Structural behaviour of hybrid floor systems: cold-formed steel and sustainable floorboards

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Hybrid floor systems comprising steel beams and wood-based floorboards are increasingly being considered for sustainable construction [1]. To explore the capacity of such systems, a parameterised 3D finite element model is presented for analysing the performance of hybrid flooring systems comprising cold-formed steel and various engineered bio-based products under bending loads (Figure 1). Results are validated against experimental data available for flooring systems in the literature [1].

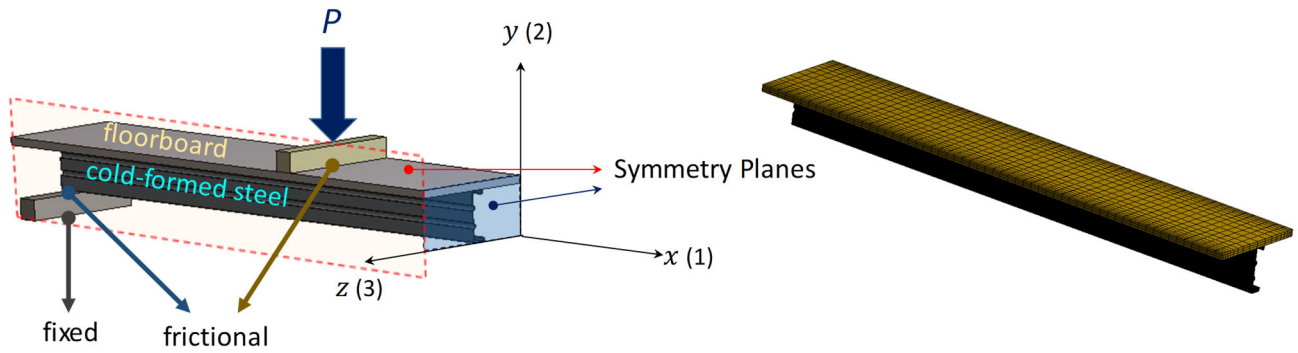

Figure 1: Composite floor system half-model under four point bending load. Symmetric boundary conditions have been applied to reduce the computational time and to increase the efficiency of the simulations.

The potential use of several engineered wood products including OSB, LSL, LVL and Laminated Bamboo in constructing hybrid floors systems is discussed in terms of their estimated ultimate moment capacity and through-thickness strain distribution once subjected to bending moments. The results provided insights into the usage of various sustainable engineered board products in novel composite floor systems and the importance of their elastic constants in addition to steel mechanical properties. The orthotropic elastic constants of wood and bamboo products are found to be important in describing the performance of such systems. Additionally, the connection between floorboards and cold-formed steel beams is shown to have significant effect on the local strain fields and the onset of failure in the studied composite floors. Comparing the predicted ultimate moment capacity (kN.m) of various composite floor systems with partial connections (practical case) highlights that by replacing PB with Laminated Bamboo, LVL, and LSL, the ultimate moment capacity of composite floor systems can be improved by 6%, 5% and 3.5%, respectively (see Table 1). No significant increase was observed for OSB due to the very low out-of-plane shear modulus (G_{23}) of OSB (170 MPa) compared to PB (958 MPa).

Table 1 : Predicted ultimate moment capacity (kN.m) of various composite floor systems. The board thickness and dimensions are the same for all systems

Connection System	Engineered Board Product				
	PB	OSB	LSL	LVL	Laminated Bamboo
No connection	40.6	40.6	41.6	41.6	41.8
Partial connection	47.8	48.0	49.5	50.3	50.5
Full connection	75	77.8	78.1	78.0	78.5

References

[1] P. Kyvelou, L. Gardner, D.A. Nethercot: Testing and Analysis of Composite Cold-formed Steel and Wood-based Flooring Systems. *Journal of Structural Engineering,* 143(11), 1-16, 2017.

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