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Expert report

on the applicability of

HILTI HIT®-HY 70

in glass construction

Rev. 1

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This expert report consists of 17 pages.

0 List of contents:

1. General

HILTI HIT®-HY 70 is an injectable adhesive mortar system originally intended for dowel fastening. For years, the application of the previous product model HIT®-HY 50 has also proven reliable in the field of structural glass construction. The fast curing and easy-to-use composite mortar system is applied in glass construction for load transmission with e.g. bearing type joints. The injectable adhesive mortar here forms a sufficiently rigid system for load transmission and prevents the contact between metal and glass. Further applications for load transmission, such as with fully glazed railing balustrades, have already been realised and will be further elaborated. For the application as an anchoring system in the brickwork, HIT®-HY 70 was granted a general technical approval [a]. The objective of this expert report is to establish the properties of the succeeding product model HIT®-HY 70 as relevant for structural glass construction. Here the mechanical characteristics shall be established and at the same time a simple design aid for bearing type joints shall be provided. Finally, a comparison of the previous model (HIT®-HY 50) and the succeeding product (HIT®-HY 70) is drawn so as to take advantage of the already extensive experience with HIT®-HY 50 in glass construction in connection with the new product.

The injectable adhesive mortar HIT®-HY 70 is a reaction resin-based mortar consisting of an organic binder and an inorganic binder. The organic binder consists of urethane methacrylate resin and reactive dilutants. The second binder consists of cement and the equivalent quantity of water which is required for hydraulic setting. The load-carrying capacity of the hybrid mortar system is primarily determined by the organic binder. The mixing ratio of the two components is 3:1. The air void content of the mortar is lower than 1% according to HILTI's information.

2. Documents on which the expert report is based

[a] Zulassungsbescheid Nr. Z-21.3-1830 des Deutschen Institutes für Bautechnik, Berlin vom 14.11.2006für HILTI Injektionsanker System HIT®-HY 70

[b] Verarbeitungsanweisung HIT-HY 70 im Glasbau, Firma HILTI

[c] HILTI HIT®-HY 70 im Glasbau- Verarbeitungshinweise für Einzelpunkthalter

[d] Prüfbericht 2007-2065 des Labors für Stahl- und Leichtmetallbau der Fachhochschule München

[e] Gebrauchsanweisung HILTI HIT®-HY 70 (Beipackbroschüre)

[f] Begleitende Untersuchungen zur Anwendung von HIT-HY 70 im konstruktiven Glasbau

[g] Dr. Schuler, C.; Bemessungskonzept für Lochleibungsverbindungen mit HILTI HIT®-HY 70

[h] Diverse Prüfberichte des Labors für Stahl und Leichtmetallbau der Fachhochschule München zu Stahl- Glas Verbindungen mit HIT® HY50

[i] Untersuchungsbericht Nr. 3626/241/07 der MPA Braunschweig vom 25.04.2007

[j] Mauthe, P.; HIT®-HY 50 Relevante Produkteigenschaften für den Einsatz im Glasbau vom10.07.1999

[k] Rehm, G.; Franke, L.; Zeus, K.: Kunstharzmörtel und Kunstharzbetone unter Kurzzeit- und Dauerstandbelastung; Deutscher Ausschuss für Stahlbeton Heft 309

[l] Franke, L.; „Gutachten, Erarbeitung eines Vorschlages für die zulässigen Druckspannungen für den Einsatz des HILTI Mörtelproduktes HY50“, vom 15.03.1999

[m] DIN 4102 T1 Brandverhalten von Baustoffen und Bauteilen, 1998-05

[n] DIN 18800 T1-T4 Stahlbauten; Bemessung und Konstruktion, 1990-11

[o] DIN 53752 Prüfung von Kunststoffen; Bestimmung des thermischen Längenausdehnungskoeffizienten, 1980-12

3. Tests performed

The following characteristics and properties were established in experiments:

3.1 Compressive strength

Compressive strength was established using cylindrical samples with the dimensions Ø5 x 10 mm. The tests were varied by factors of different sample conditionings and test temperature. Five to eight samples were tested of one sample type each. The production and conditioning was effected by the HILTI company according to a test schedule agreed on with the author of the report, and was monitored on the basis of random checks by an employee of the latter. The table below shows the parameters:

