

# GLULAM IN TRANSPORTATION STRUCTURES





## Versatile Wood Design Keeps People On the Move

Around the world, people are on the move and the need for transportation infrastructure and facilities continues to grow.

Facilities design challenges are a moving target. Some train, bus and light rail stations, airports, ferry terminals and other structures are being designed to recall the grandeur of the past, while accommodating transportation modes of the future. Others are designed with a more modern feel, yet must reflect the historic communities in which they're located. The structures serve as public gathering spaces, designed to withstand the test of time, but many must be flexible to accommodate future expansion.

Architects challenged by these needs are turning to glued laminated timbers and other engineered wood products for answers.

### **VERSATILITY MOVES ARCHITECTS TOWARD GLULAM**

Transportation building designers cite the versatility of glulam as a key selling point because it provides options for a variety of applications, both as an architectural design element and as a structural building component. Design flexibility is another key feature, since many transportation structures use glulam in combination with other building materials, such as reinforced concrete, brick, stone and steel.



*When glulam is left exposed yet protected from the elements, as it was for the Rupert Station in Vancouver, BC, the structure can stand 100 years or more.*

Moore Paterson Architects in Victoria, BC recently designed renovations and additions to Victoria Air Terminal, an airport project that incorporated the use of spruce glulam, steel and glass to create innovative and contemporary building designs.

“The old terminal couldn’t accommodate the air passenger volumes we were experiencing in Victoria, and the Victoria Airport Authority wanted expandable and flexible structures,” said Tom Moore, principal at Moore Paterson Architects. “Wood products provide us with flexibility; they’re very easy to use in a lot of different applications. Many architects tend to initially consider steel – they think they need it for strength. But in fact, you can do almost anything you want with glulam; it is a very flexible and adaptable building material.”

### **GLULAM STANDS THE TESTS OF TIME WHEN PROPERLY PROTECTED**

A common element in transportation facilities is large overhangs or canopies that protect waiting passengers. Rupert is a light rail station on the Millennium Line in Vancouver, BC. Dale Rickard, project designer of VIA Architecture, said they were mindful to protect the glulam members exposed to the weather.

“When we design a transportation structure, we recognize that these structures are built to last for 100 years or more,” he said. “Wood products will have a long life if they are well-protected – by preservative treatments, flashing or other methods.”

*Architects combined spruce glulam with steel and glass to create an innovative and contemporary roof structure for the new rotunda building of the Victoria Air Terminal in Victoria, BC. (Left)*

## **WOOD'S WARMTH CREATES UNIQUE STRUCTURES**

Architects looking to create warm yet modern spaces can look to glulam for solutions.

Greg Ransom with Arai Jackson Ellison Murakami in Seattle was the architect of Skagit Station, a multi-modal transit facility in Mount Vernon, WA. Wood was the natural choice for Ransom.

“We wanted the warmth of wood juxtaposed with brick, to help the new station blend in with the historic downtown neighborhood,” he said. “I felt steel would be too harsh for the large public space. The glulam structure added character to the building.”

When designing Rupert Station in Vancouver, Rickard said they went through a very intensive public involvement process with neighbors and community groups to gain input for the station design. “People told us they

wanted something contemporary but not cold and hard-edged; they wanted warm and modern. So that became our marching orders. We can certainly do modern, but the request for ‘warm’ led us right away to wood and glulam.”

## **GIVING PEOPLE A SENSE OF WHERE THEY ARE IN THE WORLD**

Moore said his firm’s use of glulam in the Victoria Air Terminal was driven by a desire to distinguish the facility from other airports. “We wanted to establish a scale and intimacy for the traveling public that was different than where they’d probably come from,” he explained. “Victoria is a destination, the end of the line in terms of most air travel, so most people have come from or are going to a larger airport. We wanted to create a building that had a more natural feel, a scale that reflected who we are on Vancouver Island.”

