CLT-concrete-composite floors: serviceability considerations

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Alaska (USA)
Arctic Circle
Beaufort Sea
Melville Island
Banks Island
Victoria Island
Prince of Wales Island
Inuvik
Dawson
Yukon
Great Bear Lake
Whitehorse
Northwest Territories
Nunavut
Yellowknife
Baker Lake (Qamanittuaq)
Great Slave Lake
Pacific Ocean
Fort Nelson
British Columbia
Hecate Strait
Vancouver Island
Prince George
Vancouver
Kamloops
Fort McMurray
Lake Athabasca
Alberta
Edmonton
Saskatchewan
Churchill
Reindeer Lake
Manitoba
Lake Winnipeg
Winnipeg
Hudson Bay
Kuujjuaq
Smallwood Reservoir
Réservoir de Caniapiscau
Churchill Falls
Labrador
St. John's
Newfoundland
James Bay
Réservoir Robert-Bourassa
Sept-Îles
Gulf of St. Lawrence
Saint-Pierre and Miquelon (France)
Sandy Lake
Quebec
Charlottetown
Prince Edward Island
Fredericton
Lake Nipigon
Ontario
Québec
Halifax
Thunder Bay
Montréal
Nova Scotia
Ottawa
New Brunswick
Lake Superior
Toronto
Lake Michigan
Lake Huron
Lake Ontario
Lake Erie
Atlantic Ocean
Regina
Kamloops
Other locale
Scale
0 250 500 750 1 000 km

Light-frame and –often also– mass-timber floors suffer from a variety of building-physics shortcomings.

This presentation discusses serviceability considerations and shear reinforcements of Timber-Concrete-Composite (TCC) systems.

Credit: Structurecraft

Structural Performance

- Higher bending stiffness and strength
- Higher shear stiffness and strength
- Improved vibration characteristics

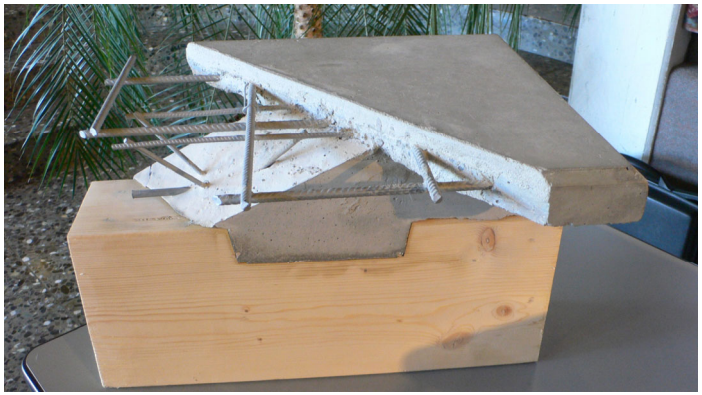
Building Physics Performance

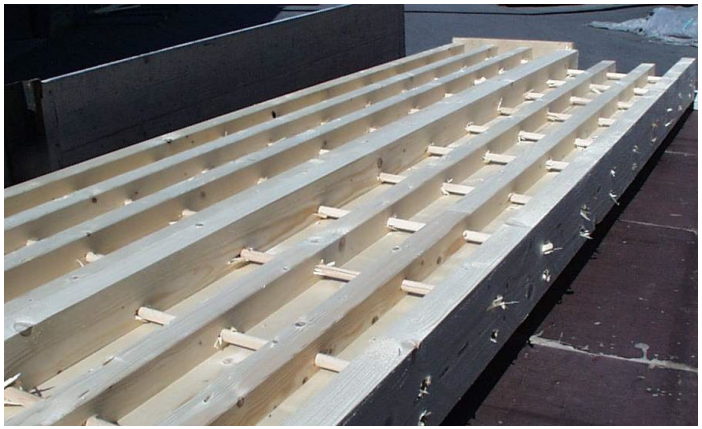
- Improved fire resistance
- Improved sound insulation
- Increased thermal mass

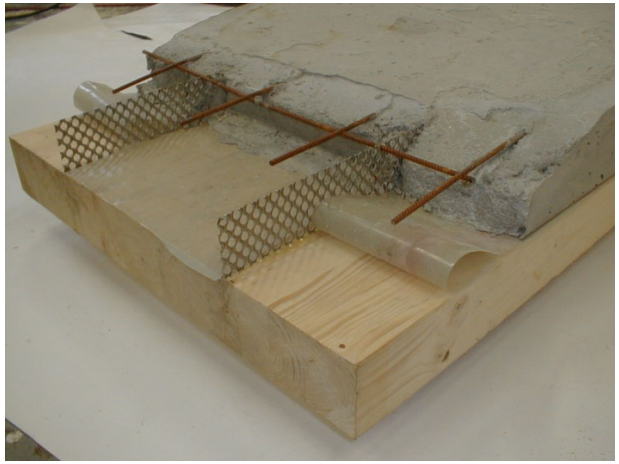
TCC systems can be applied in new construction, rehabilitation of existing buildings as well as for small and large bridges.

Challenges that limit TCC construction are lack of design standards, high cost and uncertainties about serviceability performance.

