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steel interchange

Strength of Concrete-Encased Columns

Can concrete encasing an existing steel wide-flange column be assumed to brace the steel section, even when no shear studs are present? In other words, can we assume the steel column is fully or partially braced by the concrete to reduce its effective length?

It appears that you are planning to analyze the column while ignoring the direct contribution of the concrete strength due to the absence of shear studs.

I suppose if you had a significant reinforced concrete encasement, you might be able to show that the concrete section can provide sufficient strength and stiffness to brace the column per AISC 360 Appendix 6 provisions. Usual encasement may not be sufficient, however, so I'll suggest an alternative approach.

You can consider the composite strength of an encased column even without the presence of shear studs. Chapter I of the 2010 AISC *Specification* (a free download at **www.aisc.org/2010spec**) was significantly reorganized in part to include several new provisions related to composite columns. Section I2.1 addresses encased members subjected to axial loads and does not include any requirements for shear studs. Recent research has shown that there is typically enough friction between the steel and concrete elements to allow for the member to behave compositely without any studs required, except possibly where you have concentrated loads being introduced to the section.

Where you have concentrated loads being introduced, such as a horizontal beam element framing into the column, the "new" load needs to get distributed between the steel and concrete portions in what is now called the load introduction length. This is defined in the glossary as the *introduction length*:

> "In an encased composite column, the length along which the column force is assumed to be transferred into or out of the steel shape."

The requirements for the load introduction length are presented in Section I6 of the *Specification* (Load Transfer), and can be accomplished by several different mechanisms per Section I6.3: direct bearing, shear connection or direct bond interaction.

For your condition, where you have an existing column encased in concrete, I would recommend you review the latest composite column provisions to see if they can be used to your advantage. Some of the research behind these new provisions can be found in the following publications:

- Leon, R.T., Kim, D.K, and Hajjar, J.F. (2007). "Limit State Response of Composite Columns and Beam-Columns Part 1: Formulation of Design Provisions for the 2005 AISC *Specification*." *Engineering Journal*, 4th Qtr, 341-358.
- Leon, R.T. and Hajjar, J.F. (2008). "Limit State Response of Composite Columns and Beam-Columns Part II: Application of Design Provisions for the 2005 AISC *Specification*." *Engineering Journal*, 1st Qtr, 21-46.

Both of these articles are free to AISC members, and available to nonmembers for a fee, at **www.aisc.org/ej**.

Susan Burmeister, P.E.

Code of Standard Practice vs. Contract-Specific Provisions

We are an erector bidding a project where the frame is shown as entirely field welded in the contract documents. Many of our past contracts include language indicating that the structure should be fabricated and assembled in the shop to greatest extent possible. We also believe the AISC *Code of Standard Practice* requires the fabricator to provide economical details. Can we assume that the *Code* requirement will override the expensive field welding shown on the drawings?

The short answer to your question is "No."

Section 7.8.1 of the *Code of Standard Practice* states: "The fabricator shall provide field connection details that are consistent with the requirements in the contract documents and that will, in the fabricator's opinion, result in economical fabrication and erection."

Also, contract documents often include language like: "Fabricate and assemble in shop to greatest extent possible." However, it appears from your question that the contract documents in this case do not say that.

The *Code of Standard Practice* does not override what is shown on the contract documents. This is stated in the Scope:

> "In the absence of specific instructions to the contrary in the contract documents, the trade practices that are defined in this *Code* shall govern the fabrication and erection of structural steel."

Thus, the contract documents take precedence and the *Code of Standard Practice* governs in the absence of other instructions.

If your contract documents contain the field-welded details in the drawings but state that the structure should be fabricated and assembled in the shop to greatest extent possible elsewhere (perhaps in the project specification), this would be a discrepancy. Section 3.3 of the *Code of Standard Practice* states: "When discrepancies exist between the design drawings and specifications, the design drawings shall govern." So the field-welded details would again govern—though as also stated in Section 3.3, the owner's designated representative for construction should be notified of the discrepancy.

Larry S. Muir, P.E.

