Steel Castings in Structural Design – Case Studies

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Abstract

Steel casting manufacturing offers unparalleled freedom in geometry. This geometric freedom is often leveraged to produce aesthetically shaped components for use in architecturally exposed structural steel. However, casting manufacturing can also be used to produce components that simplify fabrication, speed erection, provide improved structural performance, or to address other practical design, performance, and constructional challenges. This paper describes how steel castings have been applied in various projects. Each case study presented includes a description of the way that steel castings were employed to address various design challenges. Armed with an understanding of how steel castings have been successfully leveraged in past projects, designers will be better equipped to understand how castings can be employed in their practice to provide value to their clients and project stakeholders.

Introduction

Steel casting manufacturing accommodates the production of high integrity, monolithic structural steel components of complex geometry. The geometric freedom afforded through casting manufacturing is most recognizably used in the creation of architecturally exposed structural steel (AESS) connection details. However, casting design freedom can also be leveraged to address practical challenges faced in construction and/or to provide structural performance capabilities that may not be readily achieved using conventional steel fabrication techniques (Figure 1).

Stemming mostly from a vacuum of knowledge related to the most beneficial uses of castings in building construction, steel castings are generally viewed by North American design practitioners as an alternative to conventionally fabricated connections, regardless of the application. As such, a common practice for those aiming to evaluate the merits of casting use in a particular instance is to try to develop cost comparisons between a conventionally fabricated connection and a cast alternative. While possible in some cases, this endeavor is commonly a misleading process for several reasons.

Figure 1: 17.5-ton cast steel nodes are used at the center points of the three, 70-foot tall AESS frames which support an 11-story reinforced concrete office building above two heritage buildings in Toronto, ON. The stiffness of the nodes increased the lateral stiffness of the frames, which in turn reduced the demand on the reinforced concrete elevator and stair cores, resulting in peripheral cost savings afforded through casting use in this structure (CAST CONNEX)
detailing, erection, coatings, shipping, overheads, etc. – and amortized over the tonnage of the entire steel frame. As such, working backwards to determine the cost of a connection from the expected per-ton cost of a steel building frame is imprecise.

More importantly, the best applications for steel castings are those where the castings address a variety of design needs simultaneously. When castings are well integrated, there often isn’t a fabricated connection that can achieve all of the design criteria that the cast connection addresses. Further, a well-designed cast connection can provide savings across a variety of trades – from overall steel tonnage savings afforded through improved member utilization to savings in fabrication labor, shop coatings, field erection, field coatings, and in some cases even life cycle costs. While these peripheral savings can be substantial, they are often more challenging to quantify during design. In cases where cast steel nodes are used in complex frameworks (like space frames, trusses, or bridges), one cannot compare the cost of cast connections to fabricated connections without some accounting of the potentially dramatic differences in the structures’ overall strength, stiffness, resilience, fatigue life, and aesthetics.

As such, rather than trying to compare the cost of a cast connection against fabrication, the author encourages designers to evaluate the merits of casting use based on the cost of the castings being considered against the benefits and value they provide to the project and its stakeholders.

The review of case studies offers a means to highlight the value that can be provided by steel castings in a variety of project types and situations. To assist the reader in appreciating the nuances in successful casting use, the case studies have been categorized by the primary driver for leveraging castings in each project: 1) predominantly functional applications, 2) architecturally driven applications, and 3) applications where castings provide both special structural performance and aesthetics.

**Predominantly Functional Applications**

The decision to use steel castings in the following projects was driven by practical considerations alone – aesthetics were not an important criterion for the connections in these casting applications.

**Offshore and HSS Structures**

The concept of cast steel nodes for use in structural applications was first developed in the early 1980’s for use in the design and construction of offshore steel jacket structures – that is, space frames designed to support oil rigs and wind turbines (Figures 2 and 3).

It should be immediately apparent that connection aesthetics are of no consequence in these types of structures. Rather, cast steel nodes are used in these applications because of the significant improvement castings provide to the fatigue life of these structures, which in turn reduces their life cycle cost.

Casting manufacturing accommodates smooth transitions in thickness and geometry. With thoughtful casting design, smooth transitions can be made to coincide with the natural flow of forces within an element. This lowers geometric stress concentration factors and increases efficiency and fatigue life within cast elements. Fatigue life is particularly improved in applications where a casting replaces a welded connection at a member intersection. By introducing a cast node, weld locations are moved away from changes in geometry. This moves the residual stresses and weld toe notches that are inherent in welds away from geometric stress concentrations. The separation of the two types of stress
risers dramatically improves the fatigue resistance of the junction (Lomax, 1982). In the offshore energy industry (both in oil platform and wind tower basements), cast steel nodes provide fatigue resistances 4 to 18 times greater than would fabricated connections (Breynaert, 1995). As such, the use of cast nodes provides significant reduction in the life cycle cost of these structures.

