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Steel the Show: Understanding the Potential for Steel Reuse in Canada

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The construction industry is one of the largest generators of waste globally. Canada alone produces over four million tons of construction, renovation, and demolition waste (CRD) every year. As an industry, we are beginning to recognize that a traditional linear model, where resources are used and discarded at the end of its life, is simply unsustainable. This is driving a shift towards a circular economy approach which takes on a regenerative framework that focuses on extending material life and minimizing waste through reuse and recovery. Within construction, this implies focusing on strategies that divert waste from landfills by reclaiming building materials and reintegrating them into new construction.

Within the circular economy framework, there are several waste management strategies. The two most common ones are reuse and recycling. While these terms are often conflated, they have different implications. In the waste management hierarchy, reuse is placed above recycling as it entails using materials or objects in their original, or close to original form, whereas recycling involves remanufacturing materials into new secondary products. From an environmental perspective, recycling consumes more energy (e.g., steel is melted in an electric furnace), making reuse a more preferrable approach. In fact, studies find that reusing steel can reduce greenhouse gas emissions by 75%.

Rationale for Steel. Among the various materials used in building construction, steel presents itself as an ideal candidate for reuse. Steel is a strong, durable material with high structural integrity. It is also an engineered component that is amenable to disassembly, lending itself to reuse. Apart from the environmental benefits of reusing steel as previously mentioned, reused steel can also help reduce material costs for projects, with its price being 50-75% the cost of new steel.

The Steel Reuse Process. The reuse process involves four key stages: design, deconstruction, inspection and material testing, and fabrication for new construction.

- **Design Stage**: At the design stage, early commitment from all stakeholders is critical for integrating reclaimed steel. This includes alignment between architects, structural engineers, contractors, and clients. Designs must also meet the building code requirements of each location. For example, in British Columbia, reclaimed steel is expected to meet the same standards of new steel when being integrated in new construction (*CSA S16: Design of Steel Structures*).

- **Deconstruction**: unlike demolition, deconstruction is the process of selectively taking apart a building with the goal of maximizing reusable streel lengths. Contractors need to provide special care to minimize damage to steel components during deconstruction, especially for components that are lightweight and more vulnerable. Once salvaged, steel components are labelled and removed from the site.

- **Inspection and Material Testing**: A structural engineer or an independent testing agency will inspect the reclaimed steel to evaluate the condition and overall structural characteristics before reusing. In addition to visual inspection, components may also need to undergo material testing to determine mechanical properties. Some common testing methods include coupon testing and ultrasonic testing.

- **Fabrication and New Construction**: Steel components go to a fabricator for cleaning where it is sandblasted and stud projections are removed. Components are then refabricated with bolt connections to support future deconstruction. The steel is painted and delivered to the new site, where it is inspected once more. The components that don't meet the criteria for the new design are sent for recycling.

A Canadian Case Study. A key example of structural steel reuse in Canada is in the renovation of Canada's Parliament Building, Centre Block. A study by Bennet and colleagues evaluated the use of a technological tool to support reclaimed steel integration. They created a digital inventory of salvaged beams and an inventory of the required or "target" sections in the new design. Inputting this information into a computation design tool developed by WSP engineers allowed the team to match salvaged beams that had the specifications that matched the target sections in the new design. The reuse of structural steel in the project was estimated to save 625 tons of CO2 equivalent carbon emissions and was also cost neutral.

Despite its great potential, steel reuse industry in Canada still faces many challenges. Major barriers include the complex and costly process of deconstruction, lack of storage space for reclaimed materials, and ambiguous procurement processes.

Complexity of Deconstruction. Deconstruction is inherently time-intensive and costly as it requires careful handling and skilled labor. The fact that the current building stock in Canada wasn't designed for disassembly, further complicates the process. Negative perceptions around the use of reclaimed materials in new construction led the industry to undervalue the potential for reuse and have lower preference for deconstruction.

Providing economic incentives such as tax credits for deconstruction and procuring reclaimed materials can help create a business case for reuse. Developing guidelines and protocols for designing with reclaimed steel can also help build confidence and provide clarity for building with reclaimed steel. Governments should also take the lead in showcasing success stories to normalize reuse and demonstrate its value.

Lack of Storage Facilities. Without proper hubs for storage, reclaimed components remain on sites for longer times, potentially leading to project delays. Governments should take the lead in securing land that can be turned into warehouses for storing reclaimed materials.

Uncertainty in Material Procurement. The absence of a centralized inventory for reclaimed components presents challenges for structural engineers and designers when trying to source the steel sections with the appropriate specifications for a project. The lack of detailed images and representation of reclaimed materials adds to the difficulty of identifying suitable components.

Developing digital platforms that list available materials with pictures and specifications can facilitate material procurement. The website can also detail ongoing construction and upcoming construction projects to help match demand and supply. 3D scanners can be installed in material hubs to help capture visual representations of reclaimed materials to reduce the labor required to manually categorize items. When these infrastructural solutions are not available, forming working groups and building strong networks between contractors and designers can be crucial for ensuring smooth procurement. Recently, the introduction of a new "reclaimed materials procurement consultant" role highlights the potential for having a dedicated person for material sourcing.

Next Steps. Canada should focus on making reuse cost competitive, aligning demand and supply, and learning from international examples to build a more robust steel reuse industry. In particular, the UK serves as a strong example with their more established steel reuse industry that Canada can learn from. For example, the UK's Steel Construction Institute published the *Structural Steel Reuse Assessment, Testing and Design Principles* protocol (SCI P427) aimed to facilitate the widespread uptake of structural steel reuse, that the Canadian Standards Association take inspiration from. Canada would also benefit from more residential case studies, as existing steel reuse case studies in Canada are only available for industrial and commercial buildings. The BedZED case study, a mixed-used housing and workspace project in London, which incorporated material reuse can be an excellent case to learn from for Canada.

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