Building Envelope Solutions

Seattle Art Museum/Washington Mutual Center

By Jeremy Mucha, Vice President, Benson Industries

The new addition to the Seattle Art Museum (SAM) was a construction project conceived to solve the growth issues of a cash strapped downtown museum which owned a prime Seattle city block, and concurrently allow Washington Mutual Bank (WAMU) to develop a 42 story headquarters tower to consolidate their Seattle operations. The creative vision of Pine Street Group LLC as the developer of the mixed use block allowed this idea to become a reality. Blending the various needs of these two disparate clients provided numerous technical and conceptual challenges, not the least of which was the intricate building envelope requirements. The end product of this complex program resulted in a dynamic city block with 3 distinct signature buildings constructed in intimate contact with each other, rising from a common podium.

Original Venturi-designed building in foreground, the panel curtianwall SAM structure to the left, and the new WAMU tower in the background.

The museum had outgrown the original 1980s era Robert Venturi-designed building, which was clad with a stone and ornamented tile façade. To complement this distinct Seattle icon structure, their addition, as conceived by Allied Works Architecture, was to incorporate a flush glass and ribbed stainless steel panel curtainwall with intersecting angular planes, and notched glass zipper transitions. Superimposed on the floor to ceiling glass wall, was a stainless steel, panelized, moveable brise soleil system which allowed for light control in the gallery spaces of the 17 story steel structure. The addition was meshed in between the Venturi building and NBBJ's new WAMU Center. Although the 3 buildings share many floor elevations in common, and have to interact structurally in regards to lateral movement, they each were to have a separate visual identity. Setting it apart from the 2 museum components, the WAMU Center was clad primarily in vertical alternating bands of glass and glazed terra-cotta tiles. The cladding topography was also accented with recessed slots, stainless steel eyebrows, horizontal extrusion grilles, and flat metal panel zones. A 17th floor eco-roof garden also transitions the top of the museum addition with the mid-level of the office tower.

In order to help the museum service its construction debt, the upper 8 floors of the museum addition were built as 13 foot story height office space. WAMU will lease these floors from the museum for up to 25 years. As the museum can afford it, the floors will then be converted to 2-story gallery spaces by removing the slab and leaving the spandrel structure and cladding in place. When WAMU is using the floors as offices, the brise soleil will be in the fully open position to allow light in the offices. When converted to galleries, the sun control panels can be fully closed or partially open as is desired by the museum staff.

Benson Industries LLC of Portland, Oregon was awarded a design build contract to develop the custom unitized curtainwall systems for the combined city block development. NBBJ was the design architect for WAMU, and architect of record for the combined core and shell, while Allied Works was the design architect for SAM. Design work sessions with Benson for the museum cladding included both architects, Sellen Construction, a SAM representative, and Pine Street Group. The Facade Group and RA Heintges and Associates were both retained as cladding consultants, and as needed the structural and mechanical engineers would also be involved. Due to the complexity of the program, it took dozens of sessions to arrive at workable, functional, aesthetic, and commercially viable solutions for both towers.

The building envelope for WAMU was innovative in its use of a terra-cotta rainscreen, which is a relatively new spandrel infill option as it pertains to custom unitized cladding. The basic framing for the glass curtainwall is a thermally broken, shop assembled, stacking unitized system, utilizing dry gasketted joinery and pressure equalized glass pockets and spandrel cavities. There is a galvanized metal backpan air barrier compartment behind every terra-cotta zone allowing the tiles

WAMU Center with vertical bands of panelized terra-cotta. Inset - WAMU unitized system under construction.