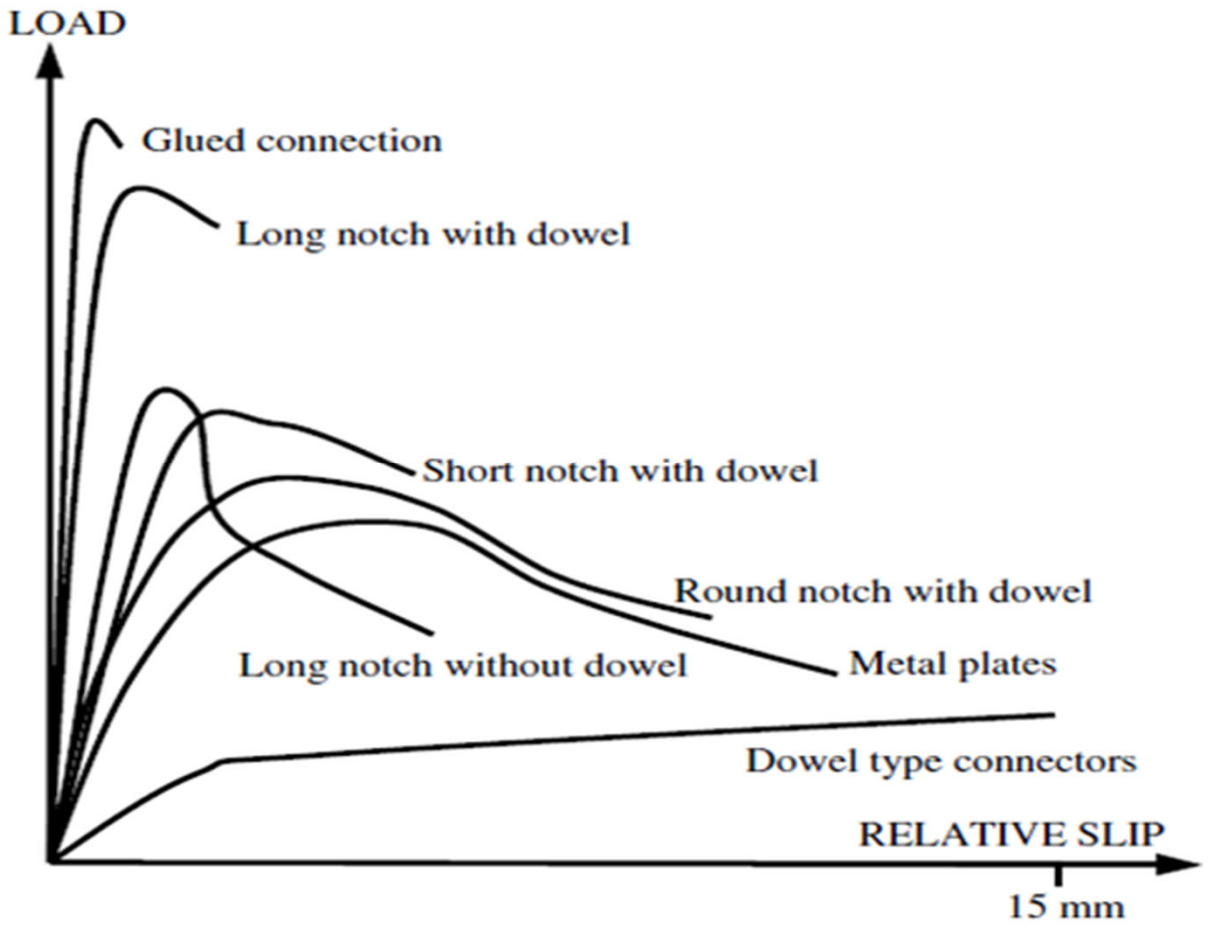
TCC systems can be categorized into being connected through contact interlocking, mechanical fasteners, and adhesive bonding.



