1 The Challenge

What is AESS?

Architecturally Exposed Structural Steel, AESS, is steel that must be designed to be both structurally sufficient to support the primary needs of the structure of the building, canopies, ancillary structures or pedestrian scale bridges, while at the same time be exposed to view, and therefore is a significant part of the architectural language of the building or structure. The design, detailing and finish requirements of AESS will typically exceed that of standard structural steel that is normally concealed by other finishes. AESS must be durable and maintainable. It must be able to resist corrosion if placed in a hostile environment and the design and finishes must also be resistant to urban pollution and general wear.

About the Guide

The Guide was developed to facilitate better communication amongst Architect, Engineer and Fabricator. It was felt that visual references would help all parties to understand the detailed intentions of the new Architecturally Exposed Structural Steel Specifications as these would be applied to the design of structures.

The Guide serves as a companion to two other AESS documents:

AESS E Sample Specification (for Engineers)

AESS F ASI Code of Practice (for Fabricators) / NZS 3404.1:2009

Both include the AESS Matrix.

The Guide was created primarily for Architects but is also intended for all design professionals interested in AESS applications. In terms of the relationship between the new AESS documents and specific areas of practice, Engineers and Fabricators have role related specifications, Architects have the Guide, and all are linked by the Matrix of Categories and Characteristics. The Matrix sits at the centre of the suite and provides the connection that links all of the documents.

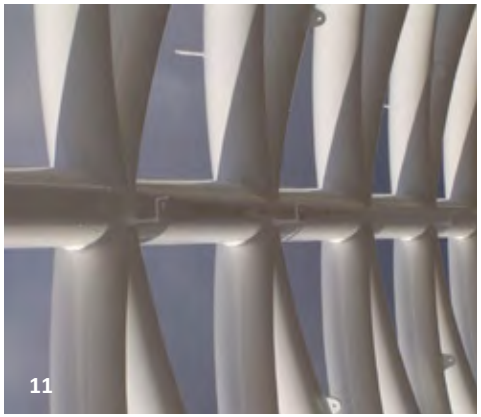
This Guide has been written to help you to more fully understand the Specification of AESS material. It provides you with visual references to help you to better understand the terms of reference. The buildings and connections included in this document are meant to be representative and to provide helpful visual references that support the key facts that are being explained by the Guide. It is also hoped that the range of projects illustrated will inspire you by highlighting the wide range of possibilities available when designing with Architecturally Exposed Structural Steel.

It is not the intention that the included details should be replicated or necessarily represent “best practices”. They are presented only to allow for a better understanding of the visual intentions of the practices and procedures outlined in the Guide and related specification documents. Understanding that “a picture might be worth a thousand words”.

The Evolution of Architecturally Exposed Structural Steel:

The basic understanding of steel construction lies in its roots as an “assembled”, largely prefabricated methodology. Steel construction is “elemental” in nature, and its artistry reliant on not only the appropriate choice of members (shapes versus tubes), but also heavily on the method of attachment. AESS steel design requires detailing that can approach “industrial design standards” when creating joints between members. The structural requirements of shear and moment resistance must be accommodated, along with tighter dimensional tolerances, along with “other” considerations such as balance, form, symmetry and economy. If the creation of connections requires an excessive degree of unique fabrication details, the designer can price the project out of existence. The method of preparation and finishing of the connections can also radically increase costs. Specialised welds and unnecessary ground and filled surfaces will increase fabrication and erection expenses.

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. Compositional issues usually necessitate the addition of “extra” steel at the joints to create a “beautiful” connection. Unfortunately not all designers are adequately informed either to choosing appropriate methods of attachment or to the cost implications of their choices.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The surge in the use of AESS has created a paradigm shift in the sequential communication that usually takes place in a more conventional building where the steel structure is hidden. The Architect now wants direct access to the Fabricator's shop to verify and comment on the edges and surfaces of the imagined product, and the Engineer is dealing with aesthetic aspects that impact the structural integrity of the frame. That leaves the Fabricator and the erector somewhere in the middle between aesthetic and technical requirements, but with a clear handle on the cost.

