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Behaviors of one-side bolted T-stub through thread holes under tension strengthened with backing plate

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ABSTRACT

Tests were carried out to investigate the one-side bolted T-stub through thread holes under tension strengthen with backing plate. For the thread length is limited by the flange thickness of T-stub, which might lead to the premature failure of the connection due to the failure of thread. The thread length could be increased by adding a backing plate. Two new failure models of the bolted T-stub were proposed to consider the potential failure of hole thread. And the design methods for tension strength of corresponding failure modes were presented. Studied parameters included the bolt pre-tension force and the T-stub flange thickness. The bolt pre-tension force almost did not affect the tension strength of a bolted T-stub, while the initial stiffness could be improved. Effects of the backing plate on the tension strength and load-displacement curve of T-stub under tension were presented through comparing those without backing plate. Test results showed that the backing plates could be efficiently improve the tension strength of the T-stubs. However, for T-stubs with same screw depth, it was more efficient to increase the flange thickness directly. The comparison between test results and calculated results from design methods indicated that the proposed design methods could be used to predict the tension strength and failure modes of the one-side bolted T-stub through thread holes and strengthened with screwed backing plates. Under the design load, the bolted T-stub was still in elastic state, which could meet the design requirement.

1. Introduction

Bolted endplate connections are widely used in steel-framed structures for it avoids welding on site, which in general requires highly skilled labor and slows down the construction speed [1]. Hollow sections are generally more efficient as structural members than conventional open sections due to their superior torsional rigidity and hence resistance to flexural-torsional and torsional buckling modes. However, the application of the hollow section component has traditionally been hampered by access constraints for a fully bolted connection. The blind bolt provided an alternate way to connect beam to a tubular column using bolted endplate, which could be inserted and tightened from outside of the tube.

Application of the blind-bolt, such as the Hollo-bolt, the Enhanced Hollo-bolt (EHB), the Blind Bolt, the Flow drill [2] and so on, in bolted beam-column connections has been widely studied recently. Wang and Wang [3] carried out tests to investigate the yield and ultimate strengths of beam-tubular column connections using Hollo-bolts under tension. Design recommendations for the beam endplate using blind bolted were proposed. Tizani et al. [4] studied the performance and reliability of EHB connection to concrete filled columns under cyclic loading. Test results showed that the connection could provide energy dissipation capacity and ductility appropriate for its potential use in seismic design.

The mechanism of blind bolt discussed above is through tightening the bolt head with appropriate torque. The threaded cone flared the sleeves and clamped against the inside of the hole, which was analogous to the clamping produced by the nut of standard bolt.

Except for using flared sleeves, the bolt can also be clamped by thread holes. In space grid structures with bolted ball joints, the grid members are connected using bolts that are screwed in to a hole with thread, as shown in Fig. 1. The design codes require that the thread length should be longer than 1.1 times of bolt diameter [5–8]. For a steel plate being thinner than 12.5 mm, the thread holes could be manufactured by flow drilling technique [9,10]. However, the bolted beam-tubular column endplate connection using thread holes has not been fully investigated yet.

The thread length is limited by the wall thickness. For a tubular column with thin walls, the failure of thread might lead to the premature failure of the connection. The thread length could be increased by adding a backing plate, as shown in Fig. 2.

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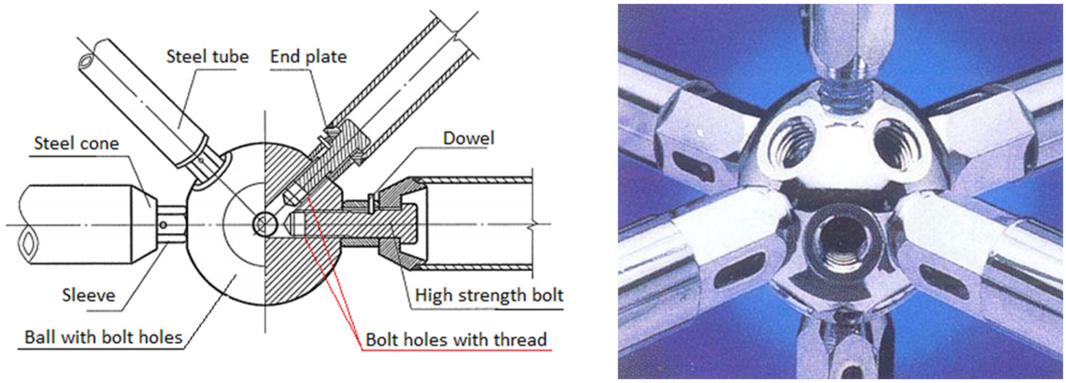

Fig. 1. Space grid net structures with bolt ball connection.

