Deutsches Institut für Bautechnik

DIBt

General Building Inspection Certificate

Approval body for construction products and types of construction

Structural Engineering Testing Authority

A public law institution jointly supported by the Federal Government and the Federal States
A member of the European Organisation for Technical Approvals EOTA and The European Union of Agreement UEA lc

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from: **8 December 2015**
until: **8 December 2020**

Applicant:
B.T. innovation GmbH
Sudenburger Wuhne 60
39116 Magdeburg

Object of approval:
ThermoPin - **Tie anchor**

National Technical Approval of the above-mentioned object of approval is herewith granted. This National Technical Approval contains 10 pages and 12 Annexes.

Deutsches Institut für Bautechnik DIBt

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I GENERAL PROVISIONS

1 The National Technical Approval verifies the usability and/or applicability of the object of approval in accordance with the regional construction regulations.

2 Insofar as the National Technical Approval requires special knowledge and experience of people entrusted with the manufacture of the construction products and construction systems in accordance with state regulations and § 17 clause 5 of the model building regulation, it shall be observed that this knowledge and experience also may be proven by equivalent verifications by other member states of the European Union. This also applies, if applicable, to equivalent verifications submitted in the context of the convention about the European
Economic Area (EEA) or other bilateral conventions...

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7 The National Technical Approval is granted subject to revocation. The provisions of the National Technical Approval can be subsequently supplemented and amended, especially where required by new technical findings.

II SPECIAL PROVISIONS

1 Object of approval and field of application

1.1 Object of approval

The Thermopin tie anchor type H and type D with nominal diameter 7.5 mm is an anchor made of glass fibre reinforced plastic bar. Both ends of the anchor tapered. The anchor is made with a straight plastic sleeve (type H) and a slanting plastic sleeve (type D).

The operating principle of the anchor is based on utilising the form fit between the conical end of the plastic bar and the concrete.

The anchor is shown installed in Annex 1.

1.2 Area of application

The anchor can be used to manufacture three-layer reinforced concrete wall panels. The layers consist of a facing shell and load-bearing layer made of standard concrete, and one or more layers of insulation panels. The load-bearing layer consists of a pre-cast part or a pre-cast part and a layer of concrete mixed in-situ. The anchors are used to connect the facing shell with the load-bearing layer. The type D anchor may only be used in conjunction with the type H anchor to retain facing shells which are freely suspended. The type D anchor must be installed at 45° to the vertical. It may only be used to transfer permanently centric tension loads. The type H anchor may also be used to retain facing shells which are floor-mounted. The type H anchor must be fitted horizontally. It may only be used to transfer temporary centric tension and pressure loads.

Anchorage is in reinforced standard concrete of strength class minimum C20/25 and maximum C50/60 in accordance with DIN EN 206-1:2001-07 “Concrete; Part 1: Fixing, characteristics, manufacture and conformity”.

Only the temporary or permanent forces from the facing shells working vertically or parallel to the wall in the direction of their own weight may be transferred into the anchor. The facing shell may also impress temporary forced deformations parallel to the wall into anchors type H and type D.

Reinforced concrete wall panels up to size 12 m x 6 m can be manufactured with the anchors.

The direction of installation of the finished-part walls with freely suspended facing shells must be clearly indicated, for instance by using transport anchors.

The anchor can be used for internal and external walls. The temperature of the component on the surface of the facing shell may be between +65 °C and -20 °C (see DIBt notifications 5/1995 “Principles for determining the temperature stress on multi-layer wall panels surfaced with concrete.”) On the inside of the load-bearing layer, the temperature may not permanently exceed 40 °C. The anchor is permanently (*missing word*) for exposure classes XC, XD and XS under DIN EN 1992-1-1:2011-01 with DIN EN 1992-1-1/NA2011-01, section 4.2.

2 Provisions for the construction product

2.1 Properties and composition

The anchor must correspond to the details given in the Annexes in its dimensions and material characteristics.

The material details, dimensions and tolerances for the anchor not specified in this General Building Inspection Certificate must correspond to the details on file at the German Institute for Construction Technology.

2.2 Packing, storage, transport and labelling

2.2.1 Packing, storage and transport

The anchors must be packed and delivered as fixing units.

Attention must be paid to the following aspect during storage and transport of the ThermoPin tie anchor:

- no effects due to impact loads, hammer blows or blows with sharp objects;
- no storage of items with sharp edges directly on the ThermoPin tie anchor;
- no contact with oils and solvents;
- protected from flying sparks, naked flames and the effect of heat;
- packaging of the bars before transport must guarantee that the bars are protected from mechanical damage cause by forklifts or lifting equipment;
- dry storage;
- the storage temperature must be between -20 °C and 40 °c ;
- not permanently exposed to direct sunlight.

2.2.2 Labelling

Packaging, packing inserts or delivery notes for the anchors must be labelled by manufacturer with the German mark of conformity (Ü mark) in accordance with the Laender [German Federal State] Ordinances on Conformity
Marks. The identifying mark of the manufacturing plant, the authorisation number, overall length, position of the sleeves, anchor type (H or D) and designation of the anchor must also be given..

The products may only receive this mark if the prerequisites outlined in Section 2.3 have been fulfilled.

At least one anchor per package must be permanently marked in accordance with Annex 2.

2.3 Certificate of conformity

2.3.1 General information

The attestation of conformity of the anchors with the provisions in this National Technical Approval must be implemented for each production plant with a certificate of conformity based on factory production control and regular third-party monitoring, including the initial type testing of the anchors in accordance with the following stipulations.

The anchor manufacturer shall engage an approved certification body as well as a third party approved for monitoring purposes in order to grant a certificate of conformity and third-party monitoring, including the associated product tests.

The manufacturer must present the declaration that a certificate of conformity was issued by marking the marking the construction products with the conformity mark (Ü mark) with reference to the product's intended use.

The certification body is required to give the German Institute for Civil Engineering a copy of the conformity certificate granted by the same for information purposes.

2.3.2 Factory production control

A factory production control shall be set up and implemented in each anchor production plant. Factory production control refers to the continuous monitoring of production carried out by the manufacturer by which means it is ensured that the construction products produced by it fulfil the provisions of this national technical approval..

The inspection plan on file at the German Institute for Civil Engineering is the benchmark for the scope, type and frequency of factory production control.