Another very significant advantage steel castings provide is in improving member utilization, thereby reducing overall steel tonnage in steel structures comprised of hollow structural section (HSS) members (trusses, space frames, or bridges). In HSS-to-HSS connections, local connection limit states often drive member selection. That is to say, the wall thickness of an HSS member must typically be heavier than otherwise necessary to resist localized connection failure modes. Additionally, shear lag effects at complex tubular connections can reduce available member strength and also drive section selection, reducing overall structural efficiency.

Conversely, HSS member selection is not dependent on local connection strength when designing tubular structures with cast nodes. This allows for every member in a complex framework to be optimized solely based on member forces. As such, tubular structures designed with cast nodes benefit from the ability to optimize HSS member sizes with no concern for connections, providing economies in overall tonnage.

Furthermore, estimating service deflections in HSS structures constructed with conventionally fabricated connections can be challenging and imprecise. Tube-to-tube connections are flexible, and depending upon the ratio of the web to chord member dimensions, HSS connections can be extremely flexible. Research has shown that deflections estimated in bridges constructed using HSS without accounting for HSS connection flexibility can be underestimated by as much as 20-percent (Frater and Packer, 1992). As such, connection flexibility cannot be neglected in the computation of deflections when using conventionally fabricated connections. The corollary of not being able to accurately compute deformation is that the estimation of the structure’s natural period will be inaccurate by the same degree.

The issue of imprecise estimation of deflection and fundamental period of HSS structures is eliminated through the use of cast nodes. As previously discussed, castings can be shaped to accommodate the natural flow of forces through the junction and increasing local wall thickness in heavily loaded regions or where additional stiffness is required is trivial with castings. This is in contrast to conventionally fabricated connections which must either be locally reinforced to increase connection stiffness, which is costly and often unsightly, or where the wall thickness of the HSS...
member must be increased leading to global structural inefficiency, which is also costly. Further, because cast nodes can be designed to control connection flexibility, HSS structures constructed using cast nodes are typically stiffer than conventionally fabricated HSS structures. In structures where deflections or natural period considerations govern the design, the connection stiffness offered through the use of cast nodes translates directly to cost savings in reducing the tonnage of HSS necessary to meet flexibility criteria. This is particularly important when considering castings in the design of bridges constructed from HSS.

Oakland International Airport Terminal 1 Seismic Retrofit, Oakland, CA

Another benefit of casting manufacturing is that it can allow designers to create heavy structural steel sections of any geometry. Castings are isotropic and can be produced to have consistent mechanical properties through heavy sections. As such they are ideal for use as “disturbed region” elements – i.e. structural components that will be subjected to complex, multi-axis stress states.

This was one of the reasons castings were leveraged in the design of the seismic retrofit of Terminal 1 at Oakland International Airport. The retrofit included the creation of a rigid steel diaphragm at the top of the existing reinforced concrete columns / underside of the vaulted precast concrete roof panels, and the addition of hysteretic damping via buckling-restrained braces framing from the new diaphragm down to foundations. The diaphragm was comprised of HSS members spanning unbraced between adjacent columns in up to 8 directions from each column. Special cast steel collars were designed to interface the structural steel members to the existing concrete columns. In construction, two cast steel collars are fastened together with pre-tensioned high strength bolts, with the void space between the cast collars and the column being subsequently filled with grout. The cast steel collars were designed to remain predominantly elastic during a design-level seismic event, thereby transmitting diaphragm collector forces “around” the columns (Figure 4).

