Illinois Department of Transportation
2300 South Dirksen Parkway / Springfield, Illinois / 62764

September 7, 2010

CIRCULAR LETTER 2010-09

BRIDGES WITH GUSSET PLATES, FRACTURE CRITICAL MEMBERS OR HOAN DETAILS

COUNTY ENGINEERS/SUPERINTENDENTS OF HIGHWAYS
MUNICIPAL ENGINEERS/DIRECTORS OF PUBLIC WORKS
CONSULTING ENGINEERS

This circular letter provides information and direction regarding three issues associated with bridge rating and/or inspection: gusset plates, fractural critical members, and "Hoan details." This guidance will aid local agencies in properly identifying and reporting on bridges having certain structural characteristics of particular concern.

Gusset Plates

As a result of the collapse of the I-35W Interstate highway bridge in Minneapolis, Minnesota, the Federal Highway Administration (FHWA) and the Illinois Department of Transportation (IDOT) have published documents providing guidance on the inspection and load rating of gusset plates on non-load-path-redundant steel truss bridges. The department issued All Bridge Designers (ABD) Memorandum 10.2, dated May 11, 2010, "Load Rating Guidance for Bolted and Riveted Gusset Plates in Steel Truss Bridges," which can be viewed at http://www.dot.il.gov/bridges/ABD102.pdf. This memorandum references FHWA Technical Advisory T5140.29, which may be found at http://www.fhwa.dot.gov/bridge/t514029.cfm , and strongly encourages bridge owners to check the capacity of gusset plates.

The first step in determining the capacity of gusset plates is inspection. Current inspection guidelines provide that all gusset plates joining main load carrying members must have a hands-on inspection. This includes compression and tension members, but not connection plates of secondary members. The department recommends performing a hands-on inspection of all gusset plates at or before the next fracture critical inspection or routine National Bridge Inspections Standards (NBIS) inspection.

The full, non-corroded gusset plate thickness, as well as the overall height and width, should be measured for calculation purposes and for comparison to the original design and shop plans. Any areas of section loss should be measured, and the quantity should be calculated and documented.

Documentation of section loss should be reported to the NBIS Program Manager immediately. Additionally, any signs of warping or buckling should also be documented and immediately reported to the NBIS Program Manager.

Attached are examples of gusset plate section loss documentation. A photo should be taken of both sides of all gusset plates, i.e. typically both sides of both gusset plates (minimum 4 photos) at each panel point location. Photos of the interior face of the gusset plates may be difficult to take and/or may not show the entire interior surface, but they should still be taken.

The thickness of the gusset plate is critical in calculating its load carrying capacity. In most cases, rudimentary methods (tape measure, ruler and straight edge, etc.) of measuring plate thickness do not provide measurements precise enough to accurately quantify section loss. The Federal Highway Administration (FHWA) Technical Advisory T5140.31 (http://www.fhwa.dot.gov/bridge/t514031.cfm) recommends ultrasonic testing as the most appropriate method for measuring remaining plate thickness at locations of section loss. Ultrasonic testing may also be the best method for measuring full plate thickness at non-corroded locations.

Field measurements should be compared to the original design and shop plans if they are available. Any discrepancies should be documented and brought to the attention of the NBIS Program Manager. If plans are not available, detailed drawings of the gusset plates should be made depicting the plate size, thickness, and bolt or rivet pattern and spacing.

After the field inspection is completed, any structure not originally designed for HS 20 live load or whose original dead load has changed, or having gusset plates with section loss, should have a new load rating performed. The capacity of the gusset plates should be determined and included in the load rating. Gusset plate capacities should also be considered when analyzing truss bridges for permit loads. A list of known steel truss structures potentially having gusset plates will be sent to the IDOT District Bureaus of Local Roads and Streets for dissemination to the local agencies. This list is not meant to be all inclusive; it should instead serve as a starting point for local agencies to search their inventory for structures with bolted or riveted gusset plates.