The results of the factory production control shall be recorded and evaluated. The drawings must contain the following information as a minimum:

- designation of the construction product or the raw material and components
- the type of control or testing
- date of manufacture and testing of the construction product or the raw material ls or components
- results of the controls and tests and, if applicable, a comparison with the requirements
- the signature of the person responsible for factory production control.

The records are to be preserved for at least five years. Upon request, they shall be presented to the German Institute for Civil Engineering and to the respective Federal State's Building Supervisory Authority.

In the event of inadequate test results, the necessary measures required in order to eliminate the defect shall be implemented immediately. Construction products which do not meet the requirements shall be handled in a way which excludes the possibility of being confused with products which conform to the requirements. After the defects have been eliminated insofar as is technically possible and necessary for demonstrating the elimination of the defect, the relevant tests shall be repeated.

2.3.3 Third-party monitoring

Factory production control at each production plant shall be reviewed by third-party monitoring at regular intervals and at least once per year.

As part of third-party monitoring, a type test must be carried out on the anchor and random samples tested. The authorised body shall be responsible for sampling and testing.

The inspection plan on file at the German Institute for Civil Engineering is the benchmark for the scope, type and frequency of third-party testing.

The results of certification and third-party monitoring shall be preserved for at least five years. They are to be presented upon request by the certification authority or the monitoring authority, respectively, to the German Institute for Civil Engineering and to the respective Federal State's Building Supervisory Authority.

3 Provisions for layout and design

3.1 Draft

3.1.1 General information

Engineering planning must be provided for the anchors. Taking into account the loads to be anchored, checkable calculations and design drawings are to be produced. Design drawings must contain precise details of the position, size and type (H or D) of the anchors, as well as the type and thickness of the thermal insulation and the anchorage length in the concrete (hnom).

The maximum size of the reinforced concrete wall panels is 12 m x 6 m.

The facing shell must be unmovable and non-rotatable when fixed with the anchors to the load-bearing layer. Only type H anchors may be used to retain facing shells which are floor-mounted. To retain freely suspended facing shells, anchors type D, type H and a special thermal insulation block must be used. The proof for the special thermal insulation block must be provided separately. This thermal insulation block must meet minimum values in accordance with Annex 3, Table 3.

At least two type D anchors per pre-cast part are to be arranged for freely suspended facing shells. If several anchors are used, these must be arranged next to one another on the horizontal axis. A special thermal insulation block must be arranged for every type D anchor to accept the horizontal pressure components from the slanted rod. Type H anchors are to be provided in the other areas of the pre-cast part.

Type H anchors must be arranged in a square grid as far as possible.

Facing shells for element walls must be floor-mounted and can only be fixed with type H anchors.

For element walls, the anchors must not be taken into account for securing the joint between the supporting shell pre-cast part and the concrete mixed in-situ.

Expansion joints are to be arranged between the facing shells of individual reinforced concrete wall panels and to the adjacent components to prevent contact between the facing shells themselves or other components.

At least one single-layer reinforcement of 1.88 cm2/m must be arranged in the facing shell in a horizontal and vertical direction, centrally as far as possible.

The key installation parameters, component dimensions and minimum axis and edge distances are given in Annexes 3 to 6, and these must be maintained.

3.2 Design

3.2.1 General information

The anchors must be designed at the ultimate limit state for load-bearing capacity and suitability for use. Proof is provided of direct local force introduced by the anchors into the concrete in the area of the facing shell and in the load-bearing layer.

Proof must be provided that the loads to be anchored are transmitted in the component. Static proof for the concrete layers including securing the joint between the load-bearing pre-cast part and the concrete mixed in-situ must be provided in accordance with DIN EN 1992-1-1:2011-01 and DIN EN 1992-1-1/NA:2011-01. In the static proof for the bearing layer, no contribution or stabilising function by the facing shell may be included.

To guarantee the pull-out resistance of the anchors, the crack width in the facing shell in the ultimate limit state of suitability for use is to be limited to $w_k = 0.3$ mm. The post-limit stiffness of the concrete is to be taken into account.

3.2.2 Determination of anchor forces and anchor deformations

To determine the anchor forces and anchor deformations, the cross-section values and material characteristics of the anchor as set out in Annex 3, Table 1 (type H) and 2 (type D) are to be used.

The tensile and compression forces on the anchor are to be determined for type H from concreting pressure, wind, temperature, creep and shrinkage. For a freely suspended facing shell, its own weight and possibly the own weight of add-on components caused by the type D anchor and the associated thermal insulation block are to be recorded.

The effects of temperature and shrinkage are to be determined as follows:

- Temperature gradient in the facing shell:
  $\Delta T=5K$
- Temperature difference between facing shell and load-bearing layer:

  $\Delta\upsilon=\upsilon_V-\upsilon_T$ (1)

  υ_V and υ_T in accordance with Table 1
- Differences in shrinkage can be taken into account using the simplified method in Table 1, footnote 1)

Table 1: Concrete temperatures on outside and inside

	Summer	Winter
Concrete temperature facing shell υV	+65°C	-20 °C [1)]
Concrete temperature load-bearing shell υT	+25°C	+20 °C

[1] υ_V is to be reduced by 10K for a more simplified method of taking shrinkage differences into account.

The proof of deformation at the ultimate limit state of suitability for use is carried out under a rare combination of effects.

The rigidity figures for the facing shell must be unfavourably taken into account with the ultimate limit rigidity figures for state I or II.

3.2.3 Proofs required

Proof of tensile and compressive strength must be provided at ultimate limit load-bearing state for anchor type H. Proof must be provided for anchor type H for deformations crosswise to the axis of the bar at ultimate limit state of suitability for use. For floor-mounted facing shells, proof may be provided at the ultimate limit state of suitability for use taking the supporting effect of the thermal insulation layer into account.

At the ultimate limit state of load-bearing capacity, proof of tensile and compressive strength must show that the design value of NEd capacity to withstand stress does not exceed the NRd value of capacity to withstand stress.

$|N_{Ed}| \leq |N_{Rd}|$ (1)

NEd = design value of capacity to withstand stress (Effect) in accordance with section 3.2.2 NRd = design value of capacity to withstand stress (Resistance) in accordance with section 3.2.4

At the ultimate limit state of suitability for use, proof of deformation for the anchors at wall level and proof of permitted crack width for the anchors in the facing shell must be provided (see also section 3.2.4). Values for internal forces and deformation in the transverse elasticity of the connection between the concrete layers must be taken into account. If no precise figures on shear stiffness are available for an interaction between anchor and thermal insulation, the thermal insulation should be ignored in the proof of deformation, but its full shear stiffness value included in the proof of crack widths.

existing w ≤max. w (2)

existing w = characteristic value of existing deformation

max. w = characteristic value of deformability in accordance with section 3.2.4

Proof of shear load must be provided at limit load-bearing condition for anchor type D.

