BOLTHOLD™ AN43 PULL TEST METHOD

1. Background

The BoltHold chemical asphalt anchors provide a method to mount equipment and devices directly to asphalt roadways and similar asphalt surfaces. One of the most critical metrics for evaluating the suitability of an anchor for a particular application, is the anchor's ability to resist pull forces, thus keeping the load properly anchored to the surface.

This report provides a description of the test method used, and typical test results, to arrive at a pull rating for the anchors.

2. Methodology

The test involves pulling on an installed anchor vertically until (1) it rises a certain amount above the immediate surroundings, or (2) until a certain deformation in the asphalt takes place, whatever comes first.

Case (1) is the typical mode of failure when an anchor breaks away from the material it is embedded in. In the case of asphalt anchors, this failure was observed for expansion or sleeve anchors. These failures occurred at relatively low pull forces -- 100-200 lb. Failure is determined when the anchor rises 1/4" above the asphalt.

Case (2) is applicable to chemical anchors. In the case of the Bolthold chemical anchors, the bond between the anchor and the asphalt is as strong as the asphalt itself. As a result, when the pull force exceeds the strength of the asphalt, the asphalt starts to crown -- a small hill starts to rise concentrically with the anchor. As the force increases, the diameter of the hill increases, as well as its height. Failure is determined when the height of the crown reaches 1/2" above asphalt 6" away, (assuming that the surface is flat for a radius of 9" around the anchor).

Pull-to-failure tests were run for short time periods -- 10-20 seconds.

3. Test Surface

Our tests were performed in one paved residential driveway. The asphalt is at least 20 years old, and is 2" - 2.5" thick. The layer underneath is mostly compacted earth, with little evidence of gravel. We consider the test surface to be sub-standard even for residential driveways. The test results were thus taken as conservative; we have seen better results with better asphalt. Ambient temperatures were between 50F and 80F during the series of tests that were run in the Spring and Fall of 2012 in West Orange, NJ.

4. Anchor Preparation

The anchors were installed following the installation instructions for each model. A hole was drilled and cleaned, filled with EPX2 grout, then the anchor was pushed in until it was flush with the surface. The pull test was performed after at least 24 hours, to allow the grout to fully cure.

5. Test Setup

A force gage was attached to the anchor on one end, and to a cantilevered beam on the other. The beam rests on an hydraulic jack. As the jack is raised, increased force is applied to the anchor and the reading is captured in the gage. A max memory on the gage is used to retrieve the highest reading before the anchor/asphalt yielded.

It is recommended that a stiff spring be added between the gage and the gage, to make the reading less critical and jerky. We were not able to find a suitable spring that is short enough to fit in the limited headspace we had in our setup.

6. Test Results

Model	Forces	Notes
SP12	2,400 lb. To 1/2" crown	
SP10	1,800 lb. To 1/2" crown	
SP18	Over 2,400 lb.	Exceeded limit of force gage
SP14	700 lb. - 900 lb.	

Numerous tests were performed on the SP14 anchors in 2011, on the SP12 and SP10 in 2012 and on the SP18 in 2013. The variations in max pull forces were relatively small -- less than 15% from minimum to maximum.

7. Torque Test

When the equipment is bolted to the anchors, a certain amount of torque is applied to the anchors while tightening the bolts.

We ran a torque test on the SP12 and found that it did not yield with torque as high as 180 inch-pound. When the test was repeated on an anchor that was previously tested to failure (crowning), the anchor still held against a torque of 180 inch-pound. Note that this is not necessarily the torque limit -- it was the maximum torque that we could apply and measure using the torque wrench available to us.

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