

THE DESIGN, DETAILING, FABRICATION AND EXECUTION OF ARCHITECTURALLY
EXPOSED STRUCTURAL STEEL

by

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Abstract

Architecturally exposed structural steel, AESS, is a unique member designation used in contract documents to describe steel members designed according to stringent provisions as to be completely exposed in close proximity to the human eye after the structure is completed, rather than concealed from view. These members are often used to convey architectural art or expression, and have a distinctive beauty that attracts the eye. The requirements for AESS members are much more stringent than those for typical structural steel members, and therefore is more controversial as to whether it is worth the extra attention it requires.

The purpose of this report is to examine the design, detailing, fabrication and execution of architecturally exposed structural steel. This is done by examining what contributes to each of these stages from design to field erection. Much of this report is based on guides and sample specification by various sources, including the Structural Engineers Association of Colorado (SEAC), Rocky Mountain Steel Construction Association (RMSCA), and the *AISC 303-10 Code of Standard Practice for Steel Buildings and Bridges* (American Institute of Steel Construction Committee on the Code of Standard Practice, 2010) in addition to other sources. The conglomeration and in-depth review of this information provides the Structural Engineer, Architect, Fabricator and Owner an enhanced understanding and knowledge of AESS, as to make better decisions throughout its use.

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I also want to thank Joshua, for always being there for me, even in stressful times. I wouldn't have made it this far without you.

Dedication

This report is dedicated to my parents, David and Stanna, who always encouraged me to challenge myself and reach my full potential. I wouldn't be where I am today without your sacrifices and love.

Chapter 1 - Introduction

What is AESS

Architecturally exposed structural steel, AESS, is a unique member designation used in contract documents to describe steel members designed according to stringent provisions as to be completely exposed in close proximity to the human eye after the structure is completed, rather than concealed from view. These members are often used to convey architectural art or expression, and have a distinctive beauty that attracts the eye. The requirements for AESS members are much more stringent than those for typical structural steel members, and therefore is more controversial as to whether it is worth the extra attention it requires.

The purpose of this report is to examine the design, detailing, fabrication and execution of architecturally exposed structural steel. This is done by examining what contributes to each of these stages from design to field erection. Much of this report is based on guides and sample specification by various sources, including the Structural Engineers Association of Colorado (SEAC), Rocky Mountain Steel Construction Association (RMSCA), and the *AISC 303-10 Code of Standard Practice for Steel Buildings and Bridges* (American Institute of Steel Construction Committee on the Code of Standard Practice, 2010) in addition to other sources. The conglomeration and in-depth review of this information provides the Structural Engineer, Architect, Fabricator and Owner an enhanced understanding and knowledge of AESS, as to make better decisions throughout its use.

Appropriate Applications

Extremely versatile, AESS may be utilized for a structure in its entirety, or may be placed in key locations to provide visual interest. Appropriate applications are dependent on the Owner, Architect, and Structural Engineer's vision of the project and the feeling they want the AESS to induce. AESS is commonly seen in such places as canopies, airport terminals, atriums, and even in retail and office applications. Figure 1 shows the use of AESS in an airport terminal in

Chicago, IL. According to AISC, 90% of architecturally exposed structural steel is seen on canopies (American Institute of Steel Construction, 2006). AESS is often desired only in areas where the viewer can see it, due to its impact to both cost and scheduling. The opportunities for AESS are endless, but overall, it is most important to understand and balance visual appeal with the stringent requirements and increased costs. This is where it is imperative that the Architect and Structural Engineer have a clear line of communication and dialogue, so that AESS is used both appropriately and efficiently. Most exposed steel is not defined as AESS. When the AESS designation is used, the provisions from Chapter 10 of the *AISC Code of Standard Practice for Steel Buildings and Bridges* are required to be implemented; therefore, it is imperative to clearly define what members are designated as AESS on the contract documents. This understanding and dialogue is vital to the use and success of AESS in a project from the early planning stages to final erection of the structure.



Figure 1: AESS Airport Terminal (The United Airlines Terminal, Chicago, IL. Architects: Murphy/Jahn and A. Epstein & Sons Int'l) (American Institute of Steel Construction, 2006)

Chapter 2 - General Requirements

In order for the use of AESS to be a viable option, some general ways to promote and manage early success are: (American Institute of Steel Construction, 2006)

- Establish realistic expectations for the project

This occurs in the planning phase. Those involved in the project, for example, the Owner, Architect, Structural Engineer, and Fabricator, should meet to discuss the goals and expectations of the project. This will aid in getting everyone's opinion, and discovering realistic ideas. It will help develop and integrate an understanding of how to get what the Owner and Architect want, while maintaining an efficient and quality design.

- Foster good communication between the Owner, Architect, Structural Engineer, and Fabricator

Communication is a very significant part of any project. Verbal and written communication in the contract documents is utilized in the design, detailing, fabrication, and erection of any AESS project, so is necessary to promote a successful project. This is different from a typical project in that any miscommunications leading to errors in design or fabrication will most likely be in direct view by the public, rather than being hid behind other finishes. Since AESS typically has increased costs and stricter tolerances associated with it, having poor communication, either verbally or in the contract documents, could increase the difficulty of meeting the requirements and expectations of others in the project team and could also cause costly errors. Face-to-face discussions between the Structural Engineer, Architect, Fabricator, and Owner will help alleviate confusion as to the expectations of the project. Any language included in the contract documents shall be detailed and clear to provide a set of guidelines for the vision of the AESS members. If everyone is

clear on the status and details of the project from start to finish, it is more likely to meet these requirements and expectations the first time, and with fewer errors.

- Develop a clear and detailed bid package

AESS has many costs associated with it above and beyond a typical structural steel project, due to more rigorous tolerance and appearance requirements. It is crucial to develop a clear and detailed bid package of the costs that accompany the AESS members. This will require the Architect and Engineer to specifically define what members are to be AESS, and clearly describe to the bidders the *AISC Code of Standard Practice* requirements, since AESS requirements apply only to members which are designated as AESS on the contract documents. This will provide focus to the design team, and help prevent problems with unforeseen costs later in the project. In order for the Owner and Architect to make the best decisions on the use of AESS, they must be provided with a thorough and accurate bid.

- Specify and use an acceptable, qualified Fabricator (and involve them in the design process to recommend cost control measures)

This step is essential to avoid conflict and promote efficiency throughout the project's conception. Less risk occurs if the Fabricator is familiar with AESS and has experience with the fabrication requirements. Involving the Owner, Architect, Structural Engineer, Fabricator and Erector that will oversee the design, detailing, fabrication and erection of the AESS members will keep the project efficient. Fabricators are skilled in making recommendations to keep costs down in ways that the Owner, Architect and Structural Engineer might not have considered. This is yet another reason to promote a good working relationship and line of communication during the life of the project.

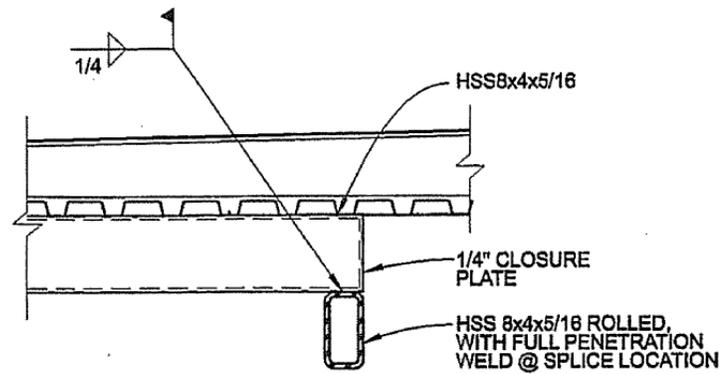
In this chapter, general requirements are considered in greater detail for various phases, including submittals, quality assurance, delivery, storage and handling, project conditions, and project coordination. These general requirements are applicable to most AESS projects.

Submittals

In general, items to be submitted must meet the conditions of the contract and Master Specification Division 1 Sections, in addition to the relevant Division 5 and any other relevant Specification Sections. Items that would be appropriate for submittal include: (Architecturally Exposed Structural Steel, 2003)

- Product data for each type of product specified
- Shop drawings detailing fabrication of AESS components

When submitting shop drawings, they must clearly illustrate which members are AESS and which are not. The details shall identify required fabrication and erection tolerances, and connection details should be consistent with perceptions shown per the structural and architectural drawings. An example of a detail showing an AESS designation is shown in Figure 2. In this detail, there is a note stating, “Steel Members and Connections are Architecturally Exposed.” This detail does not make a clear designation of which members are AESS and which are not and could therefore be improved by stating which members and areas are to be AESS. For example, the top beam shown in the detail may not be exposed to view, and therefore may not be required to be fabricated as so, which will generate a cost savings over fabricating all members as AESS. In addition to this, any special requirements and finishes for the metal decking may only be required in the exposed areas of the decking. The detail shown designates the AESS members in a very general way, which could be a more expensive alternative than specifying only the members which will be visible upon completion.



NOTE: STEEL MEMBERS AND CONNECTIONS ARE ARCHITECTURALLY EXPOSED.

**Figure 2: Example Detail Showing AESS Designation
(American Institute of Steel Construction, 2006)**

Another example of a detail showing an AESS designation is shown in Figure 3. This detail shows an HSS Steel Column, designated to be AESS, but as shown adjacent to this is a note stating “Column Above Slab Only.” This conveys that any steel located below the top of the slab does not need to be fabricated per AESS guidelines. The surfaces of the column above the slab are required to meet the fabrication and erection tolerances and finish requirements of AESS, as provided in the contract documents. In only requiring the steel above the slab to be AESS, this will generate cost savings from using a standard baseplate and connections. These parts of the column base will not be exposed to view, so the AESS designation is unnecessary.

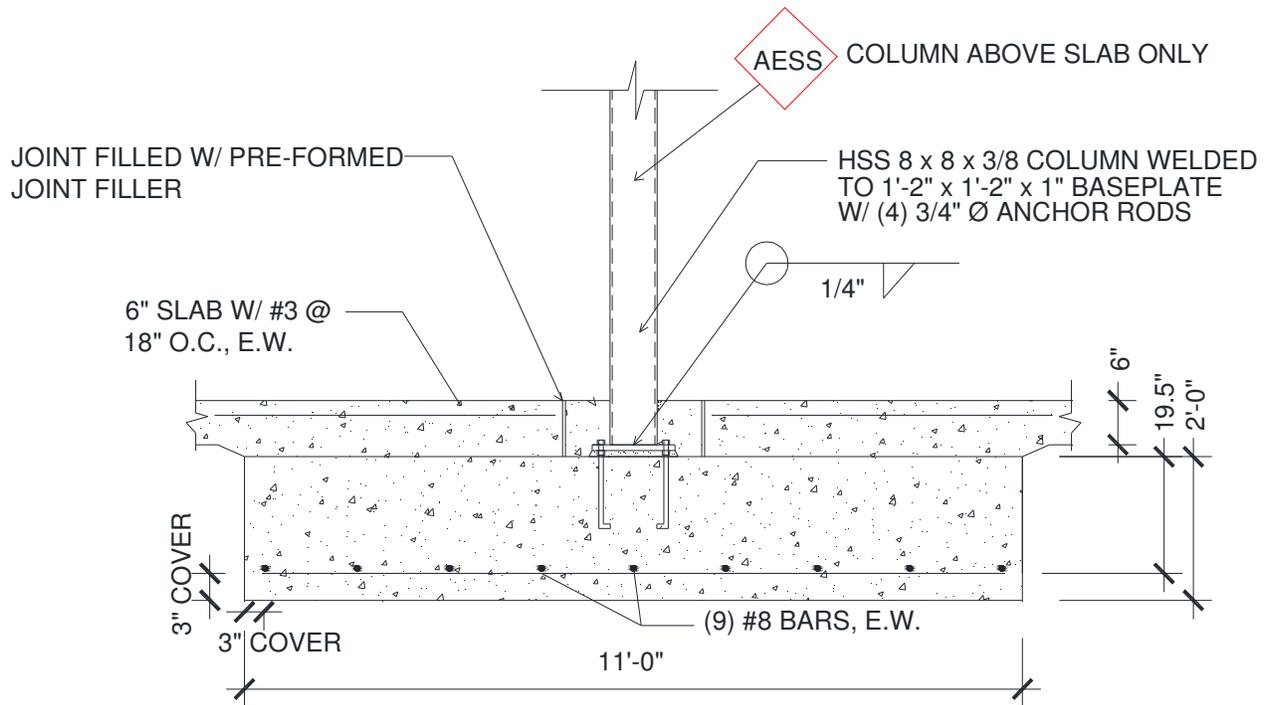


Figure 3: Example Detail Showing AESS Column Base

All welds on the shop drawings are to be shown with standard American Welding Society (AWS) symbols, showing the size, length and type (shop or field weld). The profile of the welds, finish and grinding requirements should also be shown on the shop drawings.

All bolts on the shop drawings shall be designated with the type, size, finish, bolt length and type (shop or field bolt). Special connection conditions such as high-strength bolted slip-critical, direct-tensioned shear or bearing connections must be identified. The direction of bolt head orientation should also be included on the shop drawings.

The surfaces or edges that are to be exposed must be identified on the shop drawings, as well as what class of surface preparation is expected to be used.

Any special tolerances or erection requirements desired shall be shown in the shop drawing submittal in order to confirm their use. For example, per the *AISC Code of Standard Practice* Section 10.2.4, all copes, miters and cuts in surfaces that will be exposed to view and are specified as AESS are required to have a uniform tolerance gap of 1/8". Standard tolerances for members are much greater, as they will not be visible.

- Product and procedure data for AESS paint system

Included as a submittal shall be the product and procedure information for the member finish desired. This should include the required surface preparation, primer and paint coating guidelines, and must have been coordinated with the finish coat specified in Master Specification Division 9.

- Qualification data

It is imperative to ensure that the firms and people contributing to the AESS project have knowledge and experience in order to be competent members of the project team. For this reason, it is recommended to compile qualification data for Fabricators to demonstrate their skill level. Lists and photographs of completed AESS projects, as well as contact information for those involved will aid in acquiring a Fabricator that can be trusted to make quality contributions, as well as avoid common conflicts that could cost both time and money.

Quality Assurance

To ensure the importance of quality is satisfied for the AESS project under consideration, some general guidelines to follow that will promote a quality end-product are: (Architecturally Exposed Structural Steel, 2003)

- Fabricator qualifications

The particular Fabricator selected for the AESS members shall be one with experience in fabricating members common to those being specified. They should hold a record of successful in-service performance, and be able to prove that they have the production and manpower capacity to complete the AESS members without delaying other work they may be engaged in. For example, one way that the Fabricator could prove their experience would be to provide photos, details, or owner references for past AESS projects. They should also be able to confirm that they can complete AESS on-schedule and with no or few errors causing delays.

- Erector qualifications

The steel erector selected shall be one with experience in working with AESS, with a record of completed AESS projects similar in material, design and extent to the project under consideration. This could range from photos to owner references or even traveling to completed project sites to view the Erector's past work. They should be able to demonstrate successful in-service performance on past projects, as well as confirm ability to complete AESS member erection on-schedule and with no or few errors causing delays.

- Code compliance

Comply with the *AISC Code of Standard Practice*, latest edition, Section 10 (American Institute of Steel Construction Committee on the Code of Standard Practice, 2010)

- Mockups

Mockups shall be constructed as specified in the contract documents by the Architect prior to AESS fabrication in order to ensure that specific design tolerances, finishes and aesthetic qualities meet those desired and expected from the design team. Seeing actual examples of these tolerances and finishes will help the Owner, Architect, and Fabricator realize what tolerances and finishes are realistic to their project, as well as in what range they are achievable. Tolerance and finish expectations will be more stringent for areas of members which are in closer proximity to the viewer, and could be less stringent at further distances. For this reason, mockups are created and should be viewed at various distances to decide on appropriate tolerance and finish requirements. In addition, it is common to use the approved mockups in the final member assemblies if desired. The use of mockups helps to promote quality fabrication, as well as prevent misunderstandings among the project team.

- Pre-installation conference

The General Contractor shall schedule and perform a pre-installation conference at the project site to meet the requirements of Master Specification Division 1 Section 'Project Meetings'. This meeting should include the Contractor, Fabricator, Erector, finish-painting Subcontractor, Architect, and the Structural Engineer. During this meeting, topics such as shipping, special handling, attachment of safety cables, temporary erection bracing, touch-up painting and other requirements for AESS shall be covered and coordinated. A pre-installation conference for an AESS project will differ from a typical project in that more attention will be given to how the

installation will affect the look of the members. The guidelines will be more stringent for AESS members, since they will not be concealed from view in their final position. Special handling and installation topics will be covered in greater detail, as to prevent costly errors in the field. This will help keep all members of the project team on target for successful project completion.

