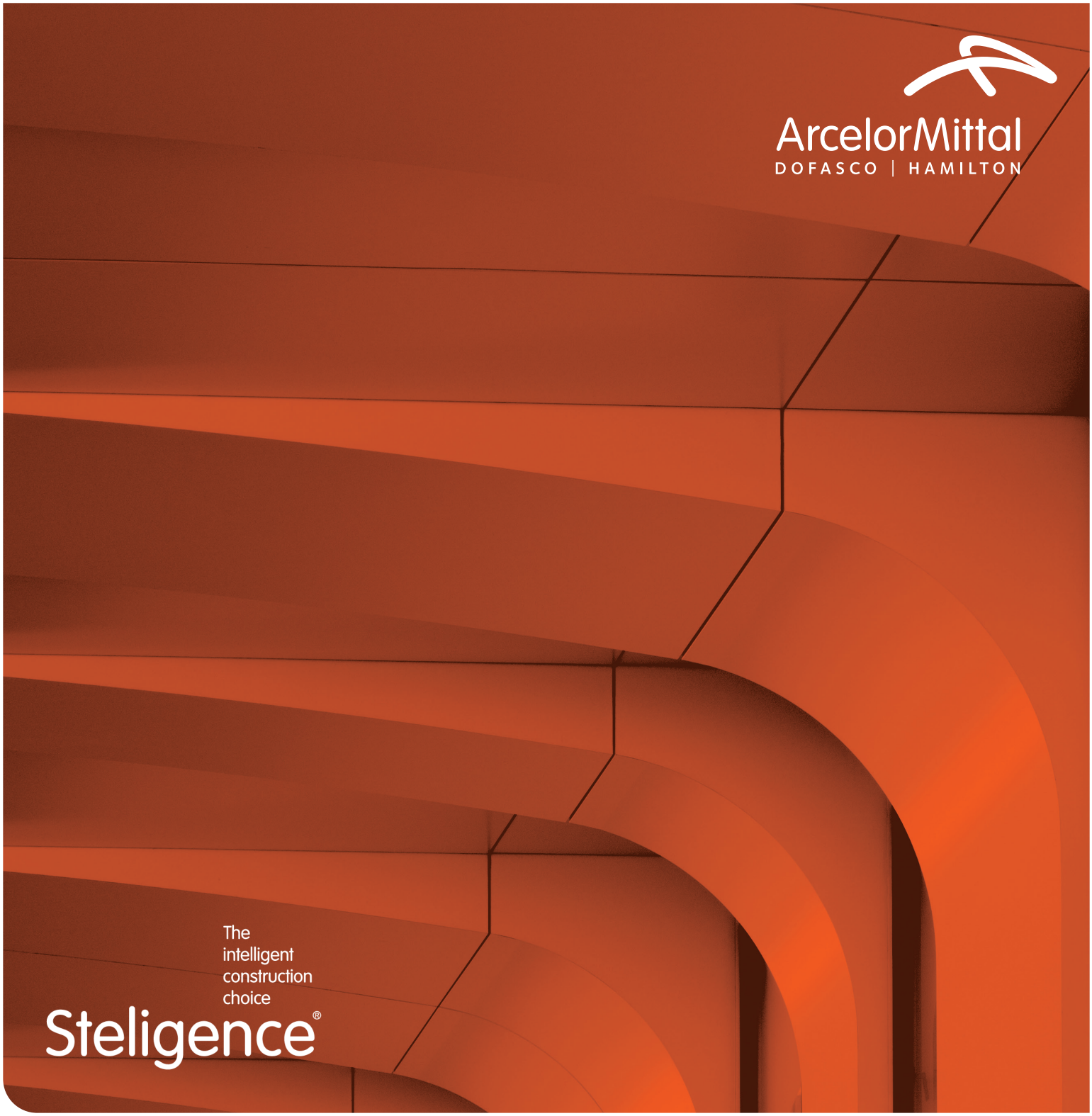


Mid-Rise Residential Case Study

Residential mid-rise buildings are a popular choice for developers in today's urban centers. Combining the benefits of low and high-rise structures, mid-rise provides an answer for densification while maintaining street level comfort for pedestrians. Numerous concrete, steel and timber-based solutions exist with each lending their own unique set of advantages. To assess the environmental and financial impacts, ArcelorMittal has completed the following case study using the holistic guiding principles of Steligence.

