Promoting Circularity of Building Materials through Novel Structural Systems for Adaptive, Deconstructable Hybrid Steel-CLT Designs

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Potential Topics: Design for Remanufacturing & Recycling for the Circular Economy; Building a Sustainable Circular Economy for Materials & Products

Abstract

Concrete and its steel reinforcement account for up to 50% of the embodied carbon emissions in typical high-rise commercial buildings. Replacing concrete floors with cross-laminated timber can lead to dramatic reductions in embodied carbon, and these reductions can be extended further if steel and CLT elements can be recovered, potentially recertified, and reused in another structural application. Vibrations and noise travel more easily through lightweight timber diaphragm floors compared to concrete slabs. These vibrations are typically reduced by pouring 1-2" of concrete on top of mass-timber floors, which impair the adaptability of the floor-diaphragm systems for deconstruction and reuse. The challenge is to design a system of connections and floor assemblies that provides the requisite structural performance, adherence to Type IV-B building codes for vibration, acoustics, and fire, while still enabling deconstruction and circularity of the structural materials.

This submission will present an innovative design strategy for deconstructable, carbon storing buildings that can enable large-scale uptake of CLT into steel-framed commercial projects. Attendees will learn about the engineering and architectural challenges in designing hybrid steel-CLT buildings without typical concrete toppings, and how the proposed design uses novel connections that allow for rapid deconstruction that reduces costs associated with building material reuse. We will also cover the functional structural performance achieved by utilizing high-strength bolted connectors in steel-CLT hybrid structures, supplemented by experimental tests results, and how these results can be used to support major changes to code requirements that would enable deconstructability of an important class of buildings where it is currently rarely done. Finally, the presentation will guide attendees through the environmental benefits of this approach through application of life cycle assessment, but using a dynamic accounting framework that reveals that CLT must stay in use for more than 60 years in order for

the prototype building to achieve net zero embodied carbon, either in the original building or reused in a new structure.