Table 1: Test parameter

Duration of conditioning [days]	Conditioning	Test temperature [°C]
1, 2, 3, 4, 7, 14, 21, 28, 120	Standard climate*	23
1, 2, 3, 4, 7	50°C	23
1, 3, 7, 14, 21, 28	below water	23
28	Standard climate*	-20
28	Standard climate*	80
10	Standard climate*	60

*) 23°C / 50% humidity

The samples with conditioning below water and with 50°C were stored one day in a standard climate before and after the stated duration. The execution of the test was also carried out by the HILTI company, except for the test temperatures -20°C, 60°C and 80°C. The test equipment as well as the test procedures had been previously approved by the author. The tests were partially accompanied by a member of the author's staff. A universal 50 kN test machine supplied by the Zwick company served as a test machine (accuracy class 1). After the application of an initial load of 50 N, the samples were loaded with a test speed of 1 mm/min up to breaking load. The breaking stress was established via the correlation "Force / sample base“. The results of the individual tests are documented in [f]. The high and/or low temperature tests were carried out in the *Labor für Stahl- und Leichtmetallbau* [Laboratory for steel and light metal construction] of the *Fachhochschule München* [Munich Technical College] and they are documented in the test report 2007-2057 [d].

3.2 Elastic modulus

The determination of the modulus of elasticity was effected using the same samples as the compressive strength test. The determination of the elastic modulus was performed by means of the correlation:

$$\mathrm{E} = \frac{\sigma_2 - \sigma_1}{\varepsilon_2 - \varepsilon_1} \qquad \text{(eq. 1)}$$

The results of the individual tests are documented in [f].

3.3 Determination of shrinkage

The amount of shrinkage was established by means of internal tests by the HILTI company. The description of the tests can be found in [f].

3.4 Coefficient of thermal expansion

The coefficient of thermal expansion was established on the basis of DIN 53783 by the HILTI company. The test execution is described in detail in [f].

3.5 Continuous load

To establish the load-bearing behaviour under continuous stress conditions, 8 samples in all were installed on the continuous load test bench of the HILTI company. The tested installation situation corresponded to a bearing type joint without any transverse elongation impediment of the HIT®-HY 70 material.

To this end, steel bolts of a thickness of 10 mm were cast into a drilled hole of a diameter of 50 mm. The hole was located in steel plates of a thickness of 8 mm and/or 30 mm. The load was effected eccentrically by two loops at the two ends of the bolts. The deformation was continually recorded via inductive distance recorders. The test was recorded over a time period of approx. 2400 hours (~ 3 months). The exact test set-up can be found in the test report by the HILTI company [f]. In addition, a creep test was carried out by the *Labor für Stahl- und Leichtmetallbau* [Laboratory for steel and light metal construction] with the configuration of the bolt diameter being 16 mm and the plate thickness 8 mm. The results of the tests are summarised in [d] .

3.6 Compatibilities with plastic in glass construction

The compatibility of HIT-HY 70 with the following materials was tested.

- Polyvinyl butyral sheeting (PVB)* by the Kuraray Europe GmbH company, Trosilfol division
- Sentry Glas Plus Folie** [Sentry Glass Plus sheeting] by the company Dupont SGP®
- Dow Corning® 993 structural glazing sealant

*Laminated glass sample with TROSIFOL XT 90 2.28 mm and BG R15 0.76 mm
**Laminated glass samples by the Seele company with a sheeting of 1.59 mm

The tests were carried out by the HILTI company. The exact test set-up can be found in the test report by the HILTI company [f].

3.7 Building material class

The building material class was determined on the basis of DIN 4102-1 by MPA [Civil Engineering Materials Testing Institute] of Braunschweig.

4. Short-time strength and elastic modulus

In the following, the established short-term strength values and the elastic moduli are presented in tabular form. The description of the test execution can be found in item 3. The average as well as the 5% and 95% fractile values (logarithmic normal distribution with 75% confidence factor) are stated. The individual values are to be found in the test reports [d] and [f]. These results serve to establish the creep resistance on the basis of the tests by Rehm, Franke and Zeus [k]. The results stated in tables 2 to 5 serve to assess the influencing factors which may become relevant for the calculation.