At the ultimate limit state of load-bearing capacity, the proof of shear load must show that the

design value of stress VEd does not exceed the V_{Rd} value of capacity to withstand stress.

$V_{Ed} \leq V_{Rd}$ (3)

V_{Ed} = design value of stress (effect) in accordance with section 3.2.2

V_{Rd} = design value of stress (resistance) in accordance with section 3.2.4

Proof must be provided that the distance between the anchor and the resting point of the facing shell is not greater than emax.

$e \leq e_{max}$ (4)

e = existing distance between anchor and resting point of facing shell

e_{max} = maximum permitted distance of anchor from resting point of facing shell in accordance with section 3.2.4

3.2.4 Design values for resistance of anchor and maximum permitted deformations or distances

For proof of load-bearing capacity, the design values for the resistance of type H anchor (centric tensile load, punching shear) are given in Annex 7, table 5. The design values for the resistance of type D anchor (shear load) are given in Appendix 7, table 6.

For proof of suitability for use of the type H anchor, the maximum permitted deformations of the anchors as a function of the thickness of the insulation are given in Annex 7, table 7.

The maximum permitted distances of the type D anchor from the resting point of the facing shell emax are given as a function of the thickness of the insulation or of the design value VRd in Annex 7, table 6.

4 Construction conditions

4.1 General information

The anchors may only be installed in the pre-cast concrete parts.

During manufacture of the anchors, records must be kept on the proof of existing concrete strength class and correct mounting of the anchors by the Technical Works Manager or his representative.

During manufacture of the reinforced concrete wall panels, these records must be available at the works and presented to the person responsible for inspection on request. Like the delivery notes, they must be preserved for at least 5 years after completion of work.

4.2 Manufacture of reinforced concrete wall panels

4.2.1 General information

The manufacture of reinforced concrete wall panels with ThermoPin tie anchors may only be carried out by companies who have the necessary specialist knowledge and experience with these anchors. The anchors are to be fitted in accordance with the design drawings produced in accordance with section 3.1 and the work steps in accordance with section 4.2.2 and 4.2.3 or assembly instructions in Annexes 8 to 11.

When the reinforced concrete wall panels are being demoulded, the concrete layers must have an average value for the compressive cube strength of the concrete $f_{c,cube}$ of at least 15 N/mm².

Production must be in a horizontal position.

4.2.2 Manufacture of the facing shell and fitting the thermal insulation and anchor

- Form, reinforce, concrete and compress the lower concrete layer (facing shell);
- Lay pre-drilled (df = 11 to 13 mm) insulation panels quickly and tension-free in accordance with the layout drawing. The insulation panels may not be drilled on the concrete after laying;

- Insert type H anchor vertically and type D anchor, if applicable, at 45° through the pre-drilled insulation panels into the lower insulation level until they make contact with the sleeve. The anchor must be inserted in the wet concrete (at the latest 1 hour after the mixing water has been added) to ensure that the anchor is properly enclosed by the concrete;
- After inserting the anchors, reseal the lower concrete layer.

4.2.3 Make the load-bearing layer and complete the pre-cast part.

Making the load-bearing layer is different for element walls and sandwich walls as follows:

Element walls:

- Form, reinforce (using bond reinforcement if applicable), concrete and compress the pre-cast load-bearing layer separately;
- Insert the hardened facing shell with thermal insulation and anchors encased in concrete, as well as transport anchors, in the wet concrete of the load-bearing layer (at the latest 1 hour after adding the mixing water);
- Re-compress the pre-cast load-bearing layer. When re-compressing, the facing shell must be secured to prevent lateral yielding.

Sandwich walls:

- Reinforce, concrete and compress top concrete layer (load-bearing layer) directly on the thermal insulation. The anchors must not be moved in the lower concrete layer either whilst the reinforcement is being installed or when the concrete is being added and compressed.

4.3 Inspection of quality in pre-cast part

At the works where the reinforced concrete wall panels are manufactured, the load-bearing capacity of type H anchors are to be inspected before first application of the anchor at the start of production, using the concrete composition and consistency intended for making the wall panels. This inspection process must be repeated for any change in the concrete recipe or consistency and at the latest after the manufacture of 200 wall panels or 4,000 m² respectively.

Special non-reinforced panel items with 4 type H anchors, but without the top concrete layer, are to be made for the inspection process in accordance with Annex 12. These test pieces are to be made together with a panel from current production on the same fabrication tables (cf section 4.2.2). After a sufficient hardening-off period, the thermal insulation layer is to be removed from the test pieces, the connection points for type H anchors are to be visually inspected, and the actual lengths of the anchors in the concrete are to be measured. Pull-out tests are then to be carried out on the 4 type H anchors in accordance with Annex 12.

To determine the compressive cube strength of the concrete during the pull-out test, at the same time concrete cubes with edge length 150 mm are to be made from the mix of panel pieces in accordance with DIN 1048, stored in dry conditions next to the panel pieces and tested at approximately the same time as the pull-out tests are carried out.

The individual values of pull-out loads Nu for type H anchors during the pull-out test must reach the values set out in Table 2 as a minimum, as a function of the planned anchorage length in the concrete hnom and the compressive cube strength of the concrete fc,cube in the test piece at the time of the pull-out test.

Table 2: Required pull-out load Nu

hnom	fc,cube = 15 N/mm²	fc,cube= 25 N/mm²
40mm	4.3 kN	5.6 kN
90mm	14.9 kN	19.2 kN

If the existing mean value for compressive cube strength of the concrete lies between fc,cube = 15 N/mm² and fc,cube = 25 N/ mm²d a linear interpolation can be carried out.

If the existing mean value for compressive cube strength of the concrete is greater than fc,cube = 25 N/mm², the pull-out load $N_{u,test}$ must be reduced in accordance with (2).

$$N_u = \sqrt{\frac{25}{f_{c,cube,test}}} \cdot N_{u,test} \qquad (2)$$

A report must be produced on the inspection of anchor load-bearing capacity for type H anchors, and the actual anchor length in the concrete, the pull-out values obtained, the compressive cube strength of the concrete in the panel pieces, the types of failure (breakage of concrete, pull out from concrete, tensile fracture or interlaminary shear fracture of anchor) and the results presented. The report must be kept on file and presented to the owner of the certificate and the DIBt.