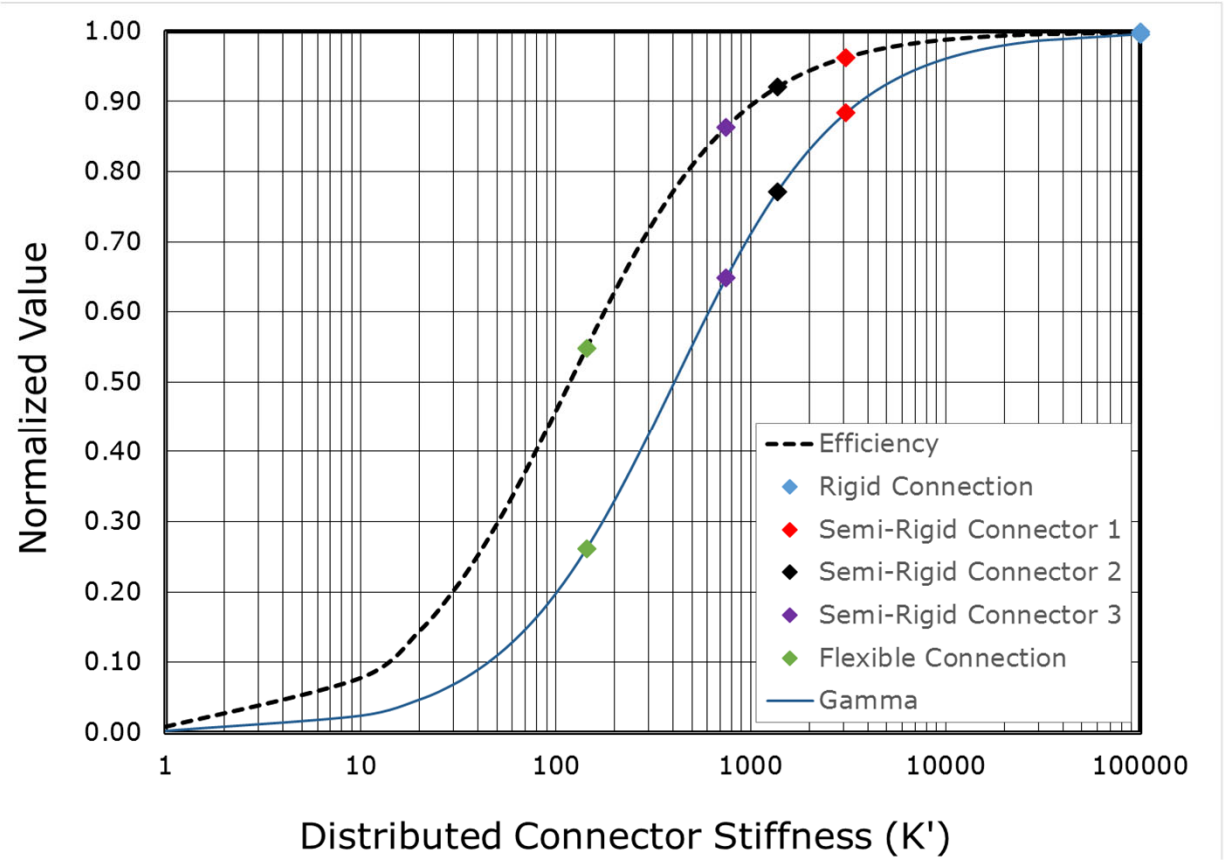




The choice of connector has a significant impact on system stiffness.

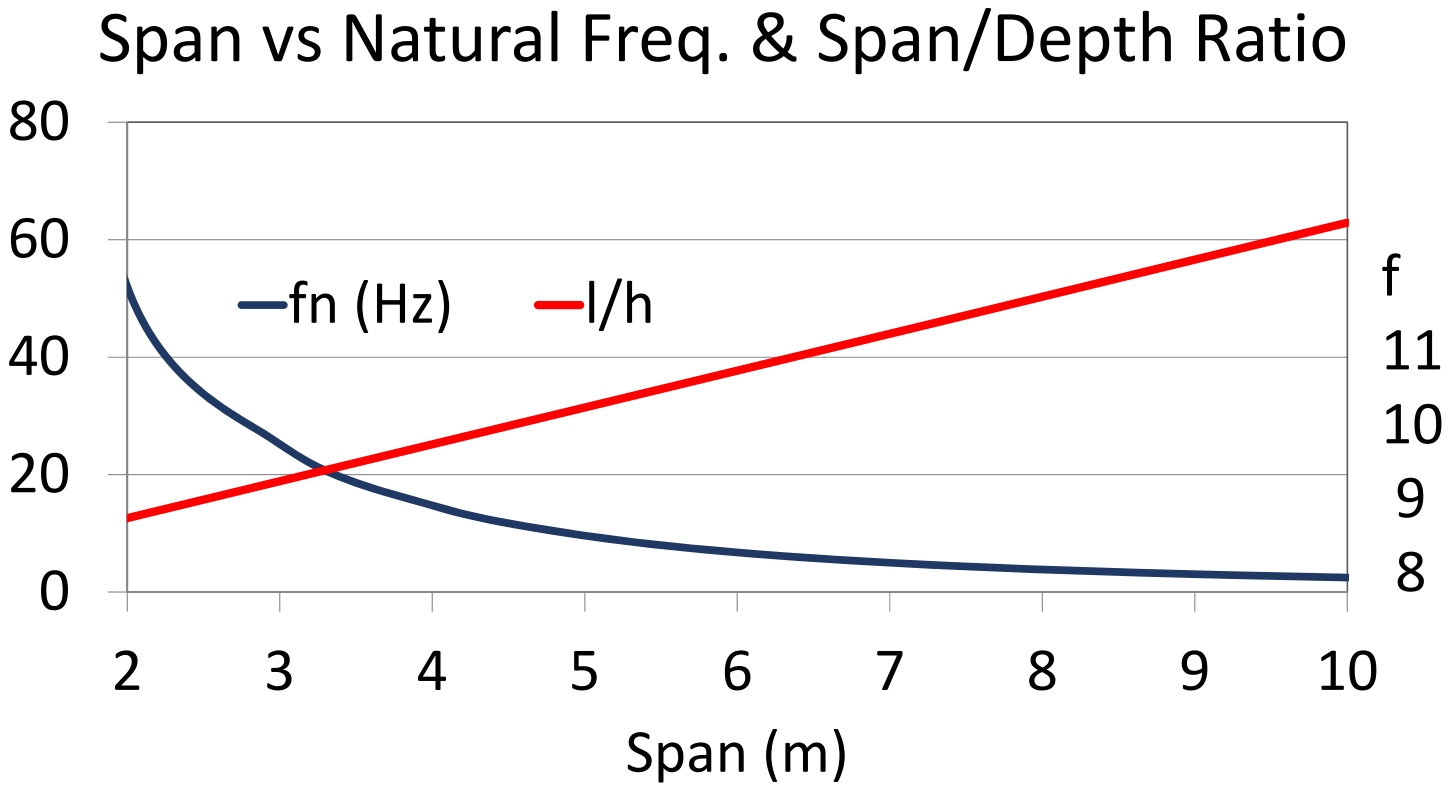


The connector stiffness impacts composite efficiency – mostly in the lower range of stiffness!