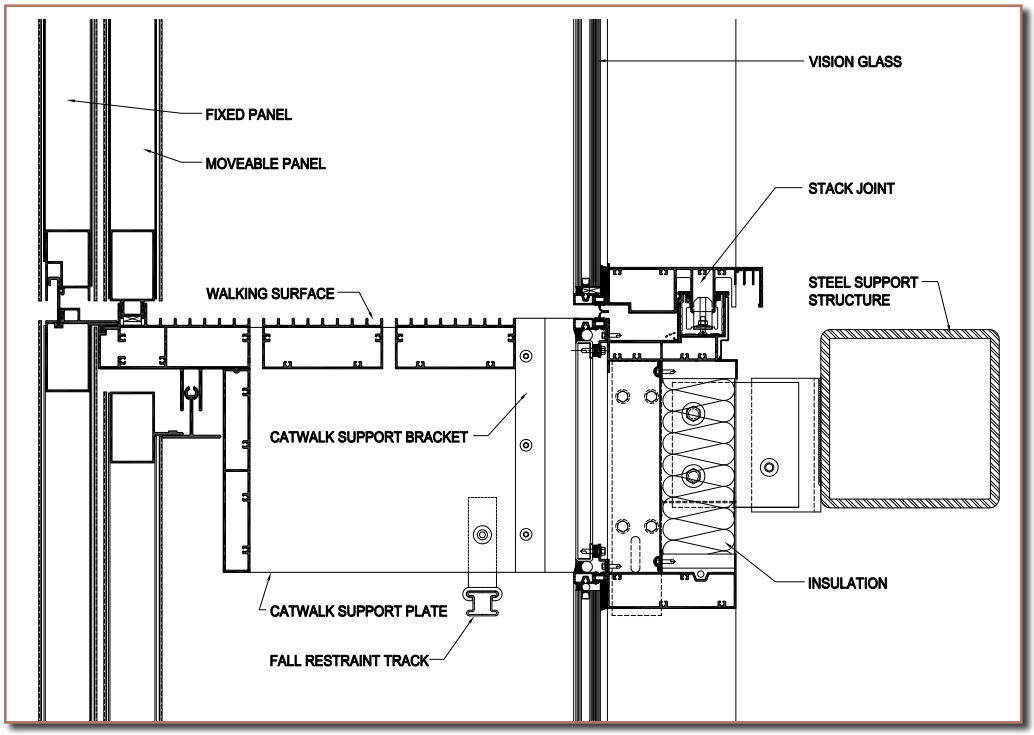
to act as a ventilated rainscreen, and not rely on any exterior sealants. The glass was conventionally captured glazed insulated units with compression gaskets on the exterior mullion caps, and an interior wet seal air barrier. The WAMU system was designed to the structural, thermal, air, water, and seismic parameters normally associated with a Class A signature office tower. The custom design on this 42 story tower utilized 111 unique extrusion profiles.

The SAM addition was several orders of magnitude more complex than a normal custom high-rise. In addition to the more typical specification requirements of the WAMU system, the SAM cladding solution had to also incorporate numerous unique technical demands in the custom building envelope. The most prominent custom feature of the SAM curtainwall is the movable, cantilevered brise soleil panel system. Brise soleil is a French term literally translated as "sun break", as this feature of the curtainwall allows variable sunshading of the vision glass from the exterior of the wall.

Behind this signature element, the basic underlying framing system was conceived as a flush glazed minimum sightline glass unitized wall. The glass was structurally attached to the aluminum extrusions with silicone sealant on all four sides, with only a thin bead of painted metal framing it on the exterior. This unit was designed to support very heavy 5 by 12-foot lites of laminated insulated floor to ceiling glass with an unbraced vertical mullion 12 feet tall. The open reveal joints of the vertical unit were designed to allow for building movements induced by thermal shock, seismic events, and lateral wind drift. The vertical reveal also forms the gasket race for the outboard thermal break element and provides a cavity for the structural knife blade support of the catwalk, which in turn supports the weight of the cantilevered brise soleil system.

View of finished catwalk access zone.

The movable brise soleil panels are built from extruded tubular sub-frames 2½ - by 12- foot tall clad with 20 gauge ribbed sand textured stainless steel formed sheet. The panels are designed to be field set on a track integrated into a catwalk element which is field bolted to the aforementioned knife blade supports emanating from the unit joints every 5 feet on center. The panels alternate with fixed units and overlapping moveable sliding units. This scheme allows the museum to fully screen the wall from exterior sunlight or allow as much as 50% daylight in to the galleries. The movable units, which weigh about 350



Curtainwall section at catwalk.

pounds, are fitted with 2 nylon shoes to allow a single individual to move them as desired while standing on the catwalk. The dead weight of the unit holds it in position against wind pressure or lateral building movements. The catwalk element is 22 inches deep and 5 feet long, and has a custom ribbed walking surface. This surface was designed to have vertical ribs spaced per the advice of the architect's ornithological consultant to be adverse to the comfort of a bird's foot. The catwalk was also required to be easily cleaned, shed water quickly and have no perforations which would allow light to leak between floors when the panels are in the closed position.

Glass unit with projecting catwalk being installed on SAM performance mock-up.

In order to gain access to the catwalk behind the brise soleil, the wall system needed to have secure access points from the interior of the museum. This was accomplished with hinged operable security doors clad with stainless steel. Once on the walking surface, the maintenance person needs to be tied off to a fall restraint system, and be able to move laterally and floor to floor safely. The support brackets for the catwalk were therefore designed to support a continuous track with a moving trolley that can resist a 5000 pound life safety load. Offsetting hatchways and permanently fixed aluminum ladders allow for climbing between catwalk levels. The vertical ladders allowed the museum to have a minimum number of penetrations through the exterior wall.

One of the biggest challenges from an engineering and fabrication standpoint was the detailing of the intersecting geometric planes that bisect and cross the plane of the curtainwall. These overlapping walls create long triangular low roof and soffit transitions which have to be coordinated with roofing membranes and cladding materials. The soffits visible from the street were clad in flat stainless panels. The roof areas were covered with sections of the same extrusion used for the catwalk foot surface to match the appearance to the brise soleil areas. The individual roof area treads had to be removable for roof maintenance and have mechanical ties to resist uplift wind pressures. Additionally, these areas had to be fabricated in triangular sections that started at 7 feet wide and diminished to theoretical zero. In addition to this complex topography, the full perimeter of the SAM envelope had to incorporate a 5-inch multi-directional dynamic building movement joint wherever it contacted WAMU or the original museum. This joint has to allow for seismic events, lateral drift from wind forces, and maintain full integrity against air and water intrusion while tracing the convoluted path between the three structures.

