CANADIAN INSTITUTE OF STEEL CONSTRUCTION
INSTITUT CANADIEN DE LA CONSTRUCTION EN ACIER

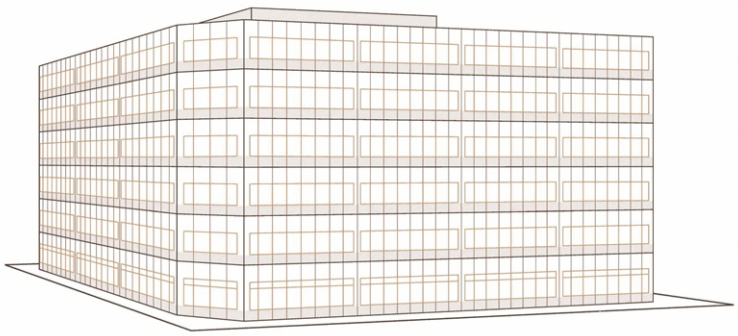
COMPARATIVE CASE STUDY: STEEL VS. CONCRETE FRAMING SYSTEMS

The CISC Solutions Centre's ***Project Solutions services*** are dedicated to developing tools and resources that help engineers, architects, owners, general contractors and other stakeholders make informed choices when selecting building materials for their projects.

We are pleased to present our latest research results - a comprehensive case study that evaluates the impacts of steel vs. concrete framing systems for typical commercial buildings in Canada.

The reference project for this case study is a six storey commercial office building located in Ontario. The case study evaluates the impacts of selecting steel vs. concrete framing on the project's entire construction cycle from concept and design to costing, construction and sustainability.

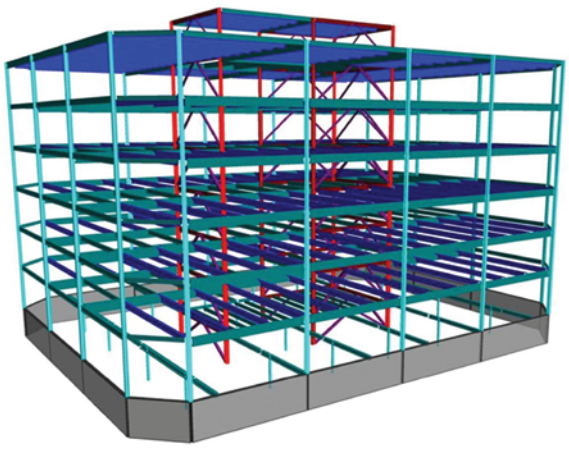
SIX STOREY OFFICE BUILDING • MISSISSAUGA, ON

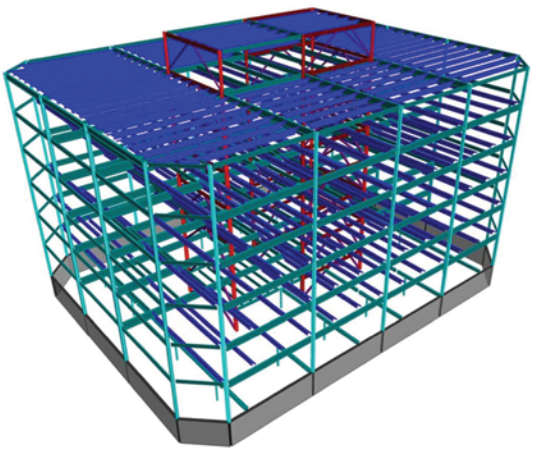


Design of concrete structure: **Y & V Engineering Ltd**
Costing of all concrete components: **C B Ross Partners**
Design of steel structure: **CISC Solutions Centre**
Costing of steel structure & components: **CISC Solutions Centre**

