Composite Action of Concrete Filled Tubes

PEER Internship Program – Summer 2013

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Introduction

Concrete Filled Tube (CFT) columns are an attractive alternative to conventional reinforced concrete and steel columns in bridge construction. In order to achieve the structural benefit of the composite section stress transfer between the two materials is required. Transfer of stress is achieved by the bond between the two materials. There are two types of bond mechanisms that contribute to the overall bond strength of the section:

Natural Bond: includes the chemical adhesion and frictional resistance between the two material

Mechanical Bond: significant irregularities in the steel to permit bearing of the steel on the concrete

One limitation of using CFTs in bridge construction today is due to uncertainty in composite interaction between the steel tube and concrete fill.

Research Objective

1. Determine if a concrete mix with no low shrinkage admixtures can achieve the bond strength required to develop composite action between the steel tube and concrete fill.
2. Study the contribution of the interior weld of spiral welded steel tubes to the overall bond strength of the CFT composite section.

Method

A total of four push through specimens were selected to accomplish research objectives. Test parameters included the type of concrete fill and the type of steel tube used in specimens.

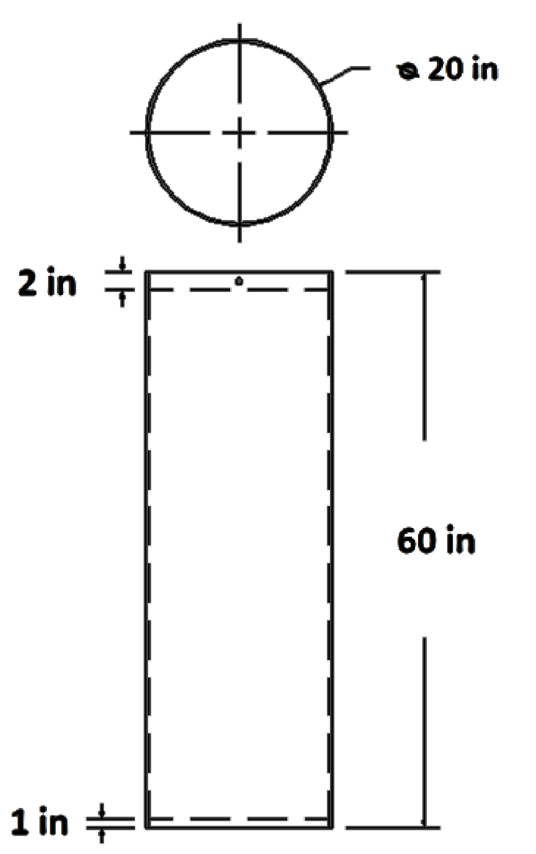

Fig. 1: Specimen Design

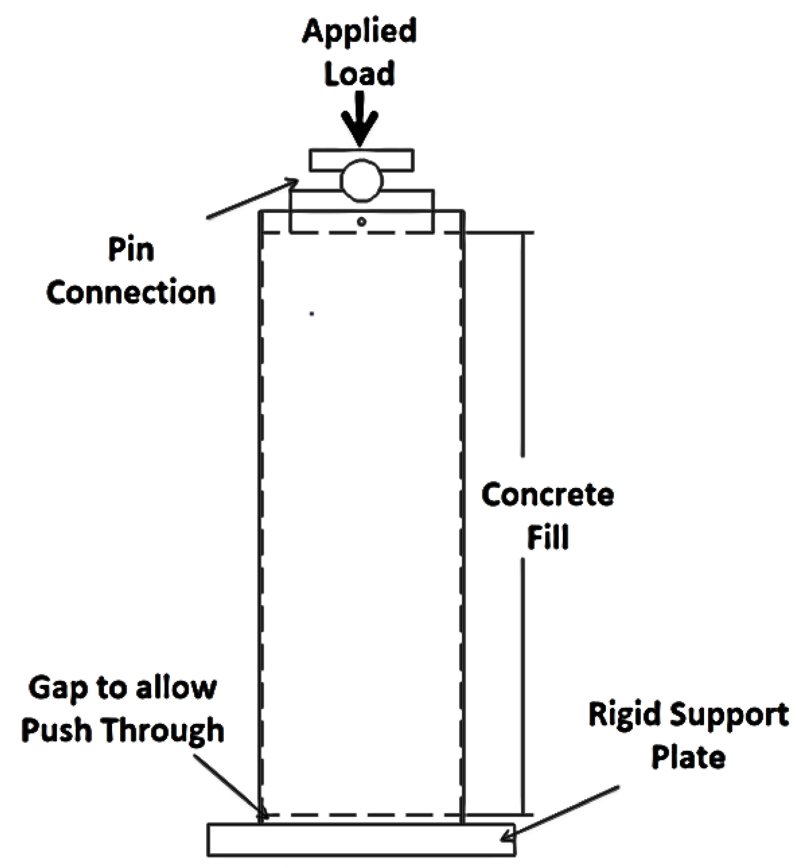

Fig. 2: Test Setup

Table 1: Test Matrix

Specimen Identification	Type of Steel Tube	Type of Concrete
SS-I	Straight Seam	Low Shrinkage
SS-II	Straight Seam	No low Shrinkage Admixture
SW-I	Spiral Welded	Low Shrinkage
SW-II	Spiral Welded	No low Shrinkage Admixture

Testing

All specimens were loaded in compression using the Baldwin Testing Machine at UW. A total of ten strain gauges and ten vibrating wire gauges were used on each specimen to monitor strain in the steel tube. The strain values were used to calculate the bond strength of the section throughout the loading process. A roller bearing connection was used to evenly distribute load from Baldwin on concrete fill. Three linear potentiometers were connected to the top of each specimen to monitor displacement of the concrete fill.

