Steel Interchange

Steel Interchange is an open forum for *Modern Steel Construction* readers to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Opinions and suggestions are welcome on any subject covered in this magazine. If you have a question or problem that your fellow readers might help to solve, please forward it to *Modern Steel Construction*. At the same time feel free to respond to any of the questions that you have read here. Please send them to:

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Answers and/or questions should be typewritten and double spaced. Submittals that have been prepared by word-processing are appreciated on computer diskette (either as a wordperfect file or in ASCII format).

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The following responses to questions from previous *Steel Interchange* columns have been received:

Regarding beam to column simple shear connections, is there a general "rule-of-thumb" as to when the different types of connections are more advantageous?

Also, can beam to column seated and stiffened connections be considered wind connections or partially restrained?

(This question was posed by Charles F. Canitz in the August issue.)

In general, there are no rules concerning what shear connections should be used where. In my opinion, the double angle connection is still the standard and I would use it for heavy loads framing into the flange of a column or the web of a girder. A shear tab or single angle is fine for lighter loads. A shear end plate is used mainly for skewed beams.

For framing into the web of a column, most erectors would much prefer a seated connection (stiffened or unstiffened, depending on the magnitude of the load). It is so much safer than any other type.

I would not use a seated connection as a wind or a partially restrained (semi-rigid) connection unless the top flange is also connected to the column. If a connection is to take any calculated moment, both flanges should be connected.

Robert O. Disque
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What procedures should be followed when assessing steel that has been exposed to a fire?

I certainly agree with the general rule-of-thumb expressed by F.H. Dill in the 1960 National Engineering Conference Proceedings as mentioned in the August 1992 *Steel Interchange*. I would, however, add that in those situations where a detailed investigation is required and/or justified, an excellent resource has been published by the British Steel Corporation, *The Reinstatement of Fire Damaged Steel Framed Structures*, "Fire Safety Journal", Volume 4, 1981, pages 21-62.

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Are washers required in connections with slotted holes because of strength requirements or are there additional reasons?

Assuming that the slots are located in one or both outer plies, the answer to this question depends on several factors:

1. Type of bolt used.
2. How the bolt is installed.
3. The purpose of the slot.
4. The type of washer used.

In brief, washers serve primarily as anti-galling devices under most conditions but it must be noted they occasionally serve a "strength" purpose, such as with tensioned large diameter A490 bolts in long slots, where they help to disperse the bearing pressures to compensate for loss of area at the slots. Such conditions are rare. There are, in addition, other situations which must be considered, as noted in the ensuing commentary.

1. Type Of Bolt.

When tensioned high-strength bolts (A325 or A490) are used with slots, the washer requirements become very complex because of several variables among which are length of slot, whether the bolt is A325 or A490, diameter of bolt, number of plies with slots, direction of slot in relation to the load, whether slots are in exterior plies, and surface conditions of the connected material. When using high strength bolts all provisions of the current RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts* and its Commentary must be considered, including those covering slots. These provisions are too numerous to repeat here. Readers are advised to acquaint themselves with this specification.

A307 bolts in slotted holes do not require washers, regardless of tightness, but good practice decrees that washers be used to prevent galling and "hang-ups" if the bolts are required to travel in the slots.

2. Bolt Installation Policy.

The degree to which the bolts are tightened depends on the purpose of the slots and whether they are provided for adjustment or to allow movement. Depending on these circumstances the bolts are installed either loose, snug-tight, or fully tensioned. Bolts which are installed "loose" must first be

snugged-up to assure that all joint plies are in contact. Then the nuts are backed-off (loosened) a certain amount, usually one-half to one full turn depending on the number of plies (very unscientific). When this technique is used the nuts must be welded or the threads peened, or the bolt provided with double nuts to prevent further undesired loosened.

Washer requirements for slots utilizing high strength bolts are given in the aforementioned RCSC Specification.

3. Purpose Of The Slots.

Slots are often provided to compensate for mill, shop, and erection tolerances. For this condition the connection may need to be "frozen" (tightened) when the structure is complete. If high-strength bolts are used the washer requirements are dependent upon the factors listed in paragraph 1 above. Allowable high strength bolt values are dependent, among other things, on the direction of the load relative to the direction of the slot.

When A307 bolts are used care must be taken that the slots are placed perpendicular to the load direction.

If the slots are provided in order to allow movement of the structure, for instance at an expansion joint, the bolts must be installed "loose" so as not to restrict the desired movement. This applies to both high-strength and A307 bolts. It is important that the bolts do not "hang-up" as they travel in the slots and one way to prevent this is to use washers. Hardened or plate (mild steel) washers can be used with equal effect with "loose" bolts.

4. Type Of Washer.

There are three types of washers commonly used in steel construction.

a. Hardened washer - intended for use with high strength bolts but they can also be used with A307 bolts.

b. Erection washer - usually ¼ to ½ in. thick and with outside diameter of 2 to 3 in. depending on bolt diameter. Commonly made of mild steel.

c. Plate washer - usually fabricated from mild steel to any size and shape required. Often used on column anchor bolts. Can be used in rectangular form to cover long slots. Can also be provided with multiple holes to service entire bolts groups.

Erection and plate washers, if used in conjunction with fully-tensioned high-strength bolts must be accompanied by a hardened washer placed under the turned element.

As previously stated, the main purpose for using washers at slotted holes is to prevent scouring and galling of the softer connected material. Strength is not greatly effected by washers except in the case of tensioned high-strength bolts where the hardened washer helps to assure that the bolt attains it prescribed load capability and keeps tension relaxation to a minimum.

Designers are cautioned against using the type of slotted expansion joint connection in which movement tens to "saw-off" the bolts. The problem is not in the bolts, which are much harder, but in the edges of the slots which may tend to erode as the number of expansion contraction cycles mount.

There is a case where absence of washers may be advantageous. A popular hung lintel connection utilized vertical and horizontal slots in order to provide adjustment in the field. Quite often designers require that the connection be made rigid after adjustment by means of welding. This welding requirement is an additional operation and increases erection costs. Joint rigidity may be attained by an alternate method using fully-tensioned high-strength bolts in the slotted holes without washers. The tensioned bolt indents the surface of the connected steel adjacent to the slot edge and provides "keying" action. This is most effective when the slotted material is mild steel and A490 bolts are used. The stationary bolt element should be on the hole side, complete with hardened washer. Before using this technique, facsimile testing should be performed to confirm the desired keying action. An additional benefit of this technique is, should the structure require future adjustment, it is not necessary to cut the welds free.

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How should I connect wide flange beams to all four faces of a structural tube column in such a way as to transfer wind moments as well as dead and live load reaction?

To connect wide flange beams to all four faces of a structural tube to transfer wind moments as well as dead and live load reaction, I suggest the detail shown on the sketch below.

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