The intelligent construction choice

Steligence®

12-Storey High-Rise Residential Building Case Study

ArcelorMittal

About 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.

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

Smarter steels for people and planet

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.

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Introduction

Major cities and the surrounding regions continue to be drivers of both local and national economies today. As economies steadily expand and job demand grows, there is a pressing need to increase the affordable housing supply for the population, through densification in high-rise buildings while limiting urban sprawl.

Concrete has long been a staple in the development of multi-storey buildings. The latest advancements in cold formed steel grades and innovative member design, have enabled sheet steel to now be used as an alternative in many aspects of building construction.

ArcelorMittal has completed two high-rise case studies which incorporate affordable and efficient design layouts for both 12 and 22-storey residential buildings. Using the holistic guiding principles of Steligence®, this pair of studies quantifies the environmental and financial impacts between concrete and steel-based designs.

Building Overview & Functionality

The case study was designed as a 12-storey residential building for a corner site overlooking two streets located within the Greater Toronto and Hamilton area.

Size: 26,655 m² Gross Floor Area

Stacking: 12-storey

Basement – 1 level underground parking

Level 1 – main entrance, amenities, services/ utilities, access to parking

Unit Types: 1BR, 2BR

Levels 2-12 – residential,

19 units per floor

Rooftop mechanical penthouse

Design Scenarios

Two unique building scenarios were analyzed comparing a steel-based design with concrete. For the purposes of the study, only the structural elements were significantly altered in each scenario.

	Steel	Concrete
Foundation & Underground Parking	Cast-in-place (CIP) concrete columns, slabs	
Lower Floors (1 & 2)	CIP concrete columns, slabs	
Upper Floors & Balconies	Composite decking, Precast concrete balconies	CIP concrete floors slabs & balconies
Structural System	Light steel framing walls, HSS columns, W-beams	CIP concrete columns & beams
Interior Walls	Light steel framing	
Core, Shear Walls	Prefabricated composite wall	CIP concrete
Exterior	Insulated steel stud wall, metal panel, window wall glazing	
Roof	Composite deck	CIP concrete slabs

Environmental Results

The Tally® plug-in for Autodesk Revit was used to assess the environmental impact of the two design scenarios from cradle to grave for the entire building. Tally® is one of the most frequently used and cited tools for building life cycle analysis. Combining the bill of materials, and North American environmental product declarations (EPDs) from GaBi life cycle inventory, the following impacts were assessed for the lifespan (60 years) of each structure:

