Blackwell

UNIVERSITY OF TORONTO'S GOLDRING CENTRE FOR HIGH PERFROMANCE SPORT

2015 CANADIAN CONSULTING ENGINEERING AWARDS SUBMISSION

UNIVERSITY OF TORONTO'S GOLDRING CENTRE FOR HIGH PERFORMANCE SPORT

1: BUILDING EXTERIOR

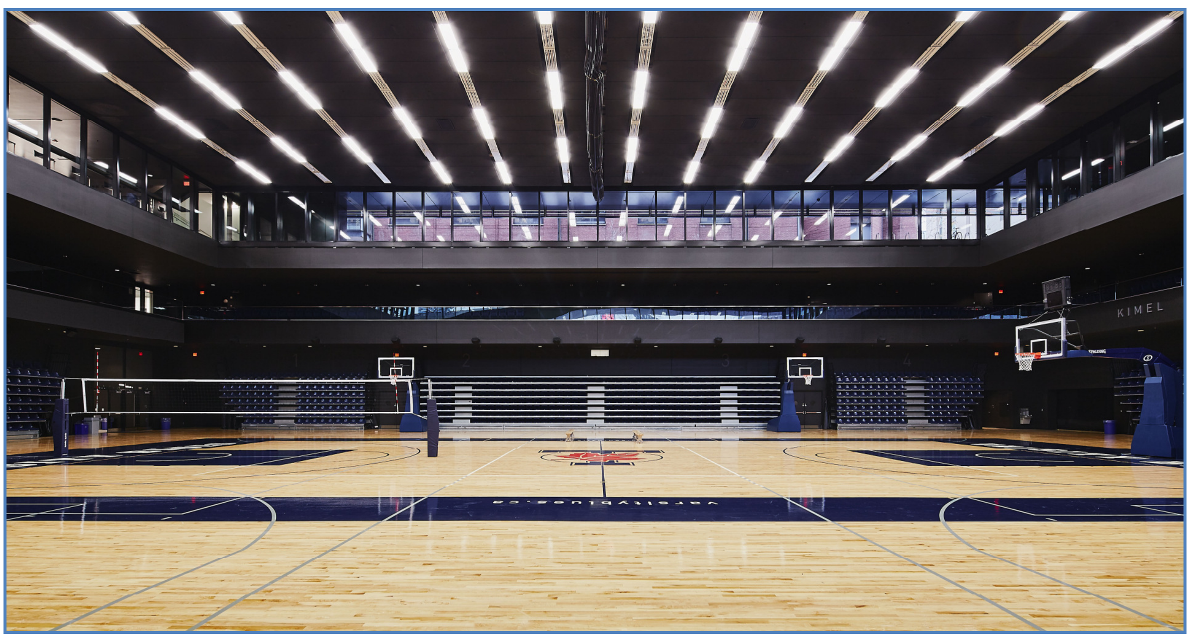
PROJECT SUMMARY

Part of an extensive renewal project of the University of Toronto's Varsity Centre, the Goldring Centre for High Performance Sport is a $58 million centre for sports research, sports medicine and recreation in the heart of Toronto. The 150,000 sq. ft., four-storey complex features teaching labs, a fitness centre, strength and conditioning centre, a state-of-the-art sport medicine clinic, and a 2,000-seat internationally rated field house for varsity basketball and volleyball. The project contributes to the quality and coherence of the university as a whole, bringing together researchers, graduate students, sport scientists, athletic therapists, coaches, and athletes to form Canada's leading Sport Institute. Built on an extremely tight site, the field house could only be located below grade due to set back requirements, which forced the building to be constructed as a bridge, with all other programs located over the playing surface.

PROJECT HIGHLIGHTS

INNOVATION

The Goldring Centre consists of three storeys of multi function program bridging over a 2,000 seat field house for basketball and volleyball. A conventional building of this type would traditionally have a long span roof over the field house and all other programs either spread or stacked adjacent to the field house, leaving no requirement for the roof to support occupant loads and not subjecting the roof to vibration induced by human activity. When it is necessary to stack one over the other, the natural solution is to place the long span space on top for the same reason. However, the chosen building site for this centre was such that neither of these options was feasible due to size restrictions of the site.

