WORLD-CLASS SPORTS FACILITY,
ONE-OF-A-KIND WOOD ROOF

RICHMOND OLYMPIC OVAL

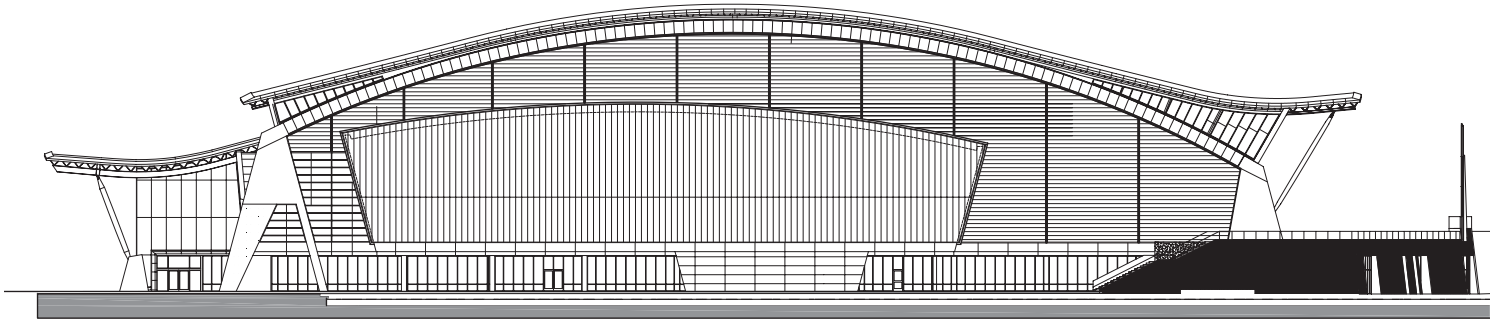









Richmond Olympic Oval



ARCHITECTURE

THE RICHMOND OLYMPIC OVAL is a signature structure for the 2010 Olympic and Paralympic Winter Games and a precedent-setting example of advanced wood engineering and design. The design of the wood roof and its application in a building of this size and significance marks the entry of British Columbia's wood design and fabrication industry onto the world stage.

The design concept of *flow, flight and fusion* was inspired by the water of the nearby Fraser River, the wild birds that inhabit its estuary and the careful meshing of forms—curved and linear—where city and nature meet.

The building is arranged on three levels: an underground parking garage; a ground-oriented entry, circulation, service and amenity level; and the breathtaking volume of the vaulted sports hall on the top level.