The configuration of the typical framing system allowed for the seamless integration of full height vision glass, spandrel glass, stainless steel panels, louvers, partial vision glass and recessed stainless band in one unit, horizontal divided vision glass, and operable access doors. The basic component of the unitized framing system is a 3½- by 9-inch deep aluminum mullion with a crimped isobar thermal break. This building block is modified internally to create the various infill permutations. In opaque spandrel locations, the design incorporates the pressure equalized rainscreen philosophy using a recessed galvanized air barrier in a waterproof compartment behind any stainless steel panel or spandrel glass zones. This approach allows the outboard element to have a ventilated cavity behind it which makes the exterior seal a less critical secondary line of water defense, providing the most secure, state of the art building envelope currently available. All of the unitized components are assembled and sealed in an off site factory location, so that minimal field assembly and personnel is required at the jobsite. The shop assembled protocol also allows the cladding designer to furnish a system that allows for the individual removal

Lower 2 floors of brise soleil in closed position, upper floors fully open.

and replacement of any external component without the sequential dismantling of adjacent units.

Another unique feature of the basic curtainwall system was its required future conversion capacity. On certain future gallery conversions, current WAMU floors are designed to be deglazed and modified internally to accept insulated rainscreen retrofit stainless steel panels, essentially converting a vision glass office area to an opaque wall. In the areas to be converted from single floor offices to 2-story galleries, the unitized system is supported by a 26-foot long steel back-up tube with exposed structural anchorages to the vertical mullions. These tubes allow for the independent support of the cladding components, and allow the museum to physically remove floor slabs while the glass wall remains undisturbed. This flexibility is truly innovative and adds many layers of complexity to the initial installation and in the preparation of the shop drawings.

View from catwalk looking at tapered roof transition below during construction.

Due to sensitive nature of the artifacts being stewarded by the museum, the thermal performance of the building envelope was critical. The aluminum framing is thermally broken with glass fiber reinforced isobars, and when averaged with the glass performance values, achieves an overall u-value of .39 for the composite assembly. It was more critical than a typical office tower requires because the interior relative humidity was figured at a high 50% to allow the museum flexibility in the archival environment. With this high humidity, the chance of visible condensation on the interior metal or glass during cold winter days is a significant concern. Great care was taken with the computer predictive thermal analysis to achieve the high performance cladding and all associated vapor barriers.

As the reader can now appreciate, the technical, aesthetic, commercial, and logistical integration of the SAM/WAMU development required a cladding solution of the most demanding nature. State of the art resistance from the elements, light control with moving parts, flexibility for future needs, responsible structural integrity and a visually dynamic architectural expression are all things that demand focused quality design collaboration. Seattle is fortunate to have such an inspired upgrade to their already vibrant downtown landscape.▪

Interior view of multi-story gallery space with brise soleil partially closed.

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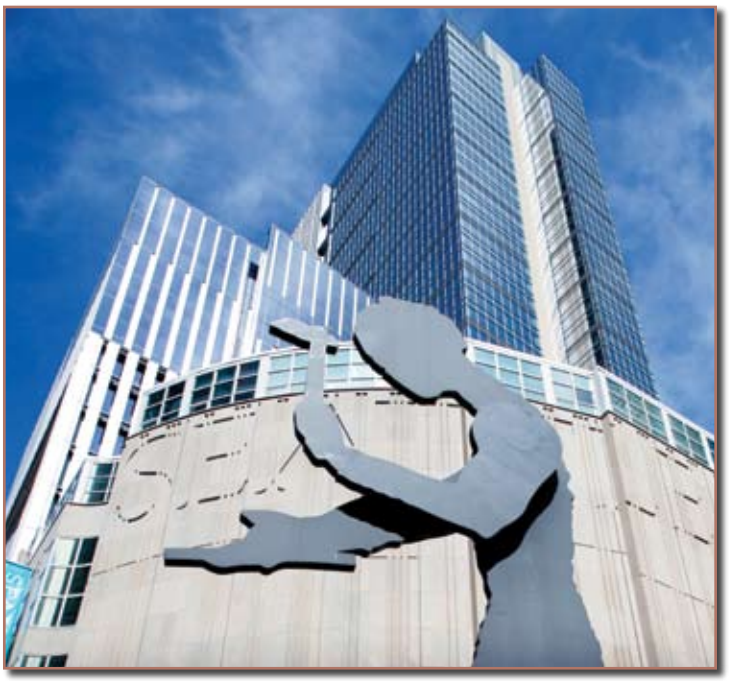
See page 46 for additional information on advanced seismic solutions developed for this project.



Venturi phase in foreground, SAM to left, and WAMU beyond.