Preliminary

Moment-Resisting Performance of Glulam Beam-to-Column Joints Composed of Various Types of Large Finger Joints

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Introduction

Large Finger Joints (LFJ) have been used as an alternative jointing method for large scale glulam frame structures in European countries where earthquake was not dominant contrary to the case of Japan. As LFJ method requires no steel wares, its cost seems to be reasonable compared with conventional mechanical joints. Preliminary test results, however, showed that LFJs had quite poor ductility, so we concluded that this type of glue joint must be reinforced by any means for adding ductility if the LFJ could be used in Japan. In this study, we tried to modify the conventional LFJ method by 'adding 'through bolts' in LFJ portion for expecting not only fail safe function and ductility but also applying pressure for gluing process.

Experiments

Materials

Figure 1 shows a specification of large finger joint used in this study.

We adopted finger profile which meets with DIN68140 because most large finger joints in Germany seemed to be produced in accordance with DIN68140 too. Table 1 shows material properties of glued laminated timber (glulam) by which the LFJ specimens were manufactured.

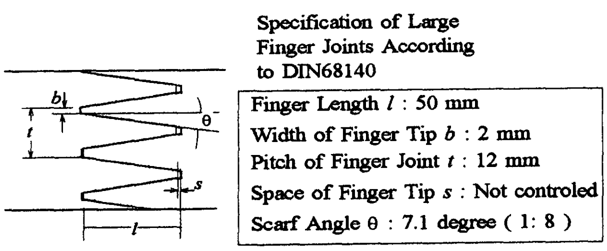


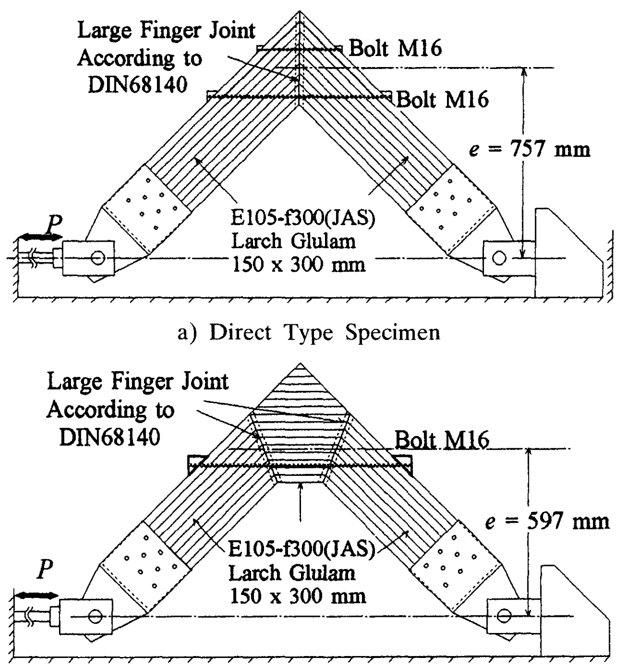
Fig. 1. Specification of LFJ.

Adhesive used for making LFJ was the phenol-resorcinol mixed resin adhesive.

Test specimens and loading scheme

Figures 2-a), b) show two types of L-shape LFJ specimens prepared in this study.

Two different types, 'Direct Type' shown in Fig. 2-a) and 'Insert Type' shown in Fig. 2-b), were designed based on the preliminary experiment and previous German reseaches[1-4]. For both types, reinforced and non-



a) Direct Type Specimen

b) Insert Type Specimen

Fig. 2. Test specimens.

Table 1. Properties of glulam used.

Intms	Species	JAS grade	Cross section	Density TD	MC	MOR of LFJ
Unit	Japanese larch	E105-f300	10 plys 150×300 mm	kg/m^3	%	N/mm^2
Mean value				544	9.72	24.72
C.V. (%)				7.0	2.0	22.2

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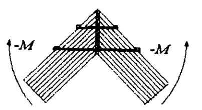
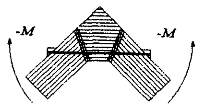
Table 2. Efficiency of reinforcement by bolts for the maximan open-mode moment.

