ENGINEERED WOOD SYSTEMS
APA EWS

公共交通運輸建築中的結構膠合木

GLULAM IN TRANSPORTATION STRUCTURES

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風格多樣的木建築確保人們通行無阻

Versatile Wood Design Keeps People On the Move

世界各地的人們都處在不停的移動之中，因此各國對公共交通基礎設施的需求也在不斷地增長。

針對這些公共交通設施在設計上的挑戰也在不斷地變化着。火車、公交和輕軌車站、機場、渡輪碼頭和其他一些交通設施，其設計不僅是對過去輝煌歷史的一種回憶，還必須能够適應未來的交通發展。另一些車站則不僅設計得更加具有現代氣息，而且還要能反映出當地的歷史特色。作爲公共聚集的場所，這些公衆交通運輸設施的建築需要設計得既能够經受得住時間的考驗，很多還必須要能够滿足未來擴建的需要。

由于受到上述這些需要的挑戰，建築設計師們開始把目光轉向了結構膠合木和其他工程木產品。

建築設計的多樣性要求使得建築師們把目光轉向了結構膠合木

設計公共交通運輸設施的建築師們把結構膠合木能提供的多樣性作爲這種材料很重要的一個賣點，因爲它可以提供多種不同的用途，既可作爲建築元素使用，同時，還可作爲結構構件本身的一部分。設計上的靈活性則是另外一個重要的特色，因爲許多公共交通運輸的建築結構都把結構膠合木與其他一些建築材料結合在一起使用，比如鋼筋混凝土、磚、石材、鋼材等材料。

來自于加拿大卑詩省維多利亞的Moore Paterson建築師事務所的建築師們最近設計了維多利亞機場的改擴建工程，這個項目就混合使用了雲杉膠合木、鋼材和玻璃，創造出頗具現代創新風格的建築設計。

“舊的機場容納不下維多利亞地區這么多的客流，機場當局需要那種今后能够擴建并且具有靈活性的建築結構，”該建築公司的總裁Tom Moore稱，“而木制結構則給我們提供了靈活多變的可能：它們可以應用在多種領域。很多設計師出于結構强度的考慮，會傾向于選擇鋼結構。但事實上，你可以將結構膠合木用于任何方面；它是一種靈活性和適應性很强的建築材料。”

在正常維護條件下，結構膠合木完全能够經受時間的考驗

公共交通運輸設施建築中一個普遍的共同點就是有一個候車用的大屋檐或雨篷。魯伯特車站是位于加拿大温哥華輕軌Millennium 綫上的一個車站。來自VIA 建築師事務所該項目的設計師Dale Rickard稱，他們在設計中，對于怎樣保護暴露在外部的結構膠合木進行了深入的考慮。

“當我們在設計一個公共交通運輸建築設施的時候，我們知道這些設施要使用100 年甚至更長的時間，”他説。“如果保護措施得當——通過防腐處理，擋水板或其他方法，那么木結構會有相當長的使用壽命。”

如果像位于加拿大温哥華地區的魯伯特車站一樣，爲露在外部的結構膠合木采取保護措施，建築的壽命就會有 100 年或更長。

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.

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 flexbility is another key feature, since many transportation structures use glulam in combination with other building materials, such as reinforced concrete, brick, stone and steel.

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."

在華盛頓州Mount Vernon的多功能交通中轉站中，結構膠合木爲來客接待室和其它辦公室提供了寬闊的空間。

Glulam trusses lend spaciousness for the Visiter Center and other offices in this multi-model transportation structure in Mount Vernon, WA.

木材的温暖感構建出了獨一無二的建築

當建築師想要創造一種温暖而又有現代空間感的建築時，結構膠合木是一種很好的選擇。

作爲西雅圖 Arai Jackson Ellison Murakami 公司設計師，Greg Ransom 設計了 Skagit 車站，該車站位于華盛頓州的 Mount Vernon，是一個多功能的交通中轉站。出于對周圍環境的考慮，建築師 Ransom 很自然地想到采用木材作爲該建築的建築材料。

“我們需要把木材帶來的温暖感與磚結合在一起，使新車站與周圍具有悠久歷史的市中心融合在一起，”他説。“我覺得鋼結構對于大型公共場所的空間來説會顯得十分生硬。而這種結構膠合木結構則給這個建築增色不少。”

