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A STUDY ON EXPERIMENTAL TESTING OF JOINTS ON TIMBER STRUCTURES

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SUMMARY

Our research group executed a bending test of four kinds of timber splice, which were twenty-nine specimens altogether. These shapes of specimens are a dovetail joint as Type A, a mortise and tenon as Type B, a "Kanawa" splice as Type C and a "Okkake-Daisen" splice as Type D in Japanese standard longitudinal joints. The sectional area of these specimens is 117 x 120 mm of Type A and B or 116 x 206 mm of Type C and D.

As a result of these tests, the modules of rupture is 1.59 (A), 2.35 (B), 8.39 (C) and 8.97 N/mm^2 (D). The joint efficiency at modules of elasticity is 5.04 (A), 10.72 (B), 46.60 (C) and 49.23% (D). The joint efficiency at modules of rupture is 4.95 (A), 7.29 (B), 26.06 (C) and 27.87% (D).

The equivalent viscous damping ratio of Type A is higher than of others at 50 mm and under of displacement, and lower than of others at 50 mm and upward. The initial equivalent rigidity is about 0.12 kN/mm (B), about 0.41 kN/mm (C) and about 0.60 kN/mm (D). The hysteresis energy of Type A and B is lower than Type C and D.

It is clarified that each destruction characteristics, each structural characteristics and each energy absorption performance on the bending test are different from other type of splice.

1. INTRODUCTION

The 1995 Hyogo-Ken Nambu Earthquake caused a large scale of damage on wooden dwelling houses in Japan. One of these damages showed us necessity of the seismic performance of splice and connection in wooden structures.

Some longitudinal joints and many orthogonal joints are executed the static loading tests on a tensile stress, a compressive stress, a shear stress and a bend stress. But there are not so many bending tests of the longitudinal joint.

It has a purpose of grasping the structure performance and an energy absorption performance by a bending test about four kinds of standard longitudinal joints in Japan, which are a dovetail joint, a mortise and tenon, a "Kanawa" splice and a "Okkake-Daisen" splice.

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2. OVERVIEW OF SPECIMENTS AND TESTS

It is executed a bending test, which is shown in figure 1, of four kinds of splice, which are twenty nine specimens altogether. These shapes of specimens are shown in figure 2. Type A is a dovetail joint, and Type B is a mortise and tenon. These sectional area of these specimens is a 117 x 120 mm. Type C is called "Kanawa" splice in Japanese, whose shape is like a shaking hands of two timbers, and which has tongue and grove with cotter pin. Type D is called "Okkake-Daisen" splice in Japanese, whose shape is like a shaking hands of two timbers with two cotter pins. The sectional area of type C and D specimens is a 116 x 206 mm. The overview of specimens is shown in table 1.