Project Conditions and Coordination

Prior to fabrication, dimensions shall be verified by field measurements where AESS is to be fit against walls and other construction that may already be in place. These field measurements should be shown on the shop drawings and coordinated with the progress of construction as to prevent delays. Any unique or unforeseen project conditions, such as a differing measurement than was originally planned for, shall be communicated to the Architect prior to fabrication and erection to ensure proper placement of AESS members and to prevent delays in construction.

It is also important to coordinate the installation of anchors for AESS members that will be connecting to the work of other trades. The methods of anchor installation shall be properly shown on the architectural and structural drawings, as well as the shop drawings. Items that will require furnishing include setting drawings, templates, directions for installing anchors, anchor bolts, and items with integral anchors. Providing these items will further ensure coordination for proper anchor installation. This is especially important to consider, since the connections of these anchors may or may not be exposed to view. Attention must be given to the appearance of those connections of AESS members to the work of other trades to ensure that they meet the design requirements for both strength and the appearance requirements of the Architect and Owner. For those anchors that will not be exposed to view, the appearance requirements will not be as stringent, as they will not be seen in their final placement.

Chapter 3 - Design and Detailing

Materials and Member Shapes

In general, materials to be specified as architecturally exposed must follow the requirements found in Master Specification Division 5 Section, 'Structural Steel'. Structural components commonly seen in AESS applications include wide flange sections, curved members, open-web beams, trusses, hollow structural sections (HSS) and cables and rods (American Institute of Steel Construction, 2006). AESS members can take many shapes to meet the Architect's expectations with today's modern fabrication machinery. The members can be cold-curved or heat-bent, to yield a curved member. Members can be punched with holes with computer-controlled cutting machinery, as is often seen in cellular or open-web beams, offering both a lighter structure, as well as an aesthetically attractive appearance. Members can even be tapered or built-up and tapered to give a unique feel to the structure. Ultimately, it is up to the Architect and Structural Engineer to decide which shapes and structural components are used, as long as the members are capable of meeting the requirements to be classified as architecturally exposed and are structurally adequate.

Primers and Finishes

Many different options in terms of primers and finishes can be considered during the design and detailing phase of construction. Depending on the project type, service life and final finish expectations, the designer shall select the appropriate surface preparation required, as well as the primer and finish. For instance, the designer may consider questions such as, 'What environment will the members be subjected to?', or 'Will a high-performance coating be required?'. Questions such as these will help the designer determine the most appropriate primer and finish selections, and coordinate with the Architect where they will need to be specified. This coordination can be a major contributing issue to the success of the final look of the members, since the Structural Engineer will typically write and edit the steel specifications, while the Architect will write and edit the surface preparation, primer and finish specifications.

If proper coordination is not performed, the specifications may conflict, leading to costly setbacks during the fabrication phase of construction.

Primers

A primer is only required if the member will have a finish coat, and must be synchronized with the finish coat to ensure that they are compatible. Based on whether the member is classified as AESS or not, the attention given to the primer and finish will become more or less stringent. Standard steel members may require a lower-grade primer and finish, as the member will be concealed and the appearance of the member will not be seen. Many types of primers are used for steel, and are composed of resins such as alkyd, acrylic, epoxy and zinc. The following descriptions of the resins are reproduced from part of the sample AESS specification from the *Modern Steel Construction* Supplement entitled “Architecturally Exposed Structural Steel”, section 2.2 (Architecturally Exposed Structural Steel, 2003):

- *Alkyd primers are typically referred to as shop coat primers, available in many different levels of quality depending on the level of corrosion protection required. Alkyd primers range from keeping the steel from flash rusting prior to being concealed by an interior wall, up to long-term corrosion protection. They are fast drying, which enables the Fabricator to quickly deliver the members to the job site. Standard alkyd primers can be finish coated with an alkyd or water-based enamel. Universal alkyd primers can be used under high-performance coatings such as epoxies or urethanes. In general, for exterior exposure, a high-quality, universal, rust-inhibitive primer should be used. The increase in cost over a standard “Shop-Coat” primer is on the order of \$5.00 to \$10.00 per gallon. The material cost of the paint represents a small portion of the total painting cost, while the higher quality provides greater corrosion protection to the steel.*
- *Acrylic primers are corrosion resistant and water-soluble, often providing a lower VOC (volatile organic compound) content. They are available in shop-coat quality up to a universal primer for use under high performance coatings such as epoxies and urethanes.*

- *Epoxy primers provide excellent corrosion protections for steel and can be top coated with a variety of finishes. Epoxy primers can be applied in the shop and typically have a high film-build that can be used to hide minor imperfections.*
- *Zinc rich primers provide superior corrosion protection by providing cathodic protection to the steel. Zinc rich coatings can be specified as either organic zinc or inorganic zinc. Both inorganic and organic will meet class B slip coefficients for bolted connections. In arid regions, organic epoxy/zinc primers should be specified, as they do not rely on an outside source (humidity) for cure. Inorganic zinc requires a constant humidity of no less than 40% relative humidity for proper curing. If an intermediate and finish coat are to be completed in the shop, the lack of humidity can cause delays in both the painting process and project as the zinc must be cured prior to top-coating. Although a urethane finish coat can be applied directly over an organic zinc, it is suggested that an intermediate epoxy coating be used to prevent “pin-holing” in the urethane coating, promote adhesion of the system, and increase film build to hide imperfections in the steel. Alkyd finish coats should not be specified over zinc primers. For galvanizing repair, an organic zinc with not less than 90% zinc by weight in the dry film should be used for re-galvanizing welds and damage due to erection.*

Table 1 describes some common primers for AESS members. These primers are listed in order of cost, with the least expensive at the top, moving to the most expensive at the bottom. A galvanizing repair paint is generally 3-5 times more expensive than a standard alkyd primer, depending on primer manufacturer or supplier. As previously mentioned, the selection of primer for the AESS members will vary based on the desired use.

Table 1: Common Primers for AESS Members

(Table developed from sample AESS specification section 2.2) (Architecturally Exposed Structural Steel, 2003)

PRIMER TYPE	DESCRIPTION
Standard Alkyd	Fabricator's standard alkyd red oxide, rust-inhibiting primer.
Modified Alkyd	Fast curing, universal modified alkyd, rust-inhibiting shop coat with good resistance to normal atmospheric corrosion. Primer shall comply with all federal standards for VOC, lead and chromate levels.
Acrylic	Acrylic water-soluble shop coat with good resistance to normal atmospheric corrosion. Primer shall comply with all federal standards for VOC, lead and chromate levels.
Two-part Epoxy	Fast-curing two-part epoxy. Primer shall comply with all federal standards for VOC, lead and chromate levels.
Organic Epoxy/Zinc	Organic, epoxy/zinc-rich, meeting class B surface requirements for slip-critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels.
Inorganic Zinc	Inorganic zinc-rich primer, meeting class B surface requirements for slip-critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels.
Galvanizing Repair Paint	High-zinc-dust-content paint for galvanizing welds and repair-painting galvanized steel, with dry-film coating not less than 90% zinc dust by weight.

Finishes

Upon completion of the priming process of the members, they will be subjected to some type of finish, selected during the design phase to be compatible with the primer and finish desired. The three most common finishes for AESS are painted, galvanized, or duplex, which consists of paint coated over the galvanized finish. These three finishes differ primarily in their service life, or how long they will effectively last. Painted finishes typically have the shortest service life of the three, ranging from 20 to 30 years. The service life of a galvanized finish is next, ranging from 60 to 70 years. The duplex finish is the longest lasting of the three finishes, with a service life ranging from 100 to 150 years.

If possible it is better to apply the finish to the members in the field upon erection, but they may also be applied in the shop, as field finishing can be extremely costly. The drawback to applying the finish in the shop is that the finish will most likely be damaged during shipping and erection, requiring the finish to be touched-up or even completely re-applied to correct the damages. Touching-up finish damages can be very costly and difficult to blend well with undamaged finish areas, so if members are to be shop finished, extra precautions should be in place to protect them from damage during shipping and erection.

Some common finishes for commercial AESS members are shown in Table 2, listing both a description and the common modes of application. Those modes with an asterisk (*) are the preferred methods of application for that particular finish, for optimum results.

Table 2: Common Finishes for AESS Members Used in Commercial Projects
(Table developed from sample AESS specification section 2.2) (Architecturally Exposed Structural Steel, 2003)

FINISH TYPE	DESCRIPTION	APPLICATION (*PREFERRED)
Alkyd (Oil-based)	An alkyd finish would be acceptable for interior applications and some exterior applications. This finish dries to a hard, durable finish. When it is applied and specified for exterior use, alkyds will chalk and fade with ultraviolet exposure in a relatively short period of time.	Brush Roller Spray
Acrylic (Waterborne)	An acrylic finish would be acceptable for both interior and exterior applications. Acrylics provide quality color and gloss retention under ultraviolet exposure, as well as low odor and VOC content for interior applications.	Brush Roller Spray
Epoxy	An epoxy finish is typically used for interior use where abrasion resistance is required. The high-build nature of this finish can help cover imperfections in the steel, but will chalk and fade with ultraviolet exposure.	Brush Roller *Spray
Polyurethane	A polyurethane finish provides high performance protection with excellent color and gloss retention, with a higher build than that of an alkyd or acrylic finish, which helps cover imperfections in the steel.	Brush Roller *Spray

Fire Resistance

As required by the building codes, structural members must meet or exceed minimum fire resistance ratings. This minimum hourly rating is based on the building construction type, which is determined by the building height and area, as well as whether the member is a primary or secondary element of the structure. A primary structural frame element is one that has a direct connection to the columns and braces that were designed to carry the gravity loads. The failure of a primary element could lead to failure of the load-carrying capacity of the structure, which could result in complete structural failure. A secondary structural element is one that does not have a connection to the columns, such as an element in the roof or floor structure. The failure of a secondary element will most likely not result in complete structural failure. Based on the building construction type and primary or secondary designation, the minimum hourly fire resistance rating can then be found from the *International Building Code (IBC)*. With this rating, the designer will then select appropriate fire protection materials to be applied to the AESS members. If the designer wished to leave the members unprotected, rather than using fire protection materials, an engineering analysis of the structure would need to be conducted by a qualified structural Fire Protection Engineer. The analysis would have to prove that the members were compliant with the performance objectives of the *International Building Code* for the particular project. This analysis can be costly to the design of these members, but is sometimes possible and necessary based on the project.

When it is desired to apply fire protection materials to the surface of the AESS members, several commercially tested materials are available to provide the level of safety required by the *IBC*. Generally, these materials should meet the following guidelines (Parker, Beitel, & Iwankiw, 2005):

- Provide the required thermal protection when tested
- Be a manufactured product or system
- Be efficient to apply, yielding uniform thickness
- Have adequate bond to the underlying steel
- Be resistant to corrosion, weathering, and aging

- Resist abrasion damage resistance for materials that are applied within the reach or access of the building occupants
- Be non-combustible

Some common fire protection materials include intumescent materials, sprayed fire-resistive materials (SFRM) and board-type materials. Intumescent materials are coatings typically brushed or sprayed on the member surface that, when exposed to extreme heats, expand and swell to protect the underlying material. SFRMs are cementitious and thicker, resembling a plaster-type rough finish, as seen in Figure 4. Board-type materials wrap around the member, concealing it completely. SFRM and board-type materials are not commonly used for AESS members, as they conceal the members in a way that does not leave them exposed to view and are therefore not architecturally pleasing. For this main reason, intumescent fire protection materials are the foremost selection for AESS members.



**Figure 4: Structural Steel Column Protected with SFRM
(Parker, Beitel, & Iwankiw, 2005)**

Two common types of intumescent fire protective coatings are used for AESS applications. These include thin-film intumescent and epoxy-based intumescent. It is important to remember that these intumescent have a thickness and texture that can affect the

desired look of the element, and may require alterations to the design proportions and detailing for appearance.

Thin-Film Intumescent

Thin-film intumescent are fire protection materials applied directly to the steel surface by brushing or spraying. These coatings are fairly thin, approximately 0.03 to 0.40 inches when dry, and are applied in thin layers that can be built-up by applying multiple layers. When thin-film intumescent are exposed to heat, they undergo a chemical change and produce an insulating char layer that is 15 to 30 times thicker than the coating's initial thickness (Parker, Beitel, & Iwankiw, 2005). A primer is required to be applied to the steel surface before the thin-film intumescent, in order for it to properly adhere to the surface. If a finish paint is specified, it shall be applied over the properly dried surface of the intumescent.



**Figure 5: Structural Steel Members Protected with a Thin-Film Intumescent
(Parker, Beitel, & Iwankiw, 2005)**

Use of thin-film intumescent for AESS members typically provide 1 to 2 hours of fire resistance, but can reach 3 to 4 hours for massive structural members (Parker, Beitel, & Iwankiw, 2005). Because these coatings are very thin, they are not typically recommended for exterior

(outdoor) applications, as they are not likely to wear well through weathering. Figure 5 shows the appearance of a thin-film intumescent.

Epoxy-based Intumescent

Epoxy-based intumescent are a more heavy-duty fire protection material than the thin-film intumescent. They were developed for structures which could be exposed to severe fire exposures, such as those used in offshore and petrochemical applications. The epoxy-based intumescent react to high-heat environments by producing a thick char layer, which protects the member from the heat for a certain period of time, typically up to 4 hours. This char layer can range from approximately 0.2 inches to over 1.0 inch thick, depending on the size of the member and fire resistance requirements, which is typically 50 to 100 times the original thickness (Parker, Beitel, & Iwankiw, 2005). This is much higher than was seen for the thin-film intumescent (0.03 inch to 0.40 inch thickness or 15 to 30 times thicker than the coating's initial thickness). Contrary to the thin-film intumescent, the epoxy-based intumescent do not require the application of a primer prior to the intumescent for a satisfactory surface bond. Instead, they only require the surface to be clean of oil, grease, or heavy mill scale.



**Figure 6: Steel Column Protected with Epoxy-Based Intumescent
(Parker, Beitel, & Iwankiw, 2005)**

Although the epoxy-based intumescent is more durable for exterior applications, it has a thicker and rougher appearance than that of the thin-film intumescent, which could limit its use on AESS members. The increased durability and fire-protection hourly rating also causes the epoxy-based intumescent to be more expensive than the thin-film, typically resulting in its use only in severe fire exposures that may require it. Figure 6 shows the appearance of an epoxy-based intumescent.

Chapter 4 - Sample Board and Mockups

When making the decision to use AESS members in design, it can sometimes be unclear as to what the look of the members will be in their final stage. The Architect may know the exact look they want, but making this communication to the Fabricator and others in the design team can be difficult. For this reason, it can be advantageous to have a visual standard for the team to examine and base their selections on, and to compare the look of AESS standards to ordinary structural steel standards. This is typically done through the use of a tool called a sample board.

Developed by the Steel Liaison Committee of the Structural Engineers Association of Colorado (SEAC) and the Rocky Mountain Steel Construction Association (RMSCA), the sample board consists of many small samples of fabricated structural steel that compare AESS specified surface finishes to those without AESS requirements. These samples are visuals for the design team as to how different finish requirements affect the look of the final product. The samples indicate the quality that will be expected of the Fabricator, and are commonly used during the bid phase to ensure accurate cost estimation. The goal of the sample board is to pinpoint what features and finishes are important to the design team, and make decisions as to what they will require for their AESS members. The sample board is also a valuable tool in that it can be examined from various distances to gain a better understanding of what can be easily seen or not seen.

An example of a sample board is shown in Figure 6. Designers or Contractors may attain an actual sample board through purchase from an independent producer, such as Zimkor Industries (Architecturally Exposed Structural Steel, 2003). The purchase of a sample board tends to save money throughout the design and fabrication of the AESS members, as it helps to prevent costly errors due to miscommunication. Closer views of some of the samples shown in Figure 7 are given in Chapter 6, to support fabrication specifications.



**Figure 7: SEAC/RMSCA Sample Board
(Architecturally Exposed Structural Steel, 2003)**

Once the AESS members have been designed with the standards as illustrated from the sample board and specification, the next step is to ensure that the Fabricator and the rest of the design team are in sync with the final product being specified and it is what the Architect has visualized. This is done through the production of mockups. Mockups, or trial versions of members with the desired finish requirements, are fabricated to give a tangible feel for the appearance and quality that will come from the Fabricator’s shop and erection processes. Mockups can range from 3-dimensional renderings, to small, isolated pieces of a member, to full-scale members, depending on the requests of the Architect. Mockups are typically requested at least four weeks prior to the fabrication of the AESS (Architecturally Exposed Structural Steel, 2003), and shall be requested only when necessary (as determined by the design team), as they tend to be very costly.