Local agencies are encouraged to utilize their own resources or consultants to perform the load ratings as necessary. The department does not have the resources necessary to perform load ratings for all the local agencies. Note that load ratings must be performed by or under the direct supervision of an Illinois Licensed Structural Engineer and must be signed and sealed by that Structural Engineer.

To assist with determining the load rating of gusset plates, guidelines are attached to ABD Memorandum 10.2. An additional resource referenced in ABD Memorandum 10.2 that may be used when performing load rating calculations is FHWA Publication No. FHWA-IF-09014, titled “Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges.” When completed, local agencies should submit documentation

to IDOT, including detailed inspection reports and load rating computations. An Excel spreadsheet used for determining gusset plate capacities and any other software input files, such as Virtis, should also be submitted for use in evaluation of the load rating analysis. If the local agency is unable to perform the required load rating analysis, in-depth inspection information should be submitted to IDOT in a timely fashion. Reduced size (11" x 17") copies of existing design and shop plans should be provided if available.

Fracture Critical Member Update

The department provided direction and guidance on new fracture critical requirements and the inspection of fracture critical members with the August 17, 1990 issuance of Circular Letter #90-25, "Fracture Critical Member Inspections (http://www.dot.il.gov/blr/manuals/cl1990-25.pdf). This circular letter amends Circular Letter #90-25.

Circular Letter #90-25 excluded from fracture critical inspection requirements those structural members meeting one or more of the following characteristics:

1. Truss tension members made up of more than two components (e.g., a truss panel having a lower chord with 4 eyebars).

2. Diagonal tension members of riveted trusses.

3. Floorbeams attached to the main structure by rivets or bolts and clip angles.

4. Riveted built-up flexural members.

5. Eyebar pins in trusses.

6. Other tension and flexural members for which a structural analysis shows that redundancy is provided.

Current guidelines no longer automatically allow these members to be omitted from the fracture critical inspection requirements. A member with internal redundancy can still be fracture critical, and structural and internal redundancy should be neglected when classifying fracture critical members. Only load path redundancy, or lack thereof, is to be considered when determining if a member is to be considered fracture critical. Likewise, floorbeams supporting other steel members or those spaced at greater than 15 feet require fracture critical inspections.

Local agencies should survey their inventory for any structures having characteristics which previously may have excluded them being reported as fracture critical members. If any structures are located, information regarding those structures should be submitted through the District Bureau

of Local Roads and Streets. Inventory information for ISIS items 92A1, 92A2 and 92A3 should be provided. Circular Letter #90-25 and the Illinois Structure Information and Procedure Manual should be consulted for additional information on reporting on fracture critical members.

Additionally, the criteria in Circular Letter #90-25 for determining the fracture critical inspection interval are no longer valid. The current criteria can be found in Section 3.3.5.2 of the Structural Services Manual.

Hoan Details

In December 2000, the Hoan Bridge in Milwaukee, Wisconsin, had two of its three main girders fail. After months of investigation, the cause of the failure was attributed to constraint-induced fracture. The forensic investigation showed that the specific detailing of certain types of welded joints, such as longitudinal welded attachments on web plates intersecting vertical welds, created the high constraint condition. These types of details, commonly referred to as "Hoan details," are vulnerable to brittle fracture initiation under normal service loads and therefore, are of specific concern to bridge owners.

Attached are sample details to assist bridge owners with identifying structures having details susceptible to constraint-induced fracture. These details are often located at the intersections of longitudinal and transverse web attachments in areas where the web is under tension. There are two typical applications of this situation:

1. Locations where longitudinal web stiffeners intersect vertical web stiffeners or stiffeners attached to the web for connection of crossframes or diaphragms.

2. Structures with wind bracing where horizontal bracing or connection plates intersect vertical web stiffeners or stiffeners attached to the web for connection of crossframes or diaphragms.

Research shows the gap between the longitudinal and transverse welds is the most important parameter in determining the vulnerability of this type of detail. Details with less than ¼-inch separation between welds create a condition of high constraint. When the gap is greater than ¼-inch, the constraint of the web plate is relieved, and the risk of constraint-induced fracture is much less of a concern.