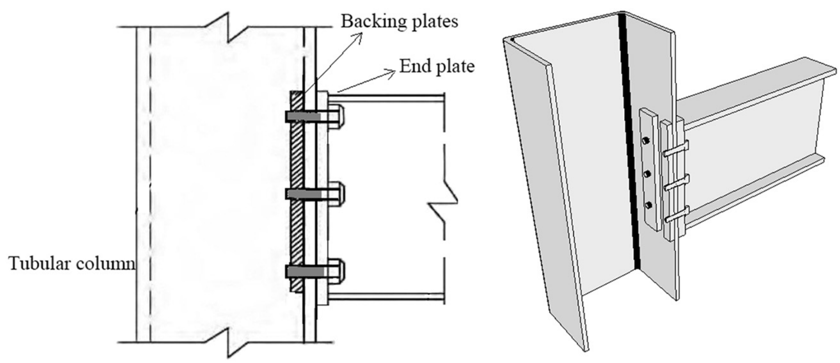

Fig. 2. Bolted beam-tubular column connection with backing plates.

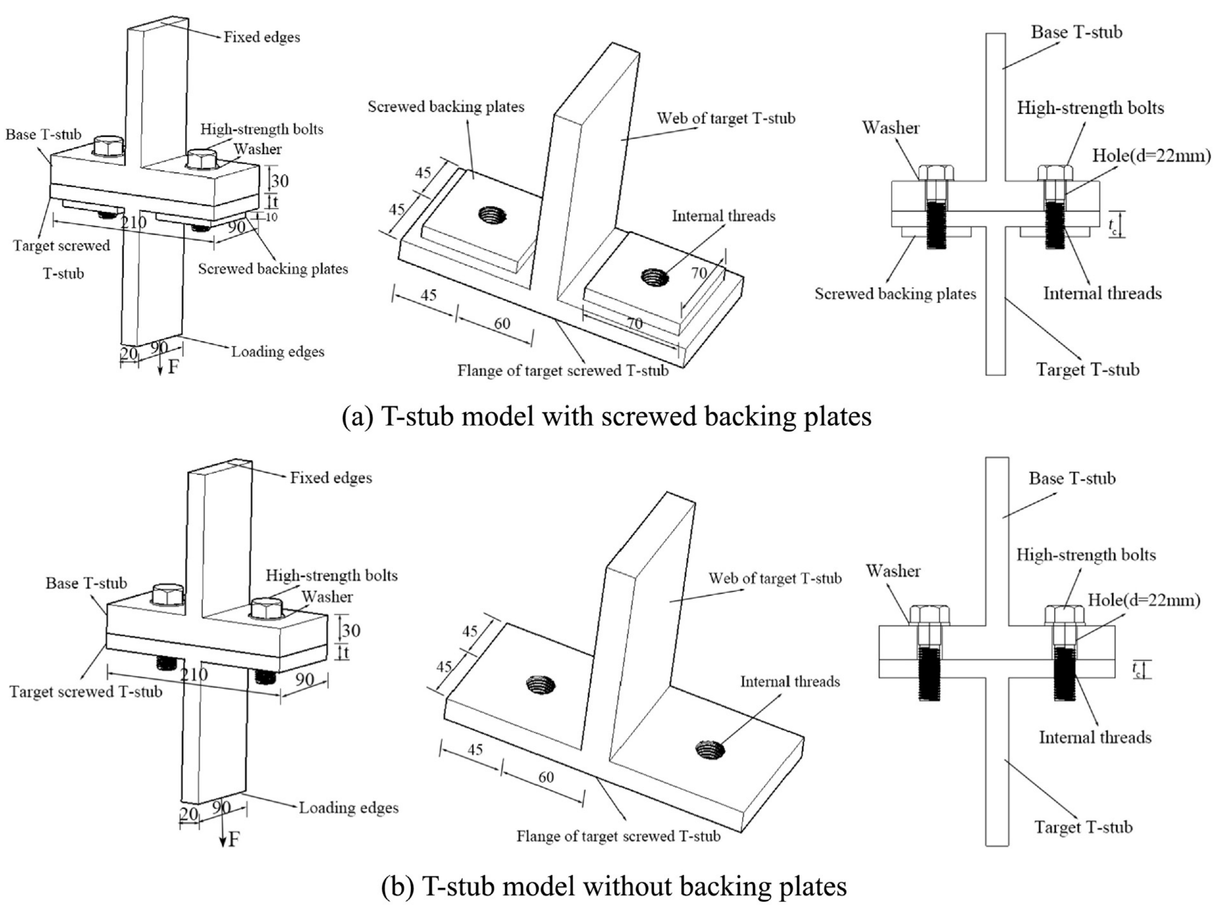

Fig. 3. Dimensions of studied T-stubs.