	Steel	Concrete	Timber
Envelope	Insulated steel stud wall, Indaten™ Weathering Steel cladding		
Level 1 Podium	Cast-in-place (CIP) concrete transfer slabs, beams, walls, columns		
Core, Shear Wall	CIP concrete	CIP concrete	Cross laminated timber (CLT)
Levels 2-6	Composite deck, steel load bearing walls, light HSS columns and W beams across hallways	Concrete demising walls, precast concrete floor slabs	Glue laminated timber (GLT) floor slabs, beams, columns, CLT load bearing
Roof	Steel deck	Precast concrete	GLT slabs

Building Overview & Functionality

The case study was designed as a 6-storey mixed-use commercial and residential building located in the Greater Toronto and Hamilton area. The design uses a split ground level podium for the commercial space separated by a pedestrian walkway, and residential units occupying the upper levels.

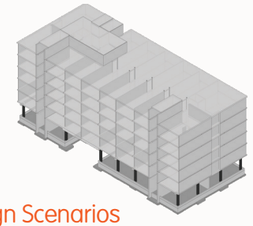
Size: 6,916m^2 Gross Construction Area

Stacking: 6-storey

Level 1 – Retail, building amenities

Level 2-6 - Mix 1-2 Bedroom Units (75)

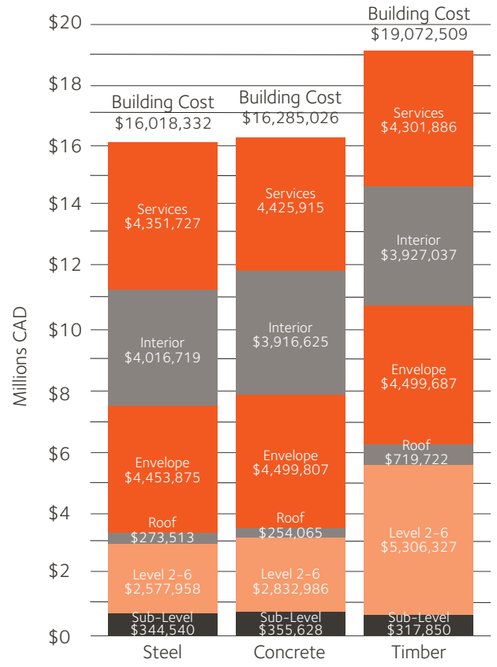
Rooftop mechanical penthouse



Design Scenarios

Three different design scenarios were analyzed covering steel, concrete and timber construction. For the purposes of the study, only the structural elements of the core, upper levels and roof were significantly altered.

Building Cost ($)



Financial source: Preliminary Construction Cost Estimate by Altus Group

Financial Results

Construction cost estimates were obtained for the three design scenarios. In terms of total cost, the steel design was the most economical at $16M CAD. The concrete estimate was 2% higher than steel, while mass timber was significantly higher at 19%. This difference was attributed mainly to the increased material and installation costs of the mass timber in the upper floors and roof, which were more than double that of steel when expressed as cost per unit area.

Structure Elemental Unit Rate Summary ($CAD/m^2)

	Steel	Concrete	Timber
Level 1	80	80	80
Level 2-6	418	459	860
Roof	233	217	614

Financial source: Preliminary Construction Cost Estimate by Altus Group

Construction Schedule

The structural schedule for each design was determined by calculating the working days per floor and totaled for the building. The number of working days per floor was based on crane activities and average time for concrete casting, installation of slabs, decking, wall panels and members. The schedule for the facade and overlap with the structure was equivalent for all designs. At 153 construction days total, the steel design showed a schedule reduction of 5% and 12% over timber and concrete respectively.

Construction Schedule Summary (Days)

	Steel	Concrete	Timber
Structure	98	118	106
Façade	70	70	70
Overlap	-15	-15	-15
Total	153	173	161

