HILTI HUS3-H6
Screw anchor

MFPA Fire Assessment

GS 6.1/21-041-2 (29.06.2022)

MFPA Leipzig GmbH

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Object:	Assessment of the load bearing behaviour of Hilti screw anchors HUS3-H 6 under tension load and one-sided fire loading according to the standard temperature-time curve for anchoring in prestressed concrete hollow core slabs - abbreviated version
Client:	**Hilti Aktiengesellschaft** Feldkircherstrasse 100 9494 Schaan Liechtenstein
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This document covers 9 pages, including 0 appendices.

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1 Objective and request

MFPA Leipzig GmbH was ordered by Hilti AG to assess the load bearing behaviour of Hilti screw anchors HUS3 and HUS4 under tension load and one-sided fire loading according to the standard temperature-time curve (STTC, see [N1]) for anchoring in prestressed concrete hollow core slabs.
The document at hand summarizes the design concept and the corresponding characteristic load bearing capacities for Hilti screw anchors HUS3-H 6. For the detailed derivation of the values, please see [G1].

2 Description of the construction

The Hilti screw anchor HUS3 is an anchor made of galvanized steel, produced in sizes 6, 8, 10 and 14. The anchor is screwed into a pre-drilled cylindrical drill hole, with the special thread cutting an internal thread into the anchoring base during the setting process. Anchoring is achieved by mechanical interlock of the special thread. With [P1], a current European Technical Assessment is available for Hilti screw anchors HUS3.
The Hilti screw anchor HUS3 is offered in the following head types

- -H: hexagonal head,
- -A: external thread,
- -C: countersunk head,
- -P: pan head as well as
- -I: internal thread

The advisory opinion at hand covers Hilti screw anchors HUS3-H with hexagonal head.

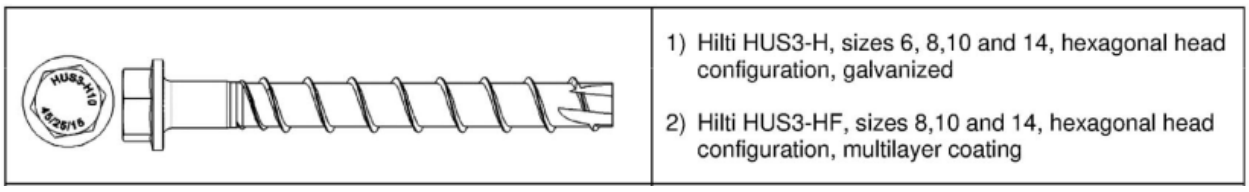

Figure 1: Hilti screw anchor HUS3-H, from [P1]

The on-site geometry of Hilti screw anchors HUS3-H is specified in Figure 2 (from [P1]).

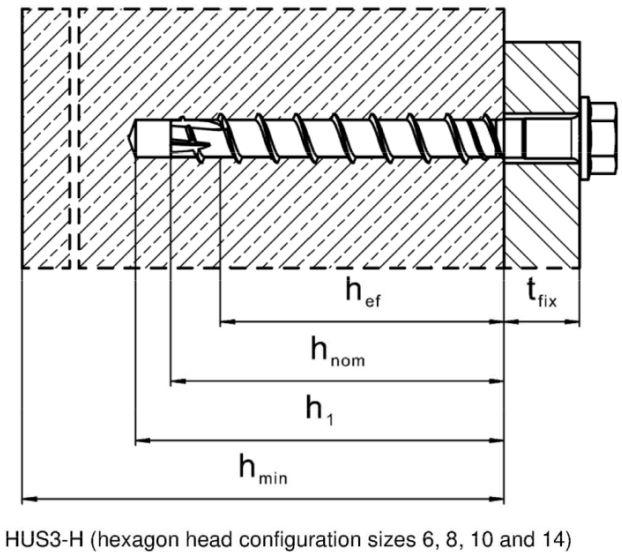

Figure 2: Hilti screw anchor HUS3-H: On-site geometry, from [P1]

Different nominal embedment depths are provided for each screw size. In order to realize a wide range of attachment thicknesses t_{fix}, additionally, Hilti screw anchors HUS3 are available in different lengths.
In connection with the performance characteristics in case of fire for anchoring in prestressed concrete hollow core slabs, the screw anchor

- HUS3-H 6

is investigated.

