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14 March 1991

USNRC
Region 4
Attn.: Robert D. Martin
611 Ryan Plaza Drive
Arlington, TX 76011

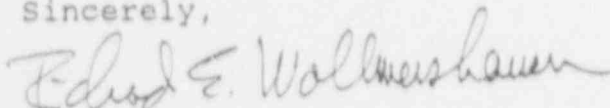
Subject: Hilti Expansion Anchors

Dear Mr. Martin,

We have completed our investigation into the 1" and 3/4" x 12" Hilti Kwik Bolt expansion anchors. Attached is our test report #81-90-E which summarizes our investigation and findings. It also gives revised published values for the 1" anchor.

We have sent this report to all licensees on March 8, 1991, listed in my letter of 11 January 1991. If you have any comments or questions, please call me.

Sincerely,



Richard E. Wollmershauser, P.E.
Director, Technical Services

\rwmartin

PDR



JUN-7 1991

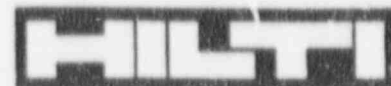


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March 14, 1991

Dear NPP Operator:

RE: Hilti Kwik Bolt II Carbon Steel Expansion Anchors

This is a follow up to my letter of January 8, 1991 regarding the Hilti Kwik Bolt II expansion anchor anomalies observed during testing at two sites in 1990. We have concluded our investigations and testing. The attached Test Report Number 81-90-E summarizes our findings and gives information and data on the revised 1" and 3/4" x 12" Kwik Bolt II machined expansion anchors.

The revision consists of changing the expansion sleeve (wedge) material from AISI 1010 to 304 SS on only the 3/4" x 12" and all 1" Kwik Bolt II expansion anchors. Some of the 1" ultimate tensile and corresponding allowable loads were modified and are presented in the tables in the report.

One of our field engineers will be calling to assist you and your organization in this matter.

In the interim, if you have any questions, please contact Jerry Burrow, Manager, Field Engineering in Tulsa at 1-800-727-3427 or me.

Sincerely,

Richard E. Wollmershaw, P.E.
Director
Technical Services

/rl

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TEST REPORT

HILTI

Number #81-90-E

Date March 7, 1991

Ref

HILTI THREE QUARTER AND ONE INCH KWIK BOLT II INVESTIGATION TESTING SUMMARY

1.0 INTRODUCTION AND PURPOSE

This report summarizes the investigation undertaken to establish the cause of and solution for the unexpected performance of the Hilti Kwik Bolt II one inch and 3/4 x 12" expansion anchors. It includes summaries of testing conducted to support the solution and Quality Assurance testing resulting in the release of an anchor with AISI 304 stainless steel expansion sleeves replacing the AISI 1010 on the original Kwik Bolt II. Hilti's published tensile values for the 1" Kwik Bolt II anchor have been adjusted to reflect test results.

2.0 BACKGROUND INFORMATION

During testing of the Kwik Bolt II in Michigan in June 1990, a number of 1" and 3/4" Kwik Bolt II anchors exhibited unexpected behavior. Although the average ultimate tensile values were well above the published loads, the test values had a larger than expected coefficient of variation. Additional testing at the site could not duplicate this anomaly. Investigation of the site concrete revealed an outside concrete slab with a composition of dolomite aggregate with dolomite fines and a compressive strength in excess of 10,000 psi.

As a follow-up to the Michigan site testing, an in-house investigation was initiated at the Hilti Testing Laboratory in Tulsa, Oklahoma. In an attempt to duplicate the initially observed anomaly, 14 test variations were investigated without any indication of reoccurrence of the anomaly. These test variations included:

- * Concrete with a compressive strength of more than 10,000 psi
- * Drill bit diameters on the high and low end of the tolerance range.
- * River gravel, granite and limestone aggregates.
- * Solid limestone rock.
- * Diamond cored holes.

More than 85 anchors were tested.

In December 1990, during testing of the Kwik Bolt II anchor line in Pennsylvania, an anomaly was reported with the 1" Kwik Bolt II anchor size. Two of four anchors tested pulled out of the concrete at an ultimate load of as much as 70% below published. Subsequent testing conducted at the Pennsylvania site confirmed these findings. Investigation of the concrete revealed an outside concrete slab with a composition of carbonaceous dolomitic limestone, quartz and limestone fines and a compressive strength in excess of 5500 psi.

Recent testing in Michigan and Pennsylvania has shown the anomaly to also occur in outside concrete slabs with; a) carbonaceous limestone, with siliceous fines and a compressive strength in excess of 8000 psi; and, b) fine grained dolomite coarse aggregate and natural siliceous and limestone fines with a compressive strength in excess of 6000 psi.

Testing of the entire Kwik Bolt line showed the 3/4" x 12" anchor bolt made from AISI 11L41 material also exhibited the anomaly. All other sizes, including the cold formed 3/4" anchor sizes, performed as expected.