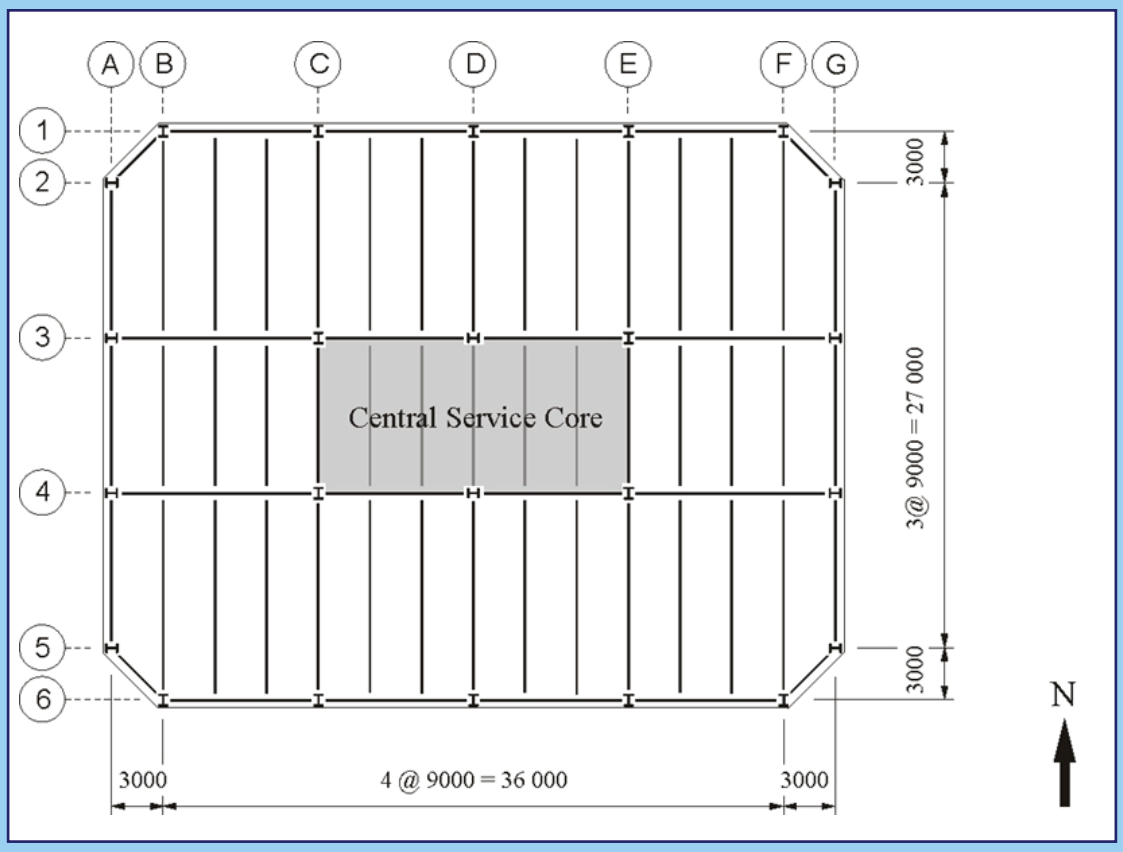
- **Project Type:** 6-storey office building + penthouse and a basement parking level
- **Location**: Mississauga, ON
- **Specifications:**
  - NBC 2010 Live Loads in office areas, Ground and Parking Floors; 4.8 kPa in service core and Penthouse floor
  - Superimposed dead loads: 0.95 kPa on roofs; 1.4 kPa on Ground Floor and 1.6 kPa in other floor areas
  - Curtain wall cladding
  - Soil bearing capacity: 400 kPa (allowable)
  - Column-free interior layout

