading end.

The tolerances for the locations of the various detail items varies. The most critical locations are stiffeners and/or gusset plates to which lateral diagonal bracing attaches and the bearing points. The normal tolerance on these items is ± 1/8 in. (± 3 mm). The next most critical locations are stiffeners to which floor beams or crossframes, which carry load, are connected and diaphragm connecting hole groups when they are in the web instead of in a stiffener. The normal tolerance for these is ± 1/4 in. (± 6 mm). The tolerance for bearing stiffeners is ± 1/2 the thickness of the stiffener. The tolerance for connecting stiffeners non-direct load diaphragm or cross bracing is normally ± 3/4 in. (± 19 mm). The tolerance for intermediate stiffeners and splices is the least critical and a tolerance of ± 1 in. (± 25 mm) is normally satisfactory. The tolerance for the locations of drain connecting holes depends on the design of the bridge. The horizontal location of holes for simple tubular drains is less

critical than more detailed systems involving drop basins, couplers and pipes. The tolerance for the location of welded and bolted splices and coverplate ends is the least critical and ± 2 in. (± 50 mm) would be acceptable. An exception would be a bolted splice which a connecting stiffener or gusset plate incorporated into it.

D. STIFFENERS, GUSSETS & OTHER CONNECTING ITEMS

These items are checked using the shop drawings for compliance for the following:

1. Hole size and spacing
2. Width and thickness
3. Welding
4. Angle to the web

When checking stiffeners for **hole size and spacing**, check enough spacing to be assured that the dimensions are correct. When stiffeners have been stack drilled, template punched or drilled are used after checking the pattern of holes for correctness of dimensions, the individual stiffeners need only be checked for key dimensions. One method to ensure placement of correct stiffeners is to verify the piece number of the stiffeners.

The measurement of the stiffeners for **width and thickness** is taken with a steel ruler or tape. Nominal readings are taken and they need not be measured with a micrometer unless a discrepancy in nominal size is suggested. No records of these measurements are recorded unless a rejectable discrepancy is found.

The inspection of the **welding** of the stiffeners is done as part of the ongoing welding inspection. Welding inspection should not be left until the laydown inspection is to be done. Discrepancies noted and corrective actions required are to be recorded in any convenient method that will ensure that they are done.

When checking the **angle** of the stiffener **to the web**, it is suggested that a protractor be used.

E. BOLTED SPLICE JOINTS

1. The shop drawings are used to check the splice plates and fill plates for the following:

   a. Size
   b. Positioning
   c. Hole location and hole edge distance

   The flange splice plates must be UM plates or oxygen flame cut. Web splice plates may be sheared.

2. The girders or beams are checked for proper alignment of both the flanges and the webs. Fill plate thickness is to be such that there will be a maximum gap of 1/16 in. (1.6 mm) caused by misalignment of plate surfaces across the splice point. It is stressed this tolerance is a maximum and that when adjustments are made, the gaps be minimized as much as possible. Fill plates which are called for on the shop drawings may be required

to be replaced with different thickness plates because only one fill plate is allowed in any one position (no stacking of fill plates). Fill plates, except those that extend beyond the splice plates for bolting purposes need not be UM or oxygen flame cut.

3. The gap between the ends of the girders or beams is checked. The specifications call for a maximum gap of 1/2 in. (13 mm) between girders and 1/4 in.(6 mm) between beams.

4. Hole locations (edge distances)

5. Gap between girders (max. - min. girders-beams)

6. Match marking (when, where, how, special systems)

7. Tacks (when, where, how, limitations, preheat, length)

F. GIRDERS OR BEAMS

1. Web to flange tilt (tolerances, methods of measurement, correction mid girder, end girder bearing point)

2. Welding (if not done before - also in ongoing inspection of welding)

3. Piece mark identification (where, how, x-end - heat numbers)

4. Material condition (kinks, bends, humps, scabs, etc.)

G. DOCUMENTATION (give copy of discrepancies and corrections to shop)

SECTION 3: POST LAYDOWN INSPECTION

The shop will not be permitted to drill or ream to full size any holes in any splice assembly until the laydown inspection has been made and the relative positions of the beams or girders have been found to be within tolerances with regard to elevation and horizontal positions.

A. DRILLING OF HOLES

After the drilling operation, the following items should be checked:

1. While in the laydown position, the splice assembly holes should be checked for quality and position. Articles 2408.02 L of the Standard Specifications specify the quality of drilled holes (check for size of holes, elongated holes, punched or drilled holes etc.).

2. Edge distance of hole, that is, the distance between the centerline of the hole to the edge of material, must be checked. Check not only the splice plate holes but also the holes in the beams or girders. If a hole or holes are found to have edge distances less than 1 1/2 in. (38 mm) as called for on the plans, consult the Structural Materials

Engineer for proper corrective procedure to be followed.

B. MATCHMARKING OF MATERIALS

Article 2408.02, N.3 of the Standard Specifications requires that before parts are disassembled, they shall be match marked using low stress riser stamps so that they can be reassembled in the same position when the structure is erected in the field. After the drilling operation (burrs removed, edges ground, etc.), this match marking must be done prior to disassembling.

C. INSPECTION FOR WORKMANSHIP

Article 2408.03, J.1 of the Standard Specifications states, "The workmanship and finish shall be first class in all respects and equal to the best practice in modern bridge shops. Shearing and chipping shall be neatly and accurately done and all portions of the work exposed to view shall be neatly finished." This includes a check on repair of welds, grinding of chain marks, handling marks, oversized or overlapped welds, flame cut corners and edges, sheared edges, etc.

SECTION 4: LAYDOWN INSPECTION (MEMBERS NOT ASSEMBLED)

The following is a list of items that must be checked for the members of bridge structure that are not assembled. Appropriate tolerances and inspection procedures as outlined previously in this instructional memorandum shall be used during inspection.

A. SIMPLE SPAN BRIDGE BEAMS

1. Length of members
2. Camber
3. Detail materials
4. Squareness of bearings
5. Welds (bearings, stiffeners, cover plates, some "no weld" areas, etc.)
6. Grinding
7. Holes (size, location, etc.)

B. MAIN MEMBERS (CROSSFRAMES - DIAPHRAGMS)

1. Jig fit up
2. Dimensions after welding
3. Grinding
4. Welding
5. Holes (locations, size, etc.)
6. Piece marks