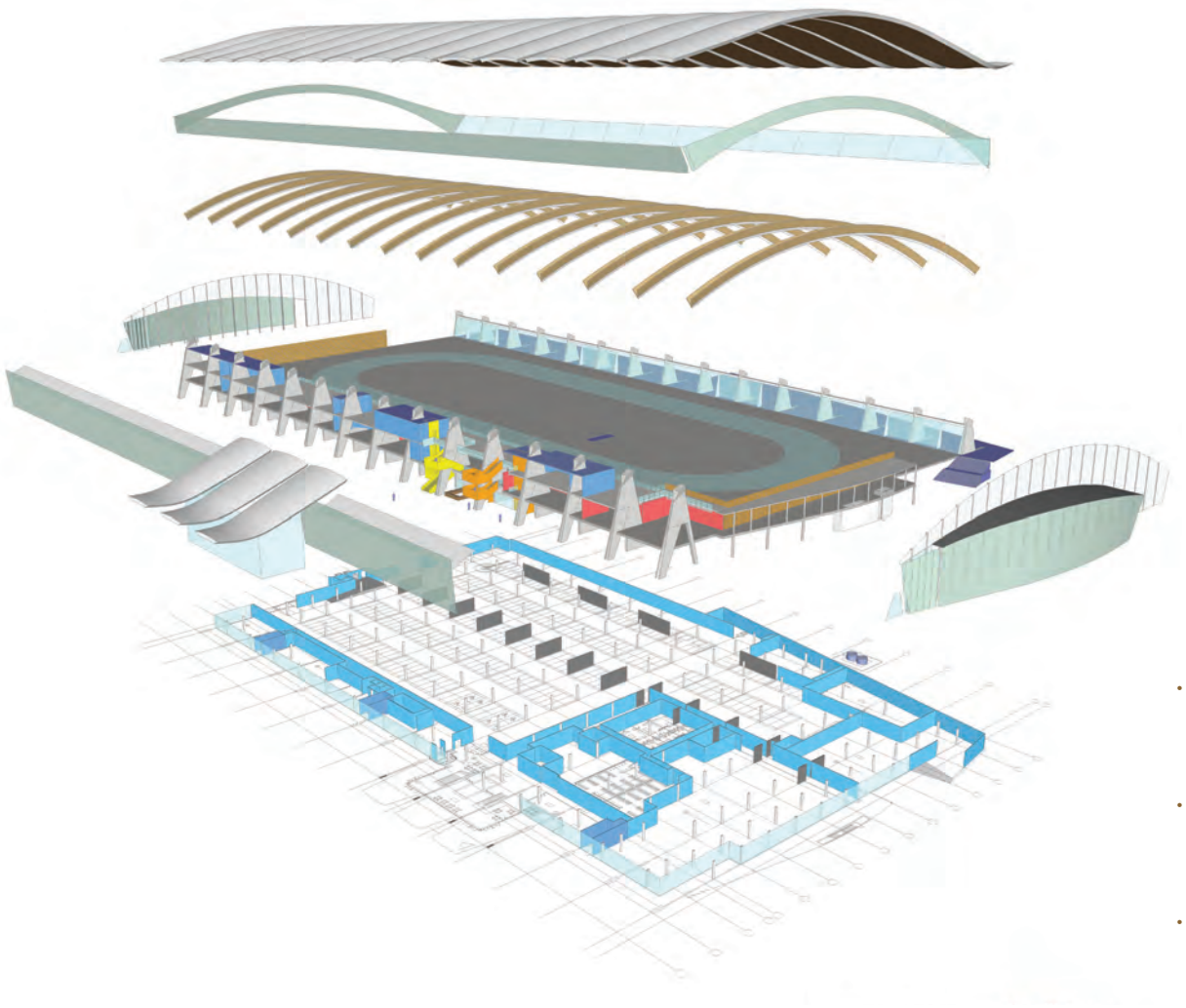
For the 2010 Olympic Winter Games, the Oval will house a 400-m speed skating track with temporary capacity for approximately 8,000 guests. After the Games, the facility will be converted to multi-purpose sports use. The main sports hall will become an indoor activity area divided into three sections: ice, court and track and field.

The ice section will have two ice rinks. The court section will be a combination hardwood and rubber surface playing area capable of hosting a wide variety of sports, while the track and field section will have a rubberized turf surface that will be home to an indoor running track and other sports. The space will be convertible to different configurations that allow the facility to be used for a combination of ice and dry sports as demand warrants, including occasional reconfiguration for major short track and long track speed skating events.

"The architectural design of the Richmond Olympic Oval emanates from several poetic images based in the cultural history of the site and the surrounding geography. For example, the articulation of the Oval roof evolved from the image of the Heron being a native bird in that community.

The roof has a gentle curve that peels off on the north side of the facility, emulating the wing of a heron with its individual feather tips extending beyond the base wood truss structure. This allows for the opening of the facility's interior to a view of the north shore mountains and the Fraser River at the North Plaza."

LARRY PODHORA – CANNON DESIGN



FACTS

- One of the 2010 Olympic and Paralympic Winter Games' most prominent buildings and venue for the long track speed skating events, the Richmond Olympic Oval features a one-of-a-kind, all-wood roof structure
- The structure comprises composite wood-steel arches, which span approximately 330 ft (100 m), with a hollow triangular cross-section that conceals mechanical, electrical and plumbing services
- Spanning the 42 ft (12.8 m) between arches are novel, prefabricated WoodWave Structural Panels© consisting of ordinary 2×4-in (38×89-mm) lumber arranged geometrically to optimize both structural and acoustic efficiency. The design is not only economical but it provides a striking aesthetic for this high-profile facility
- The CAD $16-million Oval roof is one of the world's largest clearspan wooden structures and covers an area of 6 ac (2.4 ha), roughly the size of four and a half football fields





STRUCTURE

THE TWO LOWER FLOORS OF THE BUILDING are cast-in-place concrete. Extending through the floors are massive, inclined concrete buttresses from which the great arched roof springs.