Conditioning in standard climatic conditions

These tests served to examine the influence of the storage duration on the strength of the product in standard climatic conditions. The results showed that the storage duration in standard climatic conditions does not have any significant influence on the strength of HIT-HY 70.

Table 2: Compressive strength values Standard climate

Storage duration [days]	Compressive strength [N/mm²]			E-module [N/mm²]		
	Average	5% Fractiles	95% Fractiles	Average	5% Fractiles	95% Fractiles
1	65.5	52.5	73.6	1760	1458	1947
2	64.8	56.3	70.1	1740	1564	1850
3	68.7	66.0	70.3	1792	1726	1831
4	70.8	63.4	75.2	1842	1619	1975
7	64.7	60.5	66.9	1730	1327	1916
14	66.5	56.6	71.1	1870	1785	1910
21	64.7	62.9	65.8	1632	1503	1708
28	57.0	48.6	61.8	1690	1301	1931
120	68.0	61.4	71.6	1793	1443	1988

Conditioning by water storage

These tests were designed to examine whether water, as an aggressive medium, has an effect on the strength of HIT®-HY 70. The results showed that in the first days of curing, the strength of HIT®-HY 70 decreased slightly. **After a curing period of 28 days, no further strength decrease was detected**. The elastic modulus achieved the level of conditioning in standard climatic conditions after a curing period of 28 days.

Table 3: Compressive values - water storage

Storage duration [days]	Compressive strength [N/mm²]			E-module [N/mm²]		
	Average	5% Fractiles	95% Fractiles	Average	5% Fractiles	95% Fractiles
1	58.3	54.4	60.5	1482	1291	1590
3	64.4	56.0	69.6	1411	1140	1579
7	64.0	62.2	65.1	1583	1371	1712
14	57.2	53.2	59.4	1323	1288	1343
21	55.0	52.6	56.4	1433	1378	1464
28	67.0	60.2	70.9	1818	1685	1894

Conditioning via temperature storage

These tests served to detect the behaviour of the injectable adhesive mortar HIT®-HY 70 in the first days of the curing phase, if the mortar is applied at a relatively high temperature. **The results showed that in this case no strength decrease is to be found.** The elastic modulus achieved the level of conditioning in standard climatic conditions after a curing period of 4 days.

Table 4: Compressive strength values Storage at 50°C

Storage duration [days]	Compressive strength [N/mm²]			E-module [N/mm²]		
	Average	5% Fractiles	95% Fractiles	Average	5% Fractiles	95% Fractiles
1	63.8	52.2	70.7	1565	1380	1676
2	66.3	59.9	70.1	1579	1435	1665
3	62.3	58.7	64.5	1586	1336	1736
4	73.6	71.1	75.1	1831	1713	1904
7	71.0	60.2	77.8	1986	1438	2326

Test at high and low temperatures

These tests served to examine how HIT®-HY 70 behaves after the curing process at the recommended upper and lower application temperature ('in service temperature'). The results showed that at low temperature the strength increases considerably. At a test temperature of 60°C, a strength reduction of virtually zero is detected. But at a temperature of 80°C, the strength decreased considerably. **Thus a significant strength reduction will not occur at the maximum temperatures of 50 to 60°C which are assumed for glass construction.** The elastic modulus decreased considerably at high temperatures and increased considerably at low temperatures.

Table 5: Compressive strength values Test temperatures -20°C, 60°C and 80°C

Test temperature	Compressive strength [N/mm²]			E-module [N/mm²]		
	Average	5% Fractiles	95% Fractiles	Average	5% Fractiles	95% Fractiles
-20°C	83.5	76.5	87.2	2458	2301	2541
23°C	57.0 - 70.8	48.6 - 63.4	61.8 - 75.2	1632-1793	1301-1785	1708-1988
60°C	67.0	60.2	70.7	1475	1214	1631
80°C	41.9	37.1	44.4	1056	854	1163

5. Long-term strength

Long-term strength was established on the basis of the results gained from tests by Rehm, Franke and Zeus [k]. To this end, the admissible compressive strength is determined on the basis of the short-term strength values by reducing the short-term values via various factors. These reducing coefficients take the following factors into consideration:

- creep strength
- increased temperatures
- aging

- material scattering.