3 References

3.1 Utilized guidelines, rules and standards

The analyses are based on the following guidelines, rules and standards:

[N1] DIN EN 1363-1:2020-05: Fire resistance tests - Part 1: General requirements; German version EN 1363-1:2020

[N2] DIN EN 1992-4:2019-04: Eurocode 2 - Design of concrete structures - Part 4: Design of fastenings for use in concrete; German version EN 1992-4:2018

[N3] DIN EN 206:2017-01: Concrete - Specification, performance, production and conformity; German version EN 206:2013+A1:2016

[N4] DIN EN 1992-1-2:2010-12: Eurocode 2: Design of concrete structures - Part 1-2: General rules - Structural fire design; German version EN 1992-1-2:2004 + AC:2008

3.2 Reference documents

The analyses are based on the following additional documents:

3.2.1 ETAs and verifications of applicability

[P1] ETA-13/1038: Hilti screw anchor HUS3, Concrete screw for use in concrete – Deutsches Institut für Bautechnik, 28.07.2020

3.2.2 Assessment and test reports

[G1] Gutachterliche Stellungnahme Nr. GS 6.1/21-041-1: Bewertung des Tragverhaltens von Hilti Betonschrauben HUS3 und HUS4 unter zentrischem Zug und einseitiger Brandbeanspruchung gemäß Einheitstemperaturzeitkurve bei Verankerung in Spannbetonhohldielen – MFPA Leipzig GmbH; 21.06.2022

4 Assessment of the performance

4.1 Design concept

The characteristic load bearing capacity of a fastener under centric tensile loading in case of fire shall be determined from the minimum value of the load bearing capacity for steel failure, pull-out failure and concrete cone failure

$$N_{Rk,fi}(t) = min\left[N_{Rk,s,fi}(t), \quad N_{Rk,p,fi}(t), \quad N_{Rk,c,fi}(t)\right]. \tag{1}$$

In connection with the failure mode concrete cone failure, the load bearing capacity $N^0_{Rk,c,fi}(t)$ $[kN]$ for concrete cone failure of a single fastener is determined below. The characteristic load bearing capacity $N_{Rk,c,fi}$ to be considered in the framework of the design has to be determined for each specific construction capturing the influences of neighbouring anchors and the edge distance. In this context, reference is given to [N2], Chapter 7.2.1.4 and Appendix D.4.2.2.

4.2 Load bearing capacity in case of fire

The characteristic load bearing capacity of a single screw HUS3-H 6 in case of fire is specified in Table 1.

screw	$N_{Rk,fi}(t)$ $[kN]$			
	30min	60min	90min	120min
$h \geq 265mm$, $h_1 \geq 35mm$, $h_{ef} \geq 35mm$				
HUS3-H 6	0,260	0,260	0,260	0,260
$h \geq 380mm$, $h_1 \geq 40mm$, $h_{ef} \geq 40mm$				
HUS3-H 6	0,449	0,449	0,299	0,299

Table 1: Hilti screw anchor HUS3-H 6 for anchoring in prestressed concrete hollow core slabs: Characteristic load bearing capacity $N_{Rk,fi}(t)$ $[kN]$ of a single screw (h: cross section height, h_1: concrete thickness below the hollows, h_{ef}: embedment depth)

5 Special notes

The advisory opinion at hand is valid for Hilti screw anchors HUS3-H in combination with prestressed concrete hollow core slabs which are installed according to the manufacturer's instructions.

The load bearing capacities specified in the framework of the document at hand are determined for one-sided fire loading according to the standard temperature-time curve and are valid exclusively for this thermal loading.

The load bearing capacities specified in the framework of the document at hand are determined for centrical tensile loading in the screw anchor's longitudinal direction. Following [N2], on the safe side, a transfer to steel failure is possible for tensile loads perpendicular and oblique to the anchor axis.

The load bearing capacity values shown in this document do not apply to the failure modes of the substrate under tensile loads perpendicular and oblique to the anchor axis.

The assessment at hand is valid for prestressed concrete hollow core slabs which exhibit the strength class $\geq$ C20/25 and $\leq$ C50/60 according to [N3]. Proof of the adequate fire resistance of the prestressed concrete hollow core slabs is to be provided separately.

The load bearing capacities specified in the framework of the document at hand are determined assuming that no explosive concrete spalling occurs and are only valid under this condition. Evidence on the prevention of explosive concrete spalling is given in [N4], Chapter 4.5.

6 Signatures

This document does not replace a certificate of constancy of performance or suitability according to national and European building codes.

Leipzig, 29.06.2022

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