3-D VIEW – STEEL SCHEME

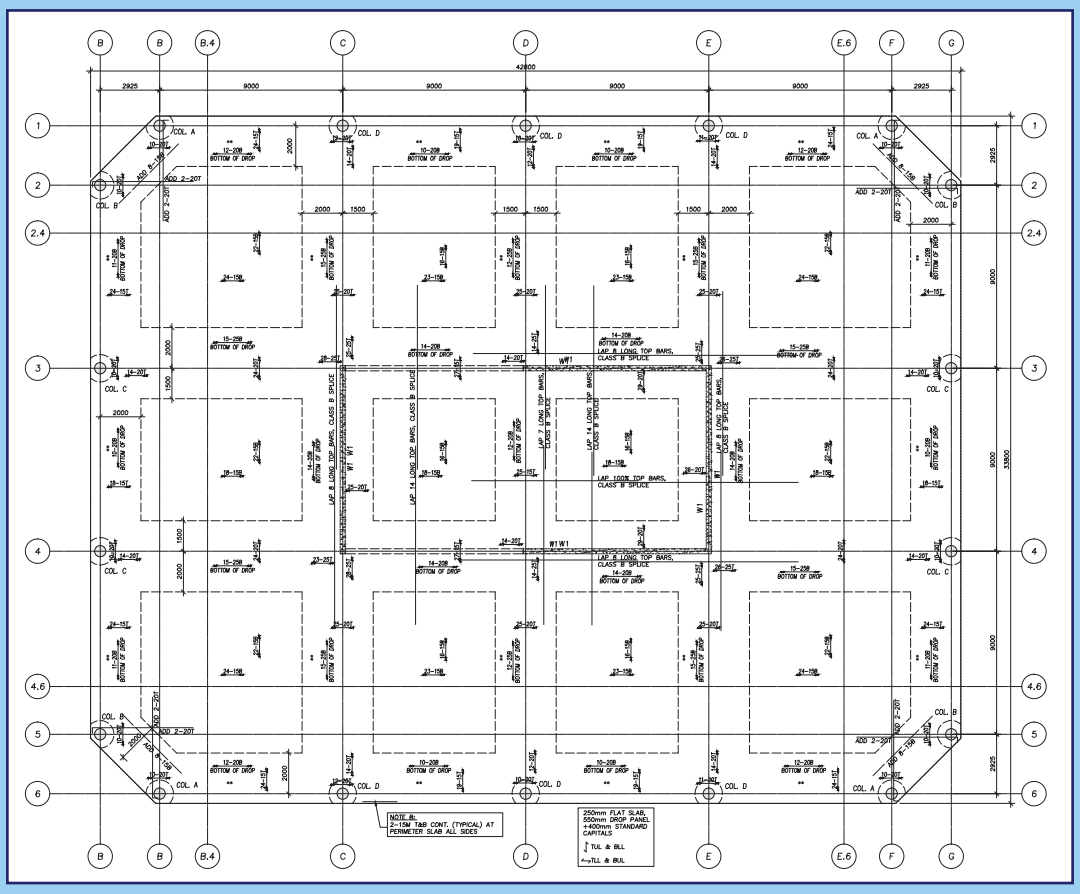




TYPICAL FLOOR PLAN - CONVENTIONAL STEEL SCHEME WITH BEAMS, JOISTS, COLUMNS AND BRACED CORE



TYPICAL FLOOR PLAN – CONCRETE SCHEME / CIP SLAB WITH BEAMS; CORE WALLS



CONSTRUCTION COST SUMMARY FOR CONVENTIONAL STEEL FRAME WITH BEAMS, JOISTS, COLUMNS AND BRACED CORE

COST SUMMARY ***Project:*** The Case, Mississauga, Ontario (6 storey office building plus basement parking level).
Steel scheme: Conventional Steel Frame with Beams, Joists, Columns, and Braced Core ***Date:*** 2014/09/16