There is currently no formal guidance addressing structures with these types of details. While waiting for guidance from the FHWA, the department developed experience with structures on the state system having details with characteristics similar to those associated with the Hoan Bridge.

The main objective of this notification is to identify structures in the inventory with Hoan details and determine an appropriate course of action. Local agencies should look for details similar to those described above and depicted

in the attached examples on future NBIS inspections. Typically, these details will be found on structures with main spans exceeding 120-feet in length, which may require longitudinal web stiffeners and/or wind bracing. If found, information should be provided to the Bureau of Bridges and Structures for assistance and determination of course of action. Depending on the configuration, web gap and condition of the detail, a special feature inspection may be initiated or a retrofit may be recommended.

If you have any questions regarding this circular letter, please contact Jack Elston at (217) 785-8748 or jack.elston@illinois.gov.

Sincerely,

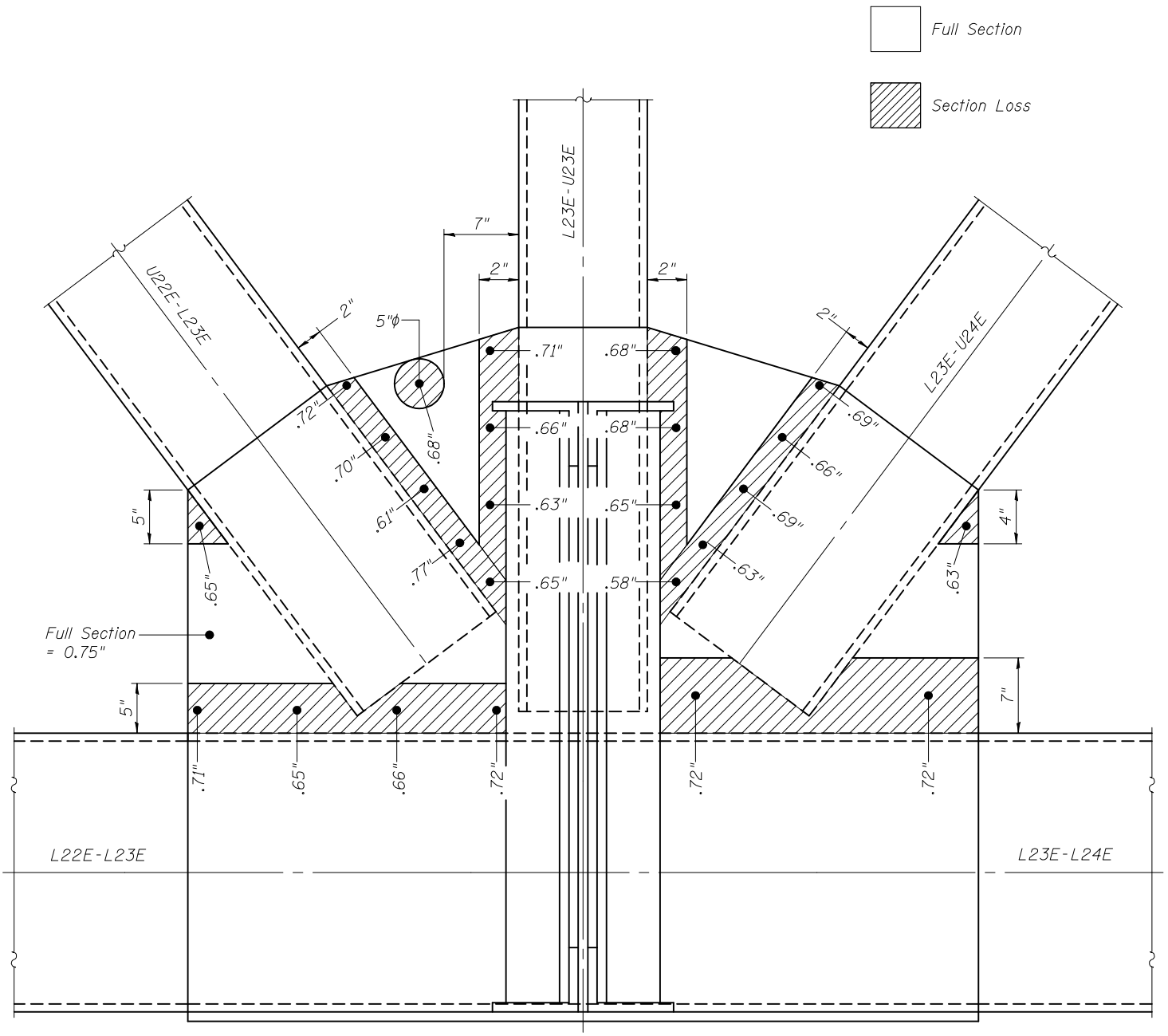
Darrell W. Lewis, P.E.
Acting Engineer of Local Roads and Streets