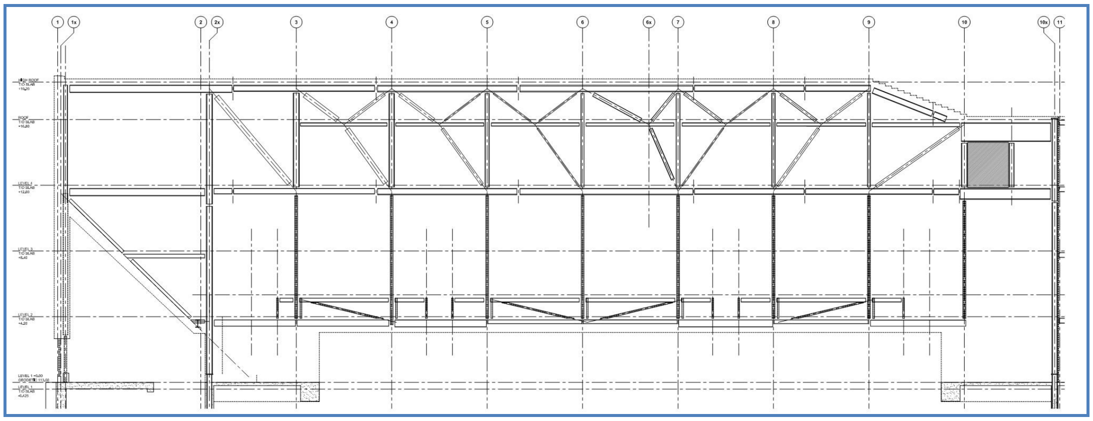


2: FIELD HOUSE

Once the basic scheme and load path was established, the most significant structural decision was relatively simple: full storey deep trusses spanning 54m at each bay forming a bridge over the field house. Many innovations were required to address the finer engineering requirements resulting from this scheme. The second and third floors are suspended from the fourth floor trusses. In order to minimize the size of the hangers and their impact on the building space, small diameter high strength rods were used. These are inside a non-structural HSS section which was pumped full of grout for fire-proofing. This provided the smallest overall hanger size and at the same time accommodated a high quality durable finish (painted steel rather than GWB) and provided a redundant load path.

3: FEATURE TRUSS

In order to pass the many doors and corridors through the web of the trusses, web arrangements had to be very strategic. In some places webs could be simply cranked out of the way by adding a bracing member, while in areas of very high shear, a full steel plate beam web was employed.



4: GENERAL LAYOUT: 2ND AND 3RD FLOOR SUSPENDED FROM 4TH FLOOR TRUSS

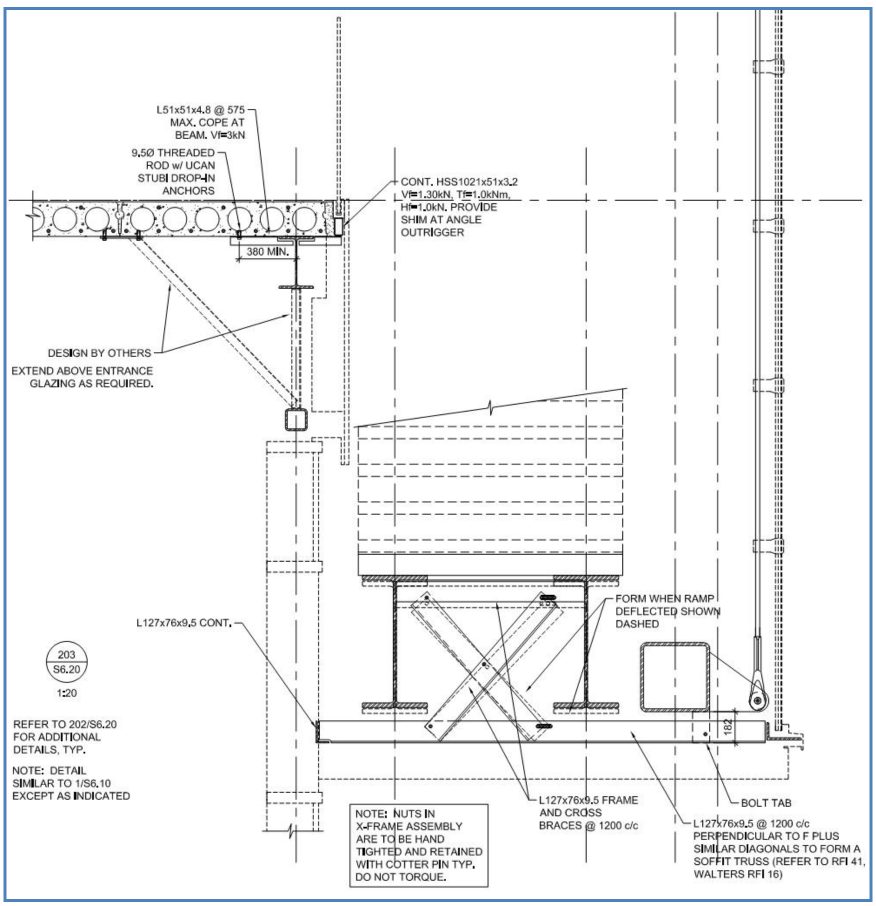
Since the floors are suspended rather than supported, an innovative erection strategy was required, allowing the top floor to be constructed first, and the erection to proceed from the top down rather than the conventional bottom up sequence. Hollow core precast slabs were threaded through the completed skeleton to fill in the floors.