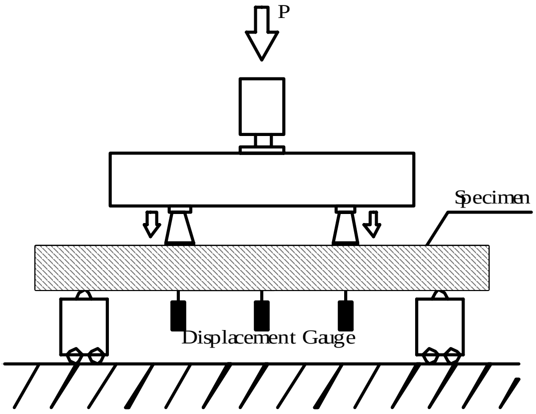


Figure 1 Loading System

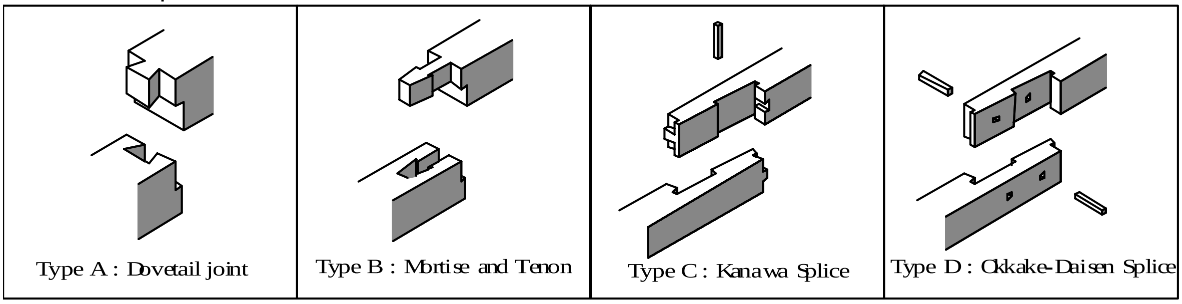


Figure 2 Specimens Types

Table 1 Overview of Specimens

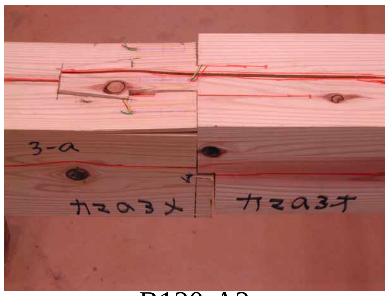
Name of Specimens	Type of Specimens	Breadth	Height	Length of Each Part: Heigth of Dovetail	Length of Each Part: Length of Tenon	Length of Each Part: Length of Splice	Longitudinal Vibration Young's Modulus kN/mm2: Tenon Side	Longitudinal Vibration Young's Modulus kN/mm2: Mortise Side	water content %: Tenon Side	water content %: Mortise Side
		mm	mm	mm	mm	mm				
A120-A1	Type A	117	120	60	—	—	4.3	7.8	23.0	17.0
A120-A2	Type A	117	120	60	—	—	8.4	9.2	13.5	26.0
A120-A3	Type A	117	120	60	—	—	9.5	9.8	22.0	26.5
A120-B1	Type A	117	120	80	—	—	5.2	8.1	26.5	12.0
A120-B2	Type A	117	120	80	—	—	8.4	9.2	20.0	17.0
A120-B3	Type A	117	120	80	—	—	9.5	9.9	20.0	23.5
B120-A1	Type B	117	120	—	60	—	6.9	8.3	12.5	24.5
B120-A2	Type B	117	120	—	60	—	8.6	9.4	20.5	21.5
B120-A3	Type B	117	120	—	60	—	9.5	10.1	25.5	19.0
B120-B1	Type B	117	120	—	75	—	7.3	8.3	16.0	19.0
B120-B2	Type B	117	120	—	75	—	8.7	9.4	23.5	17.0
B120-B3	Type B	117	120	—	75	—	9.6	10.4	24.5	18.0
B120-C1	Type B	117	120	—	90	—	7.6	8.3	11.0	14.5
B120-C2	Type B	117	120	—	90	—	9.0	9.4	18.5	16.5
B120-C3	Type B	117	120	—	90	—	9.7	10.5	28.0	19.0
C206-A1	TYpe C	116	206	—	—	360	7.2	6.5	13.0	16.0
C206-A2	TYpe C	116	206	—	—	360	8.1	8.6	11.0	17.5
C206-B1	TYpe C	116	206	—	—	420	7.2	6.5	11.0	16.5
C206-B2	TYpe C	116	206	—	—	420	8.2	8.6	16.5	12.0
C206-B3	TYpe C	116	206	—	—	420	9.5	9.0	16.5	10.0
D206-A1	Type D	116	206	—	—	360	7.6	6.7	17.0	11.0
D206-A2	Type D	116	206	—	—	360	8.7	8.3	10.5	18.5
D206-A3	Type D	116	206	—	—	360	9.5	9.1	19.5	16.0
D206-B1	Type D	116	206	—	—	420	7.6	6.8	12.0	10.5
D206-B2	Type D	116	206	—	—	420	8.8	8.5	11.5	18.0
D206-B3	Type D	116	206	—	—	420	11.6	9.1	19.0	18.0
D206-C1	Type D	116	206	—	—	480	7.9	6.8	18.5	14.5
D206-C2	Type D	116	206	—	—	480	9.0	8.6	13.0	11.0
D206-C3	Type D	116	206	—	—	480	12.0	9.2	19.5	10.0

