



2.2. Loading System

The loading system is shown in Fig. 2. One end of the bracing is pin-joined to the column and the other end is pin-joined to the actuator. Rollers are installed at two places on the bracing to prevent vertical deflection during the application of force. The front side of the diagram (of Fig. 2) is called the S-side, the back side is called the N-side, the left side is called the W-side, and the right side is called the E-side. The bracing is installed with the notch facing the S-side.

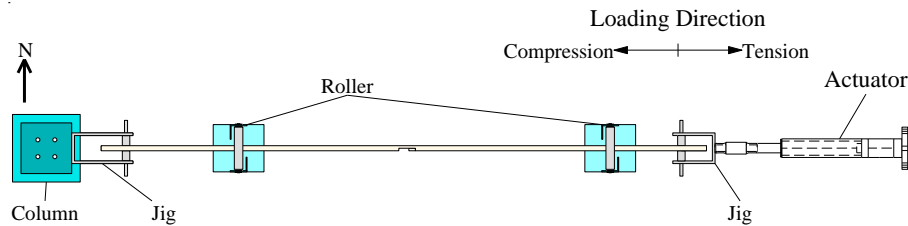


Fig. 2 – Loading system (Plan)

The applied force, a positive and negative alternating repetition of compression and tension, is performed within a range in which the buckled brace can be accommodated in the apparatus. On the compression side, the compression of the bracing corresponds to the amplitude of the story deformation angle of about 1/250, 1/200, 1/180, 1/150, 1/120, 1/100, 1/75, and 1/50 rad, respectively; a displacement of 6.0 mm, 7.5 mm, 8.4 mm, 10.1 mm, 12.6 mm, 15.1 mm, 20.2 mm, and 30.4 mm is applied, respectively; and on the tension side, a force is applied until the load reaches 10 kN.

In order to measure the influence in the in-plane direction and out-of-plane direction, strain gauges are attached 200 mm from the bracing fulcrum and on the four sides around the center.

2.3. Test Results

Fig. 3 shows the main fracture characteristics, and Fig. 4 shows the skeleton curve of the load-axial displacement relationship.

[S1] After exhibiting a maximum load of 6.4 kN on the compression side of 10.1 mm (1/150 rad), the material buckled and its resistance dropped rapidly. The maximum out-of-plane displacement was 128.7 mm on the W-side and 123.3 mm on the E-side. The bending moment in the out-of-plane direction was a maximum at the center of the bracing when compressed. When a tensile force of 12.6 mm (1/120 rad) was applied, the edge was ‘cut off’, but no other noticeable damage was observed.

[S2] After exhibiting a maximum load of 4.2 kN on the compression side of 6.0 mm (1/250 rad), the material buckled, and its resistance dropped rapidly. The maximum out-of-plane displacement was 184.3 mm on the W-side and 185.6 mm on the E-side. The bending moment in the out-of-plane direction was a maximum around the notch when compressed. It buckled to the N-side due to the compression-side force, referred to as N-side buckling. At 12.6 mm (1/120 rad) on the compression side, the surface of the notch portion was ‘peeled off’ at the N-side, and at 30.4 mm (1/50 rad) on the compression side, the notch segment was cracked.

[S3] After exhibiting a maximum load of 1.3 kN on the compression side of 6.0 mm (1/250 rad), the material broke immediately after buckling. The maximum out-of-plane displacement was 188.9 mm on the W-side and 213.6 mm on the E-side. It buckled to the notched S-side, referred to as S-side buckling, and was damaged in the notch at 6.0 mm (1/250 rad) on the compression side.

[S4] After exhibiting a maximum load of 3.2 kN on the compression side of 6.0 mm (1/250 rad), the material buckled and its resistance gradually decreased. The maximum out-of-plane displacement was 201.9 mm on



2.4. Consideration of Perform Element Tests Results

The bracing without a notch was not damaged by buckling, and the bracing with a notch generally resulted in damage to the notch. Regarding the buckling load, the bracing S1 without a notch exhibited the largest buckling load, followed by the bracing S5 with a notch. The bending moment in the out-of-plane direction of the compression side of the bracing showed a maximum at the center of the bracing (around the notch for the bracing with a notch).

3. Static Loading Test of Brace Frame Specimen

3.1. Specimens

Fig. 5 shows the outlines of the frame specimens, which consist of columns, girders, bases, studs, and bracings, all of which are made of cedar. The basic frame is 1,820 mm × 2,730 mm.

The bracing is assumed to be a two-sided bracing, and there are two specimens, a specimen F1 (without a notch), and a specimen F2 (with a notch). The bracing is 30 mm × 90 mm, and the notch depth is 15 mm, which is the same as that of the element specimens described in Section 2. The ends of the bracing are joined using double braced hardware.