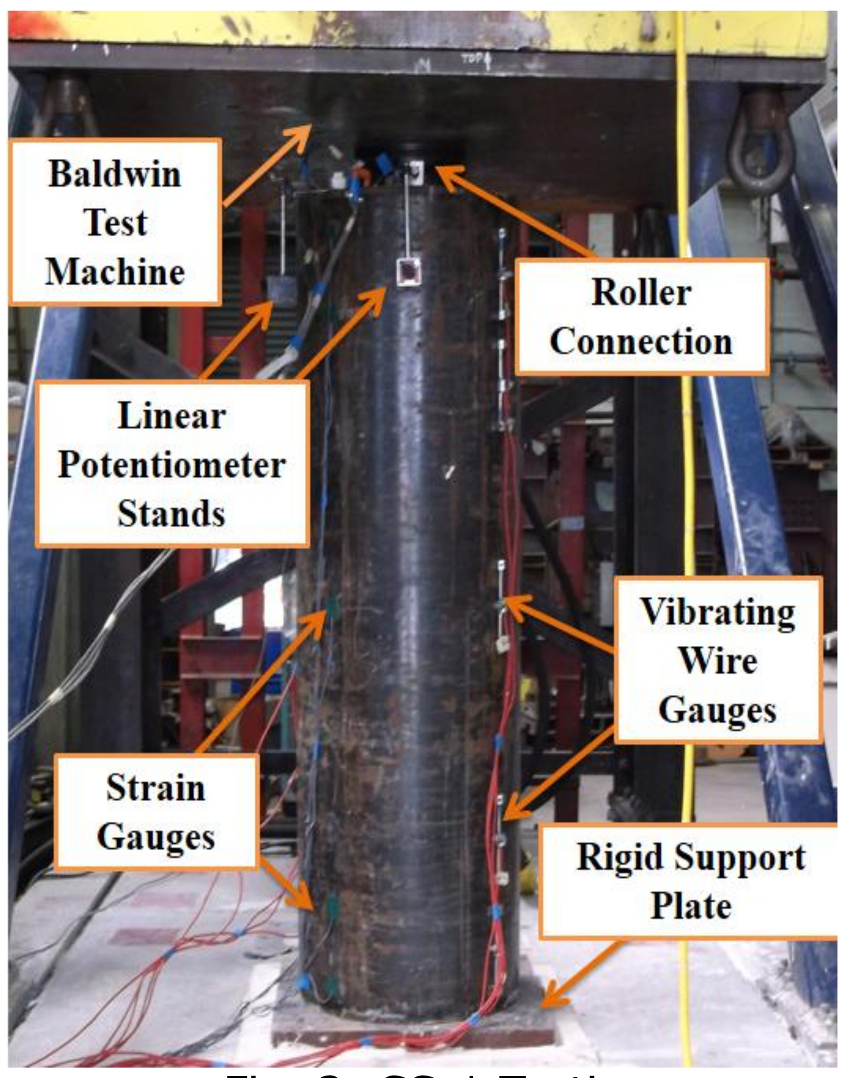

Fig. 2: SS-1 Testing

Experiment Results

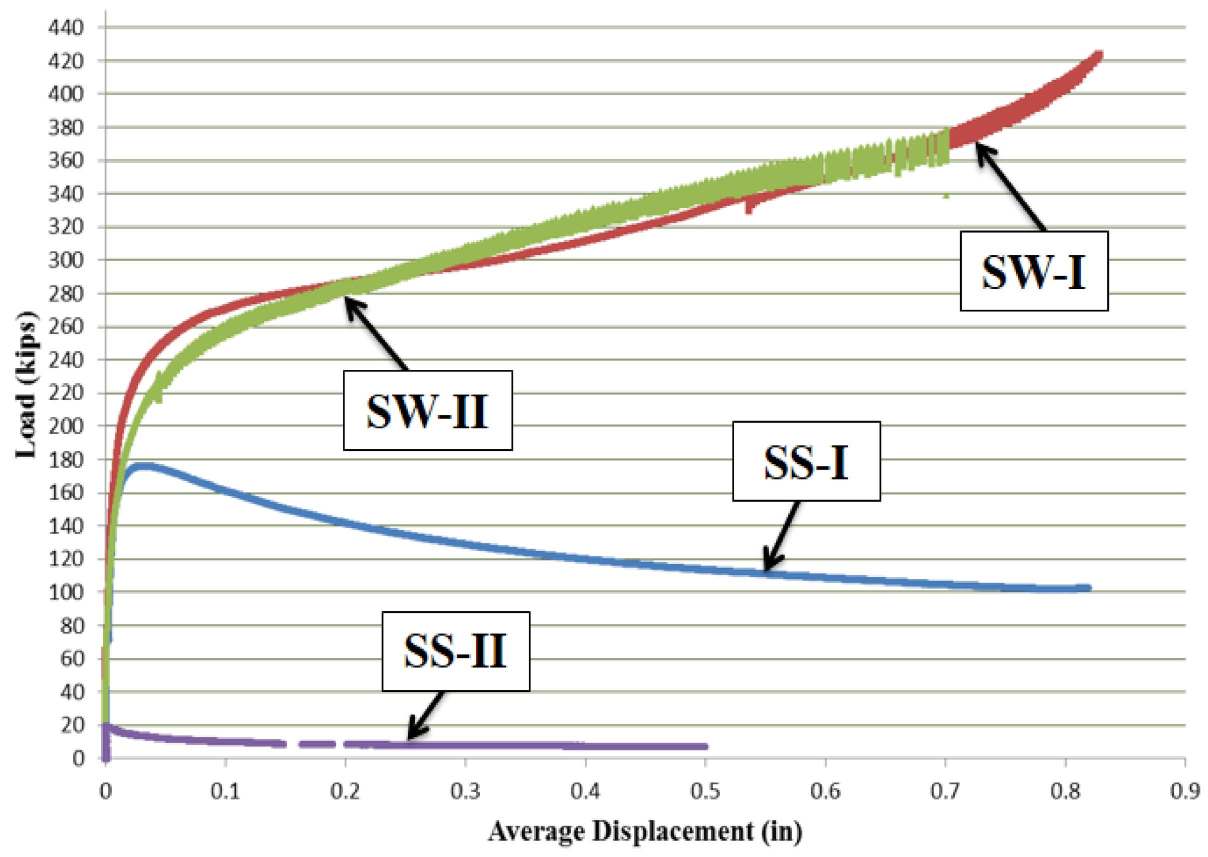

Fig. 4: Load vs. Average Displacement Specimens

The load carrying capacity of the specimens constructed with spiral welded steel tubes were significantly higher than those constructed with straight seem tubes due to the addition of mechanical bond strength by the interior spiral weld.

Both specimens constructed with spiral welded steel tubes had similar load carrying capacities even though the mixture of the concrete cores was different.
The load carrying capacity of SS-II was roughly 10% of the load carrying capacity of specimen SS-I, even though the difference in strength of the concrete core was only 5.5%. This shows that the addition of low shrinkage admixture has a significant affect on the bond strength of the CFT sections constructed with straight seam tubes.
Strain gauge data showed that specimens made with straight seam tubes were generally in compression at the bottom of the specimen, and in tension at the top throughout the load process. Strain in specimens made with spiral welded tubes varied throughout testing.

Conclusions

- CFT specimens constructed with spiral welded steel tubes have a higher bond strength and sections constructed with straight seam tubes.
- CFT sections constructed with a spiral welded steel tube and containing a concrete mix with no low shrinkage admixtures can achieve the similar bond strength as sections containing a concrete mix with low shrinkage admixtures.

Acknowledgments

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References

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