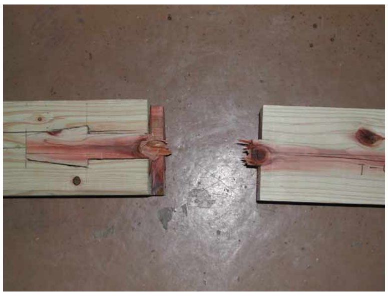
3. DESTRUCTION OVERVIEW

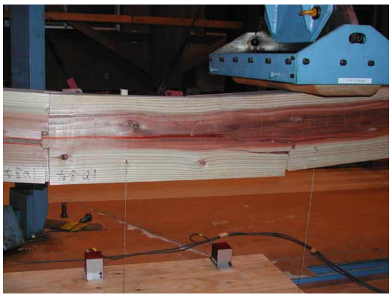
The destruction overview is shown in photograph 1. In the type A and type B, member edge of mortise side comes off. In the type B, a tenon breaks in the place with the knot which is shown in B120-B1. In the type C, the crack occurs with the tension from the salient of the tip of member. In the type D, the crack occurs with the tension from the cotter pins of member.


A120-A2

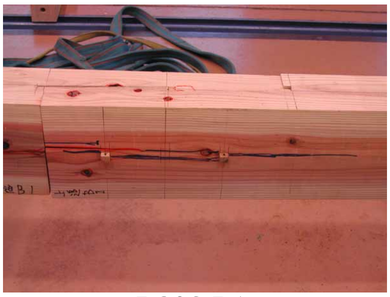

A120-B2


B120-A3


B120-B1


C206-A1


C206-A2


D206-B1


D206-B2

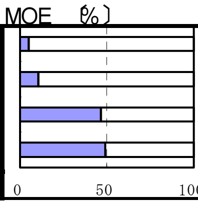
Photo. 1 Destruction Overview

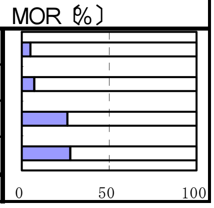
4. JOINT EFFICIENCY

The joint efficiency is shown in table 2. The max load is 1.36 (A), 1.83 (B), 13.49 (C) and 14.43 kN (D). The allowable load is 0.60 (A), 0.74 (B), 6.36 (C) and 7.61 kN (D). The modules of rupture is 1.59 (A), 2.35 (B), 8.39 (C) and 8.97 N/mm^2 (D). The joint efficiency at modules of elasticity is 5.04 (A), 10.72 (B), 46.60 (C) and 49.23% (D). The joint efficiency at modules of rupture is 4.95 (A), 7.29 (B), 26.06 (C) and 27.87% (D).

Table 2 Joint Efficiency

	Max. Load (kN)	Allowable Load (kN)	MOE (kN/mm^2)	MOR (N/mm^2)	Joint Efficiencv MOE (%)	Joint Efficiencv MOR (%)
A	1.36	0.60	0.37	1.59	5.04	4.95
B	1.83	0.74	0.79	2.35	10.72	7.29
C	13.49	6.36	3.42	8.39	46.60	26.06
D	14.43	7.61	3.61	8.97	49.23	27.87





5. ENERGY CHARACTERISTICS

The energy characteristics is defined in figure 3. The equivalent viscous damping ratio, the equivalent rigidity and the hysteresis energy are shown in figure 4, figure 5 and figure 6 respectively.
The equivalent viscous damping ratio of Type A is higher than of others at 50 mm and under of displacement, and lower than of others at 50 mm and upward. The initial equivalent rigidity is about 0.12 kN/mm（B）, about 0.41 kN/mm（C）and about 0.60 kN/mm（D）. The hysteresis energy of Type A and B is lower than Type C and D.