DESCRIPTION	QUANTITY	UNIT RATE	AMOUNT $	$ / s.m. GFA*
Structural Steel Framing: Structural steel consisting of erected steel beams, OWSJ, girders, braces and columns commencing at footings and basement wall, including corrosion protection for steel posts and exposed flange of beams in basement.	368 tonnes	3225	$1,187,660	116.84
Steel Deck & Concrete slabs 38 mm x 0.76 mm roof deck installed 75 mm x 0.91 mm steel floor deck, including flashing and edge forms, installed.	 1428 s.m. 7309 s.m.	 16.14 45.19	 $23,048 $330,308	 2.27 32.49
25 MPa normal density concrete, machine trowel finished to 65 mm thick cover slabs in floors including 152 x 152 MW 18.7/18.7 welded wire mesh, installed.	7309 s.m.	34.72	$253,768	24.96
203 mm hollow precast concrete slab, grouted in place, including concrete 25 mm topping	1428 s.m.	117.52	$167,820	16.51
Fire Protection ***Above ground floors:*** Sprayed protection on beams, joist, columns and deck underside to meet 1 hr ULC/ULI design:	7309 s.m.	41.68	$304,663	29.97
Basement level: Sprayed protection on bottom flanges of beams and columns above concrete encased pedestal to meet 2 hr ULC/ULI design	1428 s.m.	17.22	$24,584	2.42
Lateral Load Resistance: Steel braced core (included in STRUCTURAL STEEL FRAMING above)				
Basement Walls: CIP Perimeter concrete walls and 1-m high concrete encasement of interior steel posts			$186,209	18.32
Basement Floor Slab: slab on ground			$78,443	7.72
Foundations: footings, including setting of anchor rods			$169,740	16.70
*Based on a Gross Floor Area of 10165 s.m. ***Total***			$2,726,243	268.20

CONSTRUCTION COST SUMMARY FOR CONCRETE SCHEME CIP REINFORCED CONCRETE SLAB FLOORS, ROOFS, AND CONVENTIONAL CORE WALLS

COST SUMMARY ***Project:*** The Case, Mississauga, Ontario (6 storey office building plus basement parking level).
Concrete scheme: CIP reinforced concrete slab floors, roofs, and conventional core walls ***Date:*** 2014/09/16

DESCRIPTION	QUANTITY	UNIT RATE	AMOUNT $	$ / s.m. GFA*
Roofs Main roof and penthouse roof framing: CIP reinforced concrete roof slab with beams, spandrel beams and columns	1428 s.m.	262	$374,533	36.85
Floors CIP reinforced concrete floor slab with beams and spandrel beams (level 2-6), CIP reinforced concrete ground floor slab with drops and columns from footings to roof	8737 s.m.	262	$2,285,285	224.82
Lateral Load Resistance CIP reinforced concrete core walls			$316,000	31.09
Basement Walls CIP reinforced concrete perimeter walls			$180,709	17.78
Basement Floor Slab Slab on ground			$78,443	7.72
Foundations Footing for columns, core walls, and perimeter walls in basement (excavation excluded from study)			$362,812	35.69
*Based on a Gross Floor Area of 10165 s.m. ***Total***			$3,597,782	353.94

ADVANTAGE STEEL: The steel scheme has lower overall costs

COMPARATIVE COST SUMMARY: STEEL VS. CONCRETE FRAMING SCHEMES

☑ ADVANTAGE STEEL: Steel framing scheme has lower costs for most individual structural elements

1. Cost items evaluated in the study ($/GFA):

a) Main structure and foundations:

	STEEL SCHEME	*CONCRETE SCHEME*	*DIFFERENCE*
Structure	$251.50 ☑	$318.25	$66.75 ($6.20/s.f.)
Foundation	$16.70 ☑	$35.69	$18.99 ($1.77/s.f.)

b) Cost difference for individual structural elements:

