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Questions on various aspects of design and construction of steel buildings and bridges are welcome. They may be submitted via email to info@cisc-icca.ca. CISC receives and attends to a large volume of inquiries; only a selected few are published in this column.

Question: When can structural steel be left unpainted?

Answer: This question is frequently asked by both engineers and architects. According to CSA S16-14 Clause 28.7.1, it is not necessary to paint the steelwork unless required by Clause 6.6 or when specified by the designer. In most buildings, the indoor environment is intended for human occupancy with low humidity and is therefore considered non-corrosive.

Some of the applications where steel is commonly left unpainted are mentioned in the CISC Commentary on CSA S16-14, Clause 28.7:

- **Steelwork** concealed by an interior building finish (i.e. sealed off from an external source of oxygen) or in a limited corrosive environment. Detrimental rusting of steel occurs when the relative humidity exceeds 70%.

  If the steel will be exposed for a short period during construction and then covered or enclosed, it generally does not need a protective coating. But if short-term protection is needed for periods up to 6 or 12 months, a primer complying with CISC/CPMA 1-73a or 2-75 would be specified as a minimum (Clause 28.7.3.3).
- **Steelwork** encased in concrete. Moreover, uncoated steel sections that are totally encased may not require shear connections to act compositely (some conditions apply; see Clause 17.6).
- **Faying** surfaces of slip-critical joints are unpainted, except as permitted by Clause 23. If painted, the slip resistance is based on the contact surface class (S16-14 Table 3).
- **Surfaces** finished to bear, unless otherwise specified (Clause 28.7.4.2).
- **Steelwork** where any coating could be detrimental to achieving a sound weldment. CSA W59-18 Clause 5.3 stipulates the conditions under which a light coat of shop-applied primer would not adversely affect welding.

Other situations where painting is avoided:

- **Spray-applied** and intumescent fire protection, since the paint may prevent proper adhesion. If corrosion protection is required, however, producers of fire-protection products may be able to recommend a compatible primer. Also see *Fire Facts*, Section 2.14.
- **Weathering steel applications**. CSA G40.21 types A – Atmospheric Corrosion-Resistant Weldable Steel and AT – Atmospheric Corrosion-Resistant Weldable Notch-Tough Steel are commonly used in highway bridges. Weathering steel can also be used on the exterior of buildings, although the detailing of joints needs special attention in order to avoid wet spots and pockets where water can collect.

References:

Turner, D.K. 1994. *Tips on Painting Structural Steel*. Advantage Steel No. 3, CISC.

Gewain, R.G., Iwankiw, N.R., Alfawakhiri, F. and Frater, G. 2006. *Fire Facts for Steel Buildings*. CISC.

Question: What are the differences between hollow structural sections (HSS) produced to ASTM A500 and those produced to CSA G40.20/G40.21?

Answer: Square, rectangular and round HSS are available in ASTM A500 Grade C and CSA G40.21-350W Class C or H (see Figure 1). Note that A500 Grade C is distinguished from grades A and B which have lower mechanical properties. And G40.21 Class C (cold-formed non-stress relieved) is distinguished from Class H (hot-formed or cold-formed stress-relieved) which has a greater axial resistance for columns of intermediate slenderness. The main difference between HSS produced to A500 and G40 lies in the wall thickness tolerance. For HSS produced to G40, the thickness tolerance is -5% or +10% from the nominal specified value,

FIGURE 1
Square, Rectangular and Round HSS

Differences in wall thickness also affect width-to-thickness (b/t) ratios for establishing the class of section. Moreover, a decrease in plate thickness may substantially affect the applicable design strength when it depends on higher powers (e.g. square) of the thickness.

while the mass tolerance is -3.5% or +10%. For A500, the thickness tolerance is ± 10% and there is no restriction on mass variation.

Accordingly, CSA Standard S16 specifies that design properties for A500 products must be determined from a wall thickness equal to 90% of the nominal value. There is an exception to this rule in the new CSA S16:19, however, in the case of HSS used as yielding elements in seismic force-resisting systems. To account for the possibility of HSS bracing members specified as ASTM A500 being dual-certified, and thus having a wall thickness closer to the nominal value than the (90%) design value, the nominal section properties must be used to calculate the strength of the bracing members for the design of capacity-protected elements.

Differences in wall thickness also affect width-to-thickness (b/t) ratios for establishing the class of section. Moreover, a decrease in plate thickness may substantially affect the applicable design strength when it depends on higher powers (e.g. square) of the thickness.

The next differences to consider are the mechanical properties. The specified minimum yield stress (F_y) is slightly greater for square and rectangular G40.21-350W sections (350 MPa) than A500 (345 MPa), but the difference is more significant for round sections (350 vs. 317 MPa, respectively). As for the minimum specified tensile strength (F_u), the values for all shapes (square, rectangular and round) are 450 MPa for G40.21-350W and 427 MPa for A500.

For all the above reasons, there are separate tables of factored axial compressive resistances (C_r) in Part 4 of the Handbook of Steel Construction for G40 and A500 column sections.

For information on HSS produced to ASTM A1085, see the Technical Column in *Advantage Steel* No. 48, Winter 2014. AS