Scheduling source: MPa Project Consulting

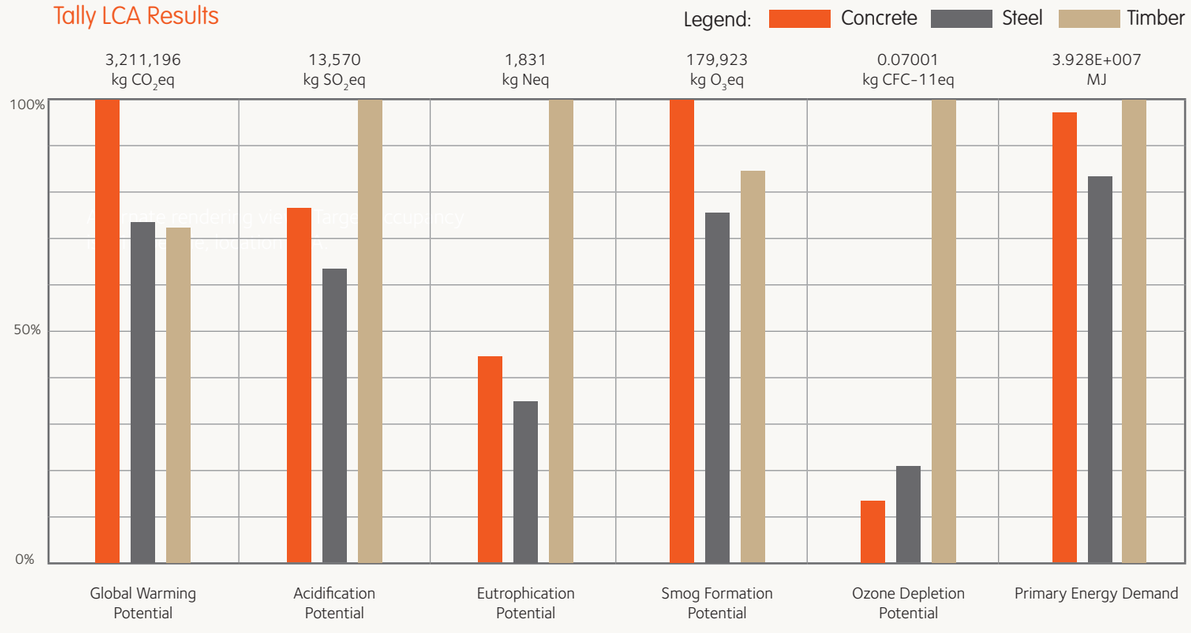
Environmental Results

To assess the environmental impact of the design scenarios, a cradle-to-grave life cycle analysis (LCA) was conducted using the Tally® plug-in for Autodesk Revit for the entire building. Tally is one of the most frequently used and cited tools for building LCAs. Combining the bill of materials, North American environmental product declarations (EPDs) and LCA data, the following impacts were assessed for a 60-year lifespan of each structure:

- Global warming (Embodied carbon, kg CO_2)
- Acidification (Acid rain, kg SO_2)
- Eutrophication (Nitrate equivalent, kg N)
- Ozone depletion (CFC equivalent)
- Smog formation (NO_x, VOCs, O_3)
- Primary energy (fossil & renewable, MJ)

Results from the Tally LCA showed the steel-based design outperformed concrete and timber in a majority of the categories. Steel had the lowest potential for acidification, eutrophication, smog formation and energy demand. For global warming, steel and timber were similar, and both were significantly lower than concrete in CO_2 equivalent emissions. While the concrete and steel designs had lower ozone depletion potential than timber, it should be noted that quantities of this scale are considered insignificant for all three designs, attributed to prior CFC ban in North America. In summary, the LCA validated that steel-based construction solutions have the smallest environmental footprint in this mid-rise case study.

Tally LCA Results



Conclusion

In this Steligence case study, three residential mid-rise building design scenarios employing steel, concrete, and timber elements were examined. The design containing the steel-based solutions was determined to be the most environmentally sustainable and economical overall.

While it is important to consider all building construction solutions for a project, this case study showed steel should be a forerunner considering the advantage it can provide to both the owner and the environment.

What is Steligence®?

Steligence® is a global initiative by ArcelorMittal using scientific evidence to show the benefits of steel design in building construction. Using a holistic analysis concept, competitive steel building solutions are identified.

Why Steligence®?

Steligence® allows building owners, architects, and engineers a fact based approach to view building construction, for collaboration to build sustainable, more cost-effective buildings.

About ArcelorMittal

ArcelorMittal is the world's leading steel and mining company. Guided by a philosophy to produce safe, sustainable steel, it is the leading supplier of quality steel products in all major markets including automotive, construction, energy, household appliances and packaging. ArcelorMittal is present in more than 60 countries and has an industrial footprint in more than 20 countries.

With a strong presence in North America, Europe, South America and South Africa, and an emerging presence in China, ArcelorMittal delivers a large scale of products, solutions and services to customers with the same quality focus in all regions. ArcelorMittal is the leader in steel technology, both in the breadth and depth of our product portfolio, and in our ability to supply a range of grades throughout the world. ArcelorMittal is a supplier of choice for all markets, a testament of our commitment to working collaboratively with our customers to engineer advanced steel grades to meet their needs.

ArcelorMittal

ArcelorMittal Dofasco
Box 2460, 1330 Burlington Street East
Hamilton, ON L8N 3J5 Canada
dofasco.arcelormittal.com

@ArcelorMittal_D
facebook.com/arcelormittaldofasco
@arcelormittal_dofasco

T 1-800-816-6333
E customer-inquiries.dofasco@arcelormittal.com

ArcelorMittal USA
1 South Dearborn Street, 18th Floor
Chicago, IL 60603 USA
usa.arcelormittal.com

@ArcelorMittalUS
facebook.com/ArcelorMittalUSA

T +1 800 422 9422
E constructioninquiries@arcelormittal.com

July 2020