Development of a collapse analysis method for timber houses based on the finite element method considering the expansion of plastic regions

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Timber houses, which have been common in Japan, are gaining attention these days due to increasing environmental awareness. However, the strength of such houses is relatively low, and given Japan's frequent earthquakes, there is a strong need to develop a strategy to assess the earthquake resistance of timber houses.

The core of the strategy will include a simulation technology that predicts the collapse behaviors of timber houses during earthquakes, on which there is already some research. Nonetheless, most studies are based on the discrete element method, which requires a complicated parameter identification process to build a model. This method is also unable to determine elastic and plastic regions in each timber beam, limiting the details of the analysis.

Under these circumstances, this study developed an elasto-plastic collapse simulation method for timber houses experiencing earthquakes, by combining the ASI-Gauss technique [1] with a novel constitutive law for a timber beam. This technique is one of the finite element methods based on the linear Timoshenko beam element that can handle the collapse behaviors of structures. The constitutive law is based on Iwasaki's work [2] and allows the evaluation of the three-dimensional expansion of the plastic region in a beam. To validate the developed method, the results were compared with data from previous experiments, including the collapses of timber houses.

References

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