Some general compliance guidelines for mockups, according to the sample AESS specification from the *Modern Steel Construction* Supplement entitled “Architecturally Exposed Structural Steel”, Section 1.4 (Architecturally Exposed Structural Steel, 2003) are:

- Locate the mockups on-site or in the Fabricator’s shop, as determined by the Architect (the size of the mockup shall be full-size unless otherwise requested)
- Notify the Architect at least one week in advance as to when the mockups will be ready for review
- Demonstrate the proposed range of aesthetic effects, through AESS fabrication requirements
- Mockup will accurately show finished surface and shall reflect the surface preparation and paint requested
- Do not begin fabrication of the final units without the Architect’s approval, upon review of the mockups
- Store the mockups in safe location during fabrication and erection, to be compared to final product (if full-scale mockups were approved by the Architect, they may be stored in a safe, undisturbed location, and may be used at the time of Substantial Completion as part of the completed work)

Chapter 5 - Cost Impact

Costs and Budgeting

When making the decision to use architecturally exposed structural steel members in a project, it is crucial to understand the cost enhancement and impact to budget that the AESS designation will contribute. In general, specifying a member as AESS can easily double or triple its cost as compared to a common structural steel member due to the required tolerances and extra design and fabrication time (Downey, 2012). This significant increase in cost and time reiterates the recommendation that AESS shall be implemented rationally and only to steel surfaces and connections that will be exposed at a level that can be seen by occupants.

During the preliminary design phases, communication between the design team and the Owner of the costs of an AESS member designation is key. The team should examine the project plans and decide where the designation would make sense and where it would not. A common misconception is that AESS is an unattractive design option to Fabricators and Owners due to the unique requirements that will increase the cost, but if properly budgeted and portrayed to the Fabricator, can be an uncomplicated process for everyone. In most cases, many of the unforeseen costs in money and time originate from change orders due to improper communication among the project team. Working together through the whole process to make decisions on the level of finish and appearance and communicating these decisions early on to everyone in the project team is key to help yield and follow a quality budget. It will aid in the performance of the team, as well as ensuring that the Owner gets what they envisioned.

Cost Matrix

To assist with making clear the costs that accompany particular AESS designation requirements, a cost matrix was developed by the SEAC and RMSCA. This cost matrix provides a cost premium range for each special finish or fabrication option that will contribute to the final appearance of the AESS member. It is important to note that the ranges shown in the cost matrix are general and may vary based on the Fabricator and their capabilities. For instance, a Fabricator that has the equipment and manpower with AESS experience to complete the project may be able to do it at a lower cost point than one with less equipment or manpower. The ranges shown take this into consideration, as it was developed by surveying a select group of national Fabricators (Architecturally Exposed Structural Steel, 2003).

For the cost matrix to work best, the project team should make appearance selections from the sample board discussed in Chapter 4, and then estimate the applicable costs, with direction from the cost matrix. The cost premiums noted in the cost matrix apply to the total weight of the AESS for that particular line item, taking into account both the fabrication and erection of the member (Architecturally Exposed Structural Steel, 2003). The project team makes decisions and examines the costs until an acceptable look and cost is determined based on the Owner's expectations; the Owner should have the final say since they are paying for the project. When everyone is in agreeance, a more accurate budget can be developed and the Master Specification can be edited to reflect the requirements. It is here that the cost matrix will help balance the project's initial budget with the desired scope. As the project progresses, the designer may need to contact the Fabricator selected for more detailed pricing based on the particular implementation.

The cost matrix developed by the SEAC and RMSCA is shown in Table 3. The AESS costs are classified, and specification references are given. A general description of the processes is given in the matrix, followed by an alphabetical note designation, corresponding to the descriptions reproduced in Table 4 following the matrix. The next column of the cost matrix illustrates which processes are required by the *AISC Code of Standard Practice*, Section 10 for

AESS (American Institute of Steel Construction Committee on the Code of Standard Practice, 2010). The following three columns show category suggestions, based on member location, and what processes would be applicable for each. Next is a column titled 'User', which is for selecting processes that may not be required by code, but are desired by the Owner. The final column in the cost matrix shows the applicable cost premium range for each process, as discussed previously. Overall, the cost matrix is a valuable tool to any AESS project in consideration, to gain understanding in the costs that may be accrued.

Table 3: AESS Cost Matrix (Architecturally Exposed Structural Steel, 2003)
 (continued on next page)

ARCHITECTURALLY EXPOSED STRUCTURAL STEEL (AESS) FABRICATION, ERECTION, AND COATING RELATIVE COST MATRIX			
Specification Section (Fabrication)	Specification Section (Erection)	AISC Code of Standard Practice Section	PROCESS

FABRICATION AND ERECTION CLASSIFICATIONS			
2.2	2.2	10.4.1	SPECIAL CARE IN PROCESSING AESS
2.2.1	3.3.1	10.2.1, 10.4.2	TOLERANCES: ONE-HALF STANDARD
2.2.2	3.3.2	10.2.5	WELDS GROUND SMOOTH
2.2.3	3.3.3	--	WELDS CONTOURED & BLENDED
2.2.4	3.3.4	--	CONTINUOUS WELDS
2.2.5	3.3.5	10.2.3	WELD SHOW THROUGH MINIMIZED
2.2.6	--	--	COPING AND BLOCKING TOLERANCES MINIMIZED
2.2.7	--	10.2.4	JOINT GAP TOLERANCES MINIMIZED
2.2.8	--	10.2.6	PIECE MARKS HIDDEN
2.2.9	--	10.2.8	SURFACE DEFECTS MINIMIZED
2.2.10	--	10.2.7	MILL MARKS REMOVED
2.2.11	--	--	GRINDING OF SHEARED EDGES
2.2.12	--	--	ROLLED MEMBERS: MINIMIZE DISTORTION
2.2.13	--	--	SEAL WELDS TO CLOSE OPEN GAPS
--	3.3.6	--	BOLT HEAD ORIENTATION DICTATED
--	3.3.7	--	FIELD WELDING AIDS REMOVED
--	3.3.8	--	CLOSE WELD ACCESS HOLES AT FULL PEN WELDS

RANGE IN COST INCREASE OVER STANDARD STRUCTURAL STEEL

SURFACE PREPARATION CLASSIFICATIONS
POWER TOOL CLEANING CLEANING (SSPC-SP3)
COMMERCIAL BLAST CLEANING (SSPC-SP6)
RANGE OF COST INCREASE OVER POWER TOOL CLEANING (SSPC-SP3)

PRIMER AND FINISH COATING CLASSIFICATIONS
FINISH A: INTERIOR ENVIRONMENT - LOW END FINISH
FINISH B: INTERIOR ENVIRONMENT - HIGH END FINISH
FINISH C: EXTERIOR ENVIRONMENT - LOW END FINISH
FINISH D: EXTERIOR ENVIRONMENT - HIGH END FINISH
FINISH E: GALVANIZING
RANGE OF COST INCREASE SHOP PRIMED WITH NO FINISH COAT

ACCUMULATED RANGE OF COST INCREASE

COST MATRIX NOTES:
 1. THE ABOVE COST INCREASE PERCENTAGES APPLY TO THE ARCHITECTURAL EXPOSED
 2. THE ABOVE COST INCREASE PERCENTAGES ARE INTENDED TO GIVE THE DESIGNER IN
 THEY ARE ESTIMATES AND WILL VARY
 FOR EACH PROJECT. CONTACT A FABRICATOR TO OBTAIN SPECIFIC PRICING FOR EACH
 BLUE DESIGNATES USER INPUT CELLS.
 GREEN DESIGNATES RESULTS CELLS.

NOTES	STANDARD AISC Code of Standard Practice Section 10 for AESS (pre-set)	CATEGORY 3 High profile conditions that are out of reach to touch and can be viewed from a distance 20 feet or more (pre-set)	CATEGORY 2 High profile conditions that are out of reach to touch and can be viewed in close proximity within 20 feet (pre-set)	CATEGORY 1 High profile conditions that are within reach to touch and can be viewed in close proximity (pre-set)	USER Custom selected by the user (interactively input)	ADDED COST RANGE TO AESS
-------	--	--	--	---	---	--------------------------

a	X	X	X	X	X	10% to 20%
b	X			X		5% to 10%
c			X	X		10% to 20%
d			X	X		20% to 30%
e				X		5% to 10%
f			X	X		5% to 10%
g	X			X		5% to 10%
h	X			X		5% to 10%
i	X	X	X	X		1% to 5%
j	X			X		1% to 5%
k				X		1% to 5%
l				X		2% to 10%
m		X	X	X		10% to 15%
n				X		5% to 10%
o		X	X	X		1% to 5%
p			X	X		5% to 10%
q			X	X		5% to 10%
		27% TO 60%	22% TO 45%	67% TO 125%	96% TO 195%	10% TO 20%

r	CLASSIFICATION, SSPC-SP# = 6					0% to 0%
s						10% to 20%
		10% TO 20%				

t	CLASSIFICATION, FINISH = A					5% to 10%
u						35% to 50%
v						10% to 20%
w						45% to 60%
x						10% to 20%
		5% TO 10%				

		42% TO 90%	37% TO 75%	82% TO 155%	111% TO 225%	25% TO 50%
--	--	------------	------------	-------------	--------------	------------

POSED STRUCTURAL STEEL PORTIONS OF THE FRAME ONLY.
 NER INFORMATION TO MAKE PRELIMINARY COST ESTIMATING JUDGEMENTS.

R EACH PROJECT.



Table 4: Cost Matrix Notes (Architecturally Exposed Structural Steel, 2003) (continued on next page)

a	Special Care in Processing AESS:	Upgraded care in the process of fabricating, trucking, handling, storing, and erecting the material is required to obtain minimally acceptable AESS. This classification is required whenever AESS is specified.
b	Tolerances:	One-Half Standard: The tolerances for structural steel frames are set by AISC Code of Standard Practice. If AESS is specified, these tolerances are required to be one-half of those of a standard structural steel. These reduced tolerances should be carefully reviewed to see if they are required, as they add significant cost to the project.
c	Welds Ground Smooth:	In a standard structural steel frame, the welds are left in an as welded condition with the slag and weld spatter removed. For AESS frames, the process is the same. Should smooth grinding of the welds be required, this classification should be specified. It is important to note that in many cases, grinding the weld will leave a blemish that is more obvious than the un-ground weld.
d	Welds Contoured and Blended:	The comments under item k apply here, but the requirements of contoured and blended welds add an additional complexity. If transitions of smoothly ground welds are required to contoured and blended, this process will be done by hand and will leave blemishes around the weld area that may be more noticeable than the as-welded condition. Samples of this process should be submitted for review prior to fabrication.
e	Continuous Welds:	Many welds in standard structural steel and AESS frames are specified for strength to be intermittent. Some AESS structures may require that these welds be continuous for aesthetic reasons. Special care is required to avoid distortion of the member. If this is the case, this classification should be specified.
f	Weld Show Through Minimized:	In standard structural steel frames, there is no attempt to minimize the show through on the back face of the welded element caused by the welding process. Typically in AESS frames, the weld show through is left the same as a standard frame. If minimized show through is required, this can be done by hand grinding the backside of the weld. It is important to note that this process may leave a blemish that in most cases is more objectionable than the show through.
g	Coping and Blocking Tolerances Minimized:	The AISC Code of Standard Practice Section 10.24 requires all copes, miters, and cuts in AESS material are to be made with a uniform gap of 1/8". This tolerance is more stringent than the tolerances that Fabricators are held to for standard structural steel material. In many cases, this requires the Fabricator to custom cut and fit each member, adding significant cost to the project. This classification is not recommended for standard AESS. It is recommended to specify this classification only where joints are within a close viewing proximity and only if completely necessary.
h	Joint Gap Tolerances Minimized:	This classification is similar to item b above. A clear distance between abutting members of 1/8" is required. Again, this is more stringent than the tolerances that Fabricators are held to for standard structural steel. This classification is difficult to achieve both in the shop and field due to material size consistency and erection fit up tolerances, adding significant cost to the project.
i	Piece Marks Hidden:	During the fabrication and erection processes, members are marked with specific piece numbers. These numbers are usually left on the piece after erection is complete. AESS pieces are marked in inconspicuous places whenever possible, but there are many cases where these marks will be seen. If removal of these marks is required for aesthetic reasons, this classification should be specified.
j	Surface Defects Minimized:	In the process of handling the materials, the flanges of the beams and columns will inevitably be deformed and scarred. If this classification is specified, these deformities and scars will be removed.
k	Mill Marks Removed:	All steel mills mark their material with heat numbers and producer information to identify the material chemistry and strength and the producer. These marks can be stenciled, stamped or taped on to the member. Most mills now stamp the markings on the piece. Removal of the stenciled or taped marking is a simple process, but removing the stamped marking is a difficult process. The common method to remove a stamped mark is to grind it out, leaving a large blemish where the marking was. This blemish is more obvious to the viewer than the mill mark. It is important to note that whenever the mill marks are removed, the traceability for those pieces is usually lost.
l	Grinding of Sheared Edges:	In the process of fabrication, some types (plate and sheet specifically) of material are sheared. The sheared edge leaves a rough surface with burrs, which is not usually ground

l	(l, continued)	for standard structural steel pieces, except where it interferes with the fit-up. AESS requirements may demand that the rough surface be de-burred and ground smooth for aesthetic reasons.
m	Rolled Members: Minimize Distortion:	In the process of fabrication, some members may be rolled into various shapes. When rolling the member, it will distort. If AESS requirements dictate that the distortion shall be minimized, this classification should be specified. The added cost range percentages noted assume that 10% of the AESS tonnage is to be rolled.
n	Seal Welds to Close Open Gaps:	In standard structural steel frames, seal welding to close joints and gaps is normally not required. AESS frames may require welds to seal gaps from environmental implications or for aesthetic reasons. Should seal welding be required, this classification should be specified. It is important to note that seal welding of members can distort them.
o	Bolt Head Orientation Dictated:	For standard structural steel frames, the orientation of the bolt heads is left up to the erector. Ease of access for placing and tightening the bolt will dictate the bolt head orientation. Should the bolt heads be required to all be on the same surface, special attention is required in the shop and field.
p	Field Weld Aids Removed:	In a standard structural steel frame, the aids used in the process of field welding are not removed. Often times they are not removed due to structural integrity issues. Should they be removed from AESS frames due to aesthetic concerns, special attention is required in the shop and in the field.
q	Close Weld Access Holes at Full-Pen Welds:	The comments under item q above also apply here. Weld access holes are the holes in the web of beams and columns to allow the welder to weld in the areas of the member's web. If they are required to be closed for aesthetic reasons, special attention is required in the shop and in the field.
r	Power Tool Cleaning (SSPC-SP3):	Power tool cleaning removes all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter using power tools. This process requires that Solvent Cleaning (SSPC-SP1) be performed prior. It is not intended that adherent mill scale, rust and paint be removed by this process. Mill scale, rust and paint are considered adherent if they cannot be removed by lifting with a dull putty knife.
s	Commercial Blast Cleaning (SSPC-SP6):	A commercial blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter.
t	Interior Environment – Low End Primer/Finish Coating:	Alkyd (oil-based) finish coat with a shop coat primer.
u	Interior Environment – High End Primer/Finish Coating:	Epoxy finish coat with an epoxy or zinc rich primer.
v	Exterior Environment – Low End Primer/Finish Coating:	Acrylic (water-based) finish coat with a shop coat primer.
w	Exterior Environment – High End Primer/Finish Coating:	Polyurethane finish coat with an epoxy intermediate coat and zinc rich primer.
x	Galvanizing (ASTM A385):	Care should be taken when specifying hot dip galvanizing for AESS. Zinc coatings produced by the hot dip galvanizing process are excellent corrosion protection systems, but when the coating becomes very thick or dull gray, the coating may not be suitable for Architectural applications. The appearance can become blotchy with sections of dull finish and sections with bright finish. Almost all of these surface effects last for the first couple of years and then the coating becomes uniformly dull gray as the protective layer of corrosion products is formed on the surface of the galvanized steel. ASTM A385 describes the effects of steel chemistry on the hot dip galvanized finish, and also states that experienced galvanizers can in many instance exercise some control over coating structure. If cosmetic (aesthetic) appearance is of concern, the purchaser should select an experienced galvanizer and discuss any concerns about aesthetics (surface appearance) prior to any galvanizing.