Type of LFJ			Specimen	M_{max} (kNm)	Mean M_{max}	Efficiency (b/a)
Direct type		a : Control	T-01	−19.61	−20.35	1.254
			T-02	−21.09		
		b : Rein-forced	BT-01	−24.51	−25.51	
			BT-02	−26.51		
Insert type		a : Control	TB-01	−20.38	−20.36	0.975
			TB-02	−22.02		
			TB-03	−18.68		
		b : Reen-forced	BTB-01	−19.85	−19.85	

reinforced (i.e. conventional German style) types were prepared, thus four different types of specimens were prepared consequently.

Cyclic load was applied based on the maximum load P_{max} obtained by the monotonic loading case as follows:

1st cycle: $0 \rightarrow 1/4P_{max} \rightarrow 0 \rightarrow -1/4P_{max} \rightarrow 0$

2nd cycle: $0 \rightarrow 1/2P_{max} \rightarrow 0 \rightarrow -1/2P_{max} \rightarrow 0$

3rd cycle: $0 \rightarrow 3/4P_{max} \rightarrow 0 \rightarrow -3/4P_{max} \rightarrow 0$

Last cycle: $0 \rightarrow P_{max}$

Results and Discussions

Moment (M)-rotation (θ) relationship

Figures 3-a), b) show typical examples of moment (M)-rotation (θ) relationship.

Generally speaking, LFJ corner joints tend to show quite brittle failure phenomena when they are subjected to the open-mode moment, while in the case of close-mode moment they can show in some extent nonlinear deformation before final failure due to the partial plastic deformation at the compressed finger jointed parts as reported by Aicher and others[4].

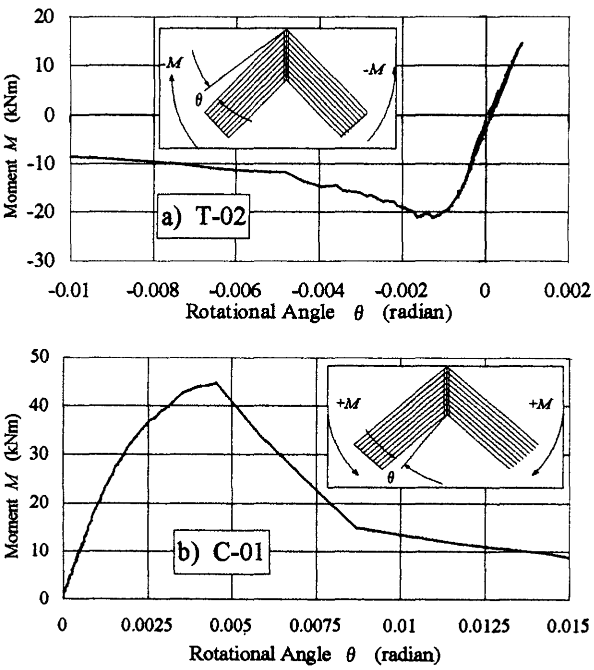


Fig. 3. Examples of M-θ relationship.

Efficiency of reinforcement by bolt(s)

Table 2 summarizes the efficiency of bolt reinforcement. From this table, it is clear that bolt reinforcement was effective for the 'Direct Type' LFJ corner joint about 25% for the open-mode moment, while there was no efficiency for for the 'Insert Type' LFJ.

Conclusions

In this study, we tested four different types of glulam corner joint specimens composed of LFJ technique for estimating their moment carrying capacity. Results and findings are summarized as follows:

1. Glulam corner joints composed of LFJ technique showed brittle failure mode especially when they failed by subjected to open-mode moment.
2. They showed, however, nonlinear load - deformation relationship before failure in some extent especially when they failed by subjected to close-mode moment.
3. Bolt reinforcement was effective for the 'Direct Type' LFJ corner joint about 25% for the open-mode moment, while for the 'Insert Type' LFJ there was no efficiency for the moment carrying capacity by adding through bolt.
4. Design equations for predicting maximum moment capacity of LFJ corner joint gave good predictions for both open-mode and close-mode moment.
5. Further researches should be continued to derive a precise design equation for predicting performance of reinforced LFJ corner joints.

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