Industrial Food Processing Facility, Livingston, CA

Developed by researchers in the Department of Civil Engineering at the University of Toronto (de Oliveira et al., 2008), CAST CONNEX® High Strength Connectors™ are standardized, capacity designed cast steel connectors for use at the ends of round HSS or Pipe brace members in Special Concentrically Braced Frames (SCBF) and Ordinary Concentrically Braced Frames (OCBF). The connectors simplify the design, speed the construction, and improve the performance of SCBF and OCBF through various means. First, the shaping and stiffness of the connectors eliminates shear lag at the brace connection. The connectors are also shaped to accommodate a double-shear bolted connection between the brace assembly and the beam-column gusset plate. As such, use of the connectors eliminates the need to field weld braces. This both improves the quality and reliability of the connection and also reduces cost, given the high cost of field welding and Special Inspection of field welds versus the lower costs associated with bolted connections. Moreover, the elimination of field welding greatly speeds erection, compressing the overall duration of structural steel field activities and thereby saving additional cost. Finally, because double-shear bolted joints can be detailed to be more compact than the alternative field welded joints (which are subject to shear lag and typically require net section reinforcement), the overall size of the gusset plates at the brace connections is reduced when using the connectors.
Reducing the size of gusset plates has been shown to improve the overall performance of braced frame structures in earthquakes and also reduces the likelihood of undesirable beam or column failure modes.

High Strength Connectors have been used in the design and construction of a wide range of building types in high and moderate seismic zones across North America. The Industrial Food Processing Facility – a high volume wine fermentation facility – in Livingston, California (Figure 5) has been selected as a case study because use of the connectors was driven entirely on the overall cost savings afforded by the connectors in addition to the value they provide in terms of compressed construction schedule, improved quality, and improved structural performance. It is also noteworthy that the cast connectors have been used in two separate phases of the facility’s development which were designed by different firms. With a fully designed, constructed, and functional first phase incorporating the cast connectors, the designers of the second phase were tasked with improving upon the original design in an effort to reduce cost. Armed with a more precise estimate of design loading, the tonnage of the gravity and the seismic force resisting system (SFRS) was reduced in the second phase. The phase 2 designers also re-evaluated the cost benefit of making use of the connectors based on the detailed economics of the first phase. Through this exercise, they independently showed that the cost of the connectors was fully justified and opted to make use of the connectors in the subsequent building phase.

École Lakay, Haiti

The designers of the École Lakay reconstruction – a trades school that was destroyed in the 2010 Magnitude 7.0 earthquake in Haiti but which has been reconstructed through an initiative led by the Canadian Construction Association and Builders Without Borders – also made use of High Strength Connectors in the building’s SFRS (Figure 6). The structural steel and connectors comprising the frame were donated; the frame was fabricated in Canada, shipped to Haiti, and erected with the aid of local labor. Use of the cast connectors in this project not only improved the expected performance of the building in a subsequent earthquake but – given the lack of skilled field welders in Haiti – the connectors were also vital to achieving the project’s goal to construct a state-of-the-art school that would provide shelter in the event of another natural disaster.

Seismic Retrofit of Centre Éducatif Sainte-Aubin, Baie-Saint-Paul, QC

CAST CONNEX® Scorpion™ Yielding Connectors were developed at the University of Toronto as a high ductility bracing solution for use in the SFRS of building structures (Gray et al., 2014). The devices dissipate seismic energy through the yielding of specially shaped cast steel connectors comprised of a highly ductile, notch tough cast steel grade. The casting’s fingers yield in flexure when the device is severely loaded in tension or compression, thus providing a full, symmetric hysteresis. At large axial device displacements, second-order geometric effects in the fingers result in an increase in the post-yield stiffness.

Scorpion Yielding Connectors can be used in both new construction and in the seismic retrofit of existing structures. They also provide unique advantages over other types of dampers. First, because the response of the yielding connector is dependent on a number of variables that can be controlled in device design (yielding finger length, thickness,
and width, number of fingers, and material properties), the
connectors can be designed to provide a higher ratio of
stiffness-to-yield strength than can typically be achieved in
other hysteretic devices. The stiffening behavior at large
drifs that is exhibited by the connectors is another advantage,
as it has been shown to provide for a better distribution of
yielding in braces over a building’s height (Gray et al.,
2014b). Finally, the small size and modularity of the devices
is of benefit in retrofit, as the yielding connectors can be
employed in a wide range of structural configurations and
retrofit work can be less disruptive to the existing building.

The Centre Éducatif Sainte-Aubin is a 1960’s-era secondary
school in the Charlevoix region of Quebec, which is the
region of highest seismic hazard in Canada (PGA=1.1g). The
school is founded on “Category F” soil (the poorest soil
category in the National Building Code of Canada) and the
existing structure was a combination of buildings/additions
that were either steel framed with an unreinforced masonry
SFRS or deficient reinforced concrete structures.

Given their ability to add stiffness – important for limiting
damage to the existing unreinforced masonry walls and RC
frames – while minimizing the additional load which must be
transferred through the existing structure, the yielding
connectors were the selected retrofit device (Figure 7).

