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Recent Research Progresses on CFDST Structures

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Extended Abstract

Concrete-filled double skin steel tubular (CFDST) member consists of inner and outer steel tubes with concrete in-filled in the sandwiched cavity. It inherits advantages of the common concrete-filled steel tube, such as high resistance, high stiffness and good constructability. It also has some other characteristics, such as lighter self-weight and better fire performance. It is found that the inner tube can provide a sufficient support to the sandwiched concrete, and the steel-concrete-steel interfaces can work together effectively under various loading conditions. The concrete-filled double skin steel tubes may provide a better design option when designing members of large cross-sectional profile. Therefore they have been used in some engineering projects in China.

This presentation introduces some research progresses on the CFDST structures, including the tensile behavior of the member, the life-cycle performance of the member and the fatigue behavior of T-joint.

For the tensile strength of CFDST member, both numerical and experimental investigations were conducted. The numerical model was established and calibrated against the test results for the CFDST member under axial and eccentric tension. The comparison showed the proposed FE model was capable to capture the structural behavior of the tensile loading experiments. Parametric studies were then conducted to investigate the influence of some key parameters, such as the material strength, the nominal steel ratio and the hollow ratio on the tensile behavior of composite members. The composite action on the composite member, the effect of loading paths and the tension-bending interaction diaphragm were also discussed. It is found that the tensile strength of the member depends on the composite action between steel tubes and sandwich concrete, and the tension-bending interaction diaphragm could be represented by a simple linear relationship. Finally, design equation to predict the tensile strength of CFDST member was proposed, and the comparison results showed that the proposed formula has a good accuracy.

For the life-cycle performance of the member, multiple factors were identified and the influences were evaluated for the CFDST stub columns. During the construction stage, the inner and outer tubes were subjected to constructional loads. While during the service stage of CFDST member, the whole composite column is subjected to service loads, occasional loads as well as environmental actions (e.g. chloride corrosion). The finite element analysis (FEA) model was developed to predict the structural behaviour with considerations of these factors. The experimental work was also conducted for CFDST columns subjected to corresponding loading protocols, and test results were used to calibrate numerical models. Discussions were made on the differences of specimens with and without considerations of these factors. Both experimental and numerical results showed that the deformation and the ultimate strength were affected by the preload, long-term sustained load, corrosion and their combinations. The effect of corrosion was significant and leads to a large reduction of column strength, and the influences of the preload and long-term sustained load could be tentatively estimated by multiplying different coefficients together.

For the fatigue behavior of T-joint, the preliminary experimental investigations were conducted on the fatigue behavior of composite T-joint consists of circular concrete-filled double-skin steel tubular

(CFDST) chord and circular hollow section (CHS) brace. The test parameters in the direct fatigue tests included the load range, the chord to brace diameter ratio and the hollow ratio of the cross section, while those in the stress concentration tests included the loading type, the chord to brace diameter ratio and the hollow ratio of the cross section. The brace was subjected to axial tension or compression during the test. The development of cracks and the degradation of joint stiffness were monitored during the fatigue loading. Stress concentration factors (SCFs) and strain concentration factors (SNCFs) were obtained from the test. Generally, SCFs increase with the increase of the parameters of cross-sectional hollow ratio and radius to thickness ratio of chord tube. It was found that the SCFs near the saddle point of the chord were higher than other positions, and steel cracks usually initiated between the saddle and the crown points, and the sandwiched concrete constrained the deformation around the connection zone.

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