DS '11 KOBE
International Symposium on
Disaster Simulation & Structural Safety in the Next Generation (DS'11)
September 17-18, 2011, JAPAN

Analytical study on buckling behavior of timber column including Kumimono

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***Keywords*:** *Traditional timber structure, 3-dimensional FEM analysis, Buckling behavior, Kumimono*

SUMMARY

It is said that superior deformation capacity and high damping performance are characteristic of Japanese traditional timber structures and that Kumimono, Kumimono is a kind of traditional timber joint, have an effect on the seismic behavior of traditional timber structures. Generally, Kumimono is manually fabricated by carpenters based on their own knowledge and experience, and is very complex structure. In addition, there are various kinds of Kumimono in Japan. Therefore, it is impossible to reveal the mechanism of seismic behavior for all kinds of Kumimono by load carrying test. In this study, we try to reveal the buckling behavior of existent timber column including Kumimono under dead loading by 3-dimensional analysis based on finite element method (FEM).

First, we simulated the buckling test of timber column with partial cutout by 3-dimensional FEM analysis in order to verify the practical effectiveness of this analysis method for traditional timber structures. LS-DYNA, general-purpose commercial software of 3-dimensional FEM analysis based on dynamic explicit method, is used for this analysis. Solid model of isotropic elasto-plasticity is used for the material properties of zelkova tree. Using the standard value of yielding stress and Young's modulus for the material condition, initial stiffness of analysis is larger than that of test results, but there is not much difference in yielding strength and deformation behavior between analysis and test results. Therefore, good results in simulations can be given by this analytical method.

Next, we conducted the 3-dimensional FEM analysis of existent timber column including Kumimono under dead loading in order to evaluate buckling property. Analysis modeling of Kumimono is made in detail, such as Masu, Keta (beam), Odaruki and Dabo. All parts of Kumimono are modeled separately and contact condition is considered among every part, so sliding and separation behavior among every part can be simulated in analysis. Under dead loading, stress of timber column is much smaller than stress in buckling and large deformation such as buckling behavior doesn't appear. Therefore, it is concluded that buckling of timber column including Kumimono is not happened under dead loading.