The paradigm shift centres on the simple fact that a "nice looking connection" or a "smooth surface" has very different meanings whether you are talking to an Architect, an Engineer or a Fabricator. Such a situation can create a misalignment of expectations in terms of what can be accomplished within specific budget limitations. Welds that are contoured and blended are not the same price as hexagonal bolts for example.

The majority of AESS projects today rely on BIM and electronic documentation to ensure a more seamless flow of information in the project.

The Development of the AESS Documents:

It was felt that the normal specification that was being used for structural steel was incomplete when it came to serving the special needs of AESS. This document focuses on differentiated Categories because it became clear that not all AESS need be created equal(ly expensive). For example, viewing distances, coating thicknesses and connection types should matter as they all impact the nature of the finish and detail required in exposed steel. A system of Categories is used to define the nature of finish and tolerance in the steel. The Categories are further defined by a set of technical Characteristics. To facilitate better communication amongst Architect, Engineer and Fabricator, categories and their associated characteristics are presented in a Matrix to provide an easy graphic reference. In total, three AESS documents reference the Matrix: this Guide, a Sample Specification, and the ASI Code of Practice (for Fabricators) / NZS 3404.1:2009.

Primary Factors of Influence that Define AESS:

There are primary factors that give rise to the differentiated Categories of AESS.

- **Connections mostly bolted or welded**
  (different aesthetics requiring differing levels of finish)
- **Tolerances required at fabrication and erection**
  (different as a function of scope and complexity)
- **Access to detail to perform required finish**
  (greater concern for workmanship may mean altering the detail or its location to allow access for different types of tools)
- **Degree of expression**
  (complexity of structure and connections)
- **Size and shape of structural elements**
  (I sections and RHS/CHS have different detailing requirements and their use infers a different approach to detailing and finish)
- **Interior or exterior setting**
  (weathering issues, need to fire protect, potential for impact damage)
- **Paint finish, corrosion resistance, fire protection**
  (depending on the relative thickness of the finish material, more or less care may be required when preparing the surface, edges and welding of the steel)


15

The Sainsbury Centre for the Performing Arts was designed and constructed by Norman Foster in 1977. The British High Tech movement brought exposed structural steel to the forefront of design, and with it an array of issues that had not a been part of architectural discourse for more than a century. The project used CHS members and a structure that was expressed on the exterior and interior of the building.


16

Architecturally exposed structural steel has grown in its use and application, to include many more sculptural exterior uses, such as pedestrian bridges. The detailing and considerations of corrosion and wear on exterior applications are of increasing importance to all involved in the design and fabrication process. Such public projects are very accountable and highly visible to the public at large.


17

AISC, in its article on Architecturally Exposed Structural Steel Construction, in Modern Steel Construction, May 2003, cited the roots of the current trend of exposed steel and transparency in design to the Chicago O'Hare United Airlines Terminal designed by Helmut Jahn between 1985 and 1988. Indeed, airport architecture has succeeded in pushing the use of exposed steel to incredible heights.

Form, Fit and Finish:

The primary factors of influence can be further summarised as Form, Fit and Finish. Unlike standard structural steel that is hidden from view, Architecturally Exposed Structural Steel is a key element of the expression of the Architectural Design. A large amount of emphasis is placed on the **FORM** of the steel in the design. The overall Form may vary greatly from regular framing and might often include curves, unusual angles or three dimensional elements. Members and connections are designed with more attention to the way that their details support the aesthetic intentions of the design. Bolted or welded connections may be chosen less for their structural capabilities or ease of erection than the way that their appearance works with the overall intention and the form of the design. This does not mean that their structural integrity must not be a key consideration in the success of the design.

Highly articulated steel structures are by their nature more difficult to **FIT.** There is significantly less play in the connections and accumulated errors can result in overall misalignment. This need to ensure accuracy, ease of fabrication, as well as bottom line constructability, puts greater pressure on the details and requires narrower tolerances throughout the entire project. Tighter tolerances will carry through when the exposed steel framing must coordinate with other trades, in particular areas of significant glazing and curtain wall. The use of stainless steel spider connections for structural glass systems puts additional pressure on allowable tolerances. If exposed steel is used with heavy timber or Glulam systems, then the fit must also take into account the differential movements and erection idiosyncrasies of these other materials.

