Experimental investigation of extended end plate joints to concrete-filled steel tubular columns

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Abstract

An experimental programme to obtain the behaviour of blind bolted extended end plate joints to circular or square concrete-filled steel tubular (CFST) columns under monotonic loading has been conducted. In order to enhance the strength and stiffness of the connections, the anchorage extensions are provided to the blind bolts to link the connection back into the concrete with the tubular. This paper investigated the effect of the end plate thickness and the column section type on the static behaviour and failure modes of the tested connections. The structural performance of the blind bolted extended end plate connections was evaluated in terms of the moment-rotation relationship, connection rigidity, the deformation pattern and the strain response. The test results showed that the blind bolted extended end plate connection to CFST columns exhibits high strength and stiffness, while its connection rotation capacity satisfies the ductility requirement for earthquake resistance in seismic region. The experimental studies also demonstrated that the strength and stiffness of the connections can be improved by providing anchorage extensions to the blind bolts, and utilising moderately thick end plates leads to joints approaching full strength for the extended end plate connections.

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Notation

B Width of square steel tube
D Exterior diameter of circular steel tube
H Column length of test joint
L Beam length of test joint
Lb Beam span
La Distance between the load application point and the beam end welded to the end plate
hb Beam section height
bfb Beam flange width
fbf Beam flange thickness
fwb Beam web thickness
et End plate thickness
E Young's modulus for steel
Ec Young's modulus for concrete
Ec0 Flexural rigidity for the beam
fy Steel yield strength
fu Steel ultimate strength
fcu Concrete compressive cube strength
n Axial load level, n = N/Nu
N Axial load applied to CFST column
Nu Ultimate axial load applied to CFST column
P Test load on the beam tip
Pu Maximum test load on the beam tip

M Connection moment
My Yield moment defined by the test joint
Me Design moment capacity defined by EC3 specification, Me = 0.67Mu
Mm Ultimate moment of the test joint
Mf Moment of the test joint at failure state, Mf = 0.85Mu
Mbps Design plastic moment resistance of the beam
θr Connection rotation
θb Beam rotation
θc Column rotation
θy Connection rotation corresponding to the yield moment of the beam
θye Connection rotation corresponding to the design moment capacity of the connection
θum Connection rotation corresponding to the ultimate moment of the connection
θuf Connection rotation corresponding to the moment of the connection at failure state
Ks Initial stiffness of connection
Kes Service-level stiffness of connection
Cm Connection moment coefficient
Cm0 Connection rotation coefficient
Ck Connection stiffness coefficient
εyr,b Yield strain of steel beam flange
εyr,w Yield strain of steel beam web
εyr,e Yield strain of end plate
εyr,c Yield strain of steel tube

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