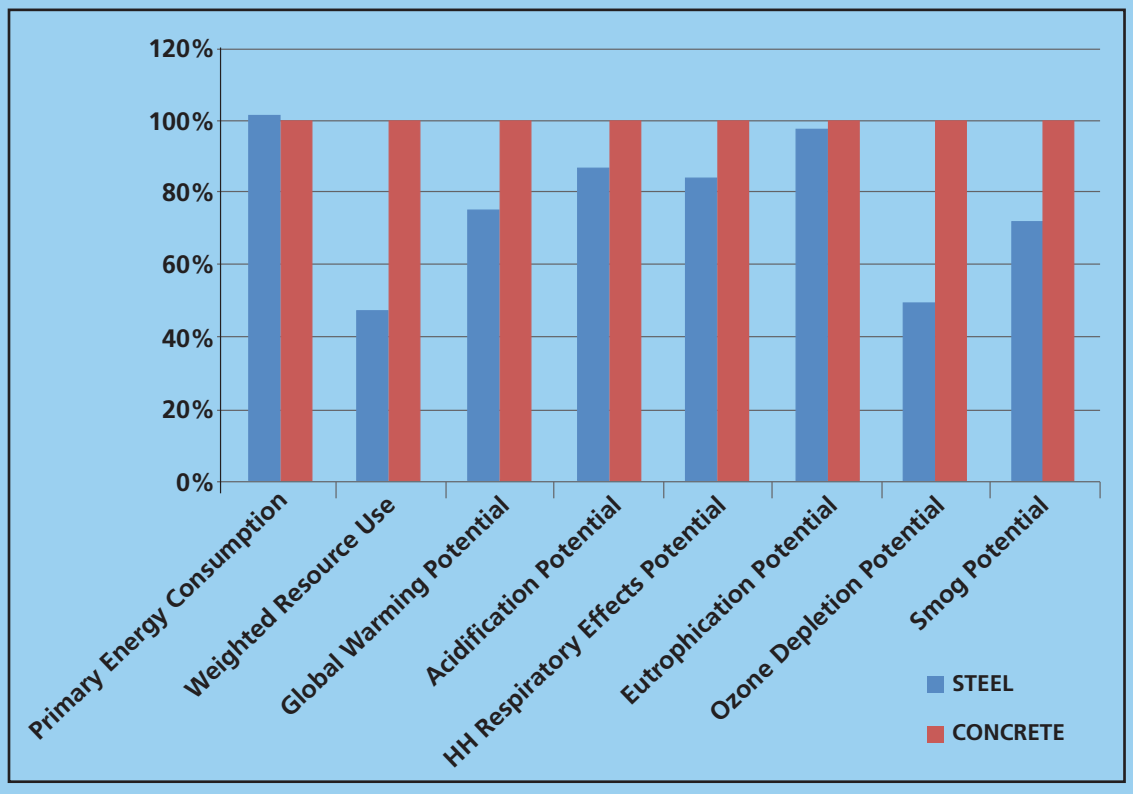
- ☑ **Structure:** $66.75/s.m.($6.20/s.f.) in favour of Steel
- ☑ **Foundations:** $18.99/s.m.($1.77/s.f.) in favour of Steel
- ☑ **Total structure:** $85.74/s.m. ($7.97/s.f.) in favour of Steel
  - **Core wall drywall cover:** $4.85/s.m. ($0.45/s.f.) in favour of Concrete
  - **Building height (cladding etc.):** no difference (same height)

☑ **Net cost difference:**
$81/s.m. ($7.50/s.f.) in favour of Steel Scheme

c) Additional savings with the steel scheme:

- ☑ **Crane costs:** Lower for the steel option due to earlier project completion.
- ☑ **Other site overhead expenses:** Lower for the steel option due to earlier project completion.
- ☑ **Interim financing cost:** Lower for the steel option due to earlier project completion.
- ☑ **Winter construction:** Better results with the steel option because CIP concrete construction incurs higher costs for heating, curing and ready-mix supply in the winter resulting in lower productivity.
- ☑ **Future changes:** The steel structure's inherent adaptability to changes reduces renovation costs and business disruption costs.
- ☑ **Speed of construction:** The steel option's early completion reduces risks associated with real estate market uncertainties.
- ☑ **Smaller columns:** Steel-framed buildings yield more usable space.

SUSTAINABILITY IMPACTS: WHOLE BUILDING LIFE CYCLE ANALYSIS (LCA) OF STEEL VS. CONCRETE FRAMING



☑ ADVANTAGE STEEL

- Steel emerged as the clear winner from a "green" perspective in the whole building life cycle analysis (LCA) that was conducted for this project.
- The LCA demonstrated that steel has a lower environmental footprint than concrete in most of the environmental impact categories that were measured.

* LCA Study conducted by Ryerson University