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steel interchange

Force Distribution and Transfer in Encased Composite Member – Part 1

Assume an encased composite column that sits on a base plate and that the load is delivered to the top of the column through a cap plate.

Section I2.1d of the *Specification for Structural Steel Buildings* (ANSI/AISC 360) states: "Load transfer requirements for encased composite members shall be determined in accordance with Section I6." Section I6.2c applies. The Commentary states: "Where loads are applied concurrently to the two materials, the longitudinal shear force to be transferred to achieve cross-sectional equilibrium can be taken as either the difference in magnitudes between the portion of external force applied directly to the concrete and that required by Equation I6-1 or the portion of external force applied directly to the steel section and that required by Equations I6-2a and b."

Some distribution of force among the elements (structural steel, reinforcing steel and concrete) must be assumed. If the distribution is based on relative strength, it seems a distribution for which Section I6 requires no force to be transferred among the steel and concrete elements is possible. However, there must be some transfer of force among the elements in order for the encased column to act as a unit. To make the point, assume a condition involving only steel: three plates (two flanges and a web) sandwiched between cap and base plates. The loads can be distributed based on relative areas. Applying criteria similar to Section I6 would indicate the three plates do not need to be interconnected. However, Section E6 would require interconnection of the elements to ensure they act as a unit, as opposed to three independent plates. Am I missing some requirement to interconnect the elements in encased composite columns?

Yes. Section I6.4a of the *Specification* (available at **www.aisc.org/specifications**) provides prescriptive detailing requirements. These minimum requirements along with the confinement steel are considered adequate by the Committee to develop the composite capacity similar to what is done in Section E6 relative to built-up compression members.

Larry S. Muir, PE, with assistance from William P. Jacobs, V, SE, PE

Force Distribution and Transfer in Encased Composite Member – Part 2

AISC Design Guide 1: *Base Plate and Anchor Rod Design* generally assumes a uniform pressure distribution under the base plate and a critical bending section in the base plate at the face of the column. Are these assumptions still valid when designing a base plate attached to an encased composite column?

The pressure distributions under the base plate described in Design Guide 1 (available at **www.aisc.org/dg**) are assumptions. The engineer must decide whether or not any particular approach is appropriate for a given situation. The Design Guide indicates that many approaches are possible and makes the following two statements:

"While this approach offers a simple means of designing the base plate… the designer may choose to use other methods of designing the plate for flexure, such as yield-line analysis, or a triangular pressure distribution assumption, as discussed in Appendix B." (Section 3.3.2)

"…both triangular and uniform distributions represent simplifying approximations... The use of a triangular pressure distribution, as shown in Figure B.1, will often require slightly thicker base plates and slightly smaller anchor rods than the uniform pressure approach, since the centroid of the pressure distribution is closer to the cantilevered edge of the plate." (Section B.1)

The location of the critical section is not an assumption. The magnitude of the critical moment and its location is a function of the assumed pressure distributions both above and below the base plate. Figure 1 shows the moment (red dashed line) superimposed on the base plate based on the model in the Design Guide. In order to determine the magnitude and location of the critical moment, a free-body diagram of the base must be drawn that is consistent with the distribution of force in the member. In most cases the critical moment will likely occur at the face of the steel element, but Chapter I permits a wide range of configurations, so every case encountered must be considered separately.

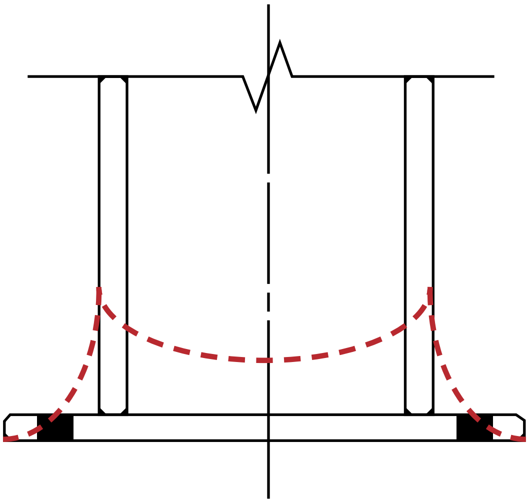

Figure 1

Larry S. Muir, PE

Collision Between Structures

Section L4 of the 2010 *Specification* states: "Drift under strength load combinations shall not cause collision with adjacent structures or exceed the limiting values of such drifts that may be specified by the applicable building code." This statement has been removed from the 2016 *Specification*. I have two structures in close proximity to each other, such that they may collide under some loading conditions. Should these two structures be treated as a single structure or is it okay to treat the structures as two separate structures? Is the decision impacted by the choice of *Specification*, 2010 versus 2016?

You may be able to arrive at an acceptable design regardless of whether you treat the portions as a single structure or two independent structures. You will have to decide the best approach for the project based on your own engineering judgment. You could look at each option to see which one would be more economical.

Collision between structures, though no longer explicitly prohibited, is not a good idea. Section L3 of the 2016 *Specification* states: "Drift shall be limited so as not to impair the serviceability of the structure." The Commentary states: "Drift limits are imposed on buildings to minimize damage to cladding and to nonstructural walls and partitions… It is important to recognize that drift control limits by themselves, in wind-sensitive buildings, do not provide comfort of the occupants under wind load." Though these statements are not directed toward collision between structures, cladding and other nonstructural elements are likely to be damaged when structures are allowed to collide, and such collisions are likely to make the occupants uncomfortable. In other words, the collision would impair the serviceability of the structure. The choice of *Specification*, 2010 versus 2016, has no impact on the design considerations related to potential collisions between structures.

Section 12.12.3 of ASCE-7 directly addresses such conditions relative to seismic design. I am not aware of similar requirements specifically related to wind.

Carlo Lini, PE

Tension Field Action in End Panels

Section G3.1 of the 2010 AISC *Specification* states: "Consideration of tension field action is not permitted… for end panels in all members with transverse stiffeners." The 2016 *Specification* does not include an explicit prohibition against consideration of tension field action in end panels. Is consideration of tension field action permitted for end panels under the 2016 *Specification*?

No. The intent is unchanged. Though there is no explicit prohibition against considering tension field action at end panels, the 2016 *Specification* only addresses tension field action for "Interior Web Panels with $a/h \le 3$." Note that the $a/h \le 3$ limit is a similar restatement of the statement (b) in Section G3.1 of the 2010 *Specification*, "Consideration of tension field action is not permitted… when a/h exceeds 3.0…" a/h ratios greater than 3 are also still not permitted.

The Commentary of the 2016 *Specification* also provides some insight and states: "The method in Section G2.1 accounts for the web shear post-bucking strength in members with unstiffened webs, members with transverse stiffeners spaced wider than $3h$ and end panels of members with transverse stiffeners spaced closer than $3h$." The method in Section G2.1 does not consider tension field action. The Commentary to Section G2.2 emphasizes the point further and states: "The key requirement in the development of tension field action in the web of plate girders is the ability of the stiffeners to provide sufficient flexural rigidity to stabilize the web along their length. In the case of end panels there is a panel only on one side. The anchorage of the tension field is limited in many situations at these locations and is thus neglected."

Larry S. Muir, PE

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