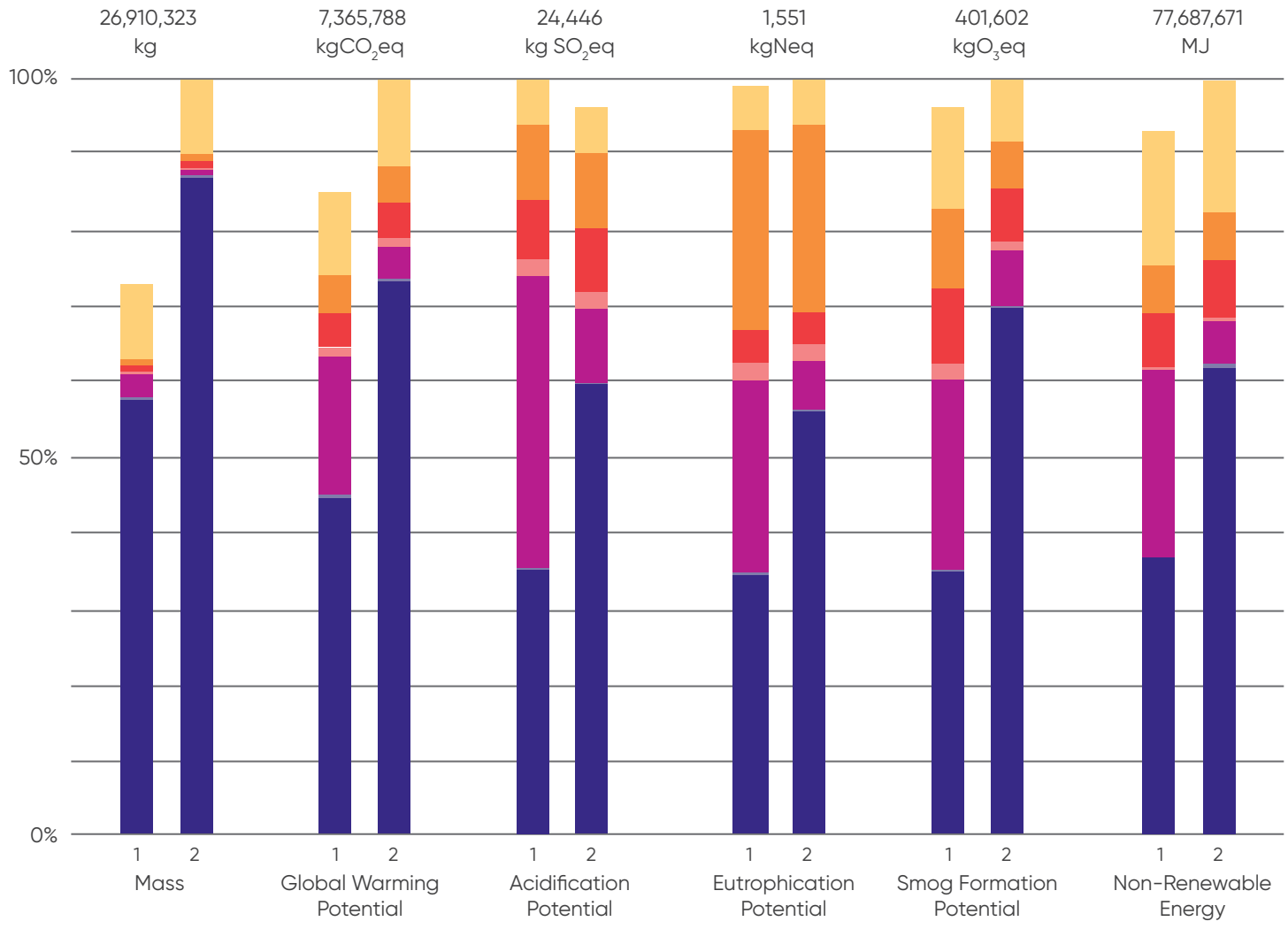
- Global warming (Embodied carbon, kg CO_2)
- Acidification (Acid rain, kg SO_2)
- Eutrophication (Nitrate eqv., kg N)
- Smog formation (NO_x, VOCs, O_3)
- Non-renewable energy (MJ)

Results from the life cycle analysis showed both designs were comparable in total values across four of the five impact indicators. The steel-based design showed a significant advantage in global warming potential (GWP), saving approximately 1.1M kg of CO_2eq or 15% when compared to the concrete design. This is equivalent to taking 220 vehicles off the road to save on annual emissions. This is primarily due to the 27% weight savings in the steel-based design. Concrete used in both designs was the largest material contributor across the five environmental impact indicators.

