PULL-OUT TEST RESULTS OF HILTI FASTENING SYSTEMS

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

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This report presents the results of testing conducted to evaluate the performance of self-drilling expansion anchors submitted by Hilti Fastening Systems of Stamford, Connecticut. Two anchors sizes (5/8 and 3/4 in.) were tested for load capacity at 1/32-in. pull-out.

Purpose

The purpose of these tests was to determine whether Hilti self-drilling expansion anchors are suitable for use on highway projects along with other similar anchors. It has been determined from previous testing programs that the ultimate pull-out load of an expansion anchor usually occurs after considerable slippage has taken place. Since expansion anchors in highway construction are used almost exclusively as lane ties, it is imperative that they be able to sustain maximum loads with minimal slippage. These tests were conducted to determine the load capacity at 1/32 in. slippage.

Test Samples

The samples tested were Hilti and Phillips self-drilling expansion anchors. The Phillips anchors were set and tested to provide a comparison under similar conditions. The Hilti anchors were supplied by the manufacturer in sizes ranging from 1/4 to 3/4 in. Only the 5/8 and 3/4-in. sizes were tested, since the smaller sizes are not generally used on construction projects.

Figure 1 shows the Hilti and Phillips self-drilling expansion anchors. Dimensionally, the anchors are quite similar. The major differences in the two types of anchors are the grooves and the expanding plugs. The grooves of the Hilti anchor are cut around the circumference the full length of the anchor, and only part way on the Phillips. The expanding plugs on the Hilti anchors are approximately 1/2 in. and 3/8 in. shorter than those used by Phillips for the 3/4 and 5/8-in. anchors, respectively. The plug taper is approximately the same. Both types of anchors can be installed using the same driving head.

Installation

The anchors were installed in the edge of an unused ramp at the Grass Lake truck weighing scales located on westbound I 94 near Jackson. The slab was 9 in. thick, built in 1962. Project records show core compressive strengths of approximately 6,000 psi in the vicinity of the area used for the tests.

Three samples of each size and type were installed midway down the slab edge. The holes were drilled with an electric roto-hammer using the anchors as bits. The anchors were expanded over the plugs using a driver and hammer. In order to obtain uniformity, all the anchors were driven to refusal. Anchors were intermixed along the pavement edge in order to minimize the effect of localized concrete conditions.

Testing

Load to the anchors was applied by using a 20,000-lb capacity aluminum testframe (Fig. 2). The load was applied at a uniform rate by the hydraulic pump and cylinder, and monitored by the use of a dynamometer ring and dial indicator. The pull-out load placed on the anchors was recorded when the anchor slippage reached 1/32 in. as measured by means of a dial indicator. Figure 3 shows the drawbar and indicator arrangement used.

Results

Results of the pull-out tests are shown in Table 1. The 5/8-in. Hilti anchors developed approximately 65 percent of the load average sustained by the 5/8-in. Phillips anchors at 1/32 in. pull-out. The 3/4-in. Hilti anchors sustained loads that averaged approximately 40 percent of those developed by the 3/4-in. Phillips anchors.

TABLE 1
PULL-OUT TEST RESULTS

Anchor Type	Bolt Diam., in.	Load at 1/32-in. Pull-Out			Average Load, lb
		Sample 1	Sample 2	Sample 3	
Hilti	5/8	6,800	3,400	1,400	3,900
Phillips	5/8	5,400	6,800	6,200	6,100
Hilti	3/4	3,100	4,000	600	2,600
Phillips	3/4	6,600	5,400	7,400	6,500

One of the 3/4-in. Hilti samples developed a load of only 600 lb at 1/32 in. pull-out. This anchor was pulled out without damage to either the anchor or concrete. Hardness tests performed on the anchor showed it to have a hardness of 42 on the Rockwell "C" scale. Other Hilti anchors had an average hardness of 52, while Phillips anchors showed a hardness value of 56, also on the Rockwell "C" scale. It was also noticed that considerable deformation of the cutting teeth occurred on the Hilti anchors during the drilling operation.

The shorter plug used by the Hilti anchors does not expand the shell as much as the longer plug used by Phillips; therefore, the effective bearing area of the anchor is smaller. This, along with the somewhat milder steel used (which allows more deformation), is probably the reason for the low pull-out loads exhibited by the Hilti anchors.

Recommendations

Based on the results and observations made, it is recommended the Hilti anchors not be allowed for use by the Department.