Chapter 6 - Fabrication

Equipment and Experience

To ensure a level of quality applicable to the project, the Fabricator who is awarded the contract for AESS members shall be one with ample experience, as determined by the Architect, to produce the specified members. This may include reviewing their experience based on prior projects they have fabricated to determine their level of workmanship. Since AESS requires substantially more time to fabricate than standard structural steel, the Fabricator selected must encompass the equipment and manpower to fabricate the AESS members, as given in the contract documents, to meet the project schedule.

It is beneficial to fabricate and assemble as many of the AESS members as possible in the fabrication shop. This will help avoid possible field errors and damages that could occur when assembled in the field, as well as cut costs. Shop fabrication and assembly is typically less expensive than field fabrication and assembly, and tends to be more accurate.

Upon fabrication, any field joints in AESS assemblies shall be located in concealed locations, unless specified otherwise by the Architect, with the assemblies detailed as to minimize the amount of field handling required. The Fabricator is required to provide clear detailing to enhance the understanding of how to expedite the member erection both efficiently and without costly field errors.

Shop Connections

Welded Connections

Welded connections completed in the Fabricator shop are required to comply with American Welding Society Standard D1.1, with the visual appearance and weld quality as specified in the contract documents. The welds shall be consistent with those provided on any mock-ups. Special care shall be taken during welding and assembly of members as to prevent misalignment and/or warping of AESS members. Weld tolerances shall follow those specified,

as well as special welding methods. Any weld access holes, cut by the Fabricator in the web of beam and column members to allow the welder access to weld the web, shall be closed as required in the contract documents for aesthetic purposes. Figure 8 shows a typical weld access hole left unfilled. The quality of the welds shown in this figure are unsatisfactory for AESS, as they have not been ground to a smooth and even consistency and the backing bar has not been removed. This detail is provided to show the appearance of an unfilled weld access hole as well as poor quality welding that would not be acceptable for AESS unless located in an unexposed area or at a great distance from the viewer.

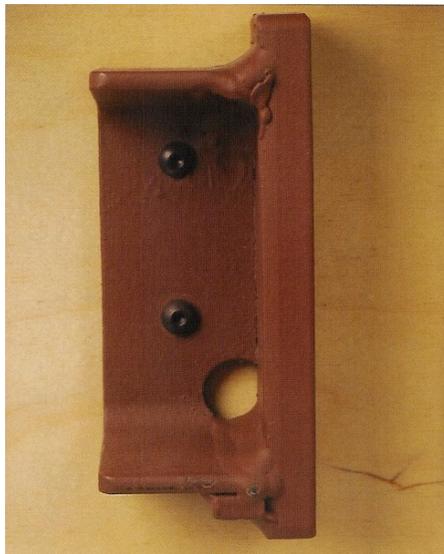


Figure 8: Weld Access Hole (Architecturally Exposed Structural Steel, 2003)

Field welding aids, such as backing bars, are used during fabrication and erection to ensure proper placement and application of weld material. In standard structural steel, these welding aids are often left in place, as they give extra structural integrity to the weld, in non-seismic areas, and the members are likely to be concealed from view. In AESS applications, these welding aids are sometimes specified to be removed, as they will affect the appearance of the member. If they are to be removed according to the contract documents, special attention shall be required in the shop and field to ensure quality weld placement and bond. Figure 9 shows the appearance of a member with and without a field welding aid.



Figure 9: Field Welding Aid Removal (Architecturally Exposed Structural Steel, 2003)

Bolted Connections

In general, bolted connections must follow the requirements of Master Specification Division 5 Section, 'Structural Steel'. In terms of high-strength bolts, nuts, and washers, per Section 05120, heavy hex-head bolt heads must be rounded with twist-off bolts. The bolts, nuts, and washers are required to be standard carbon steel in composition, as well as Cadmium plated, with a mechanically galvanized finish. In standard structural steel applications, bolt head orientation is commonly the decision of the Field Erector, and is dictated by the ease of access for placement and tightening. In AESS applications, the bolts are installed per the contract documents. If the bolt heads are all required to be on the same surface or oriented a specific way, or are a particular type or finish, they must be specified that way in the contract documents. Special attention shall be paid in the shop and field to meet the requirements specified in the contract documents.

Surface Preparation

Surface preparation, or removal of loose rust, loose mill scale, spatter, slag, flux or oil deposits to provide a clean surface for finishes, is the most important step in ensuring a quality finish on AESS members. It can also be the most expensive step, but is necessary for aesthetic purposes. Steel surfaces are prepared according to the level specified in the contract documents. These levels typically refer to the specifications from the Society for Protective Coatings (www.sspc.org). SSPC has multiple levels of surface preparation, with higher-numbered levels including the requirements of lower-numbered levels. These levels, as given in the sample AESS specification from the *Modern Steel Construction* Supplement entitled “Architecturally Exposed Structural Steel”, Section 2.2 (Architecturally Exposed Structural Steel, 2003) are:

- SSPC-SP 1 “Solvent Cleaning”
- SSPC-SP 2 “Hand Tool Cleaning”
- SSPC-SP 3 “Power Tool Cleaning”



Figure 10: SSPC-SP 3 Surface Preparations (Architecturally Exposed Structural Steel, 2003)

Figure 10 depicts SSPC-SP 3 surface preparations. The image on the left is a low-end primer/finish coating for a member in an interior environment, with an alkyd (oil-

based) finish coat over a shop-coat primer. The image on the right is a high-end primer/finish coating for a member in an interior environment, with an epoxy finish coat over an epoxy or zinc rich primer.

- SSPC-SP 6 “Commercial Blast Cleaning”

Figure 11 depicts SSPC-SP 6 surface preparations. The image on the left is a low-end primer/finish coating for a member in an exterior environment, with an acrylic (water-based) finish coat over a shop coat primer. The image on the right is a high-end primer/finish coating for a member in an exterior environment, with a polyurethane finish coat with an epoxy intermediate coat over a zinc rich primer.

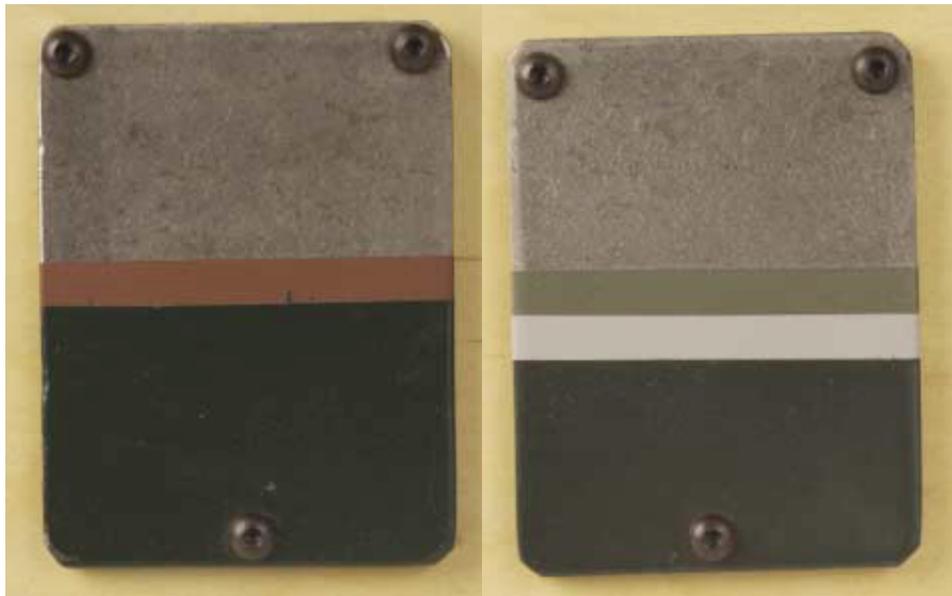


Figure 11: SSPC-SP 6 Surface Preparations (Architecturally Exposed Structural Steel, 2003)

Poor surface preparation is the leading cause of failure for paint (American Institute of Steel Construction, 2006). For this reason, a SSPC-SP 6 is typically the minimum surface preparation level required for AESS. If the surface preparation level is not specified correctly in the contract documents, change orders will be required, which will significantly impact member cost and could affect construction time.

Shop Priming

Immediately following the surface preparation of the steel surface shall be the application of shop priming, if required. Shop primer shall meet the specifications of the contract documents, and is to be applied according to the primer manufacturer's instructions. All AESS steel surfaces are required to be shop primed if there will be a finish coat, except the following: (Architecturally Exposed Structural Steel, 2003)

- Surfaces which are to be embedded in concrete or mortar (in this case, priming of partially embedded members shall be extended to a depth of 2")
- Surfaces which are to be field welded
- Surfaces which are to be high-strength bolted with slip-critical connections (this is applicable only if the primer does not meet the specified AISC slip coefficient)

Galvanizing

A specialty finish that is often used in standard structural steel and is sometimes specified in AESS is galvanization of the steel. When steel is galvanized, a zinc-coating is applied by the hot-dip process, as specified in ASTM Standard A123, to provide the steel with a corrosion-protected finish. Hot-dip galvanizing is a chemical process where iron and zinc connect to coat the member with a unique finish by the entire member being lowered into and raised out of the pool of cleaning solutions, flux solutions and molten zinc metal. In order to ensure proper coating of the inside and outside of the member, sections with enclosed areas, such as hollow structural sections, are required to provide holes in the member. These holes are used for proper venting and draining of the galvanized coating as the member is dipped at an angle, and should be located with a vent hole at the highest point and a drain hole at the lowest point. The primary reason for having vent and drain holes is to allow air and coating materials to be able to get out of the member being dipped for even coating. Another reason that these holes are important is

that if not present, cleaning solutions or rinse waters trapped in overlapping or contacting surfaces will turn to steam, creating a pressure rise inside of the member. This pressure can become very high, and could cause rupture in the fabrication of the member. While drain holes are required for galvanizing, they are often required to be plugged after the finish is complete, in order to meet AESS aesthetic requirements. This must be taken into account, as it will affect cost and time to complete the members during fabrication.

A galvanized finish aids in corrosion-protection of the steel, yet has some other areas that require addressing when used with AESS. If the zinc coating becomes very thick or dull gray when applied, the coating might not be suitable for architectural applications, as it will appear blotchy and uneven in appearance. Some areas may have a dull finish and some may be bright. This is due to the variation in steel chemistry, mainly influenced by the elements silicon and phosphorus. Control of these elements affect the appearance developed after being galvanized. This look will last for the first couple of years, and then will turn dull gray due to the corrosion-protective layer forming on the surface of the galvanized steel.

Another way that galvanizing can produce varying appearances is the fact that if members are dipped from different heats, and not all from the same dip, they may differ in color. Due to the varying appearance characteristics that could develop on the surface of the galvanized steel, it shall be fully discussed before being specified. Overall, there are some general characteristics that will affect the final look of a galvanized steel surface (Boulanger & Boake, 2011). These are:

- Impurities and presence of certain chemicals (especially silicon)
- Steel origin from different heats
- Thickness of material
- Access to all surfaces being dipped
- Size of pieces of steel

If AESS members are specified to be galvanized, they shall not be painted with alkyd top coats, as the top coat will not adhere properly to the galvanized surface. An intermediate coat of

high-build epoxy should be placed between the galvanization and the top coat to ensure a proper bond of the finish coat. AESS shall be galvanized only if required by the specifications of the contract documents.

Special Fabrication Methods

Many special fabrication methods are available for specification to AESS members. The “special” classification signifies that they shall be considered individually by the Owner and Architect, based on which are applicable to the members being specified. These special fabrication methods will impact the cost and final appearance of the AESS, as shown in the Cost Matrix from Chapter 5. Some of the common special fabrication methods, according to the sample AESS specification from the *Modern Steel Construction* Supplement entitled “Architecturally Exposed Structural Steel”, Section 2.3 (Architecturally Exposed Structural Steel, 2003), supported with requirements from *AISC Code of Standard Practice for Steel Buildings and Bridges*, Chapter 10 (American Institute of Steel Construction Committee on the Code of Standard Practice, 2010) are:

- Fabrication Tolerances

The *AISC Code of Standard Practice* Section 10.2.1 and 10.2.2 require the permissible tolerances for out-of-square or out-of-parallel, depth, width and symmetry of rolled shapes to be as specified in ASTM A6/A6M. Unless specified in the contract documents by the Architect, the exact matching of abutting cross-sectional configurations shall not be necessary. If AESS is specified, the fabricated straightness tolerances for AESS members shall be one-half of the tolerance for standard structural steel, which can add significant cost to the members.

- Welds Ground Smooth

The *AISC Code of Standard Practice* Section 10.2.5 explains that welds exposed to view are acceptable if they meet the requirements of American Welding Society

Standard D1.1, with the exception of groove welds in butt joints and outside corner joints and exposed plug welds. The projection of these weld exceptions shall be within 1/16" of the plate surface. If welds of AESS members are specified to be ground smooth by the Fabricator, special care shall be required so that the grinding will not leave a blemish which is more apparent than the un-ground weld. Grinding welds smooth is not often necessary to be specified unless required for clearances or fit of adjacent components. Figure 12 shows a typical groove weld on the left half, and the groove weld ground smooth on the right half.



Figure 12: Weld Ground Smooth (Architecturally Exposed Structural Steel, 2003)

- Contouring and Blending of Welds

When fillet welds are specified to be ground-contoured, or blended, they must be oversized initially to ensure that there will be adequate strength after contouring/blending. This oversizing is expensive but necessary to provide a smooth transition at the weld strength specified and to match the approved mock-up weld profile. If transitions of smoothly ground welds are required to be contoured and blended, this process will most likely be done by hand and will cause blemishes around the weld area that could potentially be more noticeable than the as-welded condition. For this reason, if contouring and blending of welds is desired to be specified, samples of this process should be submitted and reviewed prior to the

actual fabrication. Figure 13 shows typical structural steel welds on the left and welds which have been contoured and blended on the right.

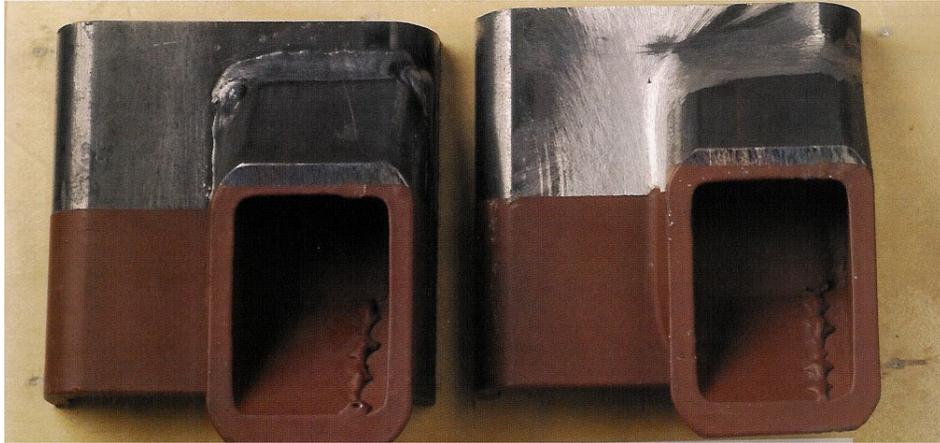
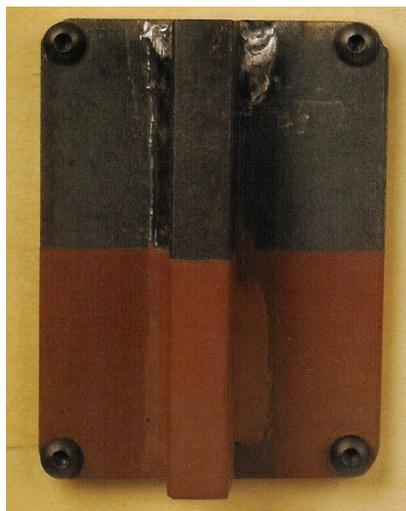


Figure 13: Contouring and Blending of Welds (Architecturally Exposed Structural Steel, 2003)

- Continuous Welds

Welds for standard structural steel are often specified for strength to be intermittent. This is not the case for AESS due to its stringent aesthetic requirements. Welding specified in the contract documents and drawings shall be provided by the Fabricator as continuous and of uniform size and profile. If continuous welds are specified, special care may also be required to address and avoid distortion of the members. In Figure 14, the fillet weld on the left is continuous, and is intermittent on the right.



**Figure 14: Continuous and Intermittent Fillet Welds
(Architecturally Exposed Structural Steel, 2003)**

- Seal Welds to Close Open Gaps

Open ends of round and rectangular hollow structural sections shall be seal welded by the Fabricator with 3/8" closure plates. Continuous seal welds shall be provided at angle to gusset-plate connections as well as locations where the AESS will be exposed to weather. This will aid in keeping moisture and other unwanted materials from entering and damaging the section. When applying this specification, the Architect must consider the distortion that may be caused due to seal welding of the members.

