ARCHITECTURALLY EXPOSED STRUCTURAL STEEL:

HOW IS IT DEFINED?

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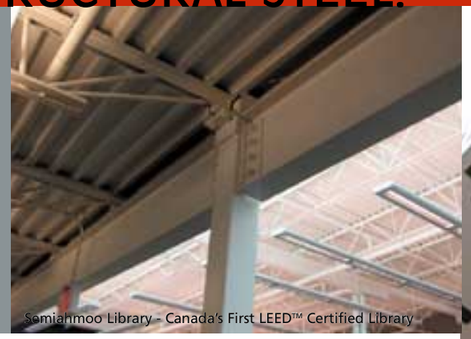
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The modern application of steel in architecture has given way to a bold new set of manifestations. The exposed use of steel in design and construction has become a popular trend and method of architectural expression. Both standard steel shapes and steel tubes or HSS sections are being employed to create the architectural character of a building. This style is defined as *"Architecturally Exposed Structural Steel"* (AESS).

Architecturally exposed steel construction has its history rooted in some of the famous cast and wrought iron structures of the early to mid-1800s. These structurally rationalist buildings used the qualities and detailing of iron components and fastenings to define the architecture of the space. Nothing was concealed. The craftsmanship was often exquisite.

Issues with fire protective design and related fatalities at the end of the 1800s, resulted in the majority of steel structures being covered with layers of gypsum, plaster and concrete. Steel connection detailing became extremely pragmatic and functional. Not until the high-tech movement of the early 1970s, followed by increased incidence of atrium spaces, sprinkler systems, new fire codes, and finally, the invention of intumescent paint coatings, did we see a real resurgence of the use of architecturally exposed structural steel in buildings. In Toronto, these early efforts may be characterized by the construction of the Eaton Center and Ontario Place.

Airport architecture has succeeded in pushing the use of exposed steel to incredible heights. Whereas the use of a fully exposed steel structure may not be allowed by the building and fire code for certain occupancies, airline terminal buildings do permit such exposure, and this, combined with requirements for extremely large column free spaces, have pushed the exploitation of the structural characteristics of steel – in particular, steel tube and truss assemblies. Expansions to Terminal One at Pearson International Airport in Toronto, to the Vancouver Domestic and International Terminals, and to numerous other terminals across Canada and the U.S., are using AESS as their material of choice.

Much of the architectural enjoyment, as well as challenge in designing with AESS is in the creation of the key details and connections that give the structure its distinctive character. After the primary choice of member type and system (shape vs. tube), the challenge lies in determining the method of connection – welding vs. bolting, and ultimately the design of the joint itself. Whereas designers tend not to be involved in connection issues for concealed structural systems, exposed systems become the architectural trademark of the building, hence requiring much involvement. Unfortunately, not all designers are adequately informed to choosing appropriate connection methods or to the cost implications of their choices. Detailing can be fun, if approached from an educated perspective!

The basic understanding of steel construction lies in its roots. Steel artistry is reliant on not only the appropriate choice of members (shapes versus tubes), but also heavily on the method of attachment. When creating joints between members, AESS design requires detailing according to industrial design standards. The structural requirements of shear and moment resistance must be accommodated, along with tighter dimensional tolerances, and other considerations such as balance, form, symmetry and economy. If the connections require an excessive degree of unique fabrication details, the designer can price the project out of existence; however, the method of preparation and finishing for the connections can radically increase costs. Specialized welds and unnecessary ground and filed finishes increase fabrication and erection expenses.

To this point in time, courses in both architecture and engineering schools do not tend to prepare students beyond the preparation of fairly standard connection details. Efforts are underway through the Steel Structures Education Foundation (SSEF) to create educational materials that address this deficiency.

Construction sequencing for architecturally exposed steel members can place limitations on detailing and increase the challenge of erection. The 90-foot long steel columns that support the upper structure of the addition to the Ontario College of Art and Design were pre-finished at the fabrication shop with a coloured fire resistant intumescent coating. Street access was extremely restrictive during the erection, and extra care had to be taken to preserve the integrity of the intumescent coating during handling and erection. A custom set of supports was constructed to hold the members in place until such time as proper lateral bracing could be provided. The integrity of the finish was also touched up intermittently throughout the construction process due to unavoidable nicks and scratches, the result of routine construction processes.

Intumescent coatings, although allowing exposed steel use in an increased number of occupancies, are not deemed by architects to be the best solution as they can result in a lumpy finish that can obscure some connection details. Fire protection methods for the exposed steel structure need to be determined early on as they should influence the type and design of connection detailing.

Some specifications for AESS place a higher level of workmanship requirements, above and beyond the regular structural and safety aspects of steel construction, to address the additional aesthetic and design considerations. Not only must more care be taken during the shop and field fabrication of the AESS product, but also other operations are necessary to raise the aesthetic and tectonic level of the steel for purely visual and tactile goals. It might be required to touch and feel the steel to ensure a smooth and defect free product, if situated at the public level.

If bolted connections are used, this may not be a difficult requirement as their tectonic characteristics are perceived to be somewhat busier, and the structural steel or tube itself is unlikely to require more than proper paint finishing. Welded connections can be at an extra expense due to the additional grinding operations. Specialty elements that require steel to be cast into unusual shapes, or bent into complex curves, also places additional requirements on the fabrication and installation that will increase the cost of the steel.

Such information needs to be conveyed to architects and engineers so that they understand the impact of line items in specifications. To illustrate the final expected result, a sample product board can be provided for each project along with a cost breakout to assist in differentiating the project costs related to high finish requirements in the exposed steel. Designers are then in a better position to both understand the product as well as the associated costs.

The examination of various AESS projects begs the question – *must all AESS buildings be designed to the same standard of workmanship?* It would seem that much unnecessary work is being carried out to make a product that is not always required to exhibit the sculptural qualities of buildings such as BCE Place by Santiago Calatrava.

Must steel that is situated 6 to 8 meters away from view be finished to the same standard as that within touching range? What happens when designers choose to use recycled steel elements (versus recycled steel % content) for reason of sustainable design as in the Chapiteau des Arts and Angus Technopole in Montreal? In both cases the designers are proudly displaying the reused state of the steel and have no intention of refinishing it to a sculptural standard. Yet it is technically architecturally exposed structural steel.

Is one answer possible or should there be a range of possibilities? Please stay tuned!

Terri Meyer-Boake is a Professor of Architecture at the University of Waterloo. She teaches in the area of building construction, environmental design and media. She has been the webmaster for the CISC website for the past two and a half years and is responsible for much of the documentation in the Project Gallery.