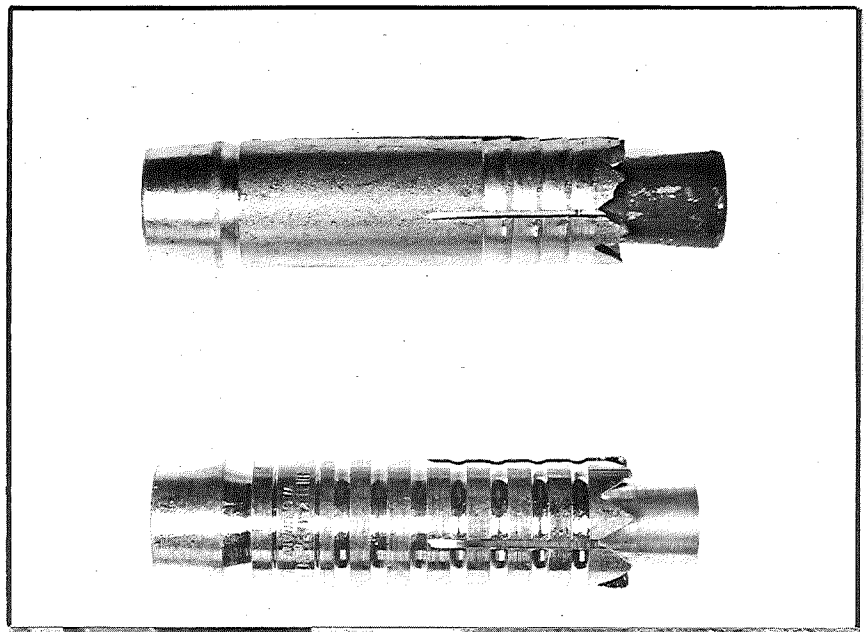
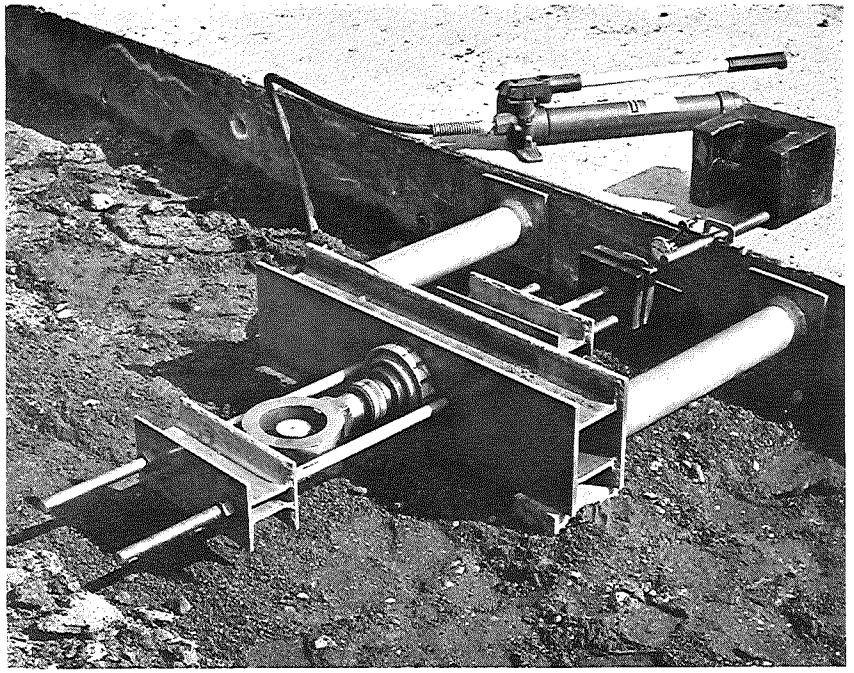


Figure 1. Types of anchors tested: Phillips (top); Hilti (bottom).

Figure 2. 20,000-lb capacity test frame used to apply load to the anchors.



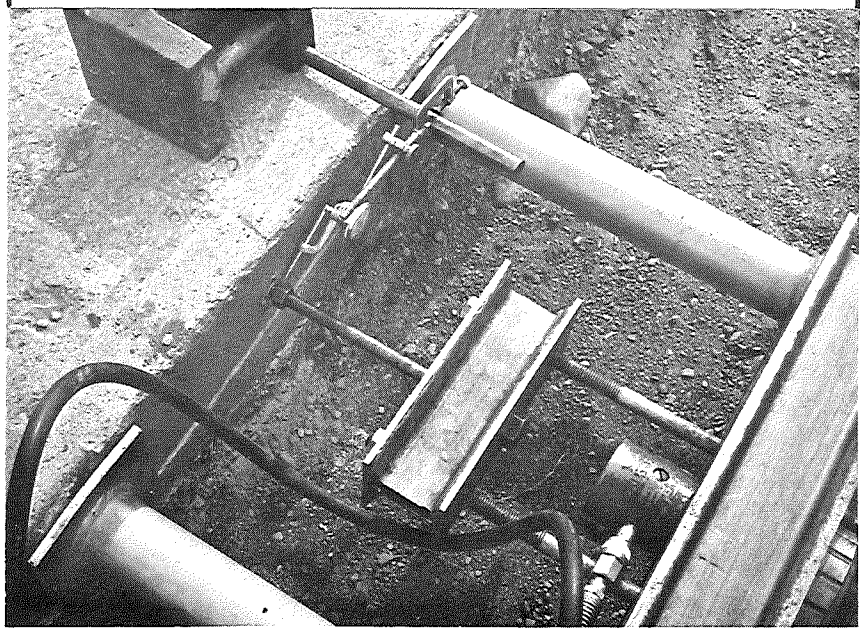


Figure 3. Drawbar and indicator arrangement used to test the anchors.