The system was designed for a service life of $2x10^5$ hours (~25 years).

The calculated value of strength is established based on [k], with the following correlation:

$$\sigma_R = \frac{\sigma_{5\%}}{A} \qquad \text{(eq. 2)}$$

where $\sigma_{5\%}$ = 58.7 N/mm²

The fractile value of 5% for the design is calculated from all average values of the 5% fractiles for samples with conditioning and testing in standard climatic conditions. It amounts to 58.7 N/mm².

A = A1 x A2 x A3 x A4 (eq. 3)

with:

A1 = 1.7

Factor A1 takes the correlation of short-term strength and long-term strength at room temperature into consideration. The value of 1.7 corresponds to a reduction of the short-term strength established on the basis of [k] of approx. 60%.

A2 = 1.0

A2 is the reducing coefficient allowing for aggressive media. Here we assume that the injectable adhesive mortar is protected from directly attacking media and so will not weather. We start by just postulating contact with water which might reach the mortar surface via penetration. The tests with samples of water storage (see table 3) show that this will not lead to a strength reduction.

A3 = 1.1 and/or 1.5

With factor A3, the influence of temporarily increased temperature is taken into consideration. The results of the strength tests at high and low temperatures show that a strength reduction may occur at temperatures exceeding 60°C. For this field of application, the author recommends to set the factor A3 to 1.5. Curing at an increased temperature (up to 50°C) does not have any effect (see table 4).

A4 = 1.0 The value would have to be determined.

The factor A4 considers strength-reducing factors which were not covered by the tests. A4 is generally set to 1.0, as the fractile value of 5% must be used for β_R.

In consideration of the above stated values, the compressive strength up to 60°C amounts to the calculated value of:

$$\sigma_R = \frac{58.7}{1.7x1.0x1.1x1.0} = \underline{31\,N/mm^2} \qquad \text{(eq. 4)}$$

This value does not include any safety factors, as in a calculation using partial safety factors the values γ_f are already considered in the assumed loads. With respect to the material, we recommend taking γ_m = 1.1 as a safety factor.

6. Simple design formula for shear-bearing-connections

At the request of the HILTI company, the user was to be provided with a simple design formula to calculate the compressive stress in HIT®-HY 70 for shear-bearing-connections. The design formula was developed on the basis of finite element calculations using parameter studies [g]. The calibration of the finite element model was carried out by experimental examinations [d]. The following pictures show the test set-up and the generated FE model.

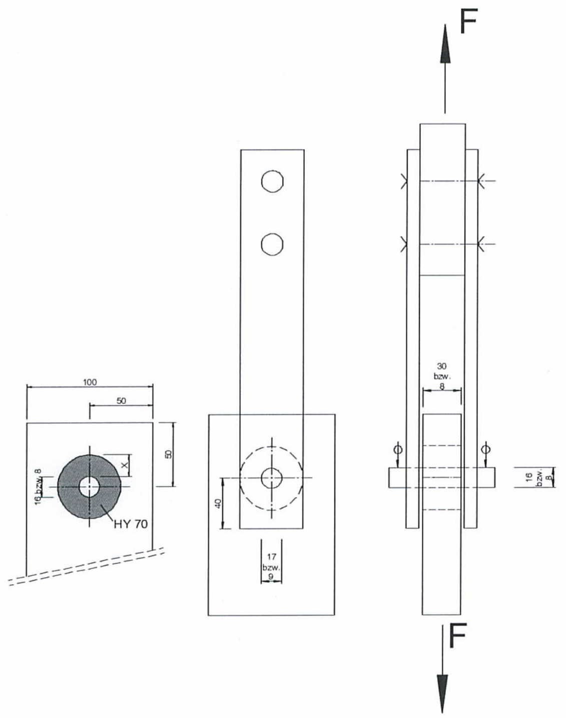


Fig. 1: Test set-up [d]