在設計温哥華的魯伯特車站時，Rickard説他們邀請了周圍的居民和很多社區團體積極投身參與該車站的設計工作。“居民們告訴我們説，他們喜歡那種現代感的車站，而不是那種看上去很冷酷的、有着堅硬棱角的車站；他們喜歡現代而又温暖的感覺。所以這就成爲了我們的宗旨和目標。我們當然可以做到使建築充滿現代感，但是“温暖”的要求讓我們立即就想到了木材和結構膠合木。”

讓人們切身感受維多利亞機場

Moore説他們公司在維多利亞機場之所以使用這種結構膠合木是由于他們想要把該機場與其他機場區別開來。“我們希望能够爲旅行者營造一種規模和親近感，要與他們離開的機場有所不同，”他解釋説。“維多利亞是一個目的地，也是許多航班的終點，大多數旅客來自或是要前往更大的機場。我們希望能够建造一個感覺更自然的機場，而其規模可以反映出維多利亞機場在温哥華島上的地位。”

在早期，Moore Paterson Architects 建築公司考慮設計維多利亞機場時，想采用鋼結構。但是Moore説他們想要在環境體驗方面使從這裏路過的旅客切身感受到維多利亞的魅力。“我們這個地區是主要的木材産地。在我們的建築結構中很好地體現木材能够充分體現我們的特色。不僅如此，對我們的經濟還能够起到支撐作用。”

位于亞特蘭大的 Indian Creek Transit Station 車站有 14 根弧型結構膠合木梁，相距 40 英尺，形成半徑爲 180 英尺的桶狀穹頂。

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

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-model 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 is different from 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.”

大型鋼制連接件將結構膠合梁穩固地固定在亞特蘭大的 Indian Creek Transit Station車站的柱梁上。

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

結構膠合木走向世界

全世界對結構膠合木在交通運輸建築中的運用正在增長。作爲美國APA EWS工程木協會的會員之一，Calvert公司最近就爲中國上海的橋梁建築提供了結構膠合梁。他們還在着手向臺灣的火車站建築項目提供結構膠合木。

“很多的交通基礎設施都需要更新，而結構膠合木使用起來的確很方便，” Doug Calvert說，“木材具有很好的美學效果。如果部分構件需要暴露在外的話，可以對其進行防腐處理，當然，我們還可以使用像阿拉斯加黃柏那種具有天然耐腐的樹種生產結構膠合木。目前，全世界的建築師們都開始關注到了結構膠合木所具有的多樣性的特點。”

Western Archrib公司（美國APA EWS工程木協會的另一家會員單位）的設計師Roger Halbgewachs也對此表示同意。“結構膠合木本身并没有什么特别的地方能在交通運輸建築結構中變得如此出色，但是它的確就是做到了這一點。我想設計師們正在尋求新的使用方法，并將它們應用到這些建築設施中去。當他們用這種結構膠合木取得成功或是了解到其多樣性的特點之后，結果就不言自明了。”

在成本預算方面，結構膠合木亦從傳統走向現代

樹種上一個簡單的變化就可以使結構膠合木的外觀從傳統走向現代。“我們在魯伯特車站所使用的雲杉結構膠合木給我們一種輕盈和均勻的感覺，這正是我們所期待的具有現代感的設計，同時它仍然保留着温暖的特色，” Rickard解釋説。“從設計的角度來看，所有鋼結構能够做到的，只要通過合理使用，結構膠合木也都可以做到。魯伯特車站就證明，結構膠合木可以很成功地用于這種類型的中轉車站設施。我們也希望它還可以爲類似這樣的設施建築提供更進一步的靈感。關于這個項目我們目前已經收到了很多積極的反饋意見。”

Moore又補充説，“維多利亞機場的木結構構件給我們一種使用鋼結構所體驗不到的規模感和親近感。而且造價還低得多，這更有助于使我們的工程項目貼近預算。”

在加拿大温哥華地區的魯伯特車站，結構膠合梁與支撑結構連接。并將連接件嵌入到横梁内部隱藏起來。

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

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 worm character,” explained Rickard. “Form 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.”