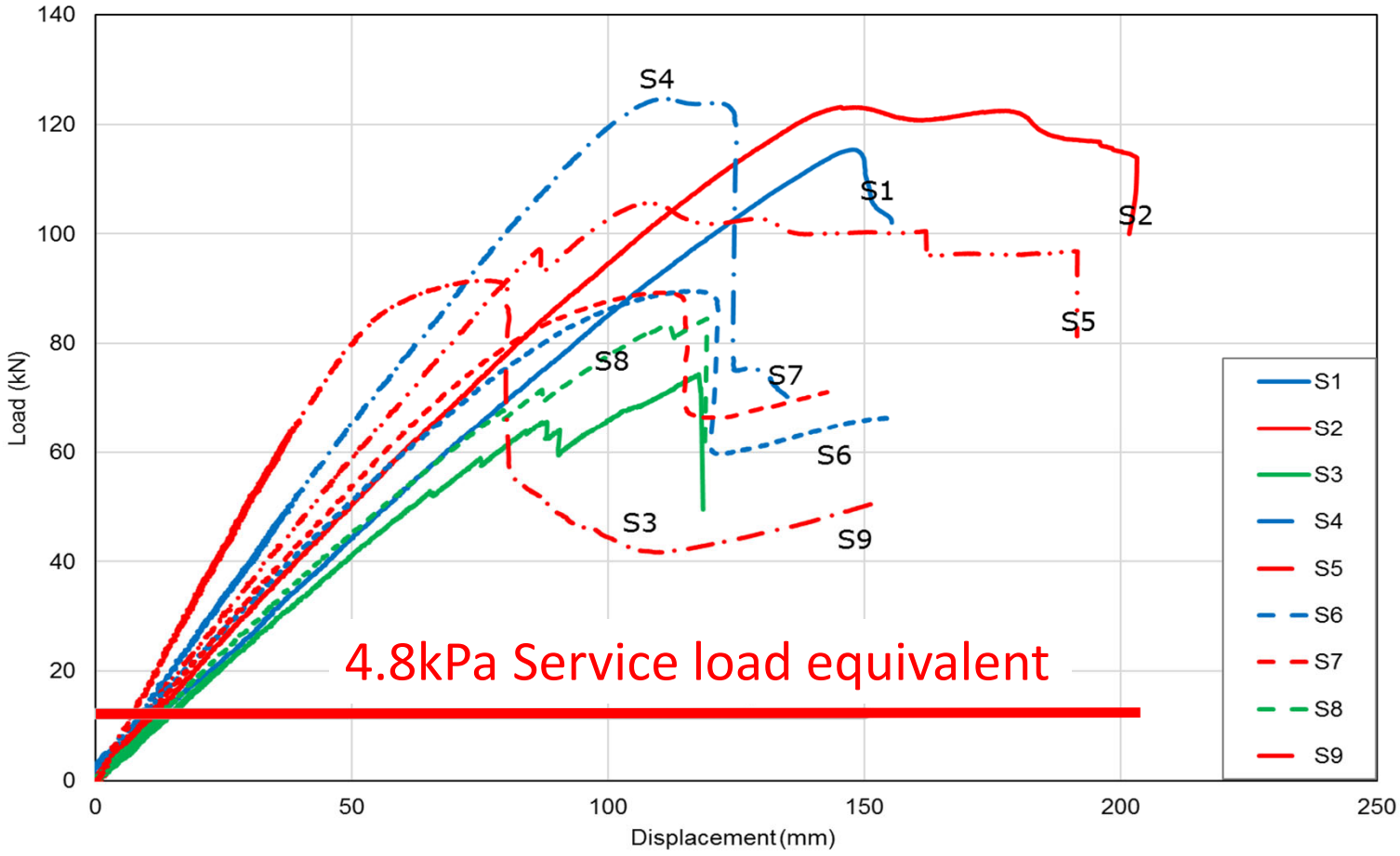


$$\text{Efficiency} = \frac{D_N - D_I}{D_N - D_C}$$

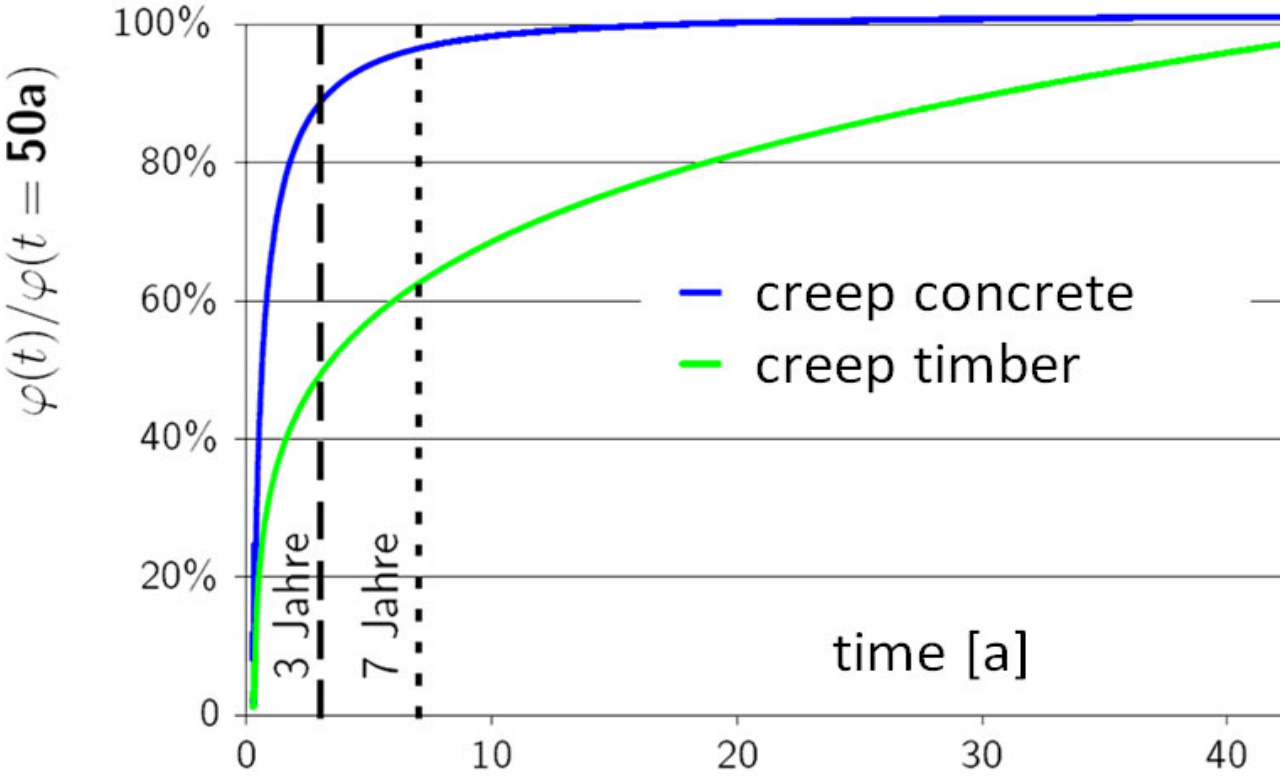
The design of typical TCC floors is governed by SLS considerations.



The ultimate load-bearing capacity of typical TCC floors is multiple times above the design service load.