- Minimize Weld Show Through

When welding on the far side of an exposed connection, the exposed side can sometimes exhibit some visual distortion markings, which are generally a function of the weld size and material thickness being used. The *AISC Code of Standard Practice* Section 10.2.3 explains that unless specific visual acceptance criteria are specified in the contract documents, the members shall be treated in the same manner as standard structural steel, with no attempt to minimize the show through on the exposed surface. If minimized weld show through is specified, the distortion and marking of the steel on the exposed side shall be ground to a smooth profile as to transition well to the adjacent material. As with other special welding specifications, this grinding could leave a blemish less attractive than the un-ground weld show through. Figure 15 shows typical weld show through in the image on the left, and minimized weld show through in the image on the right.



Figure 15: Weld Show Through (Architecturally Exposed Structural Steel, 2003)

- Coping, Blocking, and Joint Gap Tolerances

The *AISC Code of Standard Practice* Section 10.2.4 requires all copes, miters, and cuts in AESS material to be made maintaining a uniform gap of $1/8" \pm 1/32"$. This tolerance is more stringent than the tolerances that Fabricators are held to for standard structural steel material. In specifying this, the Fabricator may have to custom cut and fit members due to material size consistency and erection fit-up tolerances, which will increase the cost greatly. For this reason, the coping and blocking tolerance is not typically specified for standard AESS. It is more commonly specified only if necessary for joints in close proximity to the viewer. Figure 16 shows a standard blocking tolerance on the left and a minimized blocking tolerance on the right.



Figure 16: Blocking Tolerances (Architecturally Exposed Structural Steel, 2003)

- Piece Marks Hidden

The specific piece marks placed on members during fabrication are to communicate the designation of the member for further fabrication or erection. These markings are not typically removed for standard structural steel. For AESS, these piece marks shall either be located in areas not exposed to view, or may be specified in the contract documents to be removed for aesthetic reasons.

- Removal of Mill Marks

Marks placed on steel materials by the mill are to communicate important information about the material, such as the heat number, producer information or strength. These markings are typically either stamped or raised on the surface of the steel material. These markings are not required to be ground down or filled in unless specified in the contract documents, as removal of the mill mark will take away the traceability of the steel material, which is not often desired. It is much easier to ignore the mill marks, or locate them in areas which will not be exposed to view. Figure 17 shows the appearance of a mill mark.



Figure 17: Mill Mark Visibility (Architecturally Exposed Structural Steel, 2003)

- Grinding of Sheared Edges

During fabrication, plate and sheet steel is often sheared to create the desired member size from a larger piece of material. This shearing creates a rough edge, which is not typically ground smooth. For AESS, it may be desired to have smooth edges for aesthetic purposes, which is where the grinding of sheared edges may be specified in the contract documents.

- Rolled Members

Members specified to be rolled in the process of fabrication typically distort. For this reason, it may be specified in the contract documents for these members to be fully shaped in the shop and tied down during shipment to help minimize distortion specifically to the member elements.

Handling, Delivery, and Storage of Materials

In addition to any special fabrication methods specified, AESS members require special handling, delivery, and storage of material requirements to protect member appearance. Delivery of the AESS members to the project site may require padding the members to minimize damage. Shipment delivery shall be coordinated as to provide particular quantities at particular times to ensure efficient, continuous field erection. Upon delivery, materials should be stored to allow easy access for inspection and identification of the members. AESS members shall be kept off the ground by use of pallets, platforms, or other suitable supports, as to protect the members and packaged materials from erosion and deterioration. Handling techniques must be completed with special care as to prevent twisting, warping, or other harmful distortions to the AESS members. Pre-painted finish pieces shall be erected using padded slings or other applicable methods to prevent damage to the members. Any techniques in question shall be approved by the Architect prior to erection. The increased amount of care required in the handling, delivery and storage of AESS members is required whenever it is specified in design.

Chapter 7 - Execution

Examination

Upon site delivery, the Erector shall perform an inspection of all AESS members to ensure that there are no imperfections or damages to the members, such as twists, kinks, or gouges, which may result in site rejection due to the appearance. Any remedial actions that must be taken to correct these members prior to erection shall be coordinated through the Architect and Fabricator. After this inspection has been completed, and all members have been approved upon delivery, AESS members shall be unloaded and handled with care so as not to inflict damage to the members or surfaces by the Erector.

Preparation

In preparation for erection, the Erector shall provide connections for temporary shoring, bracing, and supports as specified and noted in the contract documents. Any temporary connections which are not included in the contract documents, but are necessary, shall be located in areas that will not be exposed to view, and must be approved by the Architect (Architecturally Exposed Structural Steel, 2003). If temporary braces or erection clips are used, special care must be taken as to avoid damage to the surfaces (American Institute of Steel Construction Committee on the Code of Standard Practice, 2010). AESS members shall be handled, lifted, and placed using padded slings or other protective measures to preserve the finishes during erection. The sequence of erection must be planned for in advance and followed by the Erector to ensure complete and timely erection of the AESS members.

Erection and Field Connections

AESS members shall be erected according to the specifications of the contract documents and best practices in steel erection. They are to be placed in proper locations at the elevation specified. Special erection techniques are available, and are very similar to the special

fabrication methods discussed in Chapter 6. Any of these special techniques will be included in the contract documents as erection requirements. Special care shall be followed by the Erector to meet these requirements.

Any field welding or bolting required shall be consistent to that used in the approved mock-ups and must meet the specified requirements in the contract documents. Splicing of members is only permitted in specified locations. Any unspecified splices, torch cutting, or field fabrication must be approved by the Architect prior to completion (Architecturally Exposed Structural Steel, 2003).

AESS members will commonly be erected using temporary field connections. These temporary connections are used only for support of the members during erection, and must be removed to meet the final AESS appearance requirements. An example of this process is shown in Figure 18. The image on the left shows parts of the field connection that protrude from the HSS surface, and require removal and replacement of a piece of an HSS section. The image on the right shows the finished look of the connection after removal and finishing of the connected area. This can be an extremely costly process to complete in the field, which is why planning shall be completed to assemble as many of the connections in the shop as possible, in sizes that can be shipped.



**Figure 18: Temporary Connection Cut Off in Field and Finished to Hide Joint
(American Institute of Steel Construction, 2006)**

Tolerances

AESS members are required to be plumbed, leveled, and aligned to a tolerance that is one-half of that permitted for standard structural steel, to ensure proper alignment and fit of the members. This guideline should be followed, unless otherwise specified in the contract documents (American Institute of Steel Construction Committee on the Code of Standard Practice, 2010).

Field Quality Control and Assurance

To make certain that structural requirements have been met in the erection of the AESS members, the Owner must engage an independent testing and inspection agency to perform field inspections and tests, and prepare test reports. The Architect will also complete a post-erection inspection of the AESS members to ensure the members meet the requirements of the contract documents and mockups and are satisfactory. The Architect, rather than the independent testing agency, is responsible for verifying the AESS requirements specified, and that the project is complete.

Adjusting and Cleaning

A final coat or area of touch-up paint is sometimes required to repair damages to the finish caused by erection, and shall be at the discretion of the Erector with approval of the Architect. If required for the welds, bolted connections, or actual steel surface, the area must be cleaned prior to application, and any new paint shall blend with the areas adjacent to the application. Any touch-up work completed by the Erector must be completed in accordance with the manufacturer's instructions, as well as those specified in Master Specification Division 9. If galvanized surfaces are to be repaired, the repair must meet the requirements of ASTM A780 (Architecturally Exposed Structural Steel, 2003).

Chapter 8 - Conclusion

Architecturally exposed structural steel, AESS, is a truly unique and distinct method of design, where structural steel members or particular parts of the members are designed to be left exposed to up-close public view. These members are used to convey architectural art or expression, as well as express the true beauty of steel as a structural material. With this designation comes more strict design requirements and tolerances to promote the aesthetic appeal of the members. The purpose of this report is to examine what contributes to the design, detailing, fabrication, and execution of AESS, as to provide a complete framework to promote an enhanced understanding and knowledge for the Structural Engineer, Architect, Fabricator, and Owner to make better decisions in its use. Each stage is examined, discussing key areas of importance to the design team.

The conclusion that can be drawn from this report is, when making the decision to utilize AESS, it is crucial to understand how the design team must come together for a quality end result. Some key areas of focus include the following:

- Expectations of the Owner, Architect, and Structural Engineer
- Communication, both early on and through the completion of the project, between the Structural Engineer, Architect, Fabricator, and Owner
- Adequate and clear documentation in the contract documents, specifications and drawings
- Costs, both in time and money, of desired aesthetic appearances
- Qualifications of Fabricator and Erector

While numerous different options and decisions in specifying members of a structure as architecturally exposed exist, it is important to understand that they provide opportunities for

growth and expression through structural design to express the aesthetic appeal of steel in innovative ways.

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Appendix A - AESS Sample Specification

This Appendix consists of the AESS Supplement entitled “Architecturally Exposed Structural Steel,” published by *Modern Steel Construction* in May 2003. This document was developed by the Steel Liaison Committee of the Structural Engineers Association of Colorado and the Rocky Mountain Steel Construction Association, and includes a sample specification for Architecturally Exposed Structural Steel. This document is reprinted courtesy of *Modern Steel Construction* magazine, and can be found through the American Institute of Steel Construction website, or directly through the following internet link: <http://www.aisc.org/store/p-1500-Architecturally-exposed-structural-steel.aspx>.

Architecturally **Exposed** Structural **Steel**



a supplement to
modern
Steel
construction
MAY 2003

While exposed structural steel was once the select province of a few noteworthy projects, architects today are increasingly using transparency in their design. The current trend may have started with Helmut Jahn's United Airlines Terminal in Chicago, but it has now spread to everything from small retail stores to office lobbies.

Unfortunately, existing codes and standards—even AISC's *Code of Standard Practice*—do not fully address the unique level of detail needed to successfully design, detail, fabricate and erect Architecturally Exposed Structural Steel (AESS). Further, because AESS costs more to fabricate than standard structural steel, it is critical that these designs are properly budgeted. The repercussion of not properly budgeting AESS is often the need for redesign, project delays, and ultimately even higher project costs. In addition, the members requiring special handling and finish are often poorly identified in the contract documents—and, since the EOR often specifies the steel while the architect specifies the paint and appearance, there is sometimes a built-in conflict or compatibility issue. Finally, the lack of acceptance criteria for AESS members often leads to disputes between the design team and the contractor over what is desired versus what was bid.

In response to these issues, the Steel Liaison Committee of the Structural Engineers Association of Colorado and the Rocky Mountain Steel Construction Association, with input from local contractors and architects, developed guidelines to assist in the specification of AESS. According to the Committee: "The goal of these tools is to allow the designer to communicate the desired appearance in a format that Contractors can price/budget/bid more appropriately."

The guidelines include three key elements:

Sample Board: The sample board includes small pieces of fabricated structural steel that indicate a range of finish surfaces that can be expected from structural steel fabricators. The board includes bare steel with fabrication "defects" and pieces with typical finish coats. The samples are intended to allow the designer to see how various fabrication techniques affect the final product. The goal of the sample board is to allow the designer to decide what features are important for their project. Physical samples allow the designer to evaluate how imperfections in the finished surface appear from various distances.

The photos printed here are taken from the sample board, but due to reproduction technology might not fully represent the actual appearance on the sample board. However, design-

ers or contractors wishing to obtain an actual sample board can purchase one from Zimkor Industries for \$1,780 by contacting William Zimmerman at wgzimmerman@zimkor.com or 303.791.1333.

Cost Matrix: Of course, knowing appearance of the final steel is only half the story. Equally important is knowing the budget impact of AESS. The cost matrix is designed to provide the designer with the cost premium associated with specifying the desired techniques to achieve the final appearance of an AESS project. The cost of producing work to a higher appearance standard varies greatly from fabricator to fabricator, depending on the equipment in the shop and the experience of the staff. This variation is indicated in the cost matrix as a range of cost premiums for each desired fabrication technique or finish coat item specified.

The cost premiums noted apply to the total weight of AESS for that particular line item, fabricated and erected. While the cost matrix was prepared initially by surveying fabricators in the Rocky Mountain region, the figures have been further checked through surveying a select group of national fabricators. The idea behind the cost matrix is to allow a designer to balance a project budget with the desired project scope. As a result, several design iterations might be required. Also, it is imperative that a designer contacts a local fabricator for more detailed pricing as the project becomes more defined.

Specification: SEAC/RCSCA has prepared a generic specification that includes many common fabrication and erection techniques to help communicate a designer's expectations to the fabricator. The specification includes a number of editor's notes to provide guidance. The headings in the specification are coordinated with the line items from the cost matrix and sample board. The intent of the specification is to provide a consistent mechanism to define appearance quality requirements that were selected with the sample board and budgeted with the cost matrix. The primary scope of the project was to offer a common language to address the appearance issues of structural steel used in exposed locations.

Although many of the finish issues are common to miscellaneous metals, stairs and railings, the specification is not written to cover all of these items. Furthermore there are numerous performance topics such as jointing for thermal movements, waterproofing and fire resistance which this document does not address. Any comments or suggestions on how the Specification can be improved or modified should be sent to Jack Petersen at jpetersen@martin/martin.com. ★

Supplement cover: the recent expansion of the Austin, TX convention center includes a spectacular atrium space that features exposed structural steel framing and a cobalt-blue art-glass wall on the exterior of the building.

SAMPLE BOARD

Closeup photos of the AESS sample board are used throughout this supplement to illustrate the visual appearance of many conditions encountered when designing exposed structural steel. A photograph of the complete board appears below.



SAMPLE AESS SPECIFICATION

SECTION 05125— ARCHITECTURALLY EXPOSED STRUCTURAL STEEL PART 1 — GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the Section.

1.2 SUMMARY

Editor's Note: It is critical to define to the bidders what members will be considered as Architecturally Exposed Structural Steel (AESS). Furthermore the degree to which the requirements of the AISC "Code of Standard Practice" apply must be spelled out.

- A. This Section includes requirements regarding the appearance and surface preparation of Architecturally Exposed Structural Steel (AESS).

Refer to Division 5, Section 'Structural Steel' for all other requirements regarding steel work not included in this section.

This section applies to any members noted on Architectural [and Structural] drawings as AESS [and in the areas defined as AESS below].

- B. Related Sections: The following Sections contain requirements that relate to this Section:
 1. Division 1 Section "Quality Control" for independent testing agency procedures and administrative requirements.

2. Division 5 Section "Structural Steel"

Editor's Note: Address alignment and location of bridging where joists are visible in Division 5 Section "Open Web Metal Joists"

3. Division 5 Section "Steel Joists"

Editor's Note: Address fastener spacing and weld show-through in areas where decking is visible in the finished structure. Coordinate paint system requirements with that of AESS

4. Division 5 Section "Metal Decking" for erection requirements relating to exposed steel decking and its connections

5. Division 5 Section "Metal Fabrications" for loose steel-bearing plates and miscellaneous steel framing.

6. Division 9 Section "Special Coatings" for finish coat requirements and coordination with primer and surface preparation specified in this section.

7. Division 9 Section "Painting" for finish coat requirements and coordination with primer and surface preparation specified in this section.

1.3 SUBMITTALS

- A. General: Submit each item below according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.
- C. Shop Drawings detailing fabrication of AESS components.



The sample on the left shows the appearance of typical structural welds. On the right, the welds have been ground smooth.

1. Provide erection drawings clearly indicating which members are considered as AESS members.
 2. Include details that clearly identify all of the requirements listed in sections 2.3 "Fabrication" and 3.3 "Erection" of this specification. Provide connections for exposed AESS consistent with concepts shown on the architectural or structural drawings.
 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length and type of each weld. Identify grinding, finish and profile of welds as defined herein.
 4. Indicate type, size, finish and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tensioned shear/bearing connections. [Indicate to which direction bolt heads should be oriented.]
 5. Clearly indicate which surfaces or edges are exposed and what class of surface preparation is being used.
 6. Indicate special tolerances and erection requirements as noted on the drawings or defined herein.
- D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects names and address, names and addresses of architects and owners, and other information specified.
[For each project, submit photographs showing detail of installed AESS.]