If a type H anchor cannot fulfil the inspection condition, the defects are to be rectified and the tests repeated at an early stage until the pull-out loads required by Table 2 are achieved.

4.4 Transport, storage and assembly of reinforced concrete wall panels

Suitable transport anchors are to be used for transport and storage. For element walls, transport anchors are to be used , which are to be concreted into both the facing shell and also the pre-cast part in the load-bearing layer.

The reinforced concrete walls may only be stored and transported upright or in a tilted position. Horizontal stacking of the reinforced concrete wall panels is not permitted. The support or bearing must not be on the facing shell. Movement of the facing shells relative to the load-bearing layer must be prevented by suitable measures. For element walls, movement is prevented by transport anchors.

The concrete strength class of the facing shell and the pre-cast part of the load-bearing layer must not be lower than C20/25 at the time of adding the concrete mixed in-situ.

During assembly of the reinforced concrete wall panels in which exclusively type H anchors are used, care must be taken to ensure that the facing shell and the load-bearing shell are standing on a common rigid base (e.g. foundation) over their full surface area.

During assembly of the sandwich walls in which exclusively type D anchors are used, care must be taken to ensure that the facing shell is standing on a rigid base (e.g. foundation) over its full surface area.

After assembly of the element walls and the application of concrete mixed in-situ, the transport anchors are to be severed.

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Department Head

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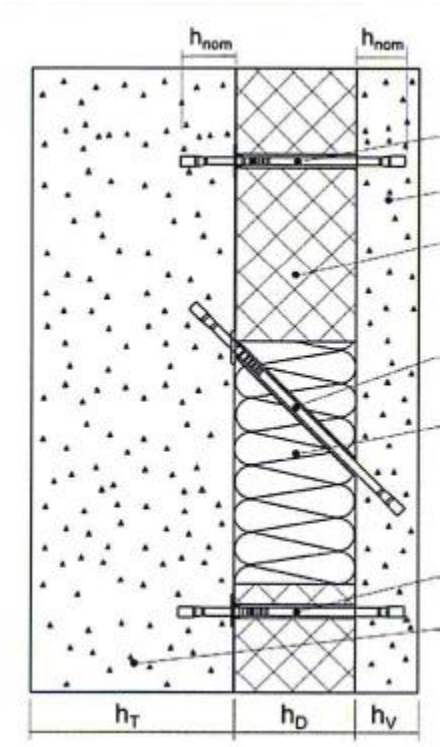


Sandwich wall

ThermoPin Type H

Freely suspended facing shell

Thermal insulation

ThermoPin Type H

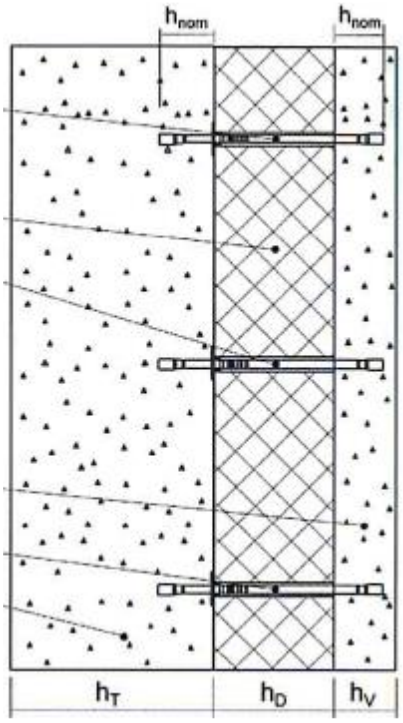
ThermoPin Type D

Thermal insulation with compressive rigidity, min. dimension 500 x 500 mm

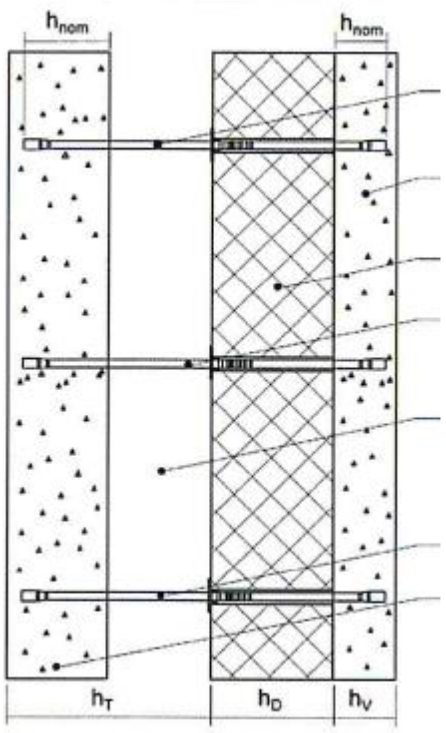
Vertical facing shell

ThermoPin Type H

Facing shell



Element wall



ThermoPin Type H

Facing shell[1)]