5: OVERALL BUILDING STRUCTURE

In addition to the challenges of the current building program, the building had to be designed to accommodate an as yet undersigned academic tower over the loading dock. A provisional tower design allowed the foundations and ground floor columns to be designed in anticipation of this.

COMPLEXITY

Careful detailing was required to accommodate the ±54mm of live load deflection of the truss. The structure had to be detailed to transfer lateral loads to the ground floor slab while moving vertically using very shallow pre-stressed high strength rod bracing. Beneath the "stramp" a scissor frame was designed so that the stramp could move differentially relative to the adjacent cable glass wall and the soffit. While the second and third floors could be suspended, the 54mm truss deflection would have resulted in unacceptable slopes at the ground floor. As a result, the ground floor was cantilevered from the perimeter using post-tensioned concrete to minimize structural depth.



6: SCISSOR FRAME DETAIL

Column base plates could not be pocketed into the ground floor slab because of interference with the post-tensioning ducts, and if left on top, it would interfere with finishes. The solution was to "nail" the columns to the foundation walls, casting in full storey deep steel columns quilled with shear studs to transfer loads to the concrete walls.

The deep excavation at the site generated extraordinary soil pressures. This was exacerbated by the fact that the interconnection of the perimeter wall with the adjacent floors was so heavily perforated with stair openings. A conventional foundation wall spanning from the lowest level to the ground floor was found to be the most economical solution relative to more complex "crib" wall solutions. A great innovation came from the geotechnical consultant who, through careful analysis of the soil and the structural movements, allowed a 33% reduction in the design earth pressure.

SOCIAL AND ECONOMIC BENEFITS

The downtown campus of the University of Toronto is a true urban university campus in the heart of the city surrounded by museums, galleries, dense commercial and residential development.

The downtown campus supports almost 60,000 students and 20,000 staff – as many as a medium sized city such as Peterborough. The demographic of this population is extremely narrow, the majority between 20 and 30 years. Good facilities, including athletic facilities are a critical part of the university experience. Good sports programs can increase a university's profile and enrollment; increasing the caliber of students, which in turn drives up academic standards.

High quality athletic facilities also help to develop a culture of health and wellness which improves the quality of student life on campus. Healthy students make healthy graduates who will enter the work force, making Canada more competitive globally and reducing long term health care costs to the public.

Athletics are also constructive social experiences, the social education of students being a critical secondary benefit of a post secondary education.

ENVIRONMENTAL BENEFITS

The best building practices produce a building that minimizes embodied energy and ongoing energy use, within the constraints of program demands.

This project combines a high quality envelope with high efficiency glass to minimize winter heat loss and summer heat gain. High efficiency boilers and heat pumps manage comfort with minimal energy cost.

7: GLASS FACADE

The challenge with building structure is to minimize embodied energy while meeting serviceability demands. Steel is the only material that can achieve the required span and configuration for the superstructure. Full storey deep trusses were used rather than girders, offering a significant savings in tonnage. Hollow core precast slabs incorporate substantial voids, eliminating material where it is not serving a functional requirement.

Post tensioned concrete was used at the ground floor achieving a substantial material reduction relative to conventionally reinforced concrete. Post tensioning makes the concrete virtually

100% effective compared to conventionally reinforced concrete whose stiffness is reduced due to cracking.

Urban intensification is possibly the greatest contribution to the sustainability of this project. By using creative engineering solutions to shoe horn this building onto a tight urban site, other open sites could be left for other purposes such as parks and green space or housing. Urban intensification takes the burden of roads, reduces automobile traffic, the resulting greenhouse gas emissions, and reduces new suburban development preserving green space.

MEETING THE CLIENT'S NEEDS

The client had one main goal for this project: fit the program on the site.

Building setback requirements were such that there was physically not enough space on the site to fit the 2,000 seat stadium. As a result, the stadium had to be located below grade where setback rules do not apply. This required the building to be constructed as a bridge with three storeys of offices, labs, and fitness facilities located above the playing surface.

To keep the field house accessible and connected to the campus, and to minimize the deep excavation required, the ceiling of the field house is one storey above grade, which meant transfers at the ground level were not possible and the main structure would have to be above the second floor. Spanning the building across the narrow dimension of the site would result in columns passing through the field house interfering with seating and sight lines and possibly play. Structure would have to span the long way – 54m. A 54m span requires a structure depth in the order of 3.5m, in order to limit the building height the structure was threaded through the building rather than above or below. The second and third floors have open programs such as the large fitness centre and the fourth floor has a dense program consisting of offices and labs. The structure chosen consists of full storey deep trusses at the fourth floor level where the truss webs could be integrated with partitions and doors.

In addition to the goal of satisfying space requirements, a mandate of the project was to construct a world class High Performance Sport Centre and vibrant student space while contributing in a congruous way to the ongoing development of the campus. Upon completion of the project it was apparent the facility will serve as a vital hub for sports, recreation, research, and therapy to students, athletes, faculty, and the greater community as a whole.