EXPERIMENTAL TESTS OF STEEL BEAM-TO-COLUMN JOINTS UNDER COLUMN LOSS SCENARIOS

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ABSTRACT

Capacity of multi-storey steel frame buildings to resist extreme loading may depend on the performance of beam-to-column joints to provide continuity across the damaged area, and thus to allow the development of alternate loads paths (AP). It is of interest to study the capacity of actual design procedures to provide enough robustness for connections under extreme loading conditions ([1], [2]). Bolted end plate connections are widely used in the steel frame constructions. The T-stub, which is the basic component of such connections, has been extensively applied to model the tension zone that constitutes the most relevant source of deformability [3], [4], [5]. Preliminary FEM analysis [6] indicated that the ultimate capacity increases very much with the development of the catenary action, but this imposes large deformation demands on connections (see Fig. 1).

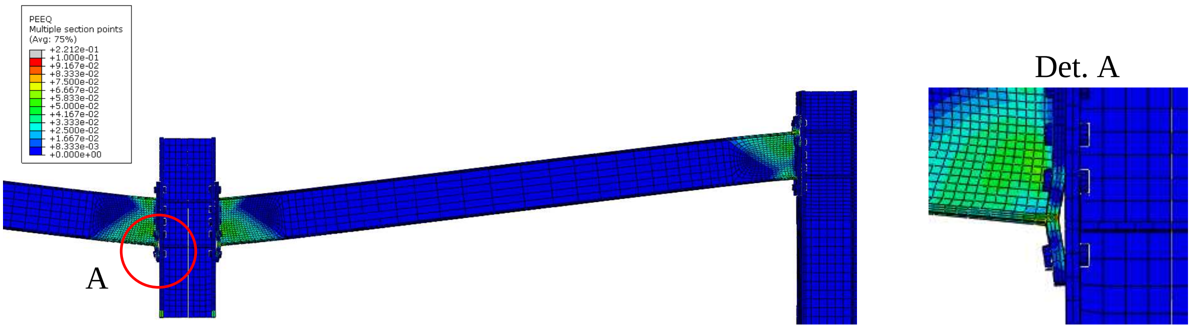


Fig. 1. Deformed shape of the beam-to-column joint after loss of a column (equivalent plastic strain PEEQ) [9]

The following typologies have been selected for the experimental program: T-10-16-100; T-10-16-120; T-10-16-140; T-12-16-100; T-12-16-120; T-12-16-140 (Fig. 3). First letter represent the T-stub, second term represents the thickness of the end plate, followed by the diameter of the bolt and then the distance between the bolts, in mm. Specimens have been tested at low and high strain rate (0.05mm/sec and 10mm/sec respectively). The steel grades were S235 for flanges, S355 for webs and 10.9 for bolts. Fillet weld with a throat thickness, a_w = 7mm was used to connect the web and the flange. Fig. 3 presents the force-displacement curves. There is a small influence of the loading rate, both in terms of ultimate resistance and deformation capacity. The failure is ultimately attained due to the fracture of the bolts, see Fig. 4.a.

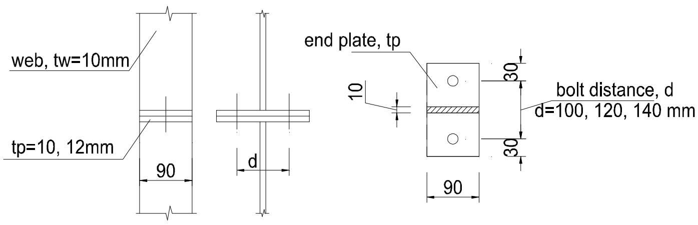


Fig. 2. T-stub characteristics

When the distance between bolt rows increases from 100 to 120 mm, there is a reduction of the resistance, but the deformation capacity increases. When bolt row distance is increased to 140 mm, the deformation capacity increases without a reduction of the resistance. No failure of the welding has been observed. A numerical analysis program has been also developed using ABAQUS computer program to validate the numerical models for T-stub components. It can be seen the FE response follows with high accuracy the actual behavior of the specimen (Fig. 4.b).

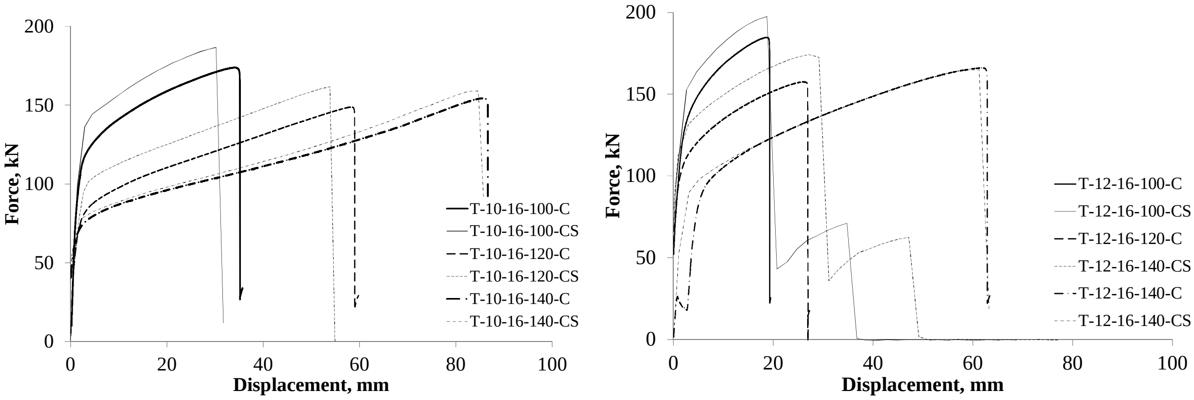
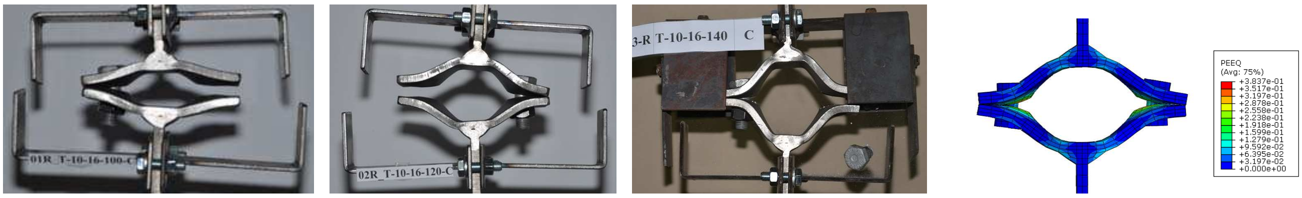


Fig. 3. Force-displacement curves, room temperature test



a) b)

Fig. 4. a) T-stub specimens T-10-16-100, T-10-16-120 and T-10-16-140 (from left to right) after failure, low strain rate test; b) deformed shape before failure from numerical analysis (the equivalent plastic strain PEEQ)

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