Thermal insulation

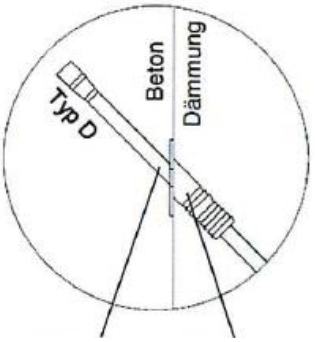
ThermoPin Type H

Concrete mixed in-situ

ThermoPin Type H

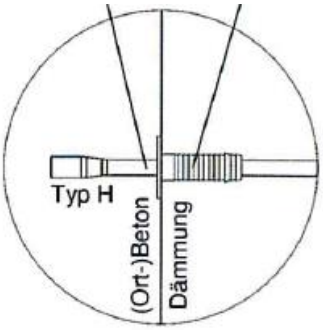
Pre-cast load-bearing shell

Detail A



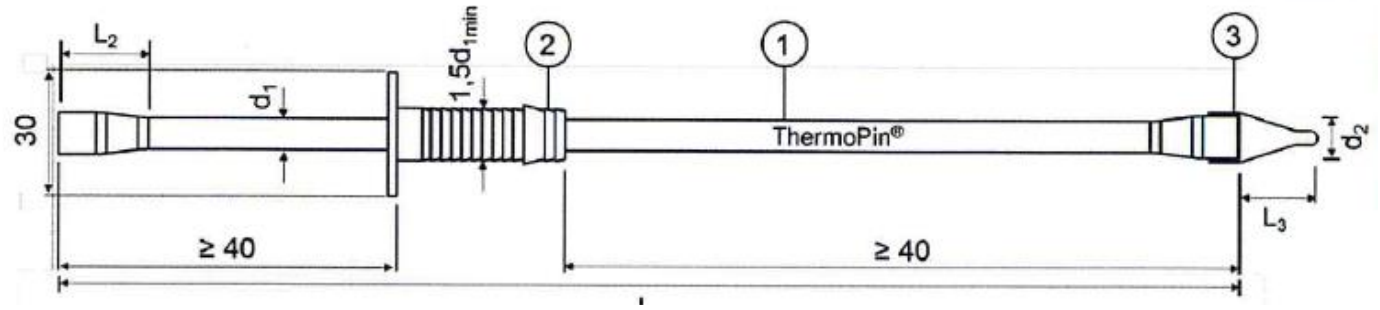
ThermoPin Sleeve

Detail B

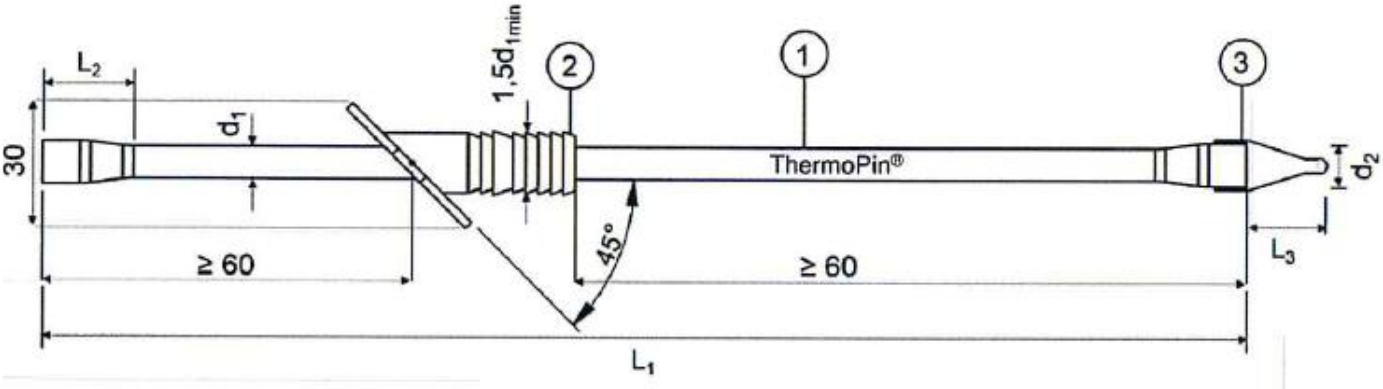


Type D
Type H
Concrete
Insulation
(In-situ) concrete

ThermoPin - Tie anchor Assembled condition	Annex 1



ThermoPin tie anchor Type H: GFK anchor with straight plastic sleeve. Dimensions in [mm]



ThermoPin tie anchor Type D: GFK anchor with sloping plastic sleeve. Dimensions in [mm]

d_1: 7.5 ± 0.3mm; d_2: 10.5 ± 0.4mm; L_2: 21.8 ± 0.3mm; L_3: 10 or 20mm ± 0.3mm

LabellingWorks identification:	B .T . innovation
Anchor:	ThermoPin
MaterialThermo Pin (1):	Glass-fibre reinforced plastic
Sleeve(2):	Plastic
End cap (3):	Plastic
DimensionsLe ngth L1:	Total length freely selectable as a function of application.
Sleeve:	Position of sleeve dependent on respective application.
L3:	10 mm or 20 mm length, depending on application

ThermoPin - Tie anchor Assembled condition	Annex 2

Table 1: Calculated values for material characteristics and the geometry of a ThermoPin Tie anchor Type H

ThermoPin tie anchor Type H	Abbreviation	Unit	Calculated value
Elasticity module - Tensile and pressure stress	E	N/mm^2	60000
- Bending stress (insulation thickness dD = 50 mm)			30000
- Bending stress (insulation thickness 50 < dD <100 mm)			Linear interpolation permitted between 30000 and 60000
- Bending stress (insulation thickness dD ≥ 100 mm)			60000
Nominal cross-section	A_{Pin}	mm^2	41.9
Moment of inertia	I_{Pin}	mm^4	134.9

Table 2: Calculated values for material characteristics and the geometry of a ThermoPin tie anchor Type D

ThermoPin tie anchor Type D	Abbreviation	Unit	Calculated value
Elasticity module (tensile, pressure, bend)	E	N/mm^2	60000
Nominal cross-section	A_{Pin}	mm^2	41.9
Moment of inertia	I_{Pin}	mm^4	139.4

Table 3: Minimum values required for rigid thermal insulation block

Rigid thermal insulation block			
EPS rigid foam			
Minimum value of short-term compressive strength of EPS thermal insulation block as pressure components in the load-bearing anchorage system	σ_{10}	$[N/mm^2]$	0.1
Minimum value of long-term elastic compression module of EPS thermal insulation block as pressure components in the load-bearing anchorage system	E	$[N/mm^2]$	2.4
XPS rigid foam			
Minimum value of long-term elastic compression module of XPS thermal insulation block as pressure components in the load-bearing anchorage system	E	$[N/mm^2]$	2.4

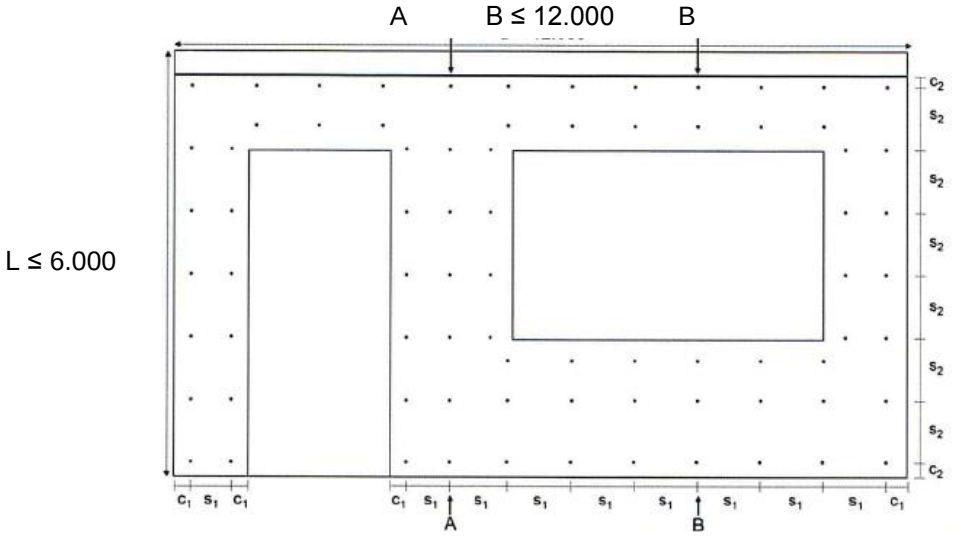
Table 4: Assembly parameters for ThermoPin tie anchor and thicknesses of shell