In the early stages, Moore Paterson Architects had originally designed the Victoria Air Terminal using steel. But Moore said they wanted to give people who pass through the terminal a better sense of where they are in the world in terms of the environment. “Our region is a major wood producer. To express wood in our structure was an inherent sensibility in who we are. It also supported our economy.”

## **GLULAM TRAVELS ABROAD**

Opportunity for use of glulam in transportation structures is growing around the world. *APA EWS* member Calvert Company recently supplied glulam beams for bridges in Shanghai, China. They are also working to supply glulam for railway stations in Taiwan.

“A lot of infrastructure needs replacement, and glulam is easy to use,” said Doug Calvert. “Wood is aesthetically



pleasing. If it's going to be exposed to the elements, it can be treated, or we can use durable species like Alaska Yellow Cedar. All over the world, architects are beginning to wake up to the versatility of glulam.”

Roger Halbgewachs from Western Archrib, another APA EWS member, agreed. “There’s nothing unique about why glulam works so well in transportation buildings; it just does. I think architects are discovering new uses and applications and applying them to these types of buildings. When they’ve had success with glulam and when they learn how versatile it can be, the results speak for themselves.”

### **GLULAM MOVES FROM TRADITIONAL TO MODERN, ON BUDGET**

Glulam can easily move from traditional to a modern, engineered look with a simple change in species. “The spruce glulam we used for the Rupert Station gave us the light, homogeneous look we wanted for a modern design, yet it still retained a warm character,” explained Rickard. “From a design standpoint, anything you can do in steel can be reasonably done with glulam. Rupert Station shows that glulam can be very successfully used for this type of transit facility. It could very well inspire further projects like it; we hope it does. We’ve received a lot of positive feedback on the project.”

Moore added, “Wood gave us the sense of scale and intimacy for the Victoria Air Terminal that we wouldn’t have gotten with steel. And, it was less expensive – instrumental, in fact, to keeping our project on budget.”

*Glulam trusses lend spaciousness for the Visitor Center and other offices in this multi-modal transportation structure in Mount Vernon, WA. (Left)*



*Indian Creek Station in Atlanta features 14 curved glulam girders spaced 40 feet apart, forming a barrel vault with a 180-foot radius.*



*Large steel plates securely anchor glulam girders to the embedded anchor bolts in the concrete columns of the Indian Creek Station in Atlanta.*



*Glulam beams are connected to the supporting structure with concealed knife plates, kerfed into the beams, in Vancouver, BC's Rupert Station.*

## Rupert Station in Vancouver, BC

### Automated light rail

Completed 2003

Rupert Station is located on the Millennium Line of Vancouver, BC's automated light rapid transit system. The line has 11 stations; six combine glulam, glass, steel and concrete elements, each for a unique design.

This project used spruce glulam (Western spruce and Lodgepole pine), which has increased in popularity due to its aesthetic qualities of lighter tones, uniformity of color and excellent finishing characteristics. VIA Architecture's desire to build a structure that was modern yet warm – one that fit into a historical neighborhood filled with centuries-old warehouses built with heavy timbers – led them to glulam.

Designed as a post disaster structure, Rupert Station can resist 150% of the normal seismic, wind and gravity loads for this area. The connection between the glulam beams and supporting steel structure uses concealed knife plates, kerfed into the beams. This gives the station a very clean, finished look, with minimal exposed steel. The diagonal timber struts that tie back to the supporting steel columns create a moment frame for optimum strength.



Architects connected spruce glulam beams, located on opposing platforms, with a steel flitch plate that arched across the light rail tracks.



"Warm and modern" were the architect's goals for the design of Rupert Station, located along an old railway corridor among centuries-old warehouses.



Architects used glass and a modern, open concept that incorporates the principle of "see-in, see-out," while glulam creates a station that is warm and welcoming.

## Bellevue Transit Center in Bellevue, WA

### Bus

Completed 2002

Designed by the Seattle architectural firm of Arai Jackson Ellison Murakami, the Bellevue Transit Center was built in the urban heart of nearby Bellevue, WA. About 7,000 people depart from ten bus bays on a typical weekday. The 14,000-square-foot canopy was designed to provide a “tree-like sense of shelter for passengers, while remaining visually open for ease of use and security,” said Frank Silkwood, AIA.



