Prediction of minimum weight design of 3D steel frame structure from decomposition into 2D frames

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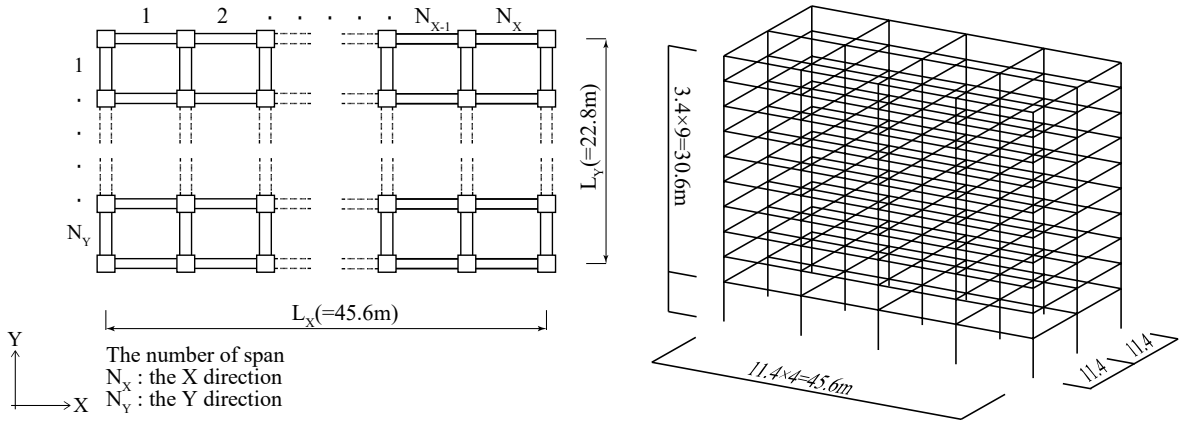
Abstract

Recent increase in computing power enables us to solve realistic, large and complex structural design optimization problems[1]. The minimum steel weight of a 3D frame building structure can be predicted from decomposition into 2D frames[2]. Under conditions, we investigate the prediction accuracy of the decomposition and composition framework, the influence of the initial value dependence on the solution, and control method to decrease the dependence.

In this study, we treat cross-sectional dimensions as design variables. The floor plan of the structure and an example of entire analysis model is shown in Figure 1. Considering structural requirement as constraints for realistic design solutions, it is proposed that prediction of the minimum weight design of a 3D frame structure based on decomposition into and composition from 2D frame. We investigate the characteristics of the optimum solutions and verified prediction accuracy of the minimum weight of the 3D frame. As a reslult, we found variations in flange width and thickness for beam are seen, although 2D frame structures have a low dependence on initial solution in the structural volume. By considering the upper and lower story constraint of the flange width, the initial solution dependence is significantly reduced, and hence the variations are decreased. The difference in the ratio between the prediction structural volume from decomposition into and composition from the 2D frames and the minimum volume of the 3D frame structure is less than 5%, and hence the minimum structural volume of the 3D frame structure can be accurately predicted by the framework.



(a) Floor plan (b) An example of entire analysis model

Figure 1. 3D frame structure

References

[1] M. Ohsaki, *Optimization of Finite Dimensional Structures*, Routledge, 2017.

[2] Y. Lee, S. Yoshitomi, and K. Uetani, "A method for estimating minimum weight of 3D unblaced steel frames using optimal solutions of 2D frames", *Journal of Structural and Construction Engineerind, the Architectural Institute of Japan*, No. 595, pp. 65-71, 2005 (in Japanese).