

Full Scale Testing of Double Tee Parking Garage Flange Connections



Double Tee Anchor

A non-corrosive, easy-to-install anchor that stabilizes parking garage flange movement and reduces the need for repeat repairs.



Fortress Stabilization has performed full scale testing of the Double Tee Anchor to repair an active parking garage with typical flange failures. The parking deck's Double Tee beams are 60-feet long, 8-feet wide with a 4-inch, non-topped deck. The Double Tee Anchor is formed using carbon fiber in a U-shaped polymer composite, pre-cured and surface prepped for installation.

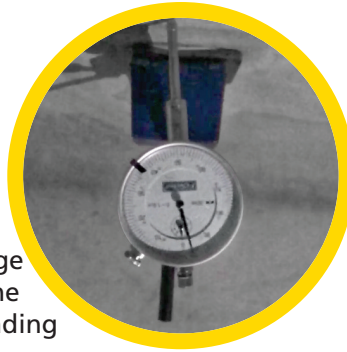
As owners and operators of parking structures know well, standard steel welded flange connections typically fail. Load forces cause premature failure of welded flange connectors either in the connector or more commonly in the concrete flange surrounding the connector. The welded connection is too rigid and causes fatigue failure in the weld or cracking of the concrete surrounding the connector's embedded anchors.

Current composite and steel repair methods also create a rigid joint having similar failures to the original connectors. Without allowing for a nominal amount of movement or flex, the connection is prone to failure. The lack of ductility in these repairs repeats fatigue failure in the concrete or the connector. Fortress Double Tee Anchors significantly reduce movement of the concrete beams while allowing for a small amount of flex in the joint creating a load transfer system through the carbon fiber and arrest fatigue stress in the concrete and the connector.



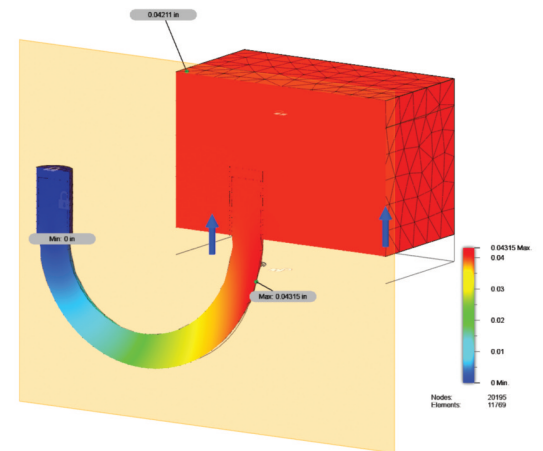
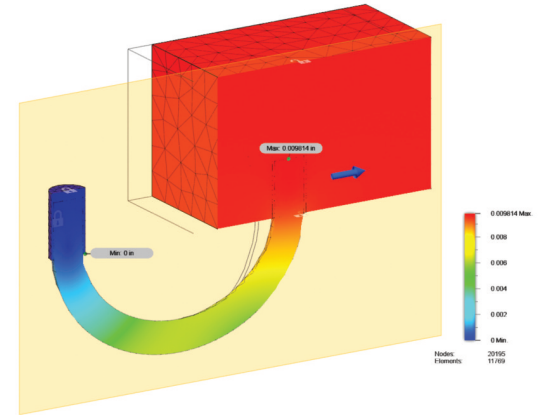
Full Scale Testing

- First, a dial indicator was bonded to the bottom of a Double Tee flange at a joint.
- A 2017 Ford F-150 crew cab was driven over the Double Tee flange joint. The front axle deflected the flange joint and a deflection reading was recorded.
- The Double Tee anchors were insulated 3 feet on center in the middle third of the Double Tee beam and at 6 feet spacing towards the ends of the beam.
- One-inch diameter holes were drilled on each side of the joint to depth of 2-inches. The holes were filled with epoxy paste and the Double Tee Anchors were inserted.
- The bonded assembly was allowed to cure and test resumed over the joint with the F-150.

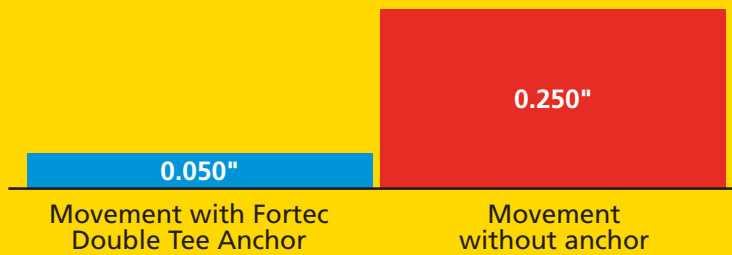


Engineered Solution

Fortress designed the carbon fiber composite profile using FEA models to evaluate horizontal (racking) and vertical (vehicle loads) forces. Physical testing has been performed to withstand over 10 times the movement of an unsupported flange. In addition, cycle testing has also been performed at 4 times the installed strain for 10,000,000 cycles.



Total joint movement observed with dial indicator:



The test joint deflected 5 times less with the Fortress Double TeeAnchor installed. The system is designed so that only the ends of the anchor are inserted into the concrete flange, allowing the middle of the U-Shape to take the strain of the expected loads, and thus not placing stress into the existing concrete. For aesthetic purposes, the carbon can be painted to match the color of the concrete or another finish. The Double Tee Anchor is low profile and does not affect the ceiling clearance of a typical Double Tee beam.



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