The main arches, 47 ft (14.3 m) apart, are comprised of twinned glulam members held at an angle to one another by a steel truss. These arches conceal the building's mechanical and electrical services in their triangular cores and support a total of 452 WoodWave panels.

Throughout the design phase, two roof options were developed: the innovative but untested WoodWave system, and a more conventional steel-deck-on-glulam purlin system. Both options used the primary wood-steel arches to span the almost 330 ft (100 m) width of the main hall. While both the client and the design team favoured wood, a number of technical and economic questions had to be answered prior to a final decision being made.

The design team conducted research and extensive testing to verify the performance of the WoodWave system in the areas of structural capacity, acoustics, architecture, sustainability, constructability, lighting, fire safety, maintenance and durability.

"To me the roof is the most spectacular part—from the inside it's like looking up at the stars."

KRISTINA GROVES – 2008 WORLD CUP SPEED SKATING CHAMPION

These studies concluded that the WoodWave system met all the physical criteria and provided superior acoustic performance to the more common perforated metal deck alternative. There was also the additional benefit of greater aesthetic appeal—by virtue of the warm appearance of the filigreed wood ceiling and a roof panel design that conceals the sprinkler system from view.

The primary structure of the Oval was required to be of non-combustible construction, but the roof assembly was permitted to be constructed using heavy timber elements. The WoodWave option, which used dimension lumber elements smaller than traditional heavy timber, was demonstrated by fire simulation modeling to meet the life safety and structural fire integrity provisions of the building code. This was due to the overlapping configuration of the WoodWave structure, and the large volume and openness of the main space.



FACTS

- The roof uses standard materials supplied directly from British Columbia mills, including:
  - 1 million bd ft (2,400 m³) of 2×4-in (38×89-mm) spruce-pine-fir commodity dimension lumber—primarily lumber affected by the mountain pine beetle infestation in British Columbia's Interior
  - 19,000 sheets of 4×8-ft (1.2×2.4-m) Douglas-fir plywood in the roof panels
  - 1 million bd ft (2,400 m³) of Douglas-fir lam stock lumber in the glulam beams
- Where the roof extends beyond the walls on the north and south sides of the building, a total of 34 yellow-cedar glulam posts (29,000 bd ft / 70 m³) support the overhangs
- The venue features an energy-saving refrigeration plant and a state-of-the-art rain water collection system
- The Richmond Olympic Oval project, which also includes a waterfront plaza, park and parkade, was completed under the budget of CAD $178 million



WOOD AND SUSTAINABILITY

THE OVAL IS DESIGNED TO MEET leading-edge, high-performance building standards. The structure itself is designed to qualify for *Silver Certification* on the Leadership in Energy and Environmental Design scale (LEED®), as well as for Green Globes.

Solid sawn lumber is by far the least energy intensive and least polluting form of construction, but prior to the creation of the WoodWave system, there was a very limited understanding of the possibilities of light framing for large and long-span buildings.

The specification of mountain pine beetle lumber from British Columbia forests and mills means the Oval's roof sets an important precedent in the effort to mitigate the impact of this unfortunate effect of climate change.

If incorporated into buildings, the salvaged wood will continue to store carbon and delay the release of carbon dioxide (a key component of greenhouse gas emissions) into the atmosphere for the life of the structure. If left to decay in the forest, this release of carbon dioxide would happen much more quickly.

Because of its low embodied energy, low toxicity and the carbon sequestered within it, wood makes a significant contribution to the overall environmental performance of the building. For example, the amount of carbon sequestered and stored in the wood used in the building amounts to 2,900 metric tonnes of CO_2. Add to this an estimated 5,900 metric tonnes of CO_2 accounting for the amount of avoided emissions resulting from the use of wood instead of more greenhouse gas intensive materials, and the total potential carbon benefit is 8,800 metric tonnes of CO_2. This amounts to removing over 1,600 cars from the road annually or to the energy used to power 800 homes in a year.