Ralph E. Anderson, P.E., S.E.
Engineer of Bridges and Structures

Attachments

cc: Dan Brydl, FHWA - Illinois Division
Gary Iles, Illinois Department of Natural Resources
Elias Ajami, Illinois State Toll Highway Authority
Bryan Smith, Township Officials of Illinois
Robert Miller, Township Highway Commissioners of Illinois
(Algonquin, McHenry County)

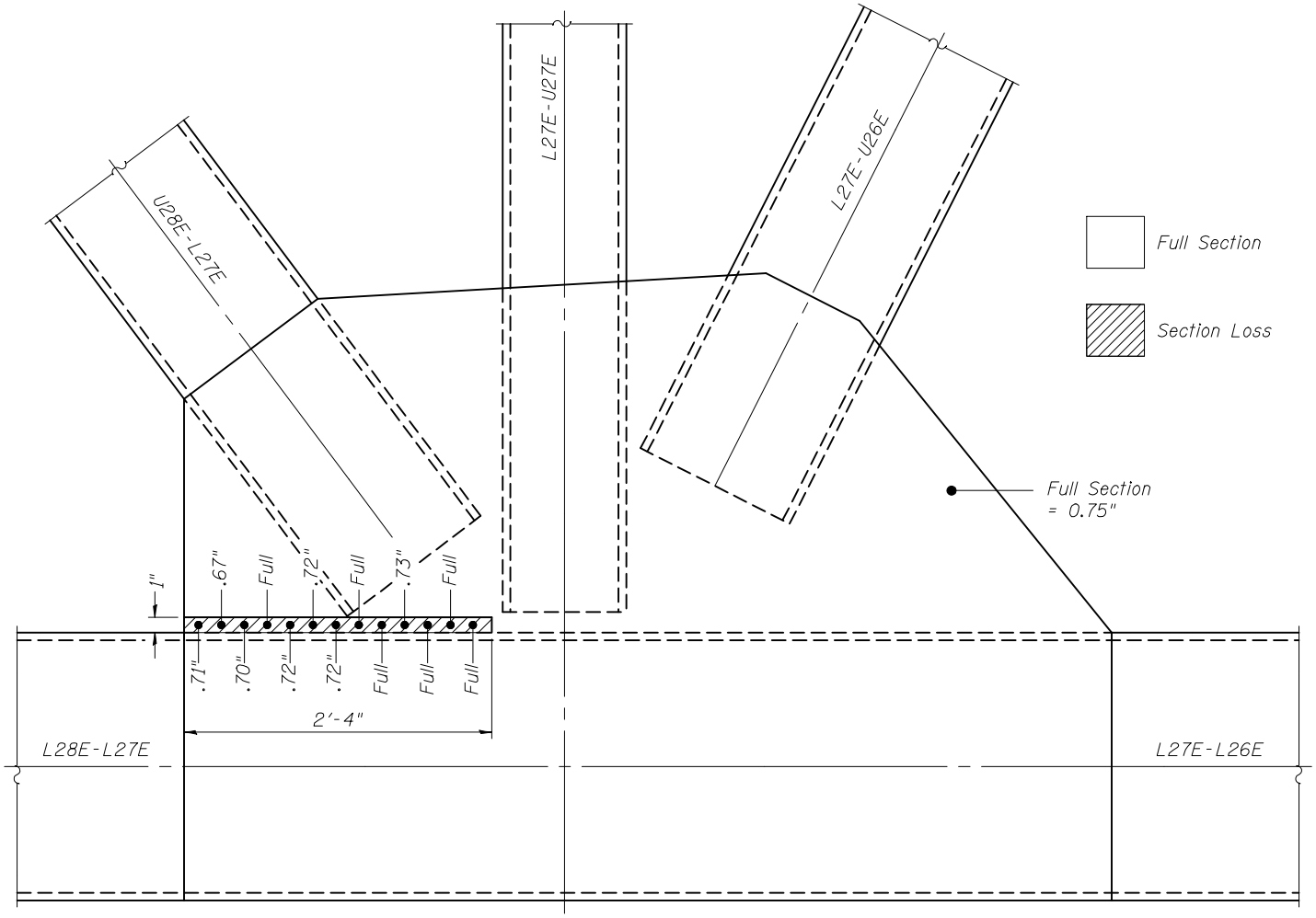
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION



SECTION LOSS EXAMPLE 1
INSIDE GUSSET ℄

ATTACHMENT 1

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION



SECTION LOSS EXAMPLE 2
OUTSIDE GUSSET ℄

ATTACHMENT 2

STATE OF ILLINOIS
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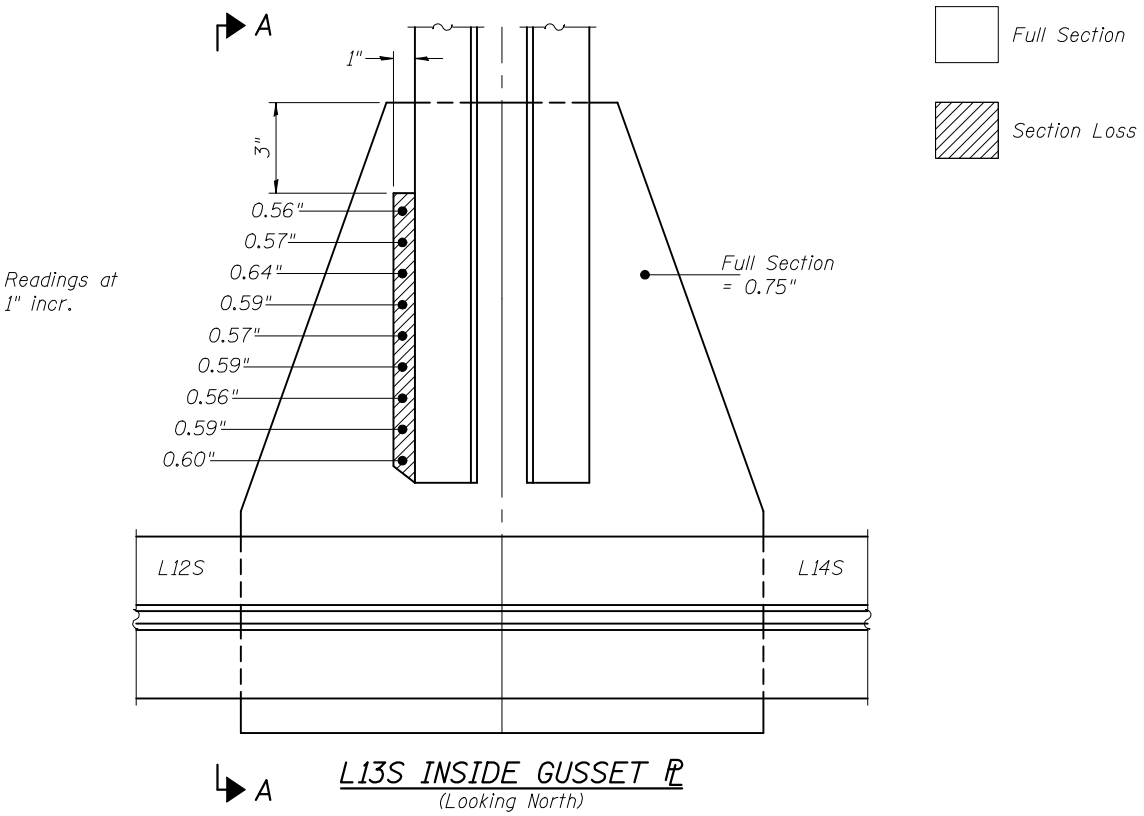
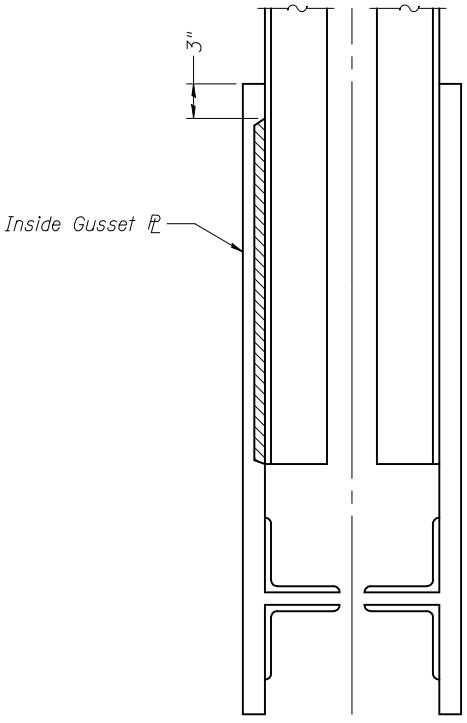


