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Numerical study of racking resistance of timber-made double-skin façade elements

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ABSTRACT

The use of a double-skin façade (DSF) is a quite new approach in the building renovation process, complementing conventional renovation strategies. A double-skin façade is an envelope wall construction that consists of two transparent surfaces separated by a cavity and can essentially improve the thermal and acoustic resistance of the building envelope. The main double-skin wall components are usually composed of a hardened external single glazing pane and a double or triple thermal insulating internal glass pane, which are connected to the frame structure. Recently, many studies have analysed the thermal and acoustic performance of DSF elements, but almost none in terms of structural behaviour, especially in terms of determining the racking resistance of such wall elements. Moreover, with a view to reduce the global warming potential, an eco-friendly timber frame instead of a commonly used steel, aluminium or plastic frame is studied in this analysis. However, structurally combining timber and glass to develop an appropriate load-bearing structural element is a very complex process involving a combination of two materials with different material properties, where the type of bonding can be selected as a crucial parameter affecting the racking resistance range. Since the costs of experiments performed on such full-scale DSF elements are very high and such experiments are time-consuming, it is crucial to develop special mathematical models for analysing the influence of the most important parameters. Therefore, the main goal of this paper is to develop the finite element mathematical model of the studied DSF structural elements with a highly ecological solution by using a timber frame. In the second step, the developed model is further implemented in the numerical analysis of racking stiffness and followed by a comprehensive parametric numerical study on different parameters influencing the horizontal load-bearing capacity of such DSF timber elements. The obtained results indicate that the new approach of the developed load-bearing prefabricated timber DSF elements can essentially improve racking resistance and stiffness compared with the widely studied timber-glass single-skin wall elements and can thus be fully recommended especially in the structural renovation process of old buildings.

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