Development of Ductile and High-Strength Semi-Rigid Portal Frame Composed of Mixed-Species Glulams and H-shaped Steel Gusset Joints

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Recent in Japan, demands for glulam portal frames to be used in wooden residential houses are increasing. These portal frames are expected to have a function as the structural component, which can sustain not only vertical loads but also lateral load due to wind or/and earthquake load.

Generally speaking, however, portal frame structures are inferior to nailed-on-sheathed shear wall structures in the aspect of strength performance. Thus, in order to develop the glulam portal frames usable in wooden residential house instead of shear walls, it will be most important to improve the strength performance of the portal frames up to the level same as that of shear walls.

By setting this level of structural performance as the target of research & development, we and some company's researcher tried to improve the strength performance of glulam portal frame by paying attentions to the selection of best assembly with materials and connection. Figure 1 shows the combination of the materials and connection. These materials are a mixed-species glulam members, in which relatively low MOE and soft quality Sugi (*Cryptomeria japonica* D.Don) was used for the inner members while high MOE and hard quality Douglas-fir (*Pseudotsuga menziesii*) was used for the outer part of glulam. This connection is steel gusset plate having flanges like H-shape steel member. In the steel gusset plate joint, the load transmission was intended to be done though the stronger laminations by means of steel flanges.

The newly developed portal frames are tested. Testing method and the detail of the materials showed in figure 2. We have 4m and 6m span lengths. As results, figure 3 shows the load-shear deformation angle on the 6m span specimen. It gave a ductile and high-strength semi-rigid glulam portal frame. It can reveal 1.9 shear resistance factor per unit meter, which implies that there is not only an equivalent shear wall having shear resistance factor of 1.96kN times 1.9 allowable strength per unit meter but also an opened space of 6m span.

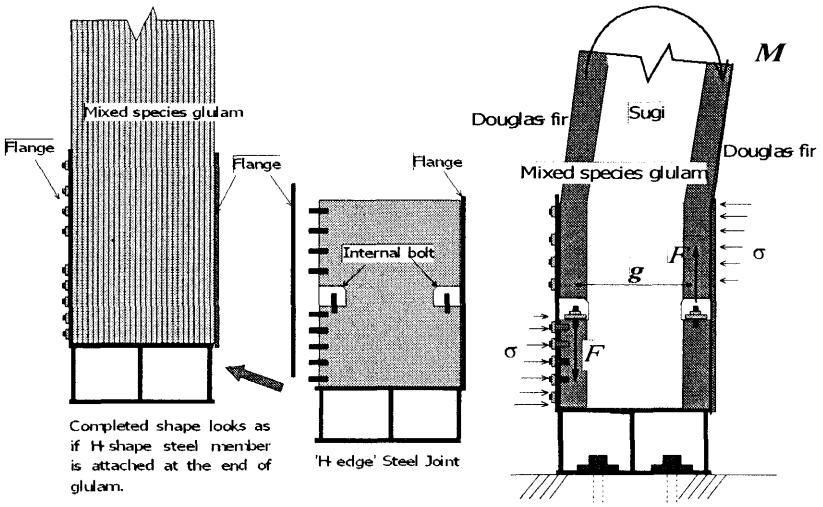

Fig. 1. Best combination of the mixed species glulam and newly developed flange-type steel gusset joint with internal bolts.

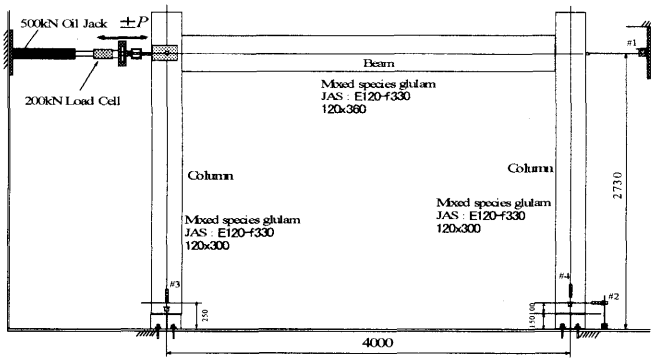

Fig. 2. Test set-up for full-scale glulam portal frame specimen.

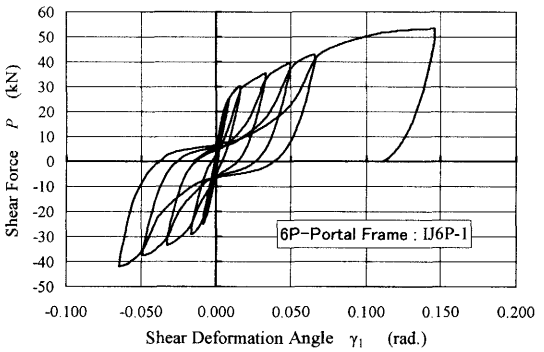

Fig. 3. Example of load (P)-shear deformation angle (γ) for 6P specimen.