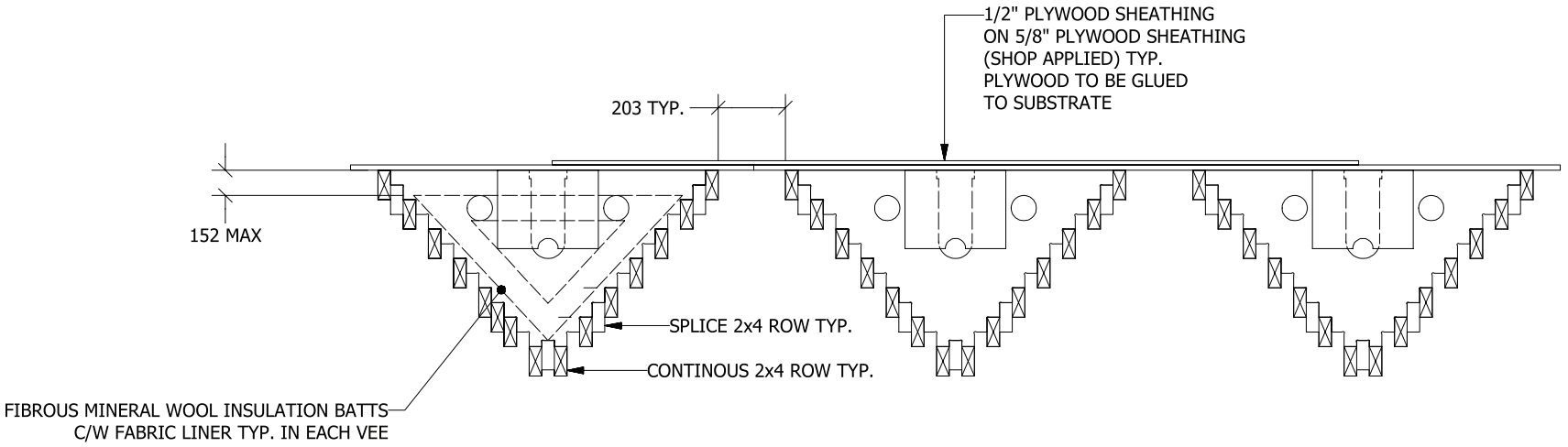
"The Oval roof demonstrates that Mountain Pine Beetle wood is a good material and can be attractive. While it won't address the epidemic directly, showcasing the use of the wood will hopefully help encourage its use elsewhere."

GREG SCOTT – RICHMOND'S DIRECTOR OF MAJOR PROJECTS

Wood products require less energy to extract and process than other materials, and buildings that use wood can require less energy to construct and operate over time. If less fossil fuel energy is consumed, fewer greenhouse gases are emitted.

In addition to using lumber obtained from British Columbia forests,wood ceilings and panelling were milled from trees felled on the site. Cuttings were taken from trees planted when the area was owned by Richmond pioneer, Samuel Brighouse. After being propagated in City of Richmond nurseries, they will be planted along the site's picturesque new Samuel Brighouse Heritage Boulevard.

Designed to convert between a speed skating facility, elite athlete training zone, international sports venue, neighbourhood recreation centre and seniors' rehabilitation area, the Richmond Olympic Oval will be a centre for sports of all kinds.



THE WOODWAVE STRUCTURAL PANEL© SYSTEM

The WoodWave panels are designed to span between the primary wood-steel arches. Each WoodWave roof panel consists of three parallel *Vee-trusses*: hollow, arched triangular sections, typically 42 ft (12.8 m) long, 4 ft (1.2 m) wide and 26 in (660 mm) deep, laid side by side and connected together by a 1⅛-in (28-mm) thick stressed skin of plywood to form a 12 × 42-ft (3.6 × 12.8-m) long panel.

The two sloping faces of each Vee-truss are built up from successive strands of 2 × 4-in (38 × 89-mm) lumber on edge, and splay out from a central bottom chord (the keel) of the same material. Each strand is vertically offset from the one below it and stitched together with nails and metal reinforcing strips. Only every second strand is continuous, with alternating strands comprised of short lengths of lumber. These splice blocks are separated longitudinally by gaps of varying length, thus creating voids that lighten the structure and enhance acoustic performance.