Architecturally Driven Applications

The decision to use cast steel connections in the following
projects was primarily driven by aesthetic considerations.
However, while architectural criteria drove the use of
castings in these projects, these components are not
ornamental; they are architecturally exposed structural steel
(AESS) connections that are a part of the primary gravity
and/or lateral force resisting systems of the following
buildings.

World Trade Center Tower 3, New York, NY

The Transit Hall of the soon-to-be-completed World Trade
Center Tower 3 building in New York will include suspended
mezzanine levels with retail accommodations. Architects at
Rogers Stirk Harbour + Partners specified many custom
AESS components for use in this feature space, including
custom-designed cast steel connectors for use at the ends of
built-up box girders that support the suspended floor levels.
The end connectors were detailed in collaboration with the
casting supplier to accommodate the tolerances at the box
girder-to-casting junction as well as at the clevis connection.
Great effort was expended in the casting’s “first article”
process to ensure the manufacturing approach would yield
components having suitable surface finish and sufficient
geometric sharpness in their details (Figures 8 and 9).

Figure 7: Cast steel yielding connectors used in the seismic retrofit of
a high school in Baie-Saint-Paul, QC (EMS Engineering)

Figure 8: Rapid prototype (3D print) of the custom cast connection for
use in the Transit Hall of 3 World Trade Center in New York, NY
(CAST CONNEX)

Figure 9: Mockup of a built-up box girder fitted with a custom casting
for 3 World Trade Center in New York, NY (Silverstein Properties)
Whitney Museum of American Art, New York, NY

CAST CONNEX® Universal Pin Connectors™ are standardized clevis-type fittings designed to connect to round HSS or Pipe members. Their exterior shaping was developed to smoothly transition the geometry of the connection from the round cross-section of the adjoining HSS to the connector's forks, thereby minimizing the connector’s profile from all sightlines. Given their aesthetics, the connectors are most commonly employed in AESS.

The new Whitney Museum of American Art in New York features Universal Pin Connectors prominently in the building’s ground level X-braces, which are visible from both the interior and exterior of the museum (Figures 10 and 11). The X-braces are a part of the building’s primary lateral force resisting system and as such the braces and connectors are rather heavily loaded.

The cast connectors were selected for use in this project by Renzo Piano Building Workshop based on their aesthetics. Alternative fabricated clevis-type connections – which must be built-up from shaped plate work – cannot achieve the smooth, curving geometry of the cast connectors. Furthermore, the aesthetic quality of such alternative fabricated details relies heavily on the skill level of the selected steel contractor’s fitters and welders who must grind significantly more weld to achieve a high quality aesthetic than is required when using the connectors (Figure 12). As such, the mass produced cast connectors offer a more reliable aesthetic and tend to have a lower installed cost than AESS-suitable fabricated alternatives.

Given their blend of aesthetics and economics, Universal Pin Connectors are very commonly used in the design and construction of community centers, libraries, and other civic structures, and because they can be used at the ends of any structural member that is axially loaded in both tension and/or compression, the range of use is broad – from hangers or compression struts supporting canopies or roof overhangs (Figure 13), to column or brace member end connections (Figure 14), to web and/or chord member end connections in trusses, space frames, and bridges (Figure 15).

Pioneer Village Subway Station, Toronto, ON

Architect Will Alsop called for the use of a single custom designed cast steel v-column base for use at the main entrance to the Toronto Transit Commission’s new Pioneer Village Subway Station. The station, intended to become a new civic landmark straddling the border of Toronto and York Region and anchoring a corner of York University Campus, will serve up to 20,000 subway passengers daily.
The exterior shaping of the v-column base was established by Alsop with a unique, jellybean-shaped base plate that transitions into legs that widen as they rise to match the diameter of the columns framing into the node from above. The centerlines of the columns meet below the underside of the node’s baseplate, spacing the casting’s legs apart. Given the extremely close viewing distance and that Alsop desired that the node be indistinguishable from the HSS members that would be welded to the node, the surface of the casting was smoothed and polished (Figure 16). With the project only calling for the creation of a single casting, casting tooling was produced from CNC-cut Styrofoam rather than wood to reduce cost (Figure 17).

Applications Where Castings Provide Both Special Structural Performance and Aesthetics

The cast steel connections in the following projects are used to address arduous structural requirements and/or practical challenges faced in construction while also meeting demanding aesthetic objectives.
Transbay Transit Center, San Francisco, CA

Wrapping the entire perimeter of the 3-city-block-long Transbay Transit Center is an AESS frame which comprises the building’s SFRS – an Eccentrically Braced Frame (EBF) arrangement – fitted with cast steel nodes at each critical junction: ground level, bus deck level, and roof level (Figures 18 and 19).

