



Hilti Corporation
Feldkircherstrasse 100
FL-9494 Schaan
Principality of Liechtenstein

www.hilti.group

Technical data

**No. 17/0002
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General Part

Trade name	Injection system Hilti HIT-RE 500 V3
Scope of document	HIT-RE 500 V3 for use in natural stone applications
Assessment by	Hilti Corporation Business Unit Anchor Feldkircherstrasse 100 FL-9494 Schaan Principality of Liechtenstein
This assessment contains	5 pages which form an integral part of this assessment
Basis of Technical data assessment	TWU-44/16 (issued: 2017)
Author(s)	T. Zenk, M. Roessle

This document is subject to revision.

Revision log

Version	Date	Comment
1.0	22.05.2017	First release

Hilti HIT-RE 500 V3 in rock base material

The injection mortar system Hilti HIT-RE 500 V3 is a chemical anchor system qualified for anchor and post-installed rebar connections according to the latest guidelines in Europe and US (see [1], [2] and [3]).

Note: Rebar connections in rock material are not covered by any codes or regulations.

Tests and results

Pull-out tests with Hilti HIT-RE 500 V3 and rebar $d = 25$ mm were performed at the Hilti test lab in Schaan, Liechtenstein. The following four rock types were tested:

- Gneissic rock ($f_{um} = 145$ MPa)
- Granite rock ($f_{um} = 183$ MPa)
- Basalt rock, type Bengal Black ($f_{um} = 343$ MPa)
- Basalt rock, type Indian Black ($f_{um} = 314$ MPa)

Note: compressive strength f_{um} has been measured on cored cylinders with $h = 100$ mm and $d = 100$ mm.





The tests (5 samples in each rock type) were performed at standard ambient temperature in confined condition (narrow support) to provoke bond failure of the mortar and avoid cone failure of the base material. The reinforcing bars were installed with compressed air cleaning according to the manufacturer instruction [4].

The test results are summarized in Table 1:

Rock specification		Gneiss	Granite	Bengal Black	Indian Black
Compressive strength f_{um} ¹⁾	[MPa]	145	183	343	314
Nominal rebar diameter d	[mm]	25	25	25	25
Drilling diameter d_0	[mm]	32	32	32	32
Embedment depth h_{ef}	[mm]	75	75	75	75
Ultimate load $N_{u,test1}$	[kN]	165.1	159.1	230.0	184.4
Ultimate load $N_{u,test2}$	[kN]	163.2	160.7	209.8	179.3
Ultimate load $N_{u,test3}$	[kN]	175.7	159.2	210.9	184.3
Ultimate load $N_{u,test4}$	[kN]	180.9	159.4	203.7	143.7
Ultimate load $N_{u,test5}$	[kN]	147.5	123.3	203.2	-
Mean ultimate load N_{um}	[kN]	166.5	152.3	211.5	172.9
Mean bond strength τ_{um}	[MPa]	28.3	25.9	35.9	29.4
Coef. of variation CoV	[%]	7.7	10.7	5.2	19.6
Failure mode		Pull out	Pull out	Pull out	Splitting

¹⁾ compressive strength f_{um} has been measured on cored cylinders with $h = 100$ mm and $d = 100$ mm

Table 1: Summary of test results Hilti HIT-RE 500 V3 in rock, detailed information given in [5]

			
Gneiss	Granite	Bengal Black	Indian Black ¹⁾

1) The rock "Indian black" was so brittle that it split at failure load.

Table 2: Photos of test samples during or after testing with Hilti HIT-RE 500 V3 and rebar d = 25 mm, detailed information given in [5]

The following notes are important to consider:

- The data only concerns the bond at the interface between the reinforcing bars and the rock.
- Other failure modes related to the rock itself may occur, therefore it is the sole responsibility of the design engineer to ensure the transfer of the forces into the surrounding rock according to the principles of Rock Mechanics.
- All tests are confined at room temperature.
- The data are based on hammer-drilled, dry holes cleaned with compressed air and injected according to the manufacturer's instruction [4]. Deviations in the installation procedure may lead to poor performance of the product.
- The data refer only to the base materials as tested.
- The data do not include any provision for influence of the base material or environment on the bond strength.

The following parameters have not been tested according to [6]:

- Functioning under sustained loads
- Failure under increasing temperature (fire)
- Corrosion resistance of rebar
- Durability of mortar
- Functioning under freeze / thaw conditions
- Installation safety in wet rock conditions

Design of rock anchoring applications:

Hilti is not familiar with design for rock anchoring applications. Especially the behavior of the base material e.g. cracks or clefts is dependent on local situations and can't be predicted by Hilti. Therefore, it is recommended to consult specialists (geologist and geotechnical engineers) for the design of rock anchoring.

However, the performed tests show that there is a high bond strength between the reinforcing bar and the rock with Hilti HIT-RE 500 V3. Since there is a lack of criteria to assess the design bond strength of chemical anchor systems for rock applications Hilti recommends to proceed for this application in an analogous way compared to the approach for post-installed rebar connections according to [6].

The design bond strength considers pull-out failure of the tested base material only. The results of the assessment valid for the tested materials is given in Table 3.

Other failure modes e.g. steel failure or failure of the base material has to be considered separately.

Rock specification		Gneiss	Granite	Bengal Black	Indian Black
Compressive strength f_{um} ¹⁾	[MPa]	145	183	343	314
Nominal rebar diameter d	[mm]	25	25	25	25
Drilling diameter d_0	[mm]	32	32	32	32
Recommended design bond strength f_{bd}	[MPa]	4,3	4,3	4,3	4,3

¹⁾ compressive strength f_{um} has been measured on cored cylinders with $h = 100$ mm and $d = 100$ mm

Table 3: Recommended design bond strength f_{bd} for Hilti HIT-RE 500 V3 in the tested base material

Remarks:

- The bond strength f_{bd} according to Table 3 fulfills the safety requirements of post-installed rebar connections according to [6].
- The recommended bond strength f_{bd} values shall not be used for diamond cored holes since no tests have been performed in cored holes.
- Values applies for temperature range 24 °C long term / 40 °C short term only.
- Installation must follow the manufacturer’s instruction for use [4]. Cleaning: Compressed air and use steel brushes is required.
- Drilled hole diameters and setting parameters shall follow manufacturer’s instruction for use [4].

Signature / Department

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30.05.2017

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Michael Röble
Group Manager Approval & TechData
Signiert von: Roessle Michael

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Thomas Zenk
Approvals & Technical Data
Signiert von: Zenk Thomas

References:

- [1] ETA-16/0142 European Technical Assessment: Post installed rebar connections diameter 8 to 40 mm made with Hilti HIT-RE 500 V3, issued 07.11.2016
- [2] ETA-16/0143 European Technical Assessment: Bonded fastener with threaded rods, rebar, internally sleeve and Hilti tension anchor HZA for use in concrete, issued from 30.11.2016
- [3] ESR-3814, Hilti HIT-RE 500 V3 Adhesive anchors and post-installed reinforcing bar connections in cracked and uncracked concrete, issued 01/2017
- [4] Hilti instruction for use (IFU) Hilti HIT-RE 500 V3, 2017
- [5] Hilti test report TWU-44/16, 2017
- [6] EAD 330087-00-0601: Adopted European Assessment Document according to Regulation (EU) № 305/2011, Annex II 7: Systems for post-installed rebar connections with mortars