The long-term behaviour of timber and concrete is different and the connector long-term performance is often unknown!



EC5 proposal

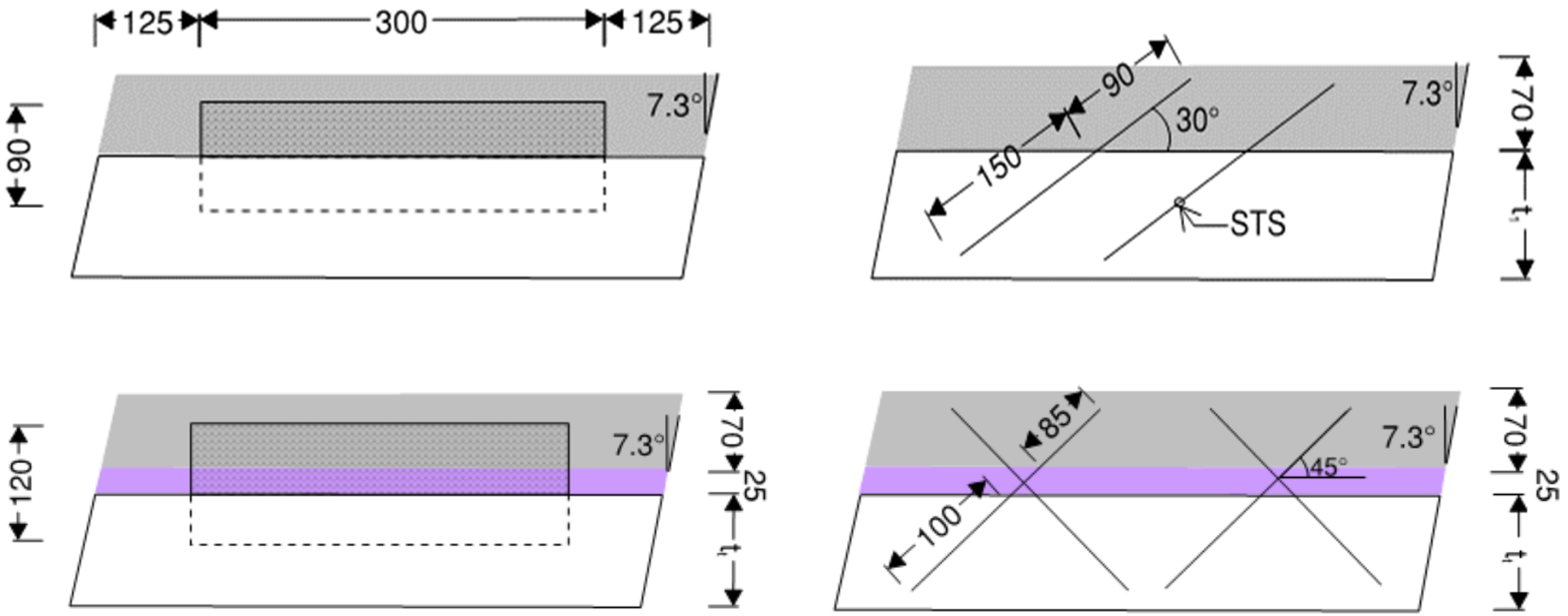
$$E_{\text{conc,fin}} = \frac{E_{\text{conc}}(t_0)}{1+\psi_{\text{conc}}\,\varphi(\infty,t_0)}$$

$$E_{\text{tim,fin}} = \frac{E_{\text{tim}}}{1+\psi_{\text{tim}}\,k_{\text{def}}}$$