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: In addition to those qualifications listed in Division 5 Section 'Structural Steel,' engage a firm experienced in fabricating AESS similar to that indicated for this Project with a record of successful in-service performance, as well as sufficient production capacity to fabricate AESS without delaying the Work.
- B. Erector Qualifications: In addition to those qualifications listed in Division 5 Section 'Structural Steel,' engage an experienced Erector who has completed AESS work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- C. Comply with applicable provisions of the following specifications and documents:
 1. AISC "Code of Standard Practice," latest edition, Section 10 as amended herein.



The connection on the left shows a connection with the typical blocking tolerance. The connection on the right shows the same connection with tolerances minimized.

Editor's Note: The following section should be edited to define how many mockup pieces are required. The Architect must define the size and extent of the pieces which are required and what specific finishes must be demonstrated.

- D. Mockups: At least four weeks prior to fabricating AESS, the contractor shall construct mockups to demonstrate aesthetic effects as well as qualities of materials and execution. A mockup for each of the following elements shall be constructed:

Build mockups to comply with the following requirements, using materials indicated for final unit of Work.

1. Locate mockups on-site or in the fabricator's shop as directed by Architect. Mockups shall be full-size pieces unless the Architect approves smaller models.
2. Notify the Architect one week in advance of the dates and times when mockups will be available for review.
3. Demonstrate the proposed range of aesthetic effects regarding each element listed under the fabrication heading below.
4. Mockup will have finished surface (including surface preparation and paint system).
5. Obtain Architect's approval of mockups before starting fabrication of final units.

6. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 - a. Approved mockups in an undisturbed condition at the time of Substantial completion may become part of the completed work.
 - E. Pre-installation Conference: The General Contractor shall schedule and conduct conference at the project site to comply with requirements of Division 1 Section "Project Meetings." As a minimum, the meeting shall include the General Contractor, Fabricator, Erector, the finish-painting subcontractor, and the Architect. Coordinate requirements for shipping, special handling, attachment of safety cables and temporary erection bracing, touch up painting and other requirements for AESS.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver AESS to Project site in such quantities and at such times to ensure continuity of installation.
 - B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. Use special care in handling to prevent twisting or warping of AESS members.



On the left, the field-welding aid (the backing bar) has been left in place. On the right, the field-welding aid has been removed and the weld ground smooth.

- C. Erect pre-painted finish pieces using padded slings or other methods such that they are not damaged. Provide padding as required to protect while rigging and aligning member's frames. Weld tabs for temporary bracing and safety cabling only at points concealed from view in the completed structure or where approved by the Architect during the pre-installation meeting. Methods of removing temporary erection devices and finishing the AESS members shall be approved by the Architect prior to erection.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Where AESS is indicated to fit against walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

1.7 COORDINATION

- A. Coordinate installation of anchors for AESS members that connect to the work of other trades. Furnish setting drawings, templates, and directions for installing anchors, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to the project site in time for installation. [Anchorage concepts shall be as indi-

cated on drawings and approved on final shop drawings.]

PART 2 — PRODUCTS

2.1 MATERIALS

- A. General: Meet requirements Division 5 Section 'Structural Steel' as amended below.
- B. High-Strength Bolts, Nuts, and Washers: Per section 05120 heavy hex heads and nuts [Provide rounded bolt heads with twist-off bolts]. Provide standard carbon steel [Cadmium plated] [Mechanically galvanized] finish.

2.2 PRIMERS

Editor's Note: The primer specified in section 05120 must be coordinated with the finish coat system listed in section 09900 to ensure coating compatibility. The use of the Federal Specification System (i.e. FS TT-P-6664) is obsolete since many of these specs do not address current VOC regulations and other environmental standards such as lead & chromate's. Primers for steel come in a variety of resins such as alkyd, waterborne, epoxy, and zinc rich

Alkyd Primers—Typically referred to as shop coat primer, this product can come in many different levels of quality depending on the level of corrosion protect required. This would include keeping the steel from flash rusting prior to being covered by in an interior wall up to long-term corrosion protection. They are fast drying, enabling the fabricator to quickly deliver product to



The left half of this sample shows a typical groove weld. The right half shows the same weld ground smooth.



This sample shows atypical weld-access hole.

the job site. Standard alkyd primers can be finish coated with an alkyd or waterbased enamel. Universal alkyd primers can be used under high-performance coatings such as epoxies or urethanes. In general, for exterior exposure, a high-quality, universal, rust-inhibitive primer should be used. The increase in cost over a standard "Shop Coat" primer is on the order of \$5.00 to \$10.00 per gallon. The material cost of the paint represents a small portion of the total painting cost, while the higher quality provides greater corrosion protection to the steel.

Acrylic Primer: Acrylic primers are corrosion resistant and water-soluble, often providing a lower VOC. They are available in shop-coat quality up to a universal primer for use under high performance coatings such as epoxies and urethanes.

Epoxy Primer: Epoxy primers provide excellent corrosion protection for steel and can be top coated with a variety of finishes. Epoxy primers can be applied in the shop and typically have a high film build that will hide minor imperfections.

Zinc Rich Primer: Zinc rich primer provides superior corrosion protection by providing cathodic protection to the steel. Zinc rich coatings can be specified as either organic zinc or inorganic zinc. Both inorganic and organic will meet class B slip coefficients for bolted connections. In arid regions (such as the Rocky Mountain Region) organic epoxy/zinc primers should be specified, as they do not rely on an outside source (humidity) for cure. Inorganic zinc requires a constant humidity of no less than 40% RH for proper cure. If an intermediate and finish coat are to be completed in the shop, the lack of humidity can cause delays in both the painting process and project as the zinc must

be cured prior to top-coating. Although a urethane finish coat can be applied directly over an organic zinc, it is suggested that an intermediate epoxy coating be used to prevent "pin holing" in the urethane coating, promote adhesion of the system, and increase film build to hide imperfections in the steel. Alkyd finish coats should not be specified over zinc primers. For galvanizing repair, an organic zinc with not less than 90% zinc by weight in the dry film should be used for reglvanizing welds and damage due to erection.

FINISHES

When possible, finish coating should be done in the field after erection. Finish coats applied in the shop almost always incur damage from handling in shipping and erection. This often results in applying an additional finish coat in the field or completing costly touch up which often does not blend in with the original finish. *Note: If finish painting is to be done prior to delivery of the steel, special sections should be added to ensure proper handling and minimize damage.

Finish coatings for commercial projects with AESS fall into the following categories

Alkyds (Oil based): Acceptable finish coat for interior applications and some exterior application. Dries to hard durable finish. When applied specified for exterior use, alkyds will chalk and fade with UV exposure in a relatively short period. Can be brush, roll, or spray applied.

Acrylics (Waterborne): Acceptable finish coat for both interior and exterior service. Acrylics provide good color and gloss re-



On the left, the fillet weld is continuous. On the right, the fillet weld is intermittent.



This sample shows the visibility of typical shop marks.

tention under UV exposure. Can be easily applied by brush, roller, or spray. Low odor and VOC for interior application.

Epoxy: Can be applied as a finish for interior use where abrasion resistance is required. High-build nature of film can help cover imperfections in the steel. Will chalk and fade with UV exposure. 4. Polyurethane: Provides high performance protection with excellent color and gloss retention. A higher film build than alkyd or acrylic helps cover imperfections in the steel. Should be sprayed applied for best appearance.

- A. Compatibility: The General Contractor shall submit all components/procedures of the paint system for AESS as a single coordinated submittal. As a minimum, identify required surface preparation, primer, intermediate coat (if applicable) and finish coat. All of the items shall be coordinated with the finish coat specified in Division 9.

Editor's Note: The primers below are listed in order of cost from lowest to highest. Coordinate requirements with the surface preparation and finish-coat sections of the specification.

- A. Primer: Fabricator's standard alkyd red oxide, rust-inhibiting primer.
- B. Primer: Fast curing, universal modified alkyd, rust inhibiting shop coat with good resistance to normal atmospheric corrosion. Primer shall comply with all federal standards for VOC, lead and chromate levels

- C. Primer: Acrylic water-soluble shop coat with good resistance to normal atmospheric corrosion. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- D. Primer: Fast-curing two-part epoxy. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- E. Primer: Organic, epoxy/zinc-rich, meeting class B surface requirements for slip-critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- F. Primer: Inorganic zinc-rich meeting class B surface requirements for slip-critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels.
- G. Galvanizing Repair Paint: High-zinc-dust-content paint for galvanizing welds and repair-painting galvanized steel, with dry-film coating not less than 90-percent zinc dust by weight.

2.3 FABRICATION

- A. Fabricate and assemble AESS in the shop to the greatest extent possible. Locate field joints in AESS assemblies at concealed locations or as approved by the Architect. Detail AESS assemblies to minimize field handling and expedite erection.



This sample shows typical weld show-through from welding the connection on the far side of the piece.



Weld show-through has been minimized.

- B. Fabricate AESS with exposed surfaces smooth, square and of surface quality consistent with the approved mock up. Use special care in handling and shipping of AESS both before and after shop painting.
- C. In addition to special care used to handle and fabricate AESS, employ the following fabrication techniques.

Editor's Note: The following is a list of special fabrication methods that may impact the final appearance of the AESS. Many of these items have significant cost premiums and should not be used indiscriminately. Refer to the cost matrix for anticipated range of added cost associated with each line item.

1. Fabrication Tolerance: Fabricate steel to one half the normal tolerance as specified in the Code of Standard Practice Section 10.
2. Welds ground smooth: Fabricator shall grind welds of AESS smooth. For groove welds, the weld shall be made flush to the surfaces each side and be within $+1/16"$, $-0"$ of plate thickness.
3. Contouring and blending of welds: Where fillet welds are indicated to be ground-contoured, or blended, oversize welds as required and grind to provide a smooth transition and to match profile on approved mock-up.
4. Continuous Welds: Where welding is noted on the drawings, provide continuous welds of a uniform size and profile.
5. Minimize Weld Show Through: At locations where welding on the far side of an exposed connection occurs, grind distortion and marking of the steel to a smooth profile with adjacent material.
6. Coping and Blocking Tolerance: Maintain a uniform gap of $1/8" \pm 1/32"$ at all copes and blocks.
7. Joint Gap Tolerance: Maintain a uniform gap of $1/8" \pm 1/32"$.
8. Piece Marks Hidden: Fabricate such that piece marks are fully hidden in the final structure or made with such media to permit full removal after erection.
10. Mill Mark Removal: Fabricator shall deliver steel with no mill marks (stenciled, stamped, raised etc) in exposed locations. Mill marks shall be omitted by cutting of mill material to appropriate lengths where possible. Where not possible, the fabricator can fill and/or grind to a surface finish consistent with the approved mock up.



A typical mill mark.



The appearance of sheared edges that have been ground.

11. Grinding of sheared edges: Fabricator shall grind all edges of sheared, punched or flame-cut steel to match approved mockup.
12. Rolled Members: Member specified to be rolled to a final curved shape shall be fully shaped in the shop and tied during shipping to prevent stress relieving. Distortion of the web or stem, and of outstanding flanges or legs of angles shall be visibly acceptable to the Architect from a distance of 20' under any lighting condition determined by the Architect. Tolerances for the vertical and horizontal walls of rectangular HSS members after rolling shall be the specified dimension $\pm 1/2$ ".
13. Seal weld open ends of round and rectangular hollow structural section with $3/8$ " closure plates. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where AESS is exposed to weather.

2.1 SHOP CONNECTIONS

- A. Bolted Connections: Make in accordance with Section 05120. Provide bolt type and finish as noted herein and align bolt heads as indicated on the approved shop erection drawings.
- B. Weld Connections: Comply with AWS D1.1 and Section 05120. Appearance and quality of welds shall be consistent with the mock up. Assemble and

weld built-up sections by methods that will maintain alignment of members without warp exceeding the tolerance of this section.

2.2 SHOP PRIMING

- A. Shop-prime steel surfaces, except the following:
 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2".
 2. Surfaces to be field welded.
 3. Surfaces to be high-strength bolted with slip-critical connections, if primer does not meet the specified AISC slip coefficient.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Prepare surfaces according to SSPC Specifications as follows:

Editor's Note: Surface preparation is the most important (and often the most costly) step in providing a good finish on AESS. A level of surface preparation is associated with each type of finish coat. It is critical that the correct level of preparation be specified on the contract documents to avoid change orders during construction. Each level of SSPC specification includes the levels below (i.e., SSPC-6 includes the requirements of SSPC-3).

1. SSPC-SP 1 "Solvent Cleaning"



Interior environment, low-end primer/finish coating: alkyd (oil-based) finish coat with a shop-coat primer over an SSPC-3 surface preparation.



Interior environment, high-end primer/finish coating: epoxy finish coat with an epoxy or zinc rich primer, over an SSPC-3 surface preparation.

2. SSPC-SP 2 "Hand Tool Cleaning." (This level of surface preparation will not be adequate for most paint systems for AESS construction.)
 3. SSPC-SP 3 "Power Tool Cleaning." (This level of surface prep is the minimum for most AESS projects. It may be acceptable for alkyd primers and acrylic or alkyd finish coats, particularly in interior applications.)
 4. SSPC-SP 6 "Commercial Blast Cleaning." (This level of surface prep adds significantly to the total cost of the steel. It is required for epoxy primers to allow adequate bonding to the steel. Recommended for locations where a rust inhibitive primer will be used in an exterior application. It is also required where polyurethane finish coats will be used over the primer.)
 5. Coordinate the required blast profile with the approved paint submittal prior to beginning surface preparation.
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop primer to surfaces that are inaccessible after assembly or erection.

Editor's Note: Finish painting in the shop is not recommended by either the fabrication or painting community that contributed to this specification. If finish painting is to be done prior to delivery of the steel, special sections should be added here.

2.3 GALVANIZING

Editor's Note: Galvanized steel should not be painted with alkyd top coats as loss of adhesion will occur. An intermediate coat of high-build epoxy should be used if an alkyd paint is described as the finish coat. Zinc coatings produced by the hot-dip galvanizing process are excellent corrosion-protection systems. When the coating becomes very thick or dull gray, the coating might not be suitable for architectural applications. The appearance can become blotchy with sections of dull finish and sections with bright finish. Almost all of these surface effects last for the first couple of years and then the coating becomes uniformly dull gray as the protective layer of corrosion products is formed on the surface of the galvanized steel. The cause of the irregular surface finishes is the variation in steel chemistry of the parts to be hot-dip galvanized. ASTM A 385 describes the effects of steel chemistry on the hot-dip galvanized finish. The two elements with the most influence are silicon and phosphorus. If these elements are controlled to recommended



Exterior environment, low-end primer/finish coating: acrylic (water-based) finish coat with a shop coat primer over an SSPC-6 surface preparation.



Exterior environment, high-end primer/finish coating: polyurethane finish coat with an epoxy intermediate coat and zinc rich primer over an SSPC-6 surface preparation.

levels, the finish will be bright and shiny. Many steel makers control the overall impurity content but not these two specific elements, so there might be some parts that are bright and shiny and some that are dull gray. Care should be taken when specifying a particular steel for hot-dip galvanizing if an architectural finish is expected.

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to AESS indicated for galvanizing according to ASTM A 123. Fabricate such that all connections of assemblies are made in the field with bolted connections. Provide galvanized finish or members and assemblies within the range of color and surface textures presented in the mock ups.

PART 3 — EXECUTION

3.1 EXAMINATION

- A. The erector shall check all AESS members upon delivery for twist, kinks, gouges or other imperfections which might result in rejection of the appearance of the member. Coordinate remedial action with fabricator prior to erecting steel.

3.2 PREPARATION

- A. Provide connections for temporary shoring, bracing and supports only where noted on the approved shop drawings. Temporary connections not shown shall be made at locations not exposed to

view in the final structure or as approved by the Architect. Handle, lift and align pieces using padded slings and/or other protection required to maintain the appearance of the AESS through the process of erection.

3.3 ERECTION

- A. Set AESS accurately in locations and to elevations indicated, and according to AISC specifications referenced in this Section.
- B. In addition to the special care used to handle and erect AESS, employ the following erection techniques:

Editor's Note: The following is a list of special erection issues that can impact the final appearance of the AESS. Many of these items have significant cost premiums and should not be used indiscriminately. Refer to the cost matrix for anticipated range of added cost associated with each line item.

Editor's Note: The AISC Code of Standard Practice specifies that AESS framing shall be constructed to one-half the tolerance of typical structural steel frames. This requirement is intended to improve fit up when the exposed steel interfaces with other materials such as curtain wall masonry, etc. If this is not the case, standard tolerances are more economical. The variations permitted under the standard frame tolerances noted in Chapter 7 will typically be acceptable when viewed by eye (without instruments).