交通設施建築個案分析

Transportation Case Studies

美國阿拉斯加惠蒂爾市的惠蒂爾渡輪碼頭 *Whittier Ferry Terminal in Whittier, AK*

渡輪碼頭*Ferry*
預計于2005年9月完工 *Expected completion September 2005*

結構膠合木的另一大優點就是安裝迅速——這對于爲阿拉斯加水上公路系統而建造的惠蒂爾渡輪碼頭來説至關重要。據ACC Hurlen Construction建築公司的高級預算員Chris Willis稱，該公司是這一項目的主要承包商，這項730萬美元的工程面臨着諸多的工期限制。

“由于漁業方面的限制，我們在海邊地區的作業只能在一月份到三月份之間進行，”他説，“這也就意味着工程的建造，包括新的碼頭，必須在四月到九月份之間完工。”結構膠合木安裝迅速的這一特點爲解決這一問題提供了最佳方案。

Western Wood Structures公司爲該項目提供了6個33英尺的梯形結構膠合木桁架。“該建築本身使用了鋼材、結構膠合木和其他木制品，如工字梁，”Dong Turner稱。“阿拉斯加交通部希望該建築有開放的空間和設施，以及開放的屋頂結構，這是他們使用結構膠合木的另外一個重要原因。”

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.”

温哥華的魯伯特車站 *Rupert Station in Vancouver, BC*

自動輕軌 *Automated light rail*
2003年完工 *Completed 2003*

魯伯特車站是位于温哥華輕軌Millennium綫上的一座車站，此綫路是該地區的自動輕軌快速中轉樞紐。在該條綫上的11座車站中，有6座是采用結構膠合木、玻璃、鋼和混凝土構件建造的，每座車站的設計都很獨特。

這個項目上使用的結構膠合木采用雲杉（西部雲杉和扭葉松）制造，這種材料越來越受到歡迎是由于其淡色調的美學特點、與周圍顏色的協調一致，以及其出色的表面效果。VIA建築設計事務所希望建造一個既現代又温暖的車站，一個能與周圍遍布着數百年歷史的木制倉庫和貨棧地區相匹配的車站，這使得他們將目光投向了結構膠合木。

與此同時，魯伯特車站被設計成一個標志性的防灾建築結構，可以抵禦該地區150%的地震、風和重力荷載。結構膠合梁與承載鋼結構之間使用隱藏連接板，連接板嵌入到横梁内部。這使車站看上去顯得非常整潔和完美，暴露在外部的鋼材面積也降低到了最小的程度。木斜撐構件與鋼柱連接，形成鋼架，最大程度上優化了結構的强度。

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.

建築師混合使用結構膠合木和玻璃，運用現代、開放的理念，遵循“内外通透”的原則。而結構膠合木則使車站看上去更加温暖、友好。

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.

建築師將位于對面站臺的雲杉結構膠合木梁連接起來，中間有弧形的鋼板橫跨輕軌軌道。
Architects connected spruce glulam beams, located on opposing platforms, with a steel flitch plate that arched across the light rail tracks.

温哥華魯伯特車站位于一條古舊的鐵路走廊邊，周圍是上百年的庫房。設計師力圖使温哥華魯伯特車站看起來“温暖并具有現代氣息”。

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

美國華盛頓Bellevue地區的Bellevue巴士系統 *Bellevue Transit Center in Bellevue,WA*

巴士 *Bus*
2002年建成 *Completed 2002*

由西雅圖 Arai Jackson Ellison Murakami 建築公司設計制造的Bellevue公交車樞紐建在美國華盛頓附近Bellevue的市中心地區。每天都有大約7000名旅客從這個公交車樞紐出發前往其他地區。14000平方英尺大的候車用遮蓬被設計成“像大樹一樣的形狀，爲了使用的方便性和安全性起見，該車站系統在視覺上運用了開放式的設計”，美國建築師學會（AIA）的FrankSilkwood稱。“我們公司設計的這種建築結構使用預制混凝土柱，該柱像“樹干”一樣從地面升起，承載用鋼管制成的“樹枝”，這些“樹枝”又承載着結構膠合木屋面。他説。“照明設備從内部的屋面板間接向上照明突出了屋蓋的結構，在結構膠合梁之間向下的燈光照明則增强了下面乘車區間的安全性。”

通長屋脊天窗白天提供自然采光，晚上起到燈塔的作用，照亮乘客去往Bellevue Transit Center的路。
A full-length ridge skylight provides natural light by day and serves as a beacon at night,guiding patrons to the Bellevue Transit Center.

Bellevue Transit Center的結構膠合木房頂設計的很高，以橋型架起候車區并爲上下車的乘客擋風遮雨。
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.

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.

“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.”