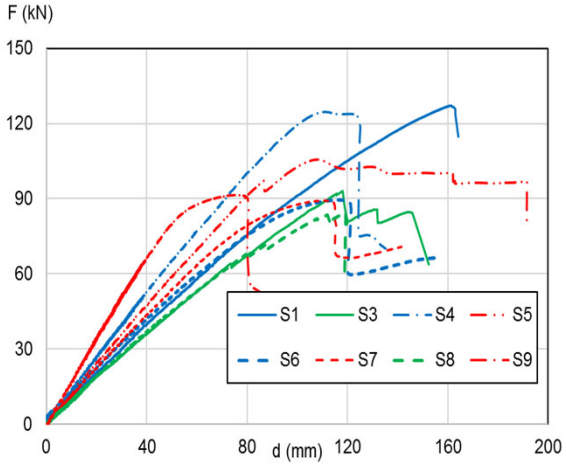
$$K_{\text{ser,fin}} = \frac{K_{\text{ser}}}{1+\psi_{\text{conn}}k_{\text{def}'}}$$

$$K_{u,fin} = \frac{K_u}{1+\psi_{\text{conn}}k_{\text{def}'}}$$

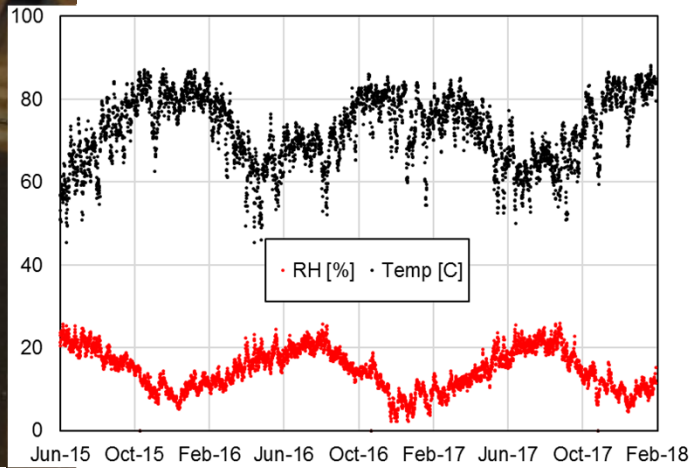
Multiple TCC systems with mass-timber panels were studied.



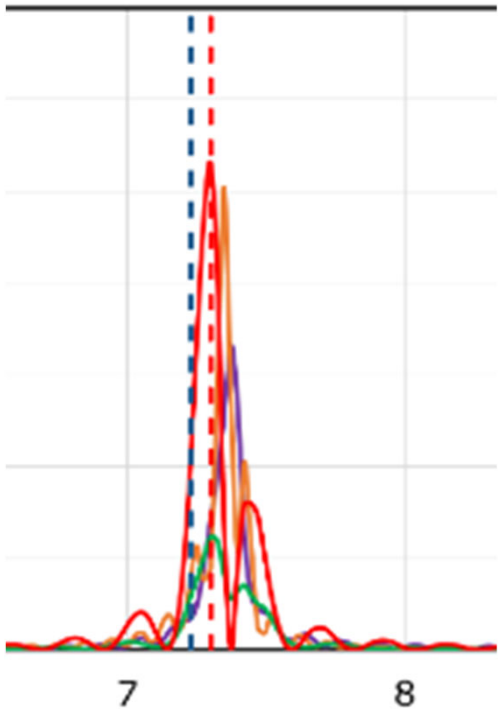
Short-term testing was conducted.