1. AESS Erection tolerances: Erection tolerances shall meet the requirements of standard frame tolerances for structural steel per Chapter 7 of the AISC *Code of Standard Practice*.
- OR
1. AESS Erection Tolerances: Erection Tolerances shall meet the requirements of Chapter 10 of the AISC *Code of Standard Practice*.
 2. Welds ground smooth: Erector shall grind welds smooth in the connections of AESS members. For groove welds, the weld shall be made flush to the surfaces of each side and be within + 1/16", -0" of plate thickness.
 3. Contouring and blending of welds: Where fillet welds are indicated to be ground contoured, or blended, oversize welds as required; grind to provide a smooth transition and to match profile on approved mock-up.
 4. Continuous Welds: Where noted on the drawings, provide continuous welds of a uniform size and profile.
 5. Minimize Weld Show Through: At locations where welding on the far side of an exposed connection occurs, grind distortion and marking of the steel to a smooth profile with adjacent material.
 6. Bolt Head Orientation: All bolt heads shall be oriented as indicated on the contract documents. Where bolt-head alignment is specified, the orientation shall be noted for each connection on the erection drawings. Where not noted, the bolt heads in a given connection shall be oriented to one side.
 7. Removal of field connection aids: Run-out tabs, erection bolts and other steel members added to connections to allow for alignment, fit-up, and welding in the field shall be removed from the structure. Field groove welds shall be selected to eliminate the need for backing bars or to permit their removal after welding. Welds at run-out tabs shall be removed to match adjacent surfaces and ground smooth. Holes for erection bolts shall be plug welded and ground smooth.
 8. Filling of weld access holes: Where holes must be cut in the web at the intersection with flanges on W shapes and structural tees to permit field welding of the flanges, they shall be filled. Filling shall be executed with proper procedures to minimize restraint and address thermal stresses in group 4 and 5 shapes.
- C. Field Welding: Weld profile, quality, and finish shall be consistent with mock-ups approved prior to fabrication.
 - D. Splice members only where indicated.
 - E. Obtain permission for any torch cutting or field fabrication from the Architect. Finish sections thermally cut during erection to a surface appearance consistent with the mock up.
 - F. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts. Replace connection plates that are misaligned where holes cannot be aligned with acceptable final appearance.
- ### 3.4 FIELD CONNECTIONS
- A. Bolted Connections: Install bolts of the specified type and finish in accordance with Division 5 section "Structural Steel."
 - B. Welded Connections: Comply with AWS D1.1 for procedures, and appearance. Refer to Division 5 section "Structural Steel" for other requirements.
 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp. Verify that weld sizes, fabrication sequence, and equipment used for AESS will limit distortions to allowable tolerances.
 2. Obtain Architects approval for appearance of welds in repaired or field modified work.
- ### 3.5 FIELD QUALITY CONTROL
- A. Structural requirements: The Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports. Refer to Division 5 section "Structural Steel" for detailed bolt and weld testing requirements.
 - B. AESS acceptance: The Architect shall observe the AESS steel in place and determine acceptability based on the mockup. The Testing Agency shall have no responsibility for enforcing the requirements of this section.
- ### 3.6 ADJUSTING AND CLEANING
- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint shall be completed to blend with the adjacent surfaces of AESS. Such touch up work shall be done in accordance with manufacturer's instructions as specified in Division 9, Section "Painting."
 - B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

ARCHITECTURALLY EXPOSED STRUCTURAL STEEL (AESS) FABRICATION, ERECTION, AND COATING RELATIVE COST MATRIX			
Specification Section (Fabrication)	Specification Section (Erection)	AISC Code of Standard Practice Section	PROCESS

FABRICATION AND ERECTION CLASSIFICATIONS			
2.2	2.2	10.4.1	SPECIAL CARE IN PROCESSING AESS
2.2.1	3.3.1	10.2.1, 10.4.2	TOLERANCES: ONE-HALF STANDARD
2.2.2	3.3.2	10.2.5	WELDS GROUND SMOOTH
2.2.3	3.3.3	--	WELDS CONTOURED & BLENDED
2.2.4	3.3.4	--	CONTINUOUS WELDS
2.2.5	3.3.5	10.2.3	WELD SHOW THROUGH MINIMIZED
2.2.6	--	--	COPING AND BLOCKING TOLERANCES MINIMIZED
2.2.7	--	10.2.4	JOINT GAP TOLERANCES MINIMIZED
2.2.8	--	10.2.6	PIECE MARKS HIDDEN
2.2.9	--	10.2.8	SURFACE DEFECTS MINIMIZED
2.2.10	--	10.2.7	MILL MARKS REMOVED
2.2.11	--	--	GRINDING OF SHEARED EDGES
2.2.12	--	--	ROLLED MEMBERS: MINIMIZE DISTORTION
2.2.13	--	--	SEAL WELDS TO CLOSE OPEN GAPS
--	3.3.6	--	BOLT HEAD ORIENTATION DICTATED
--	3.3.7	--	FIELD WELDING AIDS REMOVED
--	3.3.8	--	CLOSE WELD ACCESS HOLES AT FULL PEN WELDS
RANGE IN COST INCREASE OVER STANDARD STRUCTURAL STEEL			

SURFACE PREPARATION CLASSIFICATIONS
POWER TOOL CLEANING CLEANING (SSPC-SP3)
COMMERCIAL BLAST CLEANING (SSPC-SP6)
RANGE OF COST INCREASE OVER POWER TOOL CLEANING (SSPC-SP3)

PRIMER AND FINISH COATING CLASSIFICATIONS
FINISH A: INTERIOR ENVIRONMENT - LOW END FINISH
FINISH B: INTERIOR ENVIRONMENT - HIGH END FINISH
FINISH C: EXTERIOR ENVIRONMENT - LOW END FINISH
FINISH D: EXTERIOR ENVIRONMENT - HIGH END FINISH
FINISH E: GALVANIZING
RANGE OF COST INCREASE SHOP PRIMED WITH NO FINISH COAT

ACCUMULATED RANGE OF COST INCREASE

COST MATRIX NOTES:

1. THE ABOVE COST INCREASE PERCENTAGES APPLY TO THE ARCHITECTURAL EXPOSED
2. THE ABOVE COST INCREASE PERCENTAGES ARE INTENDED TO GIVE THE DESIGNER IN THEY ARE ESTIMATES AND WILL VARY

FOR EACH PROJECT. CONTACT A FABRICATOR TO OBTAIN SPECIFIC PRICING FOR EACH

BLUE DESIGNATES USER INPUT CELLS.

GREEN DESIGNATES RESULTS CELLS.

NOTES	STANDARD AISC Code of Standard Practice Section 10 for AESS (pre-set)	CATEGORY 3 High profile conditions that are out of reach to touch and can be viewed from a distance 20 feet or more (pre-set)	CATEGORY 2 High profile conditions that are out of reach to touch and can be viewed in close proximity within 20 feet (pre-set)	CATEGORY 1 High profile conditions that are within reach to touch and can be viewed in close proximity (pre-set)	USER Custom selected by the user (interactively input)	ADDED COST RANGE TO AESS
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a	X	X	X	X	X	10% to 20%
b	X			X		5% to 10%
c			X	X		10% to 20%
d			X	X		20% to 30%
e				X		5% to 10%
f			X	X		5% to 10%
g	X			X		5% to 10%
h	X			X		5% to 10%
i	X	X	X	X		1% to 5%
j	X			X		1% to 5%
k				X		1% to 5%
l				X		2% to 10%
m		X	X	X		10% to 15%
n				X		5% to 10%
o		X	X	X		1% to 5%
p			X	X		5% to 10%
q			X	X		5% to 10%
	27% TO 60%	22% TO 45%	67% TO 125%	96% TO 195%	10% TO 20%	

r	CLASSIFICATION, SSPC-SP# = 6					0% to 0%
s						10% to 20%
	10% TO 20%	10% TO 20%	10% TO 20%	10% TO 20%	10% TO 20%	

t	CLASSIFICATION, FINISH = A					5% to 10%
u						35% to 50%
v						10% to 20%
w						45% to 60%
x						10% to 20%
	5% TO 10%	5% TO 10%	5% TO 10%	5% TO 10%	5% TO 10%	

	42% TO 90%	37% TO 75%	82% TO 155%	111% TO 225%	25% TO 50%	
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POSED STRUCTURAL STEEL PORTIONS OF THE FRAME ONLY.
 NER INFORMATION TO MAKE PRELIMINARY COST ESTIMATING JUDGEMENTS.

R EACH PROJECT.



COST MATRIX NOTES

- a **Special Care in Processing AESS:** Upgraded care in the process of fabricating, trucking, handling, storing, and erecting the material is required to obtain minimally acceptable AESS. This classification is required whenever AESS is specified.
- b **Tolerances: One-Half Standard:** The tolerances for structural steel frames are set by AISC Code of Standard Practice. If AESS is specified, these tolerances are required to be one-half of those of a standard structural steel. These reduced tolerances should be carefully reviewed to see if they are required, as they add significant cost to the project.
- c **Welds Ground Smooth:** In a standard structural steel frame, the welds are left in an as welded condition with the slag and weld spatter removed. For AESS frames, the process is the same. Should smooth grinding of the welds be required, this classification should be specified. It is important to note that in many cases, grinding the weld will leave a blemish that is more obvious than the unground weld.
- d **Welds Contoured and Blended:** The comments under item k apply here, but the requirements of contoured and blended welds add an additional complexity. If transitions of smoothly ground welds are required to contoured and blended, this process will be done by hand and will leave blemishes around the weld area that may be more noticeable than the as-welded condition. Samples of this process should be submitted for review prior to fabrication.
- e **Continuous Welds:** Many welds in standard structural steel and AESS frames are specified for strength to be intermittent. Some AESS structures may require that these welds be continuous for aesthetic reasons. Special care is required to avoid distortion of the member. If this is the case, this classification should be specified.
- f **Weld Show Through Minimized:** In standard structural steel frames, there is no attempt to minimize the show through on the back face of the welded element caused by the welding process. Typically in AESS frames, the weld show through is left the same as a standard frame. If minimized show through is required, this can be done by hand grinding the backside of the weld. It is important to note that this process may leave a blemish that in most cases is more objectionable than the show through.
- g **Coping and Blocking Tolerances Minimized:** The AISC *Code of Standard Practice* Section 10.24 requires all copes, miters, and cuts in AESS material are to be made with a uniform gap of $1/8$ ". This tolerance is more stringent than the tolerances that fabricators are held to for standard structural steel material. In many cases, this requires the fabricator to custom cut and fit each member, adding significant cost to the project. This classification is not recommended for standard AESS. It is recommended to specify this classification only where joints are within a close viewing proximity and only if completely necessary.
- h **Joint Gap Tolerances Minimized:** This classification is similar to item b. above. A clear distance between abutting members of $1/8$ " is required. Again, this is more stringent than the tolerances that fabricators are held to for standard structural steel. This classification is difficult to achieve both in the shop and field due to material size consistency and erection fit up tolerances, adding significant cost to the project.
- i **Piece Marks Hidden:** During the fabrication and erection processes, members are marked with specific piece numbers. These numbers are usually left on the piece after erection is complete. AESS pieces are marked in inconspicuous places whenever possible, but there are many cases where these marks will be seen. If removal of these marks is required for aesthetic reasons, this classification should be specified.
- j **Surface Defects Minimized:** In the process of handling the materials, the flanges of the beams and columns will inevitably be deformed and scarred. If this classification is specified, these deformities and scars will be removed.
- k **Mill Marks Removed:** All steel mills mark their material with heat numbers and producer information to identify the material chemistry and strength and the producer. These marks can be stenciled, stamped or taped on to the member. Most mills now stamp the markings on the piece. Removal of the stenciled or taped marking is a simple process, but removing the stamped marking is a difficult process. The common method to remove a stamped mark is to grind it out, leaving a large blemish where the marking was. This blemish is more obvious to the viewer than the mill mark. It is important to note that whenever the mill marks are removed, the traceability for those pieces is usually lost.
- l **Grinding of Sheared Edges:** In the process of fabrication, some types (plate and sheet specifically) of material are sheared. The sheared edge leaves a rough surface with burrs, which is not usually ground for standard structural steel pieces, except where it interferes with the fit-up. AESS requirements may demand that the rough surface be deburred and ground smooth for aesthetic reasons.
- m **Rolled Members: Minimize Distortion:** In the process of fabrication, some members may be rolled into various shapes. When rolling the member, it will distort. If AESS requirements dictate that the distortion shall be minimized, this classification should be specified. The added cost range percentages noted assume that 10% of the AESS tonnage is to be rolled.
- n **Seal Welds To Close Open Gaps:** In standard structural steel frames, seal welding to close joints and gaps is normally not required. AESS frames may require welds to seal gaps from environmental implications or for aesthetic reasons. Should seal welding be required, this classification should be specified. It is important to note that seal welding of members can distort them.
- o **Bolt Head Orientation Dictated:** For standard structural steel frames, the orientation of the bolt heads is left up to the erector. Ease of access for placing and tightening the bolt will dictate the bolt head orientation. Should the bolt heads be required to all be on the same surface, special attention is required in the shop and field.
- p **Field Welding Aids Removed:** In a standard structural steel frame, the aids used in the process of field welding are not removed. Often times they are not removed due to structural integrity issues. Should they be removed from AESS frames due to aesthetic concerns, special attention is required in the shop and in the field.
- q **Close Weld Access Holes at Full Pen Welds:** The comments under item q above also apply here. Weld access holes are the holes in the web of beams and columns to allow the welder to weld in the areas of the member's web. If they are required to be closed for aesthetic reasons, special attention is required in the shop and in the field.
- r **Power Tool Cleaning (SSPC-SP3):** Power tool cleaning removes all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter using power tools. This process requires that Solvent Cleaning (SSPC-SP1) be performed prior. It is not intended that adherent mill scale, rust and paint be removed by this process. Mill scale, rust and paint are considered adherent if they cannot be removed by lifting with a dull putty knife.
- s **Commercial Blast Cleaning (SSPC-SP6):** A commercial blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter.
- t **Interior Environment - Low End Primer/Finish Coating:** Alkyd (oil-based) finish coat with a shop coat primer.
- u **Interior Environment - High End Primer/Finish Coating:** Epoxy finish coat with an epoxy or zinc rich primer.
- v **Exterior Environment - Low End Primer/Finish Coating:** Acrylic (water-based) finish coat with a shop coat primer.
- w **Exterior Environment - High End Primer/Finish Coating:** Polyurethane finish coat with an epoxy intermediate coat and zinc rich primer.
- x **Galvanizing (ASTM A385):** Care should be taken when specifying hot dip galvanizing for AESS. Zinc coatings produced by the hot dip galvanizing process are excellent corrosion protection systems, but when the coating becomes very thick or dull gray, the coating may not be suitable for architectural applications. The appearance can become blotchy with sections of dull finish and sections with bright finish. Almost all of these surface effects last for the first couple of years and then the coating becomes uniformly dull gray as the protective layer of corrosion products is formed on the surface of the galvanized steel. ASTM A385 describes the effects of steel chemistry on the hot dip galvanized finish, and also states that experienced galvanizers can in many instances exercise some control over coating structure. If cosmetic (aesthetic) appearance is of concern, the purchaser should select an experienced galvanizer and discuss any concerns about aesthetics (surface appearance) prior to any galvanizing.

Appendix B - Permissions for Reuse

This Appendix consists of documentation supporting the request of permissions for reuse of research documents and images.

K-State Webmail**coxli@k-state.edu****Re: Permission Request**

From : Scott Melnick <melnick@aisc.org>
Subject : Re: Permission Request
To : Lindsay Cox <coxli@k-state.edu>

Wed, Apr 25, 2012 07:24 AM

Dear Lindsay,

Please feel free to excerpt as you wish from Modern Steel Construction; just make sure you properly attribute the material.

Good luck!

Scott Melnick
Vice President
American Institute of Steel Construction
312.670.8314
melnick@aisc.org
www.aisc.org

There's always a solution in steel.

On Tue, Apr 24, 2012 at 2:00 PM, Lindsay Cox <coxli@k-state.edu> wrote:
Attn: Mr. Scott Melnick

Dear Modern Steel Construction,

My name is Lindsay Cox, and I am a graduate student in Architectural Engineering at Kansas State University. I am currently doing research for my master's report on Architecturally Exposed Structural Steel.

Through my research, I have found some of your work that I would like to include in my report. I am seeking your permission to use your work directly or as a reference for the original composition of my report.

I would like to include the following materials:

1. Text from "Structural Steel Specifications-Editing and Coordination," by Renee Doktorczyk (Published in MSC in December 2010)

2. Text from "Steel Quiz" (Published in MSC in December 2011)

Additionally, I welcome any other information you'd like to provide on Architecturally Exposed Structural Steel. I sincerely appreciate your consideration and assistance, and look forward to your reply. Thank you for your time.