Anchorage length of ThermoPin tie anchor Type H or Type D in concrete[1)]	h_{nom}	[mm]	40 – 120 or 60 - 155
Thickness of facing shell	h_v	[mm]	50 – 120
Thickness of thermal insulation	h_D	[mm]	50 – 200
Minimum thickness of bearing layer Element wall Sandwich wall	$h_{T.min}$	[mm]	60 (FT) 140 (in-situ concrete + FT) 100
Minimum gap between ThermoPin tie anchors Type H Minimum axis gap between one another and between Type H and Type D Minimum edge distance	s_{min} c_{min}	[mm]	300 150
Minimum gap between ThermoPin tie anchors Type D Minimum axis gap between one another Minimum axis gap	s_{min} c_{min}	[mm]	500 250

[1)] In accordance with Annex 5 (Type H) or Annex 6 (Type D)

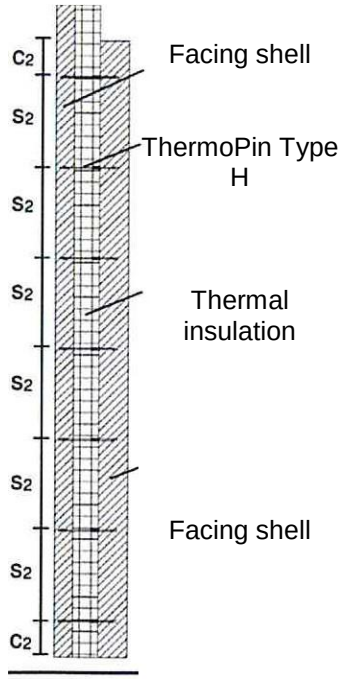
ThermoPin - Tie anchor	Annex 4
Calculated values, assembly parameters and thickness of shell	

Example of view of a wall made from pre-cast elements (Element wall or Sandwich wall) with vertical facing shell with ThermoPin tie anchors Type H

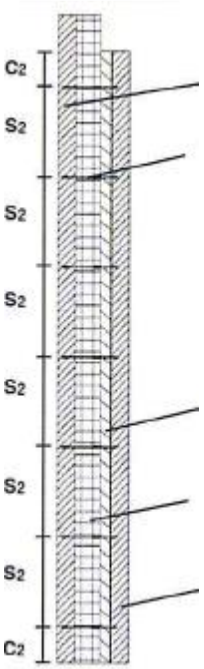


Arrangement of ThermoPin tie anchors in accordance with static calculation. Standard gap between ThermoPin tie anchors Type H: s = 300 – 500 mm. Standard edge distance: c = 150 - 200 mm.

