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A NOVEL SUB-STRUCTURING METHOD FOR EFFICIENT FE ANALYSIS OF TALL SLENDER BUILDINGS

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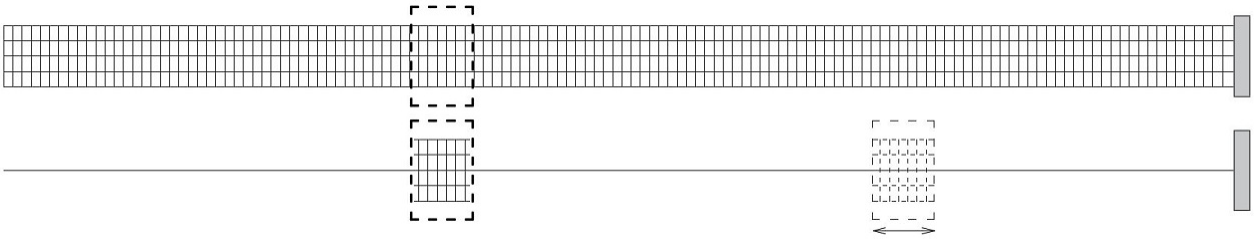
The ambition to construct tall buildings continues. To-date, 19 buildings have been completed which are over 400m high. Five of those buildings have a slenderness ratio of 10:1 (height:base width) or greater. The building illustrated below has over 8k beam and column elements (20k+ DoF). Detailed finite element analysis of structures such as these can be computationally expensive. This paper presents a suite of methods that can be used to save computer run-time in the analysis stages.

Using an existing FEA framework (based on CALFEM, [1]) we have introduced (i) a Master-Slave approach (tying DoF together to simulate rigid membrane action of the floors), (ii) shell elements for the concrete cores and (iii) more importantly for this paper, a sub-structuring *super-element* methodology [2] whereby only part of the building is modelled in detail. This note describes the *zoom-in* approach whereby an engineer can rapidly analyse and examine different domains (typically blocks of 5-10 floors) within the overall structure. This reduces the stiffness matrix very significantly. The memory and run-time savings are reported in some detail. The developed numerical analysis library produced allows sub-structures (specifically tailored for tall buildings; for example outriggers and stiff truss floors) to be introduced easily, such that an engineer can explore the consequences of different design options.



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[1] Austrell P-E *et al.*, CALFEM, A Finite Element Toolbox version 3.4.

[2] Wilson, E L, The static condensation algorithm, *Int. J Numer. Meth. Engrg*, 8, 198-203, 1978.