Atypical Roof Construction Challenges

BY DEREK RATZLAFF

Roofs can often be the defining structural feature of a new building, but engineering an atypical geometric roof can present a number of challenges. Roof construction that deviates from a traditional flat or planar roof needs extra attention to ensure it functions as well or better than a more typical roof. This article will outline some of the key points to consider when undertaking a curved or geometrically challenging roof profile.

Drainage and snow buildup

Roofs with variable slopes often require more thought when deciding how rain and snow are managed. With rain, a curving roof will naturally funnel rainwater to potentially only one or two locations; this may overwhelm a drainage system that is not designed to drain the majority of a roof area in one location. Long slopes can also induce water flow that may be too fast to control when it gets to a drain location, and parapets may be required to control water direction.

Accumulated snowfall brings different issues to curved roof surfaces. Many membrane roof systems are very slippery and may allow snow to slide and pile up on roof areas if not controlled. To achieve the uniform snow loads that produce more efficient structures, many curved roof systems use a snow guard system to reduce the tendency of snow to slide along a sloping surface. These snow guards must bring these loads back into the building, but the effort to keep snow from moving on a roof surface is usually much more cost effective than designing the roof to handle accumulated snow. A snow guard structural attachment is often complicated if they are placed after the roof membrane is installed. Special care is required if the guards require penetration through the membrane to provide the connection to the roof structure.

Thermal breaks

Roof overhangs are often required and can provide many benefits for building function, protection of pedestrians from sun or rain, or shading to prevent solar heat gain. One attribute of roof overhangs is the thermal bridging that can occur with temperature differences between interior and exterior spaces. This is especially difficult to deal with when providing a continuous soffit from the inside to outside. This was the case at Jasper Place Library where the large temperature swings in Edmonton required a thermal break to separate the concrete slabs on each side of the envelope. The solution was a continuous pre-fabricated structural thermal break. These were sent to the general contractor who installed it on the formwork prior to pouring the roof concrete. Reinforcing details within the thermal break use stainless steel to reduce the heat transfer typical within reinforced concrete construction. This system allowed significant areas of overhang that could behave structurally as part of the main building, yet endure the 50°C temperature differentials typical of an Edmonton winter without causing condensation on the interior surfaces. An additional challenge of this project was to allow for the complex structural behaviour required with the large canopy projecting over an exterior deck. The structural thermal break units were designed to transfer the variety of loads through the envelope and achieve a consistent soffit; a continuous slab behavior; and a functional envelope.

Construction issues

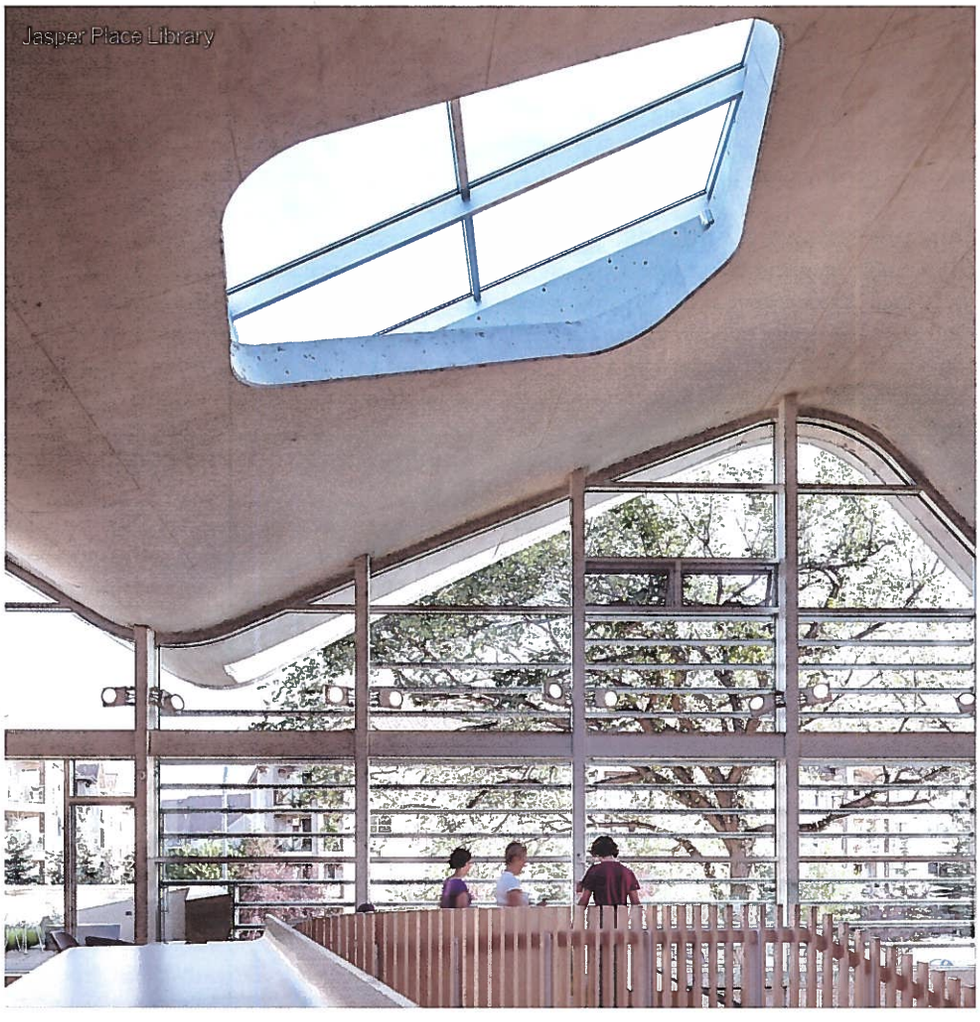
Using a non-linear or non-orthogonal building design often requires changes in the typical construction process. Often details typically used in flat or single slope roof systems no longer work in curved roof assemblies, or at least require variations in detailing to suit varying slopes. The erection of curved or undulating roofs often requires a different methodology in construction techniques.

Constructing curving structures often benefits from the flexibility of natural materials, and slender wood structures use their flexibility to advantage to achieve the curvatures required. However, this same flexibility can be a hindrance when erection requires long slender objects to be moved into position. This same flexibility can cause large stresses in the members if the erection procedure does not account for it.

At Grandview Heights Aquatic Centre, the slender glulams required large spreader beams to be used to keep the glulams in the curved shape when being lifted from the ground to the roof. Multiple spreader beams were used to provide support for the members at four points along the length, instead of only two used for a rigid beam element. Simple connection detailing allowed the placement of each element to proceed quickly. Once the procedure was in place, the erection proceeded efficiently to stay within the window imposed by both the project schedule and the weather.

Summary

In conclusion, when undertaking a curved or geometrically challenging roof profile, special structural solutions may be required. Understanding both the interaction of the environment with the building and the methods used to construct it allows these issues to be dealt with effectively to achieve interesting and innovative roof shapes. **CB**



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