3.0 TESTING/INVESTIGATION

An extensive investigation into cause and effect, including testing of over 200 anchors, revealed that there existed a variation in the coefficient of friction between the anchor expansion sleeve and different concrete mixtures. Therefore, alternative design modifications to the expansion sleeve/mandrel interface were tested, each intended to reduce the coefficient of friction between the expansion sleeve and the mandrel. Through testing, several design alternatives were evaluated and the best solution was found to be the use of stainless steel expansion sleeves.

4.0 DATA VERIFICATION TESTING

Table 1 supplies the test data for the selected design solution from the Pennsylvania test location.

Tables 2, 3, and 4 present test data depicting average ultimate tensile load values for 2, 4, and 6 ksi concrete. Table 5 presents the Hilti recommended ultimate loads which have been modified based on the test results.

The test results indicate the load values are, in most cases, the same as the data from the carbon steel expansion sleeves. Table 5 notes those values that are different from the previously published data. The reduction in values are less than 10%.

TABLE 1
TEST RESULTS OF 1" KB II AT PENNSYLVANIA SITE
IN CARBONACEOUS DOLOMITIC LIMESTONE AGGREGATE IN EXCESS OF
5500 PSI

ANCHOR DESCRIPTION	ULTIMATE LOAD (LB)	FAILURE MODE	X (LB)	S (LB)	CV %
STANDARD	45950	PULL THROUGH	43003	3559	8.3
MACHINED	48300	PULL THROUGH			
ANCHOR	42450	PULL THROUGH			
STAINLESS	34900	PULL THROUGH			
STEEL SLEEVE	43400	PULL THROUGH			
	43150	PULL THROUGH			
	42900	PULL THROUGH			
	36150	PULL THROUGH			
	41450	PULL THROUGH			
	44700	PULL THROUGH			
	45350	PULL THROUGH			
	41150	PULL THROUGH			
	45400	PULL THROUGH			
	45300	PULL THROUGH			
	44500	PULL THROUGH			

TABLE 2
AVERAGE TEST VALUES FOR 3/4" AND 1" KB-II ANCHORS
WITH 304 STAINLESS STEEL EXPANSION SLEEVES
IN 2245 PSI DOLOMITE CONCRETE

ANCHOR SIZE (IN.)	EMBEDMENT DEPTH (IN.)	SAMPLE SIZE (n)	X (LB)	S (LB)	CV (%)	RECOMMENDED LOAD (LB)
3/4"X12"	4 3/4"	11	13184	606	4.6	11000
	8	5	17600	1055	6.0	15000
1" X 6" 1" X 9" 1" X 12"	4 1/2"	3	13137	477	3.6	12500
	6	11	18862	1271	6.7	18500
	9	5	27364	1281	4.7	25000

TABLE 3
AVERAGE TEST VALUES FOR 3/4" AND 1" KB-II ANCHORS
WITH 304 STAINLESS STEEL EXPANSION SLEEVES
IN 3980 PSI DOLOMITE CONCRETE

ANCHOR SIZE (IN.)	EMBEDMENT DEPTH (IN.)	SAMPLE SIZE (n)	X (LB)	S (LB)	CV (%)	RECOMMENDED LOAD (LB)
3/4" X 12"	4 3/4"	5	20810	684	3.3	18000
	8	3	24217	1028	4.2	22000
1" X 6" 1" X 9" 1" X 12"	4 1/2"	5	17618	1167	6.6	17500
	6*	10	30397	1533	5.0	26500
	9	3	40893	2748	6.7	32500

* Concrete strength was 4150 psi for this embedment depth.

TABLE 4
AVERAGE TEST VALUES FOR 3/4" AND 1" KB-II ANCHORS
WITH 304 STAINLESS STEEL EXPANSION SLEEVES
IN 6520 PSI DOLOMITE CONCRETE

ANCHOR SIZE (IN.)	EMBEDMENT DEPTH (IN.)	SAMPLE SIZE (n)	X (LB)	S (LB)	CV (%)	RECOMMENDED LOAD (LB)
3/4" X 12"	4 3/4"	6	21905	1069	4.9	22,000
	8*	5	28178	778	2.8	23,700
1" X 6" 1" X 9" 1" X 12"	4 1/2"	5	18966	1402	7.4	19,000
	6*	5	31450	1616	4.6	31,500
	9*	5	47378	2872	6.1	40,000

* Concrete strength was 5728 psi for these embedment depths.

TABLE 5
REVISED RECOMMENDED ULTIMATE LOAD VALUES
FOR THE 1" HKB-II ANCHOR LINE
WITH 304 STAINLESS STEEL EXPANSION SLEEVE

EMBEDMENT DEPTH (IN.)	F'C 2000 PSI	F'C 3000 PSI	F'C 4000 PSI	F'C 6000 PSI
4 1/2	12500	15200	17500	19000 *
6	18500 *	22500*	26500	31500 *
9	25000	28750	32500	40000

* These are revised values.