Maximum Spacing and Edge Distance Requirements

What are the origins and purpose of the maximum spacing and edge distance requirements in Section J3.5 of the AISC *Specification*?

I recently researched this myself and found that all of the published requirements stem from a paper by R.L. Brockenbrough. The information below summarizes the various recommendations and requirements. Some limited information on field observations, which verify the Brockenbrough recommendations, is also documented by P. Albrecht and A.H. Naeemi.

For sealing against the penetration of moisture in joints, the geometry of bolted joints must provide tight contact between faying surfaces. This is accomplished by limiting the fastener spacing and edge distance. Maximum bolt spacing and edge distance requirements are provided in the 2010 AISC *Specification*, the AASHTO *LRFD Bridge Design Specifications* and the AREMA *Manual for Railway Engineering*.

For non-painted weathering steel, Brockenbrough recommended a maximum bolt spacing of $14t \le 7$ in. and a maximum edge distance of $8t \le 5$ in., where t is the thickness of thinnest element connected. AASHTO Section 6.13.2.6.2 and AREMA Section 1.5.13.b require a maximum spacing on a single bolt line adjacent to a free edge of an outside ply or shape of 4 in. + $4t \le 7$ in. The AASHTO Commentary states that the maximum spacing is applicable to non-coated weathering steel structures. According to the AREMA commentary, these requirements were adopted in 1943 and were based on experience and judgment. The AISC *Specification* requires a maximum bolt spacing of $24t \le 12$ in. for painted members and non-painted members not subject to corrosion, and follows the recommendation of Brockenbrough for non-painted weathering steel.

For non-painted weathering steel, Brockenbrough recommended a maximum edge distance of $8t \le 5$ in. AASHTO Section 6.13.2.6.6 follows the recommendation of Brockenbrough, and AREMA Section 1.9.4.b limits the distance from the free edge of an outside plate or shape to the first line of fasteners to 1.5 in. + $4t \le 6$ in. The AISC *Specification* requires a maximum edge distance for plates of $12t \le 6$ in.

References

- AASHTO (2012), *LRFD Bridge Design Specifications*, American Association of State Highway and Transportation Officials, Washington, D.C.
- AISC (2010), *Specification for Structural Steel Buildings*, ANSI/AISC 360-10, June 22, AISC, Chicago (a free download at **www.aisc.org/2010spec**).
- Albrecht, P. and Naeemi, A.H. (1984), *Performance of Weathering Steel in Bridges*, NCHRP Report 272, Transportation Research Board, July.
- AREMA (2010), *Manual for Railway Engineering*, American Railway Engineering and Maintenance-of-Way Association.
- Brockenbrough, R.L. (1983), "Considerations in the Design of Bolted Joints for Weathering Steel," *Engineering Journal*, AISC, 1st Qtr., 40-45 (AISC *Engineering Journal* papers are free to AISC members, and available to nonmembers for a fee, at **www.aisc.org/ej**).

Bo Dowswell, P.E., Ph.D.

Welding Safety

Where can I find safety information related to welding in an existing structure?

ANSI Z49.1:2012 *Safety in Welding, Cutting, and Allied Processes* includes information related to fire protection, ventilation and other issues you are likely to encounter. It's available for free at the AWS website (**www.aws.org**).

Carlo Lini, P.E.

The complete collection of Steel Interchange questions and answers is available online. Find questions and answers related to just about any topic by using our full-text search capability. Visit Steel Interchange online at **www.modernsteel.com**.

Larry Muir is director of technical assistance and Carlo Lini is a staff engineer–technical assistance, both with AISC. Susan Burmeister and Bo Dowswell are consultants to AISC.

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If you have a question or problem that your fellow readers might help you solve, please forward it to us. At the same time, feel free to respond to any of the questions that you have read here. Contact Steel Interchange via AISC's Steel Solutions Center:

1 E Wacker Dr., Ste. 700, Chicago, IL 60601
tel: 866.ASK.AISC • fax: 312.803.4709
solutions@aisc.org

Steel SolutionsCenter