Divisions

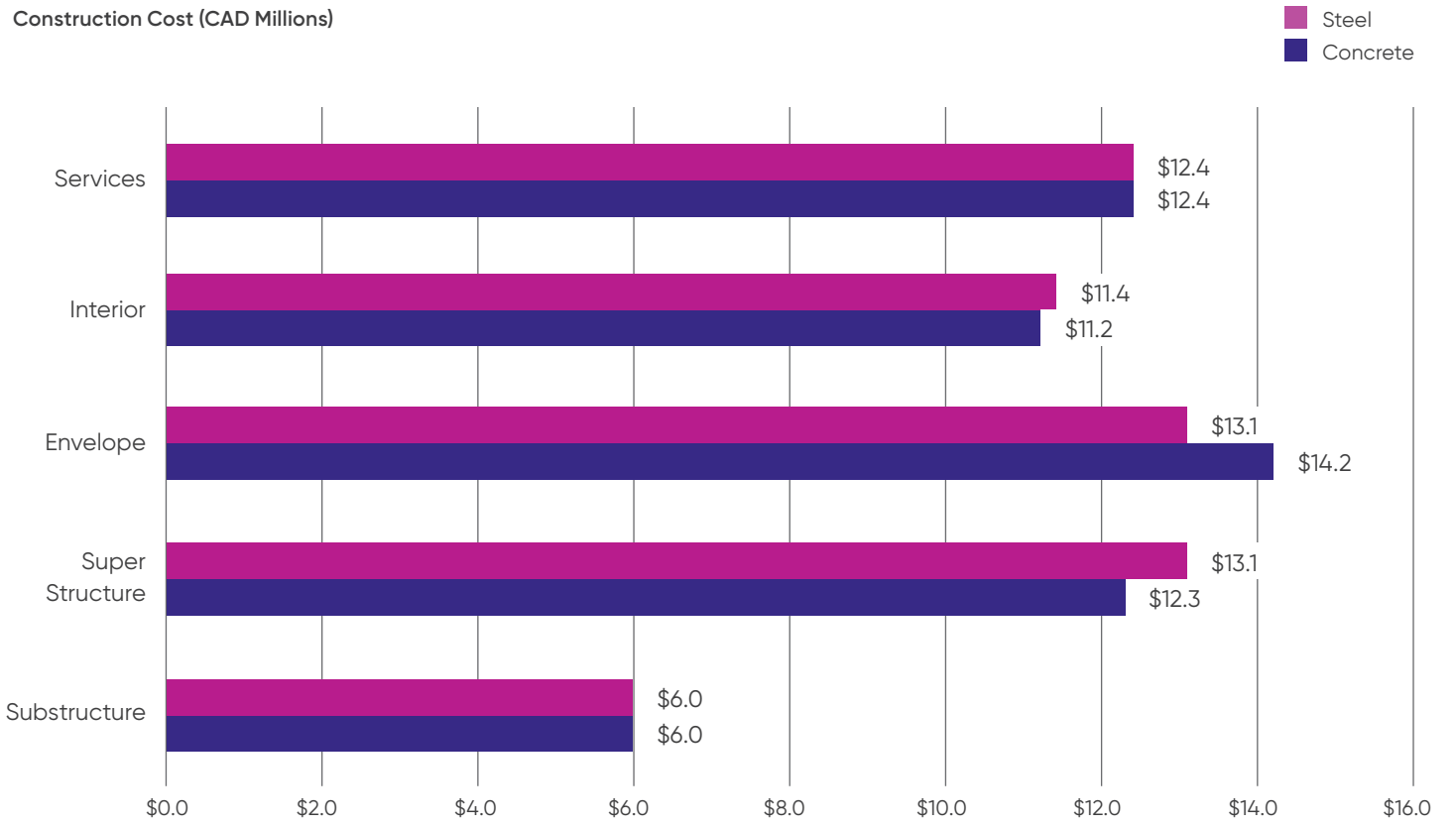
- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing
- 09 - Finishes

Tally® LCA Results



Financial Results

The Altus Group provided a full detailed cost estimate* of the concrete and steel-based designs. Overall, both designs were comparable in net construction costs with the concrete based design totaling $56.1 M and the steel-based design totaling $55.9M.



*Class D Indicative Estimate

Construction Schedule

Construction schedules were developed by MPA Project Consulting. No significant differences were observed in the construction schedule between the two designs. Estimate assumed an 8-hour workday and was based on average working time required for key activities including but not limited to: concrete casting, slab installation, decking, wall panels and member installation.

	Steel	Concrete
Structure	234	232
Façade	280	273
Overlap	-99	-93
Total	**415**	**412**

Conclusion

In this Steligence® case study, the two 12-storey residential designs were comparable in total net construction costs and construction schedule. The steel-based design had an overall lower environmental impact when compared to concrete.

While there was limited financial advantage, the sustainability of steel construction was clear with a 15% reduction in GWP, the equivalent of removing 220 vehicles from the road. Steel should be the top design choice as the building industry aims to reduce its carbon footprint in not only high-rise buildings, but office, mid-rise and Passive House as shown in other Steligence® case studies from ArcelorMittal.

Steel construction had GWP reduction of

15%

XCarb™

Towards carbon neutral steel

XCarb™ is ArcelorMittal's 'towards carbon neutral steel' transformation programme. It brings together all of the company's reduced, low and zero-carbon steel products, processes and technologies, innovation projects, initiatives and alliances in one single-minded effort to make the changes needed to get our organisation and our industry to carbon neutrality by 2050.

ArcelorMittal's objective is to be the steel company of the future. XCarb™ will play a key role in that.

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