*The glulam roof of the Bellevue Transit Center is set high to bridge the island waiting zones and extend coverage for passengers boarding or exiting their bus.*



*A full-length ridge skylight provides natural light by day and serves as a beacon at night, guiding patrons to the Bellevue Transit Center.*

“Our firm designed the structure using precast concrete columns that cantilever up as ‘trunks’ to spring points for the tubular-steel ‘branches’ that support the glulam roof canopy,” he added. “Lighting highlights the canopy

structure with indirect up-lighting of the timber deck from within the spring points of the branches, while down lights set between the glulam beams boost loading-zone lighting below for safety and security.”

## Whittier Ferry Terminal in Whittier, AK

### Ferry

Expected completion September 2005

Another benefit of glulam is quick installation – important for the Whittier Ferry Terminal being built for the Alaska Marine Highway System. According to Chris Willis, senior estimator for ACC Hurlen Construction, the general contractor, they face many scheduling restrictions for the \$7.3 million project.

“Because of fisheries restrictions, we can only work on the marine portion from January through March,” he said. “This means construction for the buildings, including the new terminal, must be completed between April and September.” Glulam’s quick installation will be key.

Western Wood Structures is supplying six 33-foot tapered glulam trusses for the terminal building. “The building itself will combine steel, glulam and other engineered wood products, such as I-joists,” said Doug Turner. “The Alaska Department of Transportation wanted a structure with open spaces, exposed utilities and an exposed roof structure, which is another reason why they used glulam.”

# Indian Creek Transit Station (MARTA) in Atlanta, GA

## Heavy rail

Completed 1993

This station services both bus and surface rail lines. The glulam roof structure features 120-foot-long primary glulam beams at 25-foot column bays, combining glulam with stone and reinforced concrete vertical elements. Secondary glulam beams and purlins frame into the main carrying beams.

The project used southern pine glulam; all wood members were stained light gray and pressure treated. To minimize maintenance, ends of the main beams were encased with stainless steel caps and all structural connections were made of stainless steel, as were the gutters and downspouts. The architects, Cooper Carry and Associates, used glulam because they wanted to create a rustic look that would harmonize with the surrounding environment and reflect a more residential character.

One of the key advantages of using the glulam framing system was a reduction in construction costs and time. The wood roof was built for less money and in less time than comparable MARTA stations using steel and concrete. In addition, the glulam roof structure weighed less than comparable steel and concrete systems. This allowed MARTA to use smaller support columns, which reduced the overall cost of the foundation.

Glulam beams have been left to weather naturally with no further finishing required. This is in contrast to a steel roof, which requires periodic repainting. MARTA's project manager, Jayant Patel, reports, "The roof structure is holding up very well and requires no maintenance."



*The wood roof structure of MARTA's Indian Creek Station weighed less than comparable steel or concrete systems, allowing architects to use smaller support columns, which reduced the cost of the foundation.*



*Indian Creek Station's suburban location called for a rustic look to harmonize with the neighborhood's natural environment.*

# Victoria Air Terminal in Victoria, BC

## Airport

Completed in 2001 and 2002; additional expansion work (including glulam) is ongoing

This project incorporated the use of spruce glulam, steel and glass to create innovative and contemporary designs for three buildings in this growing airport – the rotunda, a holding room and a baggage claim building.

Moore Paterson Architects wanted to design a facility that gave visitors a better sense of where they were in the world, and felt that glulam would help distinguish and reflect the scale of the facility and of the community. Originally designed using steel, glulam was used to create a more intimate and natural but modern feel.

In the rotunda, spruce glulam trusses form a radial pattern reminiscent of the pattern in a jet engine. Glulams for the 72-foot-diameter rotunda were fastened to a two-foot round steel hub, and then lifted into the air. Tom Moore, the architect, said the structure “didn’t move a millimeter” during installation.