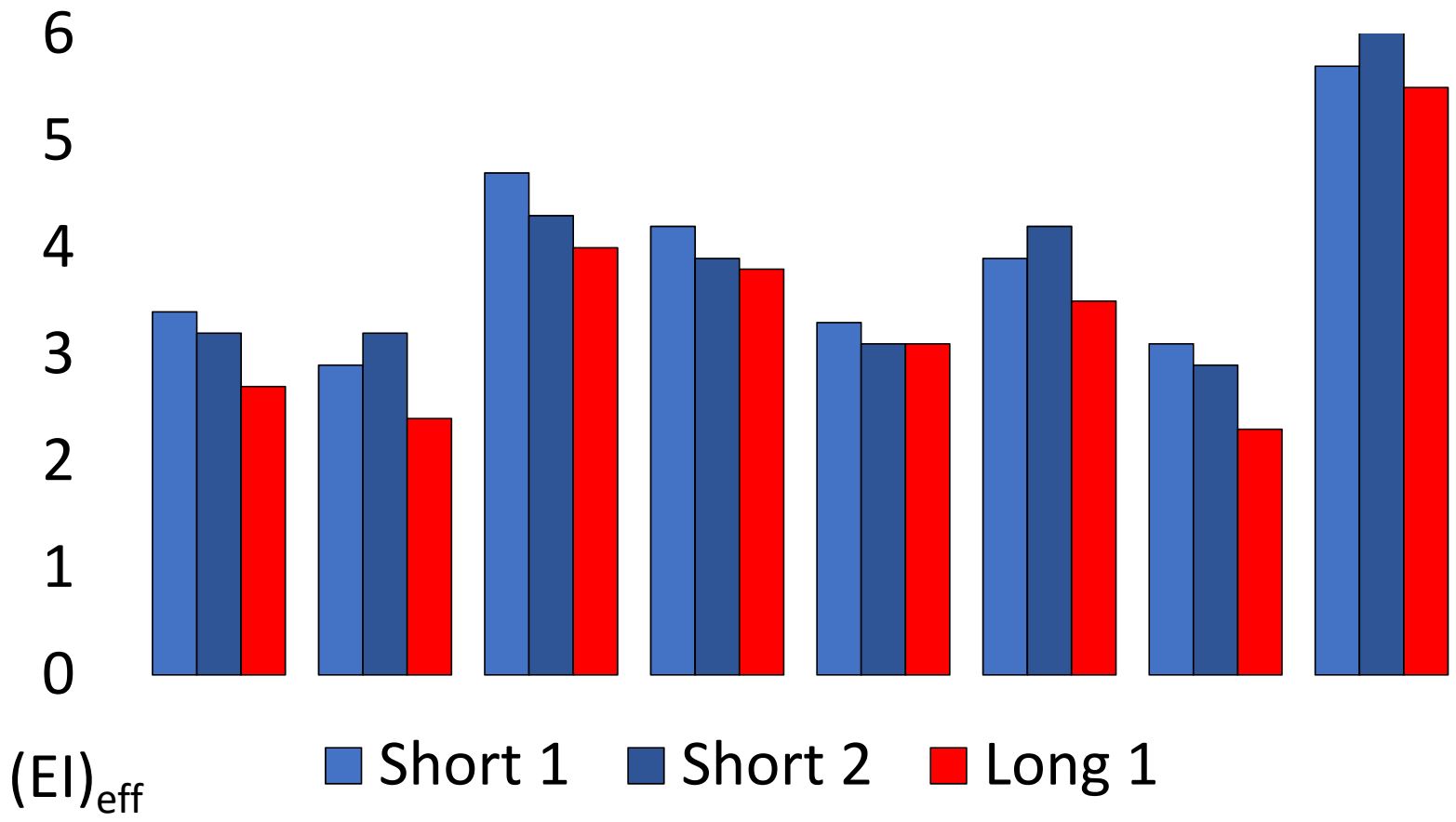
Long-term testing was conducted.



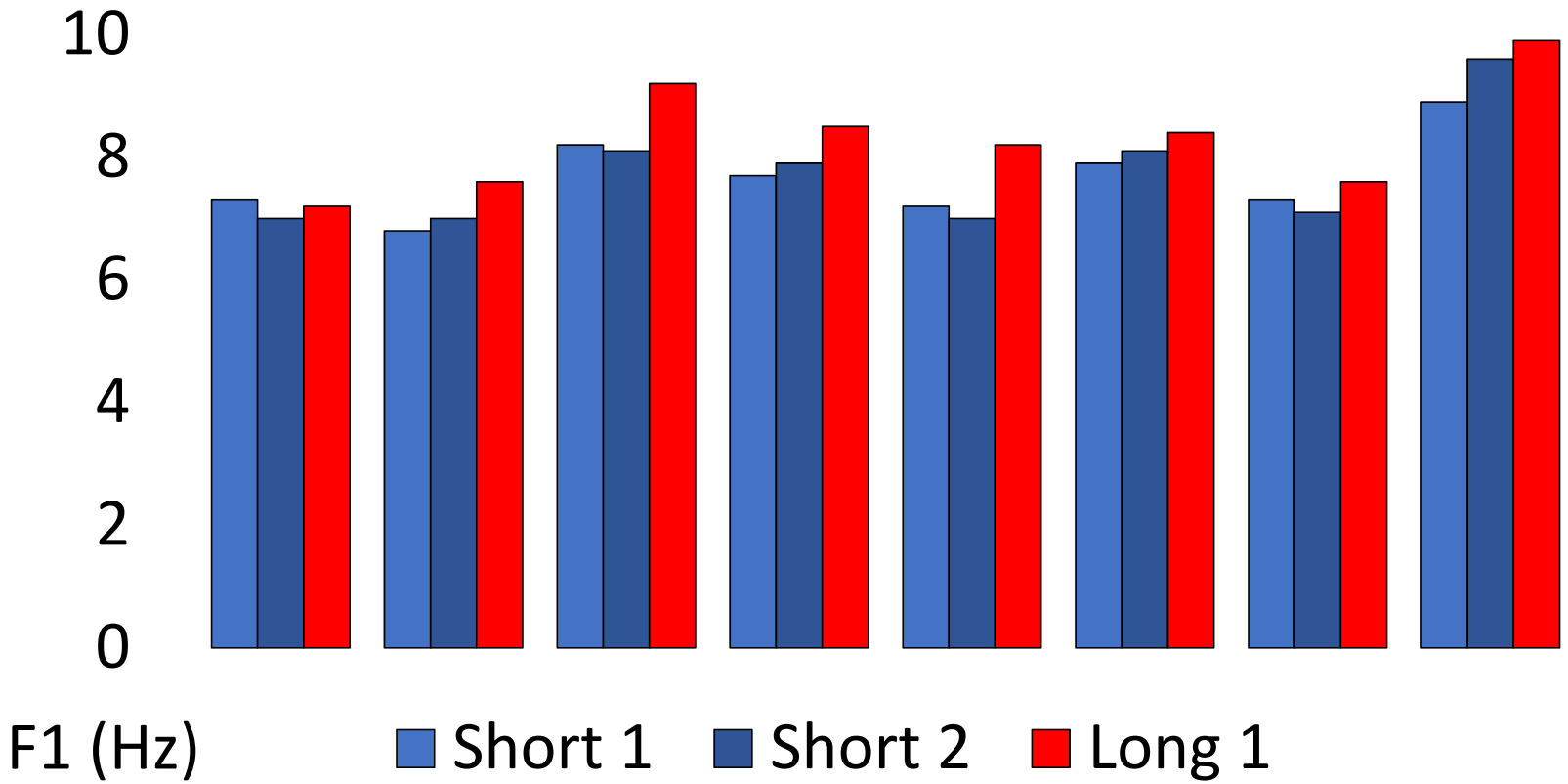
Vibration testing was conducted.