![Figure 18](image1.png)

**Figure 18:** The exoskeletal AESS SFRS, an EBF arrangement, of the Transbay Transit Center in San Francisco, CA (Thornton Tomasetti)

From below and behind, the cast nodes at the ground level integrate with 6- to 8-foot deep transfer girders which span the transverse width of the transit terminal. A built-up column sits atop each node and 32-inch diameter, 2.25-inch thick pipe members are complete joint penetration (CJP) welded to the casting’s turrets in the field (Figure 20).

The bus deck cast nodes, which form the intersection of 7 structural members, are shop (below) and field welded (above) to 32-inch diameter heavy-walled pipe members. Spandrel beams are pin-connected to the sides of the nodes via 2.25-inch thick plates shop welded to the node. Drag beams frame into the backsides of the nodes via double-shear bolted connections. The drag beams are canted and skewed; each drag pad on the node is custom-machined for a specific location of use in the structure (Figure 21).

The steel castings at the roof level are specially designed Universal Pin Connectors that have three forks to accommodate the heavy loading that would be transferred in the event of an earthquake large enough to yield (and harden under cyclic yielding) the deep EBF link portion of the roof level spandrel girder. The cast connectors are shop welded to 32-inch diameter, 1.75-inch thick pipe members and are pin-connected to two-pronged clevises which in turn are shop welded to the bottom flange of the EBF girder (Figure 21).

Each tree-like assembly, including cast nodes, is designed to remain predominantly elastic during a design-level earthquake, with inelastic deformations focused to the shear link portions of the roof level girder. Given the extremely heavy sections, arduous loading, complex geometry, and

![Figure 19](image2.png)

**Figure 19:** Various custom castings in the exoskeletal AESS SFRS of the Transbay Transit Center in San Francisco, CA (CAST CONNEX)

![Figure 20](image3.png)

**Figure 20:** Ground level cast node in the Transbay Transit Center in San Francisco, CA (left: Thornton Tomasetti; right: CAST CONNEX)

![Figure 21](image4.png)

**Figure 21:** Bus deck and roof level castings in the Transbay Transit Center in San Francisco, CA (CAST CONNEX)
architectural significance of the connections, steel castings were a clear choice for the critical junctions of the AESS SFRS framing in this project.

The transit center also includes an AESS light column feature that allows natural light to pass down into all levels of the structure. The 150-foot tall light column includes 56 cast nodes having 26 unique geometries. The vertical elements of the light column are comprised of gently curving cast nodes between straight pipe segments. The elliptical rings of the light column are made up of roller-bent pipe segments, except for the top and bottom rings.

At the topmost ring, cast nodes are used to transition from the larger-diameter column segments to the smaller-diameter roller-bent pipe segments of the ring. This connection configuration (where the web-to-chord member size ratio, $\beta$, is greater than 1) is not feasible using conventional fabrication, but is readily accommodated using cast nodes (Figure 22).

Being both very thick-walled and curving at a tight radius, the lowest ring of the light column is comprised entirely of 8 cast nodes of two geometries welded to one another to form the full ring (Figure 23). There would not have been any other practical way to create this ring without the use of steel castings.

All told, the Transbay Transit Center features 304 cast steel nodes produced from 74 unique casting geometries which range in weight from 4,400 to 44,600 pounds each, for a total of nearly 1,750-tons of steel castings.

**Esplanade Pedestrian Bridge, Boston, MA**

As described in the first section of this paper, cast steel nodes offer significant advantages over conventionally fabricated connections in fatigue-critical applications and in structures comprised of HSS. From connectors, couplers, clamps, and rope heads in cabled bridges to cast nodes in steel truss and arch bridges, there are countless examples of casting use in pedestrian, automotive, and rail bridges all over the world. In general, cast node use in tubular steel automotive and rail bridges is predominantly driven by functional requirements alone, whereas cast node use in pedestrian bridges has been driven by a need for both special structural performance and aesthetics. This is because the viewing distances in automotive and rail bridges are typically distant enough that one would not be able to tell whether a particular tube-to-tube joint was cast or fabricated (consider the St. Kilian Viaduct or the Nesenbach Highway Bridge in Germany, for example, which both incorporate cast nodes even though the connections can only viewed from long distances), whereas viewing distances are much closer for pedestrian bridges.