美國馬薩諸塞州波士頓地區的Back Bay車站 *Back Bay Station in Boston, MA*

巴士、軌道和地下鐵交通綫路 *Bus, surface rail and underground rail lines*
1987年完工 *Completed 1987*

Back Bay車站是波士頓快速運輸系統的一部分，該車站的設計旨在喚起人們對過去宏大、寬敞車站的回憶。引人注目的一連串拱形的膠合木拱形結構從波士頓市中心就可以看見。該車站設施每天要通行50000名乘客和旅游者。

該車站是由McKinnell & Wood建築設計事務所的設計師Kallmann設計建造的，這一工程自完工以來曾經屢次獲得設計上的殊榮。通常在市中心地區，建築師們會考慮用鋼材或混凝土作建築材料，但是這次他們想要通過露在外部的木結構構件來折射出温暖的感覺和美學效果。

18組膠合木結構的拱形跨度大約爲65英尺。每一組拱形結構都支撑着水平的膠合梁，這些梁由一些小的膠合柱承載，而這些膠合柱則將垂直載荷作爲點載荷轉移到拱形結構上部。更小的檩條支撑着一個木結構層和屋頂。爲了防止外向推力，拱結構的底部都安裝有鋼拉杆。

在Back Bay車站使用的18對結構膠合木拱形的跨距約65英尺，成爲波士頓城區引人注目的木建築。

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

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, 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.

Back Bay車站的兩端使用大的染色玻璃，爲波士頓成千上萬使用公共交通的人們提供更多自然光。

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 comuters.

美國佐治亞州亞特蘭大地區的 Indian Creek Transit Station (MARTA)車站
Indian Creek Transit Station (MARTA) in Atlanta, GA

重軌 *Heavy rail*
1993年完工 *Completed 1993*

該車站服務于巴士和路面軌道交通。結構膠合木制的屋頂結構跨度120英尺，柱間距25英尺。結構膠合木與用石材和混凝土建造的竖向構件結合。結構膠合次梁和檩條與主梁連接。

該工程項目使用了南方松結構膠合木；所有的木結構都油漆了銀灰色塗料并經過了加壓防腐處理。爲了將維護保養工作降低到最低點，主梁端部都采用不銹鋼帽包裹，所有的結構連接部件都使用不銹鋼，天溝和落水管也采用不銹鋼制作。Cooper Carry and Associates 的建築師之所以采用結構膠合木，是因爲他們希望能够通過這種材料的運用，營造出一種鄉村的特色從而使其與周圍的環境和諧一致，并反映出適合居住的特征。

使用結構膠合木最大優勢之一就是能够降低工程成本和縮短工期。與使用鋼材和混凝土材料建築的該條綫上的其他車站相比，木結構屋頂可以减少成本并節省時間。此外，膠合木屋頂的重量比同樣規模采用混凝土或鋼結構的屋頂輕，這一點使得該工程中柱的尺寸較小，從而减少了基礎造價。

結構膠合木梁可以無需任何修整而與大自然直接親密接觸。這就與鋼結構屋頂形成了鮮明的對比，因爲鋼結構屋頂需要進行階段性重新油漆。MARTA車站的項目經理 Jayant Patel稱，“屋頂結構做得很出色，而且幾乎不需維修和保養。

MARTA 的 Indian Creek Station 車站的結構屋頂比相應的鋼或混凝土結構輕，建築師可以使用較小的結構柱，這樣减少了基礎結構的費用。

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 車站位于郊區，需要有鄉村風格的外觀，以與周圍的自然環境相和諧。

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

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 cocrete. 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."

維多利亞地區的維多利亞機場 *Victoria Air Terminal in Victoria, BC*

機場 *Airport*
建成于2001 年和2002 年;其擴建工程（包括結構膠合木）還在進行中
Completed in 2001 and 2002; additional expansion work (including glulam) is ongoing

由結構膠合木設計的防雨篷温暖着每一位由此經過的旅客
Covered walkways are designed with glulam to warmly welcome passengers to the Victoria Air Terminal.