The Gypsum board is 12.5 mm thick, of dimensions 910 mm × 1,820 mm, with 3 pieces pasted on each side. The body edge is placed in the seam, and screws are positioned at intervals of approximately 150 mm. Hole-down hardware specced at 25 kN is installed on the capital and 35 kN is installed on the pedestal, respectively.

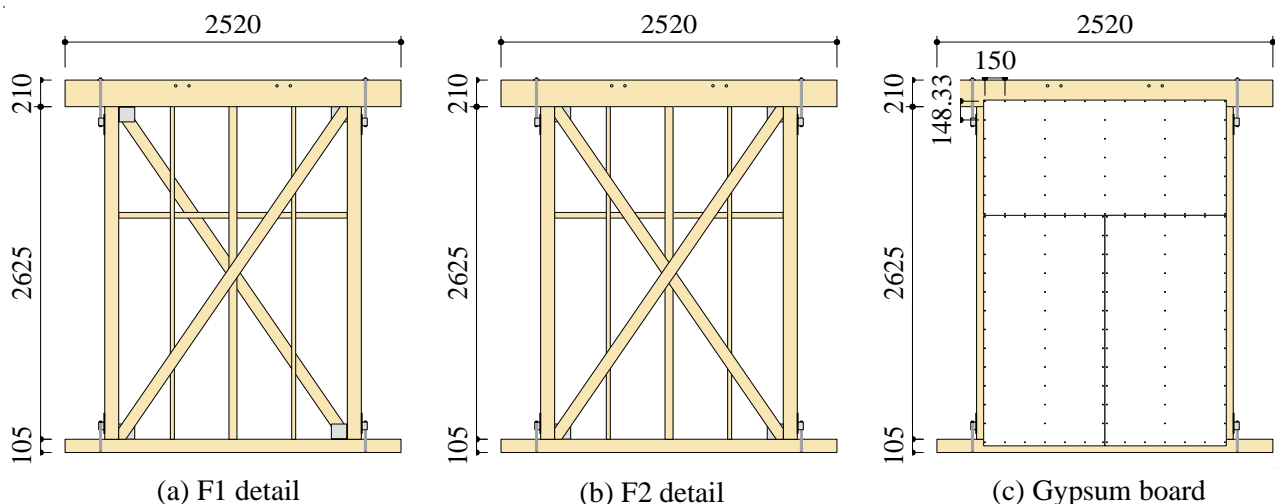
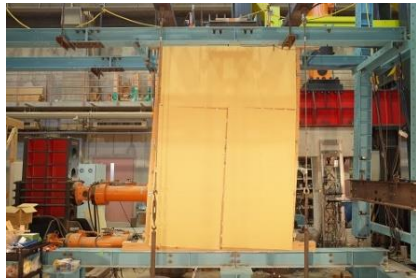


Fig. 5 – Overview of test specimens

3.2. Loading System

The loading system is shown in Fig. 6. The base of the frame specimen is fixed to a steel frame by means of anchor bolts, the surcharge load being 1 ton per column. A positive/negative alternating force is gradually imposed and increased repeatedly through a jig installed on the top of the frame. The force direction is positive in the left direction (as seen in Fig. 6). Note that the positive column is a W-column and the negative column is an E-column.

A load cell is installed at the applied position on top of the frame specimen, and the horizontal resistance of the specimen is measured. The absolute displacement u at the top of the specimen is measured using a wire displacement meter. The value obtained by dividing the absolute displacement u by the inner height H of the



(a) Before reaching (-1/50 rad)



(b) Before reaching (+1/50 rad)



(c) N-side damage



(d) Gypsum board joint damage (1/50 rad)



(e) W-side stud splitting when dismantling

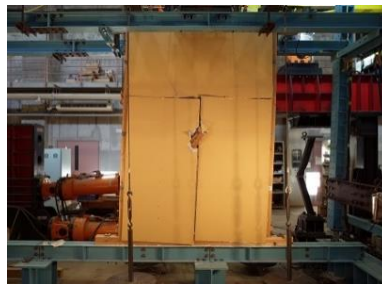


(f) Screw break

(A) Specimen - F1



(a) Reaching (+1/50 rad)



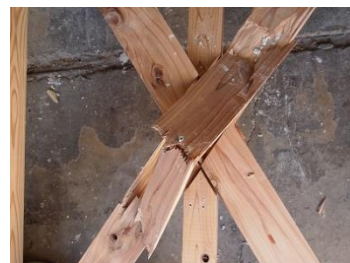
(b) Before reaching (+1/50 rad)



(c) Bracing damage (1/50 rad)



(d) Lower end of N side bracing when dismantling



(e) Bracing damage when dismantling

(B) Specimen - F2

Fig. 7 – Typical damage of specimens