L13S INSIDE GUSSET ℄
(Looking North)



SECTION A-A

SECTION LOSS EXAMPLE 3

ATTACHMENT 3

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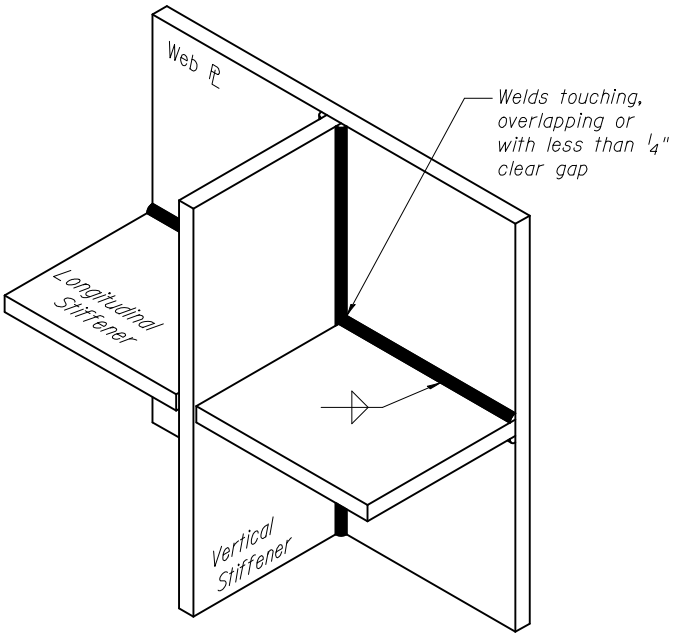
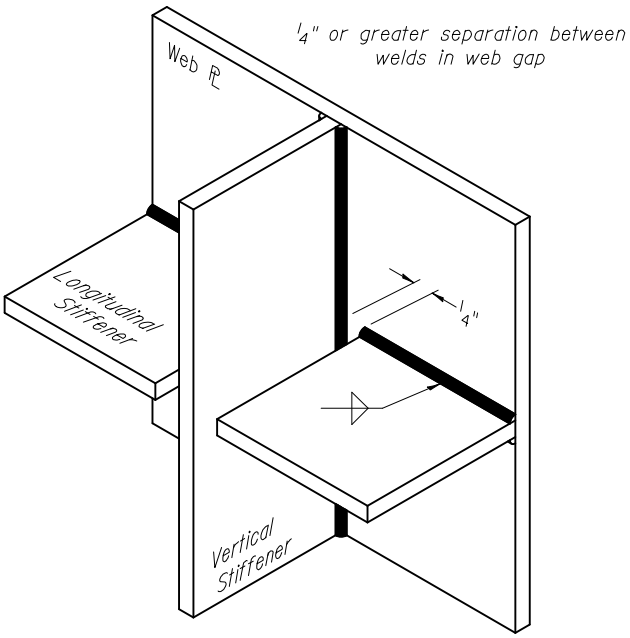


Longitudinal stiffener terminations in areas of the web subject to tension are vulnerable to constraint-induced fracture if there is insufficient weld clearance.