該工程綜合使用了雲杉結構膠合木、鋼材和玻璃爲該機場的三個建築設施營造出了一種創新和現代的設計風格——圓形大廳、存儲室和一個行李領取大樓。

Moore Paterson 建築設計事務所希望該設計能使旅客切身感受到維多利亞的魅力。他們認爲結構膠合木這種材料能够有助于反映該設施和該地區的規模的特色。最初的設計使用的是鋼結構，但是結構膠合木的使用營造出了一種更加親切、自然和現代的感覺。

在圓形大廳，雲杉結構膠合木構成的基本圖形讓人聯想到了噴氣發動機的形狀。直徑爲72英尺的圓形大廳使用的結構膠合木被固定到了一個2英尺的圓形鋼連接件上，然后被提升到空中。建築師 Tom Moore 説該建築在安裝的過程中“未移動過一毫米”。

使用雲杉結構膠合木構架，使得建築師可以建造理想中的建築且不超出預算。

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

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.

在維多利亞機場等候行李的乘客們在此休息。設計不僅溫暖更體現了溫哥華島社區的規模和風格。

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.

華盛頓 Mount Vernon 地區的 Skagit 多功能交通運輸中心
Skagit Multi-Modal Transportation Center in Mount Vernon, WA

“美鐵”火車、“灰狗”巴士和當地巴士中轉 *AMTRAK train, Greyhound bus and local bus transit*
2004年完工 *Completed 2004*

Skagit車站的設計滿足不斷增長的社區人口對多樣化交通的需求，如地方公共汽車系統、灰狗巴士、美鐵、和地方出租車。

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.

這個新的多功能建築結構綜合了一個標准的火車站設計，該設計有很大的外延和遮蓬爲候車的旅客遮風擋雨。該建築的屋頂由預先組裝的結構膠合木桁架建成，下面是售票處和辦公室。該建築還包括一家當地的商會和一間公共會議室。

“對于我們這種規模的小鎮（擁有26000人口）來説，能够擁有這樣一種多功能的吸引人的公共交通運輸中心具有很大意義，” Mount Vernon 地區商會的執行董事 Kristen Whitener 稱。

美國 APA EWS 工程木協會的會員 American Laminators 公司生産制造了優質的花旗松結構膠合梁，再經過着色和防腐等處理使其適于暴露在外。Tiger Construction 建築公司的 Steve Eisenhart 稱膠合木桁架運用起來迅速簡便，因爲它們由 Western Wood Structures, OR.公司預先安裝后，直接運輸到工程地點。

Skagit 車站的建築師混合使用結構膠合木和磚，使新的建築與歷史悠久的社區相融合。
The architect of the Skagit Station juxtaposed glulam with brick to help the new structure fit into the historic community.

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.

車站內部的設計可見結構膠合木構架。建築師認爲大型的公共場所使用鋼顯得太硬。

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

高速公路的隔音屏障 *Highway Sound Barriers*

在交通運輸設施附近經常需要一些隔音屏障，因爲這些地區的噪音控制是一個需要關注的問題。另外，由于高速公路建在住宅區附近，降低高速公路噪音的要求也就更高。因此，越來越多的交通運輸工程項目使用隔音屏障來解決這一問題。

爲了限制或排除噪音，隔音屏障必須要有很高的聲音傳播衰減率。隔音屏障質量越大則對于阻擋聲音傳播就越有效。采用結構膠合木的隔音屏障對于聲音的阻擋，可達到STC34 (2-11/16英寸厚)和STC35(3-15/16英寸厚)。

經過防腐處理，膠合木隔音屏障幾乎無需進行任何保養和維修。組件可以在工廠車間進行經濟地加工制作以方便安裝使用。

ALAMCO Wood Products公司作爲美國工程材料協會的會員單位，主要從事高速公路隔音屏障的生產。

ALAMCO的執行總裁 Claire Vermedahl稱，“木制音障設備可以設計得與周圍環境相融合，鄰近的居民也得益于這些木制音障設備的隔音效果和温暖的外觀。”

用結構膠合木制造的隔音墙與周圍的住宅完美融合。并且耐久、强度大，造價低。
Sound barriers made from glulam fit well within residential neighborhoods while providing strength, durability and low cost.

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. 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.”

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Rm 605, CITIC Building, No.19 Jianguomenwai Dajie, Beijing 100004
Tel 電話：(8610) 8526 3153
Fax傳真：(8610) 8526 3151

上海代表處
Shanghai Office
上海虹橋路 1 號港匯中心一座 4706室（200030）
Rm.4706,1Grand Gateway,No.1Hong Qiao Road
Xu Hui District,Shanghai200030
Tel 電話：(8621) 6448 4401/02/03
Fax 傳真：(8621) 6448 4404

Website 網址：www.afandpa-china.org
www. softwood.org/china
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