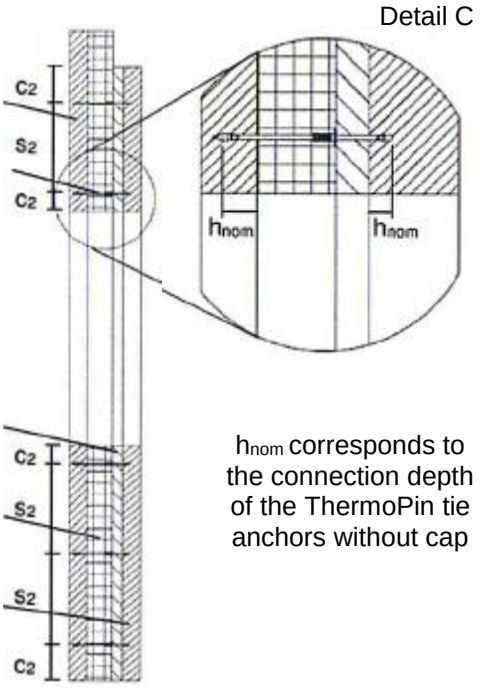
Section A-A
Sandwich wall



Section A-A
Element wall



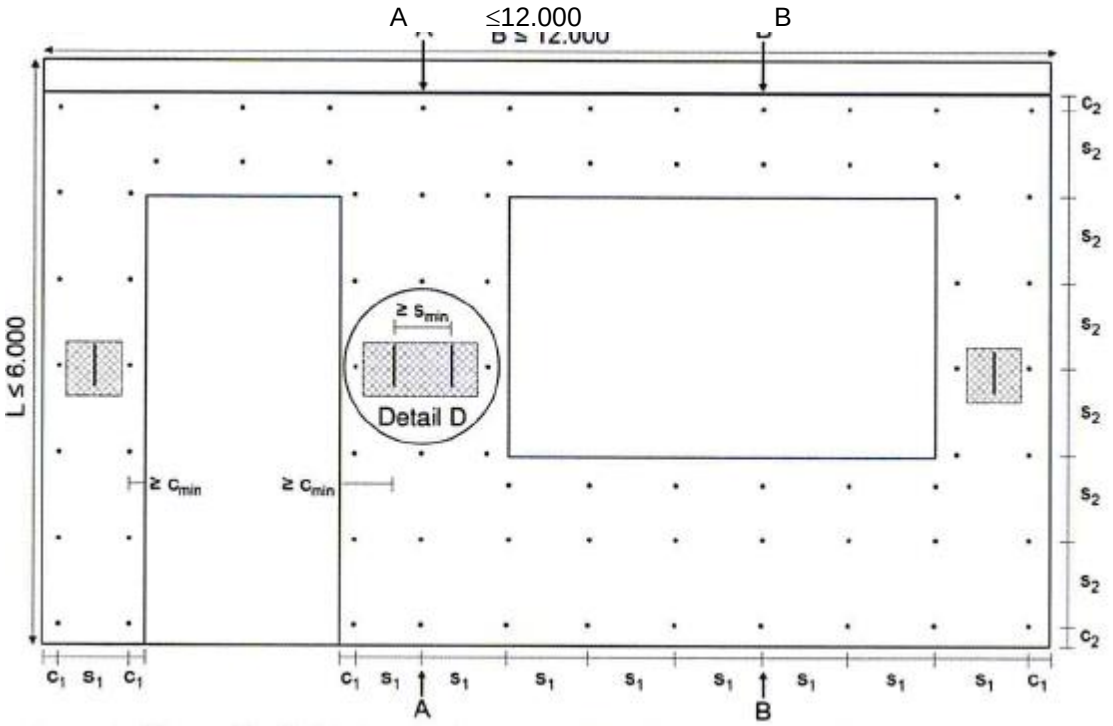
Schnitt B-B
Element wall



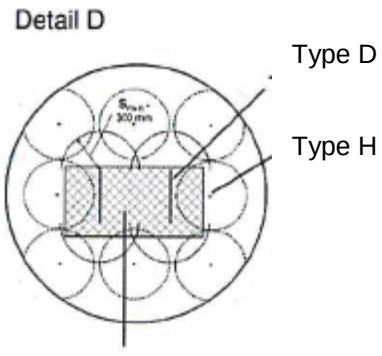
h_{nom} corresponds to the connection depth of the ThermoPin tie anchors without cap

ThermoPin - Tie anchor	Annex 5
Assembly parameters and thickness of shell	

Example of view of a Sandwich wall with freely suspended facing shell with ThermoPin tie anchors Type H and Type D.

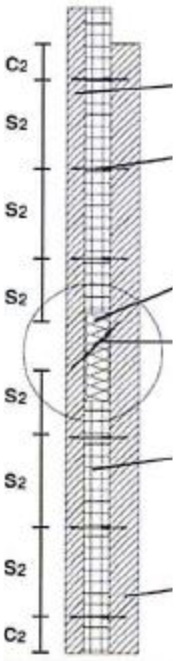


Arrangement of ThermoPin tie anchors in accordance with static calculation. Standard axis distance of anchors Type H and Type D: s = 300 – 500 mm. Standard edge distance: c = 150 - 250 mm.

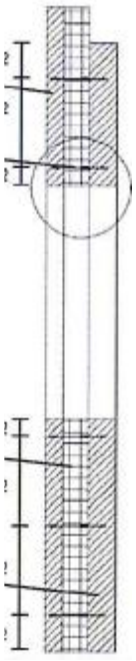


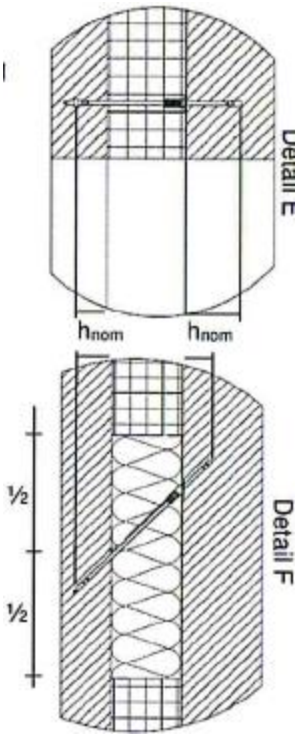
Rigid thermal insulation block

Section A-A
Sandwich wall



Section B-B
Sandwich wall





ThermoPin - Tie anchor	Annex 6
Assembly parameters and thickness of shell	

Table 5: Design values of resistances with central tensile load or compressive load for ThermoPin tie anchors Type H.

Anchor resistance	State	Concrete compressive strength	Anchoring depth in the concrete h_{nom}	
			40 mm	90 mm
Design value of capacity to withstand stress in the case of centric tension in cracked concrete where W_k = 0.3 mm N_{Rd} [kN]	Construction state	C20/25	3.7	12.8
		C50/60	5.6	18.0
	End state	C20/25	3.7	7.7
		C50/60	5.6	7.7
Design value of capacity to withstand stress in the case of centric compressive load in cracked concrete where W_k = 0.3 mm N_{Rd} [kN]	End state	C20/25 to C50/60	1.8	

Table 6: Design values for resistances in transverse load in the direction of own weight and max. distance from deformation resting point for ThermoPin connection bars Type D.

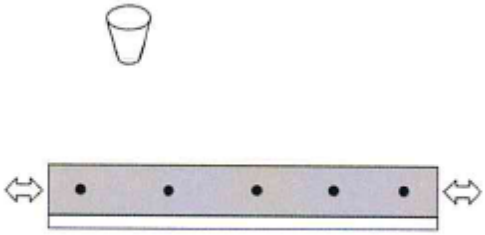
Thickness of insulation	Design values (end state)	Max. permitted distance from resting point of facing shell
h_D [mm]	V_{Rd} (lang) [kN]	e_{max} [m]
50	1.2	1.5
80	2.2	1.9
100	2.6	2.2
120	2.7	3.1
160	2.8	5.0
200	2.6	5.0

Table 8: Maximum permitted deformation of anchors across the bar axis. Intermediate values can be linearly interpolated.

Thickness of insulation h_D [mm]	Max. W [mm]
50	1.2
100	1.9
150	4.0

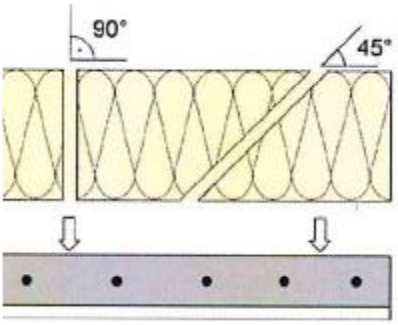
ThermoPin - Tie anchor	Annex 7
Design values for resistances	

1)



Reinforce facing shell, pour concrete in facing shell and pre-compress.

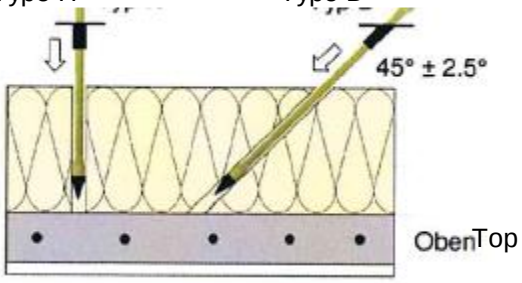
2)



Pre-drill holes with Ø 11-13 mm drill bit. For chamfered holes, drill with angle gauge. Place insulation panels with pre-drilled holes for the ThermoPins free from drilling dust as tightly as possible on the wet concrete of the facing shells.