Longitudinal stiffener terminations with 1/4" or greater clear gap between welds present a low risk for constraint-induced fracture.

SAMPLE DETAILS REFERENCED IN "HOAN DETAILS" SECTION

ATTACHMENT 4

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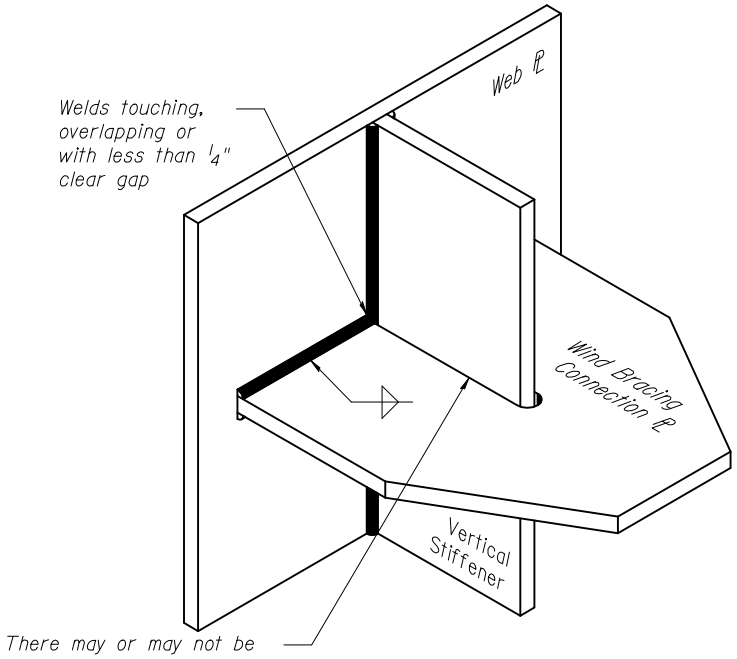
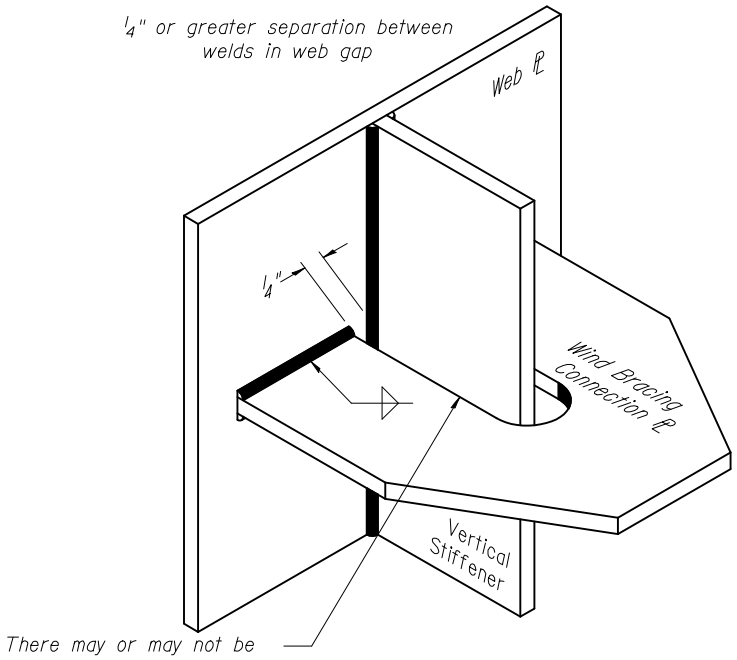


Wind bracing connection PL's in areas of the web subject to tension are vulnerable to constraint-induced fracture if there is insufficient weld clearance.



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