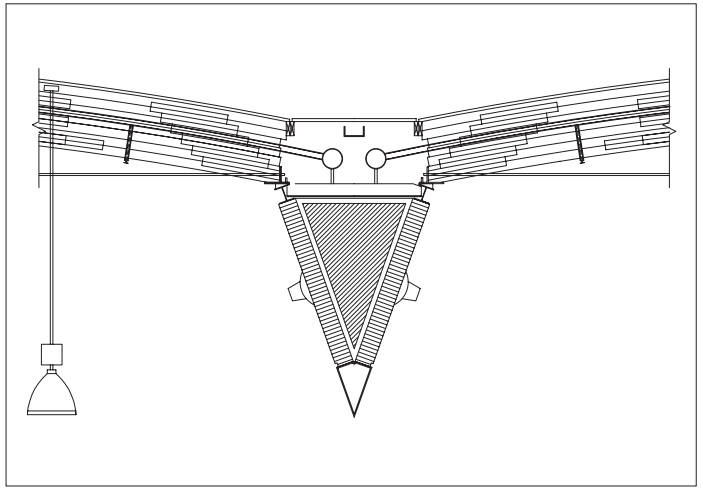
The incremental longitudinal offset of each successive row of splice blocks also creates trussing action along the length of the arched Vee-truss, thereby improving resistance to bending. At intervals along the span, inside the Vee-trusses, triangular plywood gusset plates improve lateral stiffness and help to maintain the precise geometry of the unit.

"We've spanned this enormous distance with panels using ordinary two-by-fours, the same kind you can find in every house in Canada. We couldn't have designed or built this even 10 years ago."

GERRY EPP – FAST + EPP STRUCTURAL ENGINEERS

The shop fabrication process utilizes both custom computer numerically controlled (CNC) machinery and manual means to grade and label the lumber, produce the varying lengths of lumber strands, assemble the strands into groups, press each Vee-truss into an arch, and install the steel rod tension tie, giving it a camber of 26 in (660 mm). The final product is a composite panel whose structural performance is complex, but where each component performs at optimal efficiency.

The resultant undulating WoodWave panel soffit, the regular openings in the ceiling and the saw tooth profile of the Vee-trusses also help minimize reverberation of crowd noise and amplified sound, while the shadow pattern created by the filigreed lumber strands presents a visual texture that is rare in a building of this scale.





FACTS

- The WoodWave roof panel system was conceived and engineered by StructureCraft Builders, a British Columbia-based design-build company. It is so named because it is built completely of lumber and plywood fastened together in a wave-like form to serve as a structural roof, as a finished ceiling and as a noise-reducing panel
- The panels are of tied *arch* construction that develops composite action between the laminated lumber arch and the plywood top skin and bulkheads. The construction includes a tension tie below, which creates a camber that in turn increases the effective depth of the system
- The resulting self-contained, arched panels are simple to erect and provide a stable platform for rapid installation of successive panels
- CNC prefabrication of the lumber strands and shop-based pre-assembly ensure precision and consistent quality of the final product
- To meet fire codes, factory fabrication of the panels also included the installation of sprinkler lines, a black fabric acoustic liner and mineral wool insulation within the Vee-trusses
- Acoustic performance of the building is enhanced by the same mineral wool, as well as by the large area of openings in the underside of the panels
- The Vee-shapes of the panel structure create internal voids for concealing the sprinkler piping, while allowing the sprinkler heads to protrude into the space below
- The 452 WoodWave panels were pre-fabricated by StructureCraft Builders' 25-member carpenter crew in 8 months and erected by StructureCraft Builders' 10-member carpenter crew



"The Oval will provide great benefits for our community for generations to come. With its twin focus on sports and wellness, it will have programs and services that will appeal to members of the entire community, regardless of their age, fitness or physical ability."

MALCOLM BRODIE – MAYOR OF RICHMOND



RICHMOND OLY

PROJECT CREDITS

CLIENT
City of Richmond

ARCHITECT
Cannon Design

ROOF STRUCTURAL ENGINEER
Fast+Epp Structural Engineers

PROJECT MANAGEMENT
MHPM Project Managers Inc.

CONSTRUCTION MANAGER
Dominion Fairmile Construction Ltd.

BUILDING RENDERINGS
Cannon Design

WOODWAVE DESIGN-BUILDER
StructureCraft Builders Inc.

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For more information and details, please refer to a detailed case study produced by the Canadian Wood Council



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MPIC OVAL

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