Passengers waiting for baggage at the Victoria Air Terminal are warmly welcomed in a structure designed to reflect the scale and nature of the community on Vancouver Island.



Covered walkways are designed with glulam to warmly welcome passengers to the Victoria Air Terminal.



Spruce glulam trusses helped architects achieve the desired look and keep construction on budget.

# Skagit Multi-Modal Transportation Center in Mount Vernon, WA

**AMTRAK train, Greyhound bus and local bus transit**

*Completed 2004*

This new multi-modal structure incorporates a classic train station design, with large overhangs and awnings to accommodate waiting travelers outside. The building's roof was constructed of pre-assembled glulam open-web trusses, left exposed to the ticket booths and offices below. The building also houses the local Chamber of Commerce as well as a public meeting room.

"It's a big deal for a town of our size (population 26,000) to have such a versatile, attractive transportation hub," said Kristen Whitener, executive director of the Mount Vernon Chamber of Commerce.

APA EWS member American Laminators manufactured the premium grade Douglas-fir glulam beams, which were then stained and treated for exterior exposure. Steve Eisenhart from Tiger Construction, the general contractor, said the glulam trusses went up quickly and easily, because they were pre-assembled and shipped to the jobsite by Western Wood Structures of Tualatin, OR.



*Skagit Station, designed to accommodate the multi-modal transportation needs of a growing community, serves passengers of local bus systems as well as Greyhound bus, Amtrak rail and local taxi.*



*The station's interior was designed with exposed glulam trusses because the architect felt steel would be too harsh for the large public space.*



*The architect of the Skagit Station juxtaposed glulam with brick to help the new structure fit into the historic community.*

## Back Bay Station in Boston, MA

### Bus, surface rail and underground rail lines

Completed 1987

Back Bay Station, part of the Boston, MA Rapid Transit System, was designed to recall the grandeur and spaciousness of railroad stations of the past. The striking succession of exposed, curved glulam arches is visible from Boston's downtown through large glass facades. The facility serves more than 50,000 commuters and visitors who use the station every day.

Designed by Kallmann, McKinnell and Wood Architects, Back Bay Station won numerous design awards when constructed. Typically, steel or concrete would have been considered for the

downtown location, but architects wanted to project the warmth and aesthetics associated with exposed wood framing.

Eighteen pairs of glulam radial arches span approximately 65 feet. Each pair supports horizontal glulam beams,



*The 18 pairs of glulam radial arches used in the Back Bay Station span approximately 65 feet, creating an eye-catching wooden structure in downtown Boston.*

which rest on small glulam columns that transfer the vertical loads to the arches as point loads. Smaller purlins support a wood deck and roofing. To resist outward thrust, the arches have steel tie rods installed at their base.



*Large stained glass windows were used at each end of the Back Bay station to provide additional natural lighting for thousands of Boston's daily commuters.*

## Highway Sound Barriers

Sound barriers are often needed near transportation facilities, where noise control is a concern. In addition, as highways are built closer to residential areas, the need to reduce highway noise becomes greater. Therefore, an increasing number of transportation projects use sound barriers to address the problem.

To confine or exclude noise, the barrier must have a high sound-transmission loss. Barriers with more mass are more effective at transmission loss. Sound barriers assembled with glued laminated timber panels have a sound transmission class (STC) rating of 34 (2-11/16 inches thick) and 35 (3-15/16 inches thick).

When treated with preservatives, the glulam barriers require little maintenance. Components can be economically plant fabricated for easy installation.

ALAMCO Wood Products is an APA EWS member that specializes in producing highway sound barriers.



*Sound barriers made from glulam fit well within residential neighborhoods while providing strength, durability and low cost.*

Claire Vermedahl, CEO of ALAMCO, said, "Timber sound barriers can be designed to fit well within these neighborhoods. Neighbors benefit from both sound reduction and the natural warmth that these wood barriers provide."





## GLULAM IN TRANSPORTATION STRUCTURES

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