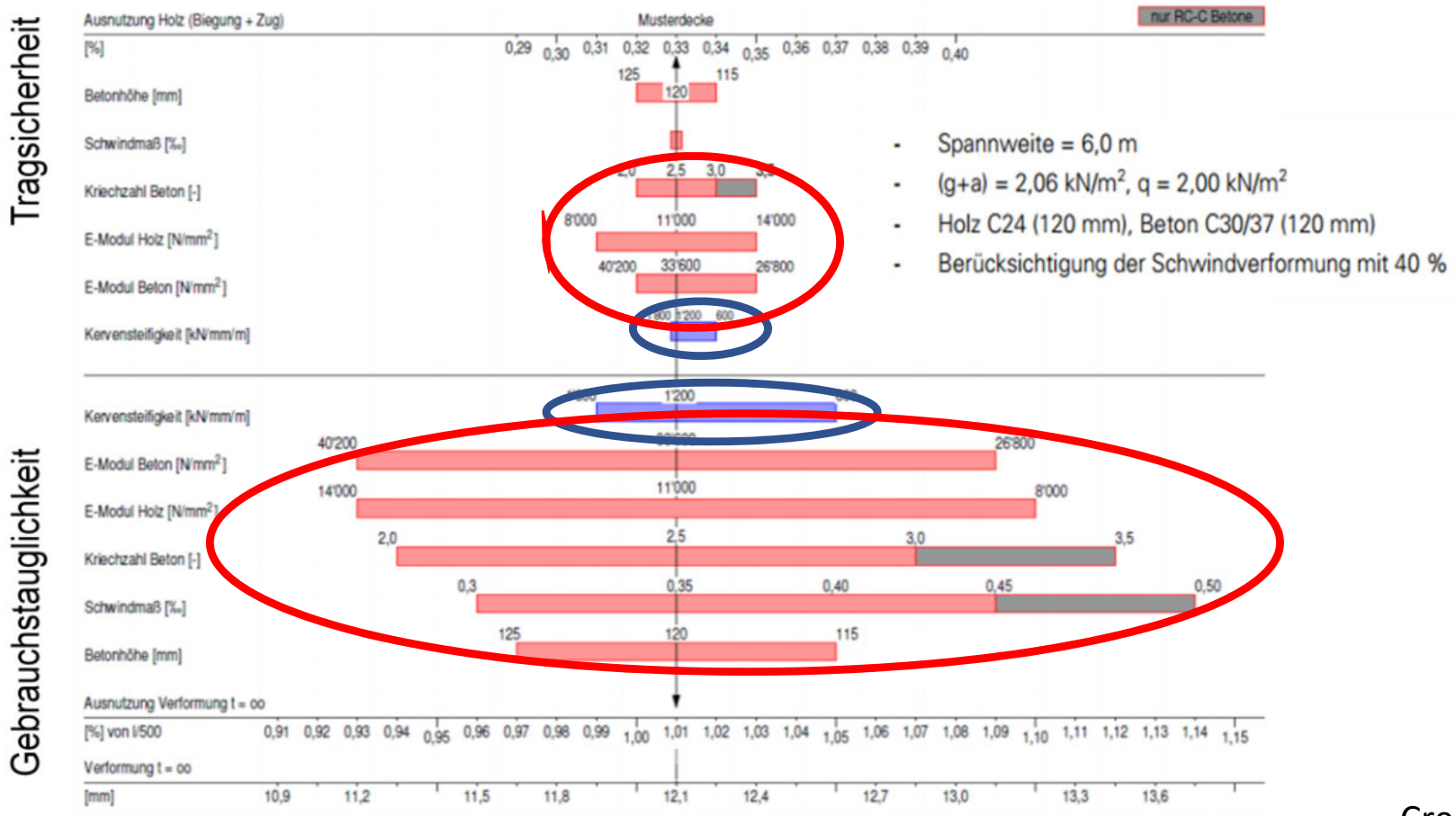
Long-term testing did not decrease effective bending stiffness.



Long-term testing led to small increases in fundamental frequency.



Material parameters have a significantly larger impact on capacity and deflection than connector stiffness.



Credit: Pirmin Jung

The ‘Arbour’ for George Brown College in Toronto, designed by oriyama/Teshima Architects & Fast+Epp features 9m span TCC.