While the **FINISH** might be the last phase of construction, *the selection of the Finish must take place at the beginning of the AESS design process*. Finishes will vary in exposed steel both as a function of the design intention as well as issues relating to weathering, interior or exterior exposure and fire protection. A high gloss finish will reveal every imperfection, and so will require more fastidious fabrication. A thicker intumescent coating will conceal many surface imperfections. Galvanizing itself has issues with surface consistencies and its selection may accompany a less polished selection of details. The bottom line for the contract is that both time and money will be wasted if the level of fabrication care greatly exceeds the nature of the Finish.

Exceptions

Form, Fit and Finish considerations will differ on projects whose intentions might fall outside of traditional Architecturally Exposed Structural Steel. Steel is often selected as the material of choice for large art installations. Here there needs to be a customised variation of the considerations presented in this Guide that form the basis of dialogue for the team. Where some artists might be looking for a very plastic appearance, others may wish to let the rough nature of the steel reveal itself. Weathering steel and stainless steel present very different opportunities as well as challenges.

Reused steel also requires a different set of considerations. Many projects seek to incorporate reused or salvaged steel for its sustainable qualities. In some instances the steel may be cleaned, but in others left with its original finish so that it can express its reuse. This type of application also demands a variation of the general intentions presented in this Guide.

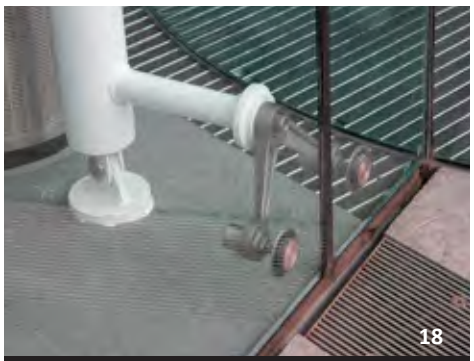
To Grind or Not to Grind?

A major motive behind the development of the AESS documents is to assist the industry in making good choices. A major source of contention and waste is the grinding of welds. Such remediation of a connection method is only warranted in the highest level of AESS. Competent, neat welding should suffice on all but the highest quality of AESS. Distance from view or function will obviate the need to grind welds. It is important to understand that the weld has a functional use and its removal will weaken the connection.

A “glove smooth” finish is also only suited to AESS 4 projects (the highest level). The grinding, filling and remediation of surfaces prior to the application of a high quality paint finish should be considered far from routine. This will incur a high cost premium and is seldom warranted. Again distance from view and function should govern.

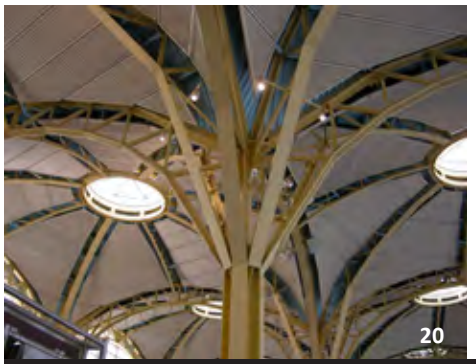
Finding an AESS Qualified Fabricator

It is highly recommended that Architects contact ASI or SCNZ for information regarding Fabricators with expertise in AESS projects.

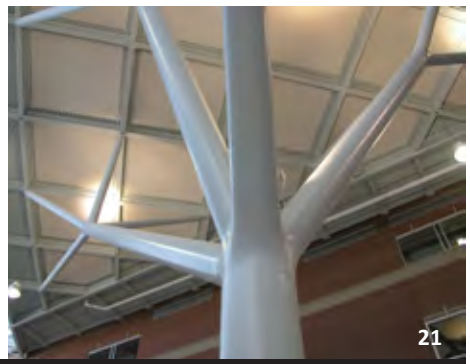


18 Specialty glazing systems require tighter tolerances and a higher level of FIT on a project.

19 Composite structural systems require higher levels of coordination and that the tolerances and construction practices of the other material be taken into account.



20 Two different steel trees. One created using I shapes to create a very textured appearance, the other using mechanical pipe and specialty castings and striving for a seamless appearance, using a high gloss finish. AESS specifications must be tailored to the overall design intentions of each individual project as they are all somewhat unique.



21