An additional benefit the use of cast nodes offers in bridges is improvement in the performance of the structure’s coating system. The performance of a structure’s paint/coating system is not solely based on the type of coating selected but also on the geometry and connections selected for the structural steel system. Sharp edges, outside corners, crevices, and welds are often sites where coating failures occur and corrosion begins due to the reduced coating barrier protection (Kogler, 2011). Research shows that the anti-corrosive performance of paint coating systems is negatively affected by corner geometries (Itoh et al., 2008).

For these reasons, it is advantageous to eliminate as many edges and irregularities as possible (Kogler, 2011), which is
best achieved through the use of cast nodes. Steel castings inherently replace corners, crevices, and narrow gaps with generous radii and gentle transitions. Clearance between connecting members at junctions is increased by pulling welded joints away from the central work point. Although field welding of some joints is still often required, overlapping welded HSS connections—which are susceptible to cracking due to shrinkage constraints and which are thus hotspots for coating system failure and corrosion problems (Sebastian, 2015)—are completely eliminated. Cast nodes pull the welded regions away from one other and allow for simple girth welds which are more readily welded, inspected, and coated. Regions that require “stripe coatings” are thus improved from an access perspective and hence also from a performance and maintenance perspective.

The Esplanade Pedestrian Bridge currently under construction in Boston is an example where casting use addresses both functional and architectural needs simultaneously. The approach spans for the arch bridge are supported on piers which feature Y-shaped cast nodes with a shaped depression that aids in the transition from the pier base—a section built up from two pipe halves and plates—to the HSS section arms. The project team expended great effort trying to develop a fabricated joint which could address the fatigue requirements while maintaining the desired appearance of the connection; however, a satisfactory fabrication could not be developed and the nodes will be cast as originally proposed (Figures 24 and 25).

Wilson Climbing Centre, Edmonton, AB

The Physical Activity and Wellness Centre at the University of Alberta includes a climbing center located in a unique, purpose-built structure. The building is a complex space frame that is in the shape of an inverted truncated cone with a skewed rooftop (Figure 26). The nearly 500 web members of the space frame are all equipped with cast steel Universal Pin Connectors (Figure 27).

The design called for use of the connectors throughout the structure as the entire steel frame is exposed to occupant view
on the building’s interior and a vertical swath of the steel frame is also exposed to view from the building’s exterior. During a value engineering effort, one proposal was to eliminate the connectors everywhere except for the location where they would be visible from both the interior and exterior of the building given that a more industrial appearance was deemed to be acceptable for those connections only visible from within the climbing gym. However, upon further study by the steel fabricator engaged to fabricate and erect the building, the cast steel connectors were found to be more economical and to provide better tolerances than connections built-up from plate. As such, the connectors were used at all web connections as originally proposed and provided both improved aesthetics and economy over conventionally fabricated connections.

Athletic Club and Spa, Beaverton, OR

As previously described, High Strength Connectors are standardized, capacity designed cast steel connectors for use at the ends of round HSS or Pipe brace members in SCBF and OCBF. Although not specifically developed for use in AESS applications, many designers have identified the aesthetics of the High Strength Connectors as suitable for exposed applications and have thus made use of the connectors in both architecturally exposed and concealed braced bays of a variety of building structures. An athletic club and spa in Beaverton is one such example (Figure 28). Other examples of AESS uses of High Strength Connectors in SCBF braces include the Joseph L. Alioto Recreation Center at St. Mary's College in Moraga, CA, the University of Anchorage Alaska KRC Career & Technical Center in Kenai, AK, and the Berkeley Art Museum and Pacific Film Archive at the University of California, Berkeley, to name a few.

Conclusions

Casting manufacturing provides an economical means of addressing a wide range of challenges in design and construction – ranging from those of a purely practical nature to those related to aesthetics and elegance in design. Comparing castings to conventionally fabricated connections on a cost basis alone is neither practical nor advisable, given the significant quality and performance advantages offered by castings. For those seeking to justify casting use on a quantitative basis, the full value that the cast components offer to the project should be identified and appropriately addressed in the comparison. Examples of the successful integration of steel castings into a variety of projects were presented to illustrate the value that castings provide and the types of design challenges they can address (countless other projects could have been referenced). With a better understanding of how castings have been used successfully in past projects, designers will be better equipped to leverage this manufacturing technique which is at the forefront of modern, efficient, and elegant structural design.
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References