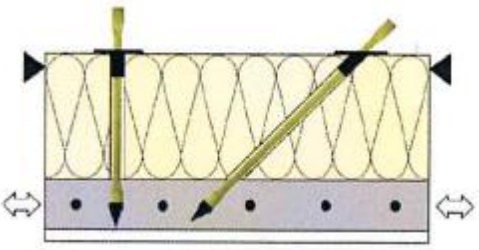
3)

Type H Type D



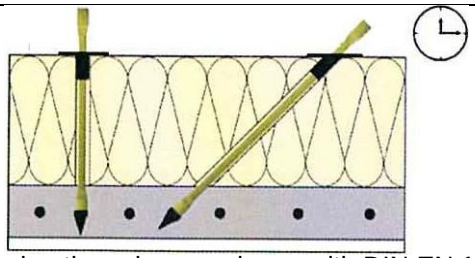
At the latest 60 minutes after adding the mixing water, insert ThermoPins through the drilled holes until the sleeve makes contact on the insulation in the wet concrete of the facing shell.

4)



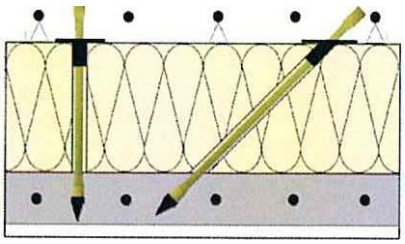
Recompress the concrete of the facing shell. Secure thermal insulation to prevent sideways displacement.

5)



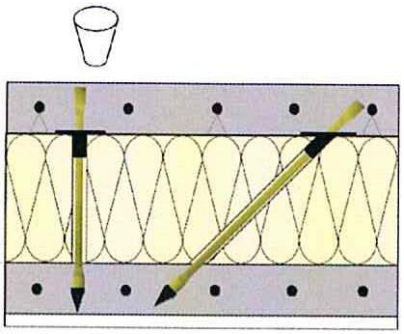
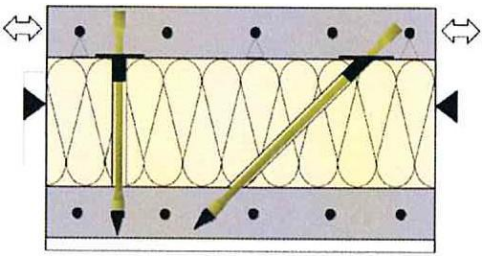
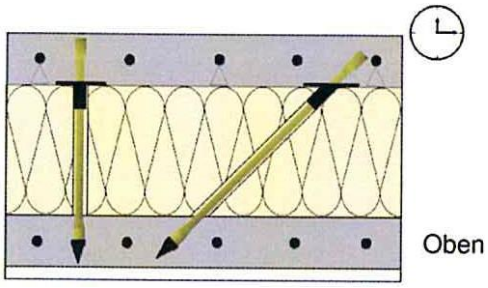
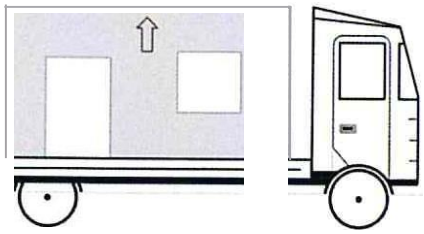
Observe curing times in accordance with DIN EN 1992-1-1 with DIN EN 1992-1-1/NA and EN 206-1.

6)

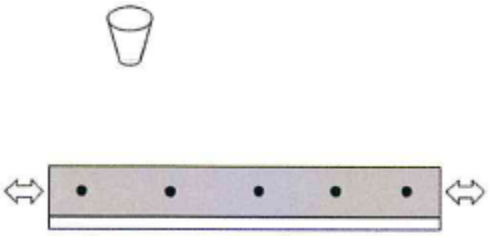
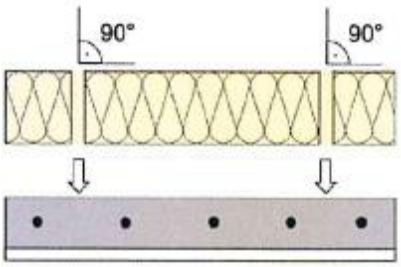
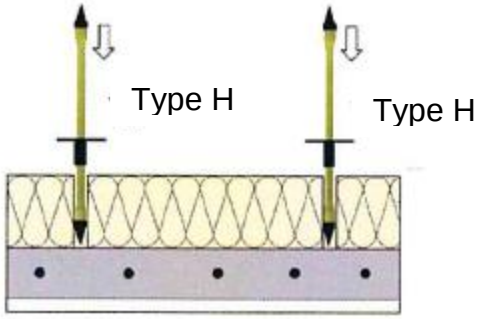
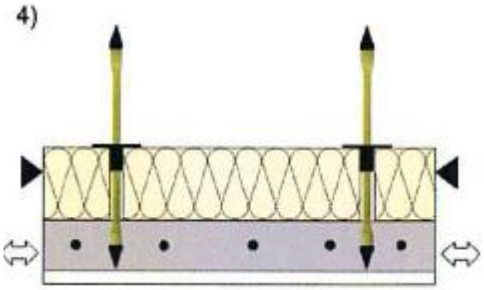
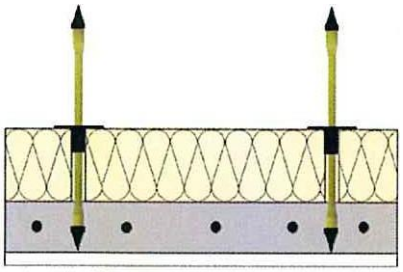
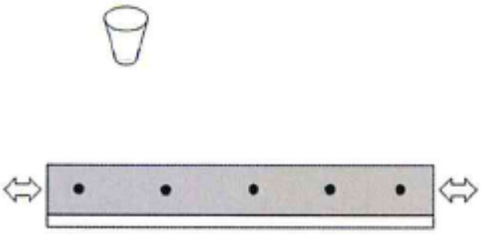


Place reinforcement on the thermal insulation and secure in place with spacers. Do not change the position of the ThermoPins.

ThermoPin - Tie anchor	Annex 8
Installation instructions - Sandwich wall	

