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Control of building sway and force flows using ultralightweight slabs
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Abstract
Design analyses are presented to demonstrate the technical advantages of substituting ultralightweight slab materials like cross-laminated-timber (CLT) for reinforced concrete (RC) floors and roofs of low-rise and high-rise hybrid building superstructures. Such substitution reduces the gravitational masses of slab by at least two-thirds without reducing functionality as bending or diaphragm slabs. Specific illustrations of design impacts of using CLT are given for hybrid building superstructures where steel or RC frameworks are the primary means of resisting effects of gravity forces associated with occupied built spaces. Results shown apply to two-story buildings in which effects of lateral forces associated with wind or seismic loads are resisted entirely by a steel moment framework, and six- and twenty four-story buildings in which RC shear walls within building cores primarily resist effects of such lateral loads. Consideration is also given to how fire engineering design decisions can impact structural performances of high-rise buildings incorporating combustible slab materials like CLT. The possible fire design solutions considered being complete encapsulation of CLT slabs using noncombustible claddings, and inclusion of RC fire floors vertically separating the superstructure into fire compartments having dimensions typically permitted for combustible construction. In the broad sense, analyses presented here suggest that it is feasible to reduce total gravitational and modal masses of superstructure by at least one-third, with concomitant reductions in superstructure and foundation construction costs. In practice engineers can have many types of lightweight slab construction techniques to choose from, apart from using CLT. Approximate percentage reductions in sway and superstructure force flows quoted herein will scale in proportion to the square-root of the ratio of the masses of RC floor slabs to masses of any substitute floor construction. © 2014 American Society of Civil Engineers.

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