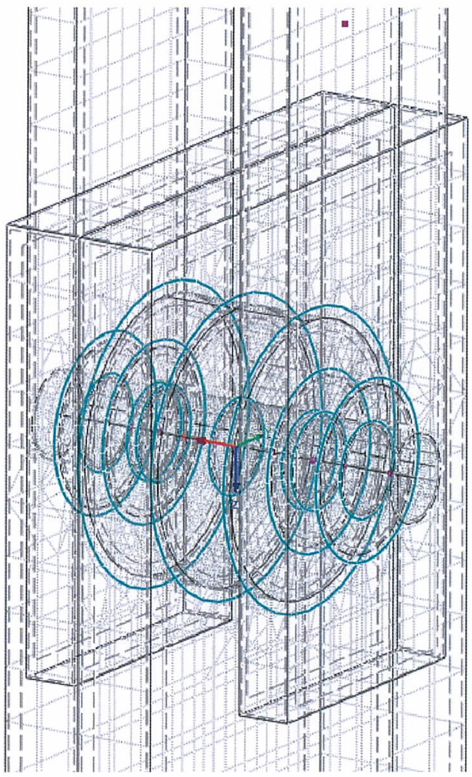
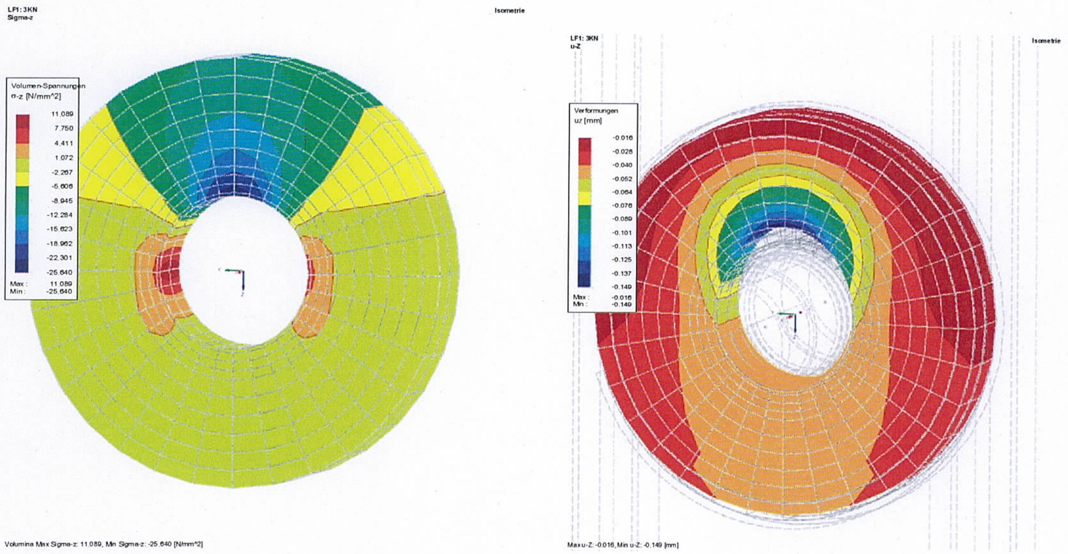


Fig. 2: FE model [g]



Figs. 3 and 4: Applicable stresses (tensile and compressive) in the HIT®-HY 70 material [g]

To establish the design concept, a parameter study was performed on the basis of the numerical model described above ($Ø_{bolt}$; t; $Ø_{hole}$) which was based on 'conventional' connection geometries as understood in steel, metal and glass construction.

The calculation results showed that the material thickness t and the bolt diameter d have a great influence on the maximum amount of the compressive stresses of the composite mortar HIT®-HY 70. The influence of the gap thickness (dimension X, see Fig. 1) is low, which can be attributed to the pressure distribution surface. **The following design formula only applies to the dimensioning of the mortar substance. The proof for the bolt and the pane will still be required.**

The following design formula was set up for centric stress:

$$F_{RD} = \frac{\sigma_{RD} \cdot t \cdot d}{\alpha_t \cdot \alpha_d} \qquad \text{(eq. 5)}$$

t Thickness of the drilled hole

d Diameter of the bolt

α_t Influencing factor of material thickness

α_d Influencing factor of Hilti Hit gap thickness

In parameter studies, the influencing factors α_t and α_d were established as follows.