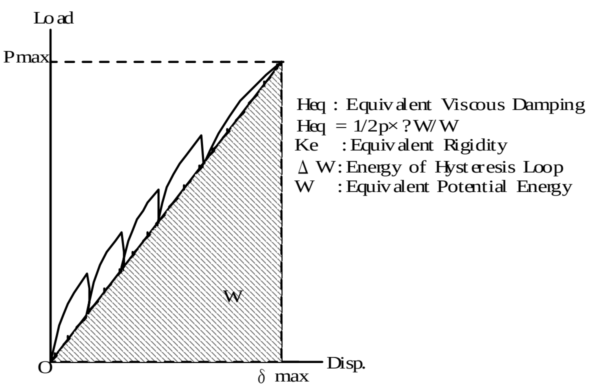


Figure 2 Equivalent Viscous Damping Ratio

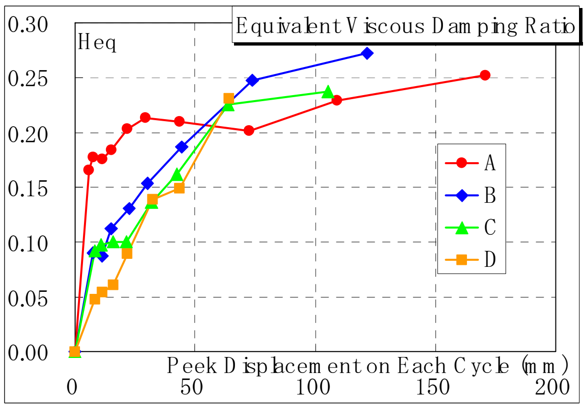


Figure 3 Equivalent Viscous Damping Ratio

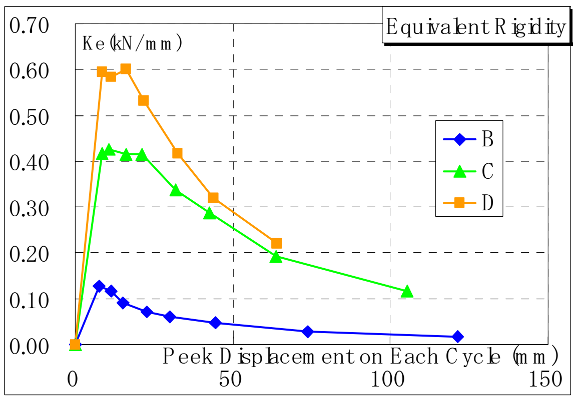


Figure 4 Equivalent Rigidity

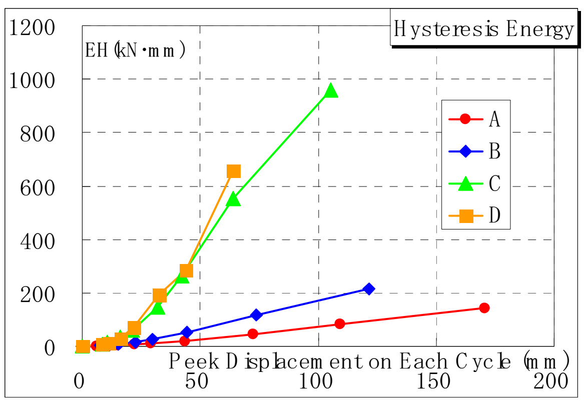


Figure 5 Hysteresis Energy

6. CONCLUSIONS

It finds a structure performance and an energy absorption performance about the typical longitudinal joint in Japan. It is clarified that a structural characteristics of splice type are different from one of other type on the bending test.

ACKOWLEDGEMENTS

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