Sincerely,

Lindsay Cox
Architectural Engineering, Business
Kansas State University
2012 Tunstall Circle
Manhattan, KS
Phone: [\(785\)577-0047](tel:7855770047)

Permission Request

From : Lindsay Cox <coxli@k-state.edu>

Tue, Apr 24, 2012 02:41 PM

Subject : Permission Request

To : melnick@modernsteel.com

Attn: Mr. Scott Melnick

Dear Modern Steel Construction,

My name is Lindsay Cox, and I am a graduate student in Architectural Engineering at Kansas State University. I am currently doing research for my master's report on Architecturally Exposed Structural Steel.

Through my research, I have found some of your work that I would like to include in my report. I am seeking your permission to use your work directly or as a reference for the original composition of my report.

I would like to include the following materials:

1. Text and images from "Dynamic Workplace," by Beth S. Pollak (Published in MSC in September 2003)

2. Text and Images from Woodstock Branch Library," by Christopher L. Thompson (Published in MSC in June 2001)

Additionally, I welcome any other information you'd like to provide on Architecturally Exposed Structural Steel. I sincerely appreciate your consideration and assistance, and look forward to your reply. Thank you for your time.

Sincerely,

Lindsay Cox
Architectural Engineering, Business
Kansas State University
2012 Tunstall Circle
Manhattan, KS
Phone: (785)577-0047

Permission Request

From : Lindsay Cox <coxli@k-state.edu> Tue, Apr 24, 2012 02:00 PM
Subject : Permission Request
To : melnick@modernsteel.com

Attn: Mr. Scott Melnick

Dear Modern Steel Construction,

My name is Lindsay Cox, and I am a graduate student in Architectural Engineering at Kansas State University. I am currently doing research for my master's report on Architecturally Exposed Structural Steel.

Through my research, I have found some of your work that I would like to include in my report. I am seeking your permission to use your work directly or as a reference for the original composition of my report.

I would like to include the following materials:

1. Text from "Structural Steel Specifications-Editing and Coordination," by Renee Doktorczyk (Published in MSC in December 2010)
2. Text from "Steel Quiz" (Published in MSC in December 2011)

Additionally, I welcome any other information you'd like to provide on Architecturally

Exposed Structural Steel. I sincerely appreciate your consideration and assistance, and look forward to your reply. Thank you for your time.

Sincerely,

Lindsay Cox
Architectural Engineering, Business
Kansas State University
2012 Tunstall Circle
Manhattan, KS
Phone: (785)577-0047

Request for Permission

From : Lindsay Cox <coxli@k-state.edu> Tue, Apr 24, 2012 01:25 PM
Subject : Request for Permission
To : melnick@modernsteel.com

Attn: Mr. Scott Melnick

Dear Modern Steel Construction,

My name is Lindsay Cox, and I am a graduate student in Architectural Engineering at Kansas State University. I am currently doing research for my master's report on Architecturally Exposed Structural Steel.

Through my research, I have found some of your work that I would like to include in my report. I am seeking your permission to use your work directly or as a reference for the original composition of my report.

I would like to include the following materials:

1. Text and images from the Architecturally Exposed Structural Steel Supplement (Published May 2003)

Additionally, I welcome any other information you'd like to provide on Architecturally Exposed Structural Steel. I sincerely appreciate your consideration and assistance, and look forward to your reply. Thank you for your time.

Sincerely,

Lindsay Cox

Architectural Engineering, Business
Kansas State University
2012 Tunstall Circle
Manhattan, KS
Phone: (785)577-0047

K-State Webmail**coxli@k-state.edu****FW: AESS**

From : Erika Winters-Downey
<wintersdowney@aisc.org>
Subject : FW: AESS
To : Lindsay Cox <coxli@k-state.edu>

Wed, Sep 05, 2012 11:26 AM
1 attachment

Lindsay, below is the permission from Scott for the AESS power point images. I have Cindi Duncan getting permission for you on the COSP.

Can you send us a copy of your draft so we can see exactly what images you are using?

Thanks,

Erika Winters Downey, SE, LEED AP
Great Plains Regional Engineer
American Institute of Steel Construction
913.206.9426
www.aisc.org
wintersdowney@aisc.org



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From: Carter, Areti [mailto:areti@aisc.org]
Sent: Wednesday, September 05, 2012 11:23 AM
To: Melnick, Scott

Cc: Erika Wintersdowney
Subject: Re: AESS

OK. Thanks.

On Wed, Sep 5, 2012 at 11:04 AM, Melnick, Scott <melnick@aisc.org> wrote:
Sure, it's fine for her masters thesis.

Scott Melnick
Vice President

American Institute of Steel Construction
p: [312.670.8314](tel:312.670.8314)
c: [312.804.1535](tel:312.804.1535)

There's always a solution in steel.

On Wed, Sep 5, 2012 at 10:41 AM, Carter, Areti <areti@aisc.org> wrote:
Scott,
Would you be the person to give permission for someone to use text/images from the AESS PPT presentation we have on our website? Please see below.
Areti

----- Forwarded message -----

From: **Erika Winters-Downey** <wintersdowney@aisc.org>
Date: Tue, Sep 4, 2012 at 1:42 PM
Subject: RE: AESS
To: Areti Carter <areti@aisc.org>
Cc: Lindsay Cox <coxli@k-state.edu>

Areti,

Lindsay is a grad student at Kansas State University and is doing a master's thesis on AESS. She has been trying to get ahold of Scott to get permission to use some text/images from our the Code of Standard Practice and the AESS teaching aid powerpoint on our website. I know Scott has been in and out with health issues. Can you help out Lindsay? See her emails below.

Thanks,

Erika Winters Downey, SE, LEED AP
Great Plains Regional Engineer
American Institute of Steel Construction
[913.206.9426](tel:913.206.9426)

www.aisc.org
wintersdowney@aisc.org

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-----Original Message-----

From: Lindsay Cox [mailto:coxli@k-state.edu]
Sent: Tuesday, September 04, 2012 1:08 PM
To: Erika Winters-Downey
Subject: Re: AESS

Erika,

Thank you for helping me with this. I am really needing permissions from AISC as soon as possible, as I'm in the process of writing right now, and it is due in a few weeks. If you could look further into this for me I would very much appreciate it, as I'm wanting to incorporate information/photos that I'm requesting permissions for into my paper as I'm writing it.

Thanks again,

Lindsay Cox

On Aug 29, 2012 9:42 PM, "Lindsay Cox" <coxli@k-state.edu> wrote:

Erika,

I just wanted to touch base again with you. To refresh your memory, I contacted you in the spring about Architecturally Exposed Structural Steel, as you were coming to Kansas State to give a presentation on this topic. I am in the process of writing my master's report on AESS, and had a couple of questions regarding permissions for you. There were a couple of articles that I contacted AISC through the Steel Solutions Center to ask for

permission to use text and images in my report, but never heard back from them. I was hoping that you might be able to either grant me permission or tell me who to contact next. Also, I was wondering if you had any extra AESS images that you could provide, with permission, for me to use? Please see below for the formal permission request. Thank you for your help, and I look forward to hearing from you soon.

Dear AISC,

My name is Lindsay Cox, and I am a graduate student in Architectural Engineering at Kansas State University. I am currently doing research for my master's report on Architecturally Exposed Structural Steel.

Through my research, I have found some of your work that I would like to include in my report. I am seeking your permission to use your work directly or as a reference for the original composition of my report.

I would like to include the following materials:

1. Text from Code of Standard Practice for Steel Buildings and Bridges, Section 10 (AISC 303-10) (Published April 14, 2010)
2. Text and images from teaching aid powerpoint presentation on AESS from <http://aisc.org/content.aspx?id=21480>)

Additionally, I welcome any other information you'd like to provide on Architecturally Exposed Structural Steel. I sincerely appreciate your consideration and assistance, and look forward to your reply. Thank you for your time.

Sincerely,

Lindsay Cox

----- Original Message -----

From: "Erika Winters-Downey" <wintersdowney@aisc.org>

To: "Lindsay Cox" <coxli@k-state.edu>

Sent: Wednesday, March 7, 2012 9:43:54 AM

Subject: RE: Presentation on AESS at KSU

Hi Lindsay,

I assume you already have our AESS literature - about a 10 page document that came out in 2003. I'm also attaching another article on fire protection of AESS - I haven't studied this one as much. I am happy to sit down and discuss with you more details. I would definitely recommend having a cost part to your report. AESS can affect the bottom line on pricing by quite a bit. I can put you in touch with several steel fabricators in KS that would put some pricing to whatever details you want them to look at.

I am happy to stay in touch and answer questions as you go along.

Erika Winters Downey, SE, LEED AP
Great Plains Regional Engineer
American Institute of Steel Construction
[913.206.9426](tel:913.206.9426)
wintersdowney@aisc.org

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-----Original Message-----

From: Lindsay Cox [mailto:coxli@k-state.edu]
Sent: Tuesday, March 06, 2012 4:08 PM
To: wintersdowney@aisc.org
Subject: Presentation on AESS at KSU

Hello Erika,

My name is Lindsay Cox, and I am a senior/graduate student in Architectural Engineering at Kansas State University. I was referred to you by Kimberly Kramer, my graduate advisor, in relation to my master's research and report. My report topic is Architecturally Exposed Structural Steel. I understand that you're presenting on this topic during next Thursday's seminar and also for the SEAKM group afterward. I was excited to hear this, and will be

attending both presentations!

Currently, I am in the beginning stages of my research, have a general preliminary outline, and am gathering information to put together my report this summer. I would be grateful for any additional information on AESS that you would be willing to provide to me, as I'm trying to learn and acquire as much knowledge that I can for a quality report. My hope is that you would also be interested in being a point of contact throughout my research for any questions I may run across.

Ultimately, I wanted to introduce myself prior to your presentations next week, and let you know that I look forward to meeting you. Also, if time permits next Thursday, I would enjoy discussing your opinion as to important aspects to be included in my report. I'm very interested in learning more about Architecturally Exposed Structural Steel, and value any assistance you could provide.

Sincerely,

Lindsay Cox
Architectural Engineering, Business
Kansas State University
2012 Tunstall Circle
Manhattan, KS
Phone: [\(785\)577-0047](tel:7855770047)

--

Areti Carter
Director of Publishing
American Institute of Steel Construction
www.aisc.org
aretic@aisc.org
[312.670.5427](tel:3126705427) (tel)
There's always a solution in steel.

www.aisc.org/nascc

--

Areti Carter
Director of Publishing
American Institute of Steel Construction

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312.670.5427 (tel)
There's always a solution in steel.

www.aisc.org/nascc



image001.jpg
16 KB

K-State Webmail**coxli@k-state.edu****Re: Permission Request**

From : Scott Melnick <melnick@aisc.org> Mon, Sep 24, 2012 11:46 AM
Subject : Re: Permission Request
To : Lindsay Cox <coxli@k-state.edu>

It's fine. Just provide the normal attribution in the reproduction (something like "Reprinted courtesy of Modern Steel Construction magazine (www.modernsteel.com).")

Scott Melnick
Vice President
American Institute of Steel Construction
p: 312.670.8314
c: 312.804.1535

There's always a solution in steel.

On Sun, Sep 23, 2012 at 11:06 PM, Lindsay Cox <coxli@k-state.edu> wrote:
Mr. Melnick,

I found one more article that I'd like permission to use. Please see below. Thank you for all of your assistance in getting permissions for my report.

Lindsay Cox

Attn: Mr. Scott Melnick

Dear Modern Steel Construction,

My name is Lindsay Cox, and I am a graduate student in Architectural Engineering at Kansas State University. I am currently doing research for my master's report on Architecturally Exposed Structural Steel.

Through my research, I have found some of your work that I would like to include in my report. I am seeking your permission to use your work directly or as a reference

for the original composition of my report.

I would like to include the following materials:

1. Text and images from "The Three C's of AESS," by Sylvie Boulanger, Ph.D., P.Eng., and Terri Meyer Boake, LEED AP (Modern Steel Construction, December 2011)

Additionally, I welcome any other information you'd like to provide on Architecturally Exposed Structural Steel. I sincerely appreciate your consideration and assistance, and look forward to your reply. Thank you for your time.

Sincerely,

Lindsay Cox
Architectural Engineering, Business
Kansas State University
2012 Tunstall Circle
Manhattan, KS
Phone: [\(785\)577-0047](tel:7855770047)

K-State Webmail

coxli@k-state.edu

AISC Copyright Permission

From : Janet Cummins <cummins@aisc.org> Thu, Sep 06, 2012 02:40 PM
Subject : AISC Copyright Permission
To : coxli@k-state.edu
Cc : Erika Winters-Downey
<wintersdowney@aisc.org>

Dear Ms. Cox,

Erika contacted me regarding your inquiry. You do not need to complete a formal copyright permission form to use text or images from the *Code of Standard Practice* in your report, you only need to give them appropriate reference.

Sincerely,

Janet Cummins

Janet T. Cummins
Engineering & Research Coordinator
AISC
www.aisc.org
cummins@aisc.org
Ph: 312-670-5411
Fx: 312-896-9022

There's always a solution in Steel.

K-State Webmail**coxli@k-state.edu**

RE: Permission Request

From : Nikki Alger <nalger@coppercreekgrp.com> Tue, Apr 24, 2012 03:27 PM
Subject : RE: Permission Request
To : Lindsay Cox <coxli@k-state.edu>

Lindsay,

STRUCTURE can give you permission to reference the below but being an older article, I do not have the contact information for the authors to give anything more than that.

Nikki Alger
Associate Editor
STRUCTURE magazine
Copper Creek Companies, Inc.
148 Vine Street
P.O. Box 545
Reedsburg, WI 53959
P: 608-524-1397 F: 608-524-4432
E: nalger@coppercreekgrp.com

-----Original Message-----
From: Lindsay Cox [mailto:coxli@k-state.edu]
Sent: Tuesday, April 24, 2012 2:36 PM
To: publisher@STRUCTUREmag.org
Subject: Permission Request

Dear Structure Magazine,

My name is Lindsay Cox, and I am a graduate student in Architectural Engineering at Kansas State University. I am currently doing research for my master's report on Architecturally Exposed Structural Steel.

Through my research, I have found some of your work that I would like to include in my report. I am seeking your permission to use your work directly or as a reference for the original composition of my report.

I would like to include the following materials:

1. Text and images from "Fire Protection Materials for Architecturally Exposed Structural Steel," by Arthur J. Parker
(Published February 2005)

Additionally, I welcome any other information you'd like to provide on Architecturally Exposed Structural Steel. I sincerely appreciate your consideration and assistance, and look forward to your reply. Thank you for your time.

Sincerely,

Lindsay Cox
Architectural Engineering, Business
Kansas State University
2012 Tunstall Circle
Manhattan, KS
Phone: (785)577-0047

K-State Webmail**coxli@k-state.edu****RE: Permission Request**

From : Michael Brack <michaelb@datumengineers.com> Tue, Apr 24, 2012 04:19 PM
Subject : RE: Permission Request 1 attachment
To : Lindsay Cox <coxli@k-state.edu>

Lindsay, I'd be happy for you to use my info in your report, on condition that I receive a copy (PDF is fine) of your final report. Thanks for asking. I look forward to learning more about this subject from your report.

Best,
Michael



MICHAEL BRACK, P.E.

President
DATUM ENGINEERS, INC. | F-2819
512.469.9490 ext. 110 fax 512.469.2924
THE ART OF STRUCTURAL ENGINEERING
www.datumengineers.com | Established 1937

-----Original Message-----

From: Lindsay Cox [mailto:coxli@k-state.edu]
Sent: Tuesday, April 24, 2012 1:46 PM
To: michaelb@datumengineers.com
Subject: Permission Request

Dear Mr. Brack,

My name is Lindsay Cox, and I am a graduate student in Architectural Engineering at Kansas State University. I am currently doing research for my master's report on Architecturally Exposed Structural Steel.

Through my research, I have found some of your work that I would like to include in my report. I am seeking your permission to use your work

directly or as a reference for the original composition of my report.

I would like to include the following materials:

1. Text and images from "The Art of Exposing Structural Steel"
(Published in Modern Steel Construction, December 2011)

Additionally, I welcome any other information you'd like to provide on Architecturally Exposed Structural Steel. I sincerely appreciate your consideration and assistance, and look forward to your reply. Thank you for your time.

Sincerely,

Lindsay Cox
Architectural Engineering, Business
Kansas State University
2012 Tunstall Circle
Manhattan, KS
Phone: (785)577-0047



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