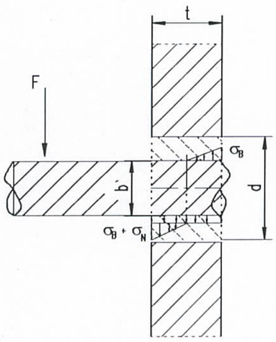
$\alpha_t = 1.15$ with material thickness <= 15 mm

$\alpha_t = 1.20$ with material thickness > 15 mm

$\alpha_d = 1.08$ with a min. gap thickness of 3 mm to a max. of 20 mm

Design formula for eccentric stress

In case of eccentric stress, as is possible for example in glass construction via eccentric fastening points (e.g. fastening points with joint outside of the glass centre), additional moment stress may act on the bearing type joint. This moment stress can be transferred via plate fasteners applied to the loop surface and must consequently not be absorbed by the bolt within the composite mortar. This is shown in the following picture.



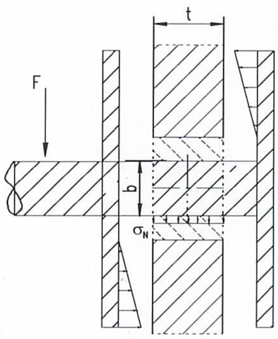


Fig. 5: Moment transfer via HIT-HY70 **Fig. 6:** Moment transfer via plate

If it cannot be excluded that the moment stress must be absorbed within the drilled hole, a calculation of the additional stress can be effected via eq. 7. For the application of eq. 7, the bolt in the drill area must be measured based on [DIN 18800] in an elastic - elastic method.

$$\sigma_D = \alpha_d \cdot \alpha_t \cdot \left(\frac{F_D}{b \cdot t} + \frac{M_D \cdot 6}{t^2 \cdot b}\right) \le \sigma_{RD} \qquad \text{(eq. 7)}$$

$\alpha_l = 1.15$ with material thickness <= 15 mm

$\alpha_l = 1.20$ with material thickness > 15 mm

$\alpha_t = 1{,}08$ with a min. gap thickness of 3 mm to the max. of 20 mm

In the following table, the admissible loads F_D are stated for the shear force to be absorbed by centrically stressed bearing type joints without any moment absorption.
Here the following specifications apply:

- Centric stress of the bolt in the drill area
- Material thickness from 8 mm to a maximum of 30 mm
- Bolts of diameters of Ø 8 mm and Ø 36 mm
- Min. material overlap X of 3 mm to a maximum of 20 mm (see Fig. 1)
- Load by <u>constant</u> action
- Max. temperatures of 60°C in the mortar substance

The admissible load F_D was established with the following admissible stress:

$$\sigma_D = \frac{\sigma_R}{\nu} \qquad \text{(eq. 6)}$$

$$\sigma_R = 31\, N/mm^2 \qquad \text{(see item 5)}$$

$$\nu = 1.5$$

Tab. 7: Admissible loads F_D [N] in case of centric stress in the drill area

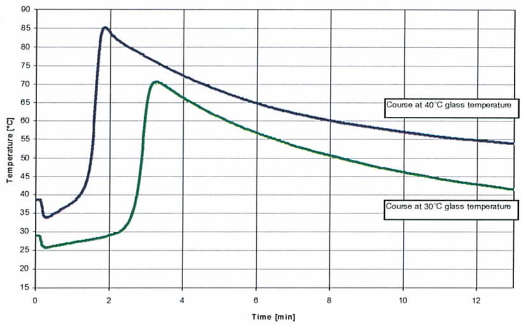
	Bolt diameter in [mm]								
Thickness HIT-HY 70 and/or glass	8	10	12	16	20	22	27	30	36
8	1096	1369	1643	2191	2739	3013	3697	4108	4930
10	1369	1712	2054	2739	3424	3766	4622	5135	6162
12	1643	2054	2465	3287	4108	4519	5546	6162	7395
15	2054	2568	3081	4108	5135	5649	6933	7703	9244
20	2608	3261	3913	5217	6521	7173	8804	9782	11738
22	2869	3587	4304	5739	7173	7891	9684	10760	12912
25	3261	4076	4891	6521	8151	8967	11004	12227	14673
30	3913	4891	5869	7825	9782	10760	13205	14673	17607

7. In-plane load introduction

The results of the compressive strength tests can also be applied to in-plane load introduction geometries such as glass blocks or load transmission between panes. The design can be effected with the long-term strength stated in item 5 (σ_R= 31N/mm²) via the correlation force / surface. The author here recommends a minimum material thickness of 3 mm in the direction of the load.

8. Heat development at the boundary surface glass - HIT®-HY 70

The curing process of the hybrid mortar HIT®-HY 70 causes a heat development in the mortar substance of up to approx. 80°C. To establish the heat development at the boundary surface mortar - glass, temperature measurements were carried out by the Laboratory for Steel and Light Metal Construction. This was designed to determine whether heat can develop which might damage the composite glass-sheeting construction in case of laminated safety glass (LSG) panes. To this end, a thermocouple was positioned at the glass edge between two 10mm-thick glass panes (see Fig. 7). Subsequently, this area was filled with HIT®-HY 70. The used mortar amount corresponded to a conventional hole filling. The heat development at the boundary surfaces was measured with two different glass temperatures (30°C and 40°C) (see Fig. 8).



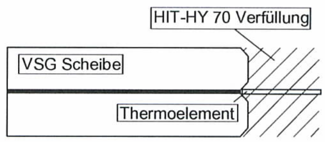


Fig. 8: Temperature development

Fig. 7: Test set-up

The curve paths show that with a glass temperature of approx. 30°C a maximum temperature of the boundary surface of 70°C is achieved. After approx. 5 minutes, the temperature will decrease below 50°C. With a temperature development of this kind, no damage to the LSG composite construction need be anticipated. With a glass temperature of 40°C, the temperature of the boundary surface increases to more than 85°C. The cooling process is considerably slower (cooling down to 50°C after > 12 minutes). Here we cannot exclude damage to the LSG composite construction in the area of the hole. The author therefore recommends the use of HIT®-HY 70 in the area of composite glass sheeting constructions to a maximum glass temperature of 30°C, or alternatively the testing of this specific application in a test set-up.

9. Building material class

MPA of the *TU* [Technical University] of Braunschweig was commissioned by the HILTI company to carry out tests with respect to the building material class based on the test standard DIN 4102-B1 [m]. The results of the tests are stated in the test report no. (3626/241/07) [i]. 'The material did not show any negative behaviour with respect to the requirements applicable to building materials of the building material class DIN 4102-B1 (hardly inflammable) based on DIN 4102-1: 1998-05, section 6.1.' [i].

10. Coefficient of thermal expansion

The coefficient of thermal expansion was established based on DIN 53752 [o] and stated as α

= 34 10^{-6} K^{-1} by the HILTI company. The determination was carried out with a temperature increase of 2 K/min.

11. Chemical compatibilities

The compatibility of HIT-HY 70 with the following materials was tested.

- Polyvinyl butyral sheeting (PVB)* by the Kuraray Europe GmbH company, Trosilfol division
- Sentry Glas Plus Folie** [Sentry Glass Plus sheeting] by the Dupont SGP® company
- Dow Corning® 993 structural glazing sealant

*Laminated glass sample with TROSIFOL XT 90 2.28 mm and BG R15 0.76 mm

**Laminated glass samples by the Seele company with a sheeting of 1.59 mm

To this end, the materials were only subjected to contact with the organic binder (reaction resin). Here the materials were subject to contact with the resin for a considerably longer period of time than is the curing time of the mortar. The penetration tests performed did not result in any infiltration symptoms. For beads of silicone adhesive, additional tests were carried out with respect to Shore hardness A. No changes in hardness were detected after the tests (44 to 46). The materials were subjected to contact with the resin for a considerably longer period of time than is the curing time of the mortar. The tests were effected by HILTI on their own responsibility.

12. Shrink behaviour during curing

The amount of shrinkage during curing was established in an internal test by the HILTI company. The test set-up is shown in figure 9 in a diagram.

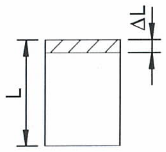


Fig. 9: Determination of the amount of shrinkage

The amount of shrinkage is established via the correlation of ΔL / L. For HIT-HY 70, this shrinkage amounts up to approx. 3%. In reality, however, it was found out that this shrinkage does not take place, as during curing the anti-cavitation effect will occur. Consequently, the author recommends that a sufficient amount of excess mortar should be injected when applying the injectable adhesive mortar [e]. It can be removed after a curing time of approx. 1 hour. If any additional mortar substance cannot flow back into the hole, you should assume the above stated amount of shrinkage.

13. Comparison of HIT®-HY 70 and HIT®-HY 50

In parallel with the tests of the samples of HIT®-HY 70, additional tests of HIT®-HY 50 were carried out and/or the results already at hand were quoted so as to be able to draw a comparison between the two injectable adhesive mortar types with respect to the most important properties.

The following properties were compared:

- Compressive strength
- Elastic modulus
- Coefficient of thermal expansion
- Compatibility with other plastics used in the building industry

The compressive strength established for the HIT®-HY 70 material is approx. 10% higher than the strength of HIT®-HY 50 (in case of storage of the samples in standard climatic conditions and testing at room temperature). The elastic modulus of HIT®-HY 70 for storage in standard climatic conditions is approx. 30% lower than the one of HIT®-HY 50. Thus HIT®-HY 70 is slightly more elastic (softer) than HIT-HY 50. The coefficient of thermal expansion of HIT®-HY 70 is slightly lower than the one of HIT®-HY 50. The following table summarises the comparison once again.

Table 8: Comparison of HIT® HY 70 and HIT® HY 50

	HIT-HY 50*	HIT-HY 70	Change
Compressive strength	59 N/mm^2	65 N/mm^2	+ 10%
Elastic modulus	2480 N/mm^2	1750 N/mm^2	- 30%
Coefficient of thermal expansion	$38x10^{-6} K^{-1}$	$34x10^{-6} K^{-1}$	- 10%

* information by HILTI

As a result, from the author's point of view, the injectable adhesive mortar HIT®-HY 50 can unrestrictedly be replaced by HIT®-HY 70 for the applications stated in this document. This also relates to the certificates of approval already at hand where HIT®-HY 50 is stated as a reliable compound filling. From the author's point of view, the deviation of the elastic modulus, in absolute terms, assuming a standard thickness of the mortar applied, has no more than a minimal effect on the resulting deformation

14. Summary

The HILTI company commissioned the author to submit an expert report that would establish and document the properties relevant for the application of HIT®-HY 70 for use in structural glass construction. The results of the performed tests are described in detail in sections 4 to 11. All data are only valid if the manufacturer's application information [e,c] is complied with, if the injectable adhesive mortar is injected properly and if the HIT®-HY 70 substance is not subject to direct weathering. Another precondition is that the curing times "t_{cure}" [e] stated by the HILTI company are observed. In the following, the most important results of the tests are summarised once again. A number of the properties (building material class, coefficient of thermal expansion, compatibilities and shrink behaviour) were determined by HILTI on their own responsibility and are here only documented.

Long-term compressive strength without safety factors

The calculated value of the long-term compressive strength was established according to the calculation proposal by Rehm, Franke and Zeus [k] with σ_R = 31 N/mm². This value applies up to a material temperature of 60°C. In case of temperatures ranging from 60 to 80°C, a value of σ_R = 23 N/mm² will apply.

The stated values do not include any partial safety factors and they only apply for uniaxial loads. In the stated stress area up to 31 N/mm², we can assume a linear-elastic material behaviour.

Elastic modulus

The elastic modulus is established using the average values from the compressive strength tests with storage in standard climatic conditions. It is given by the author as E = 1700 N/mm². If required, the influence of high and low temperatures on the design must be considered in borderline case examinations (e.g. E_{min} = 1000 N/mm² / E_{max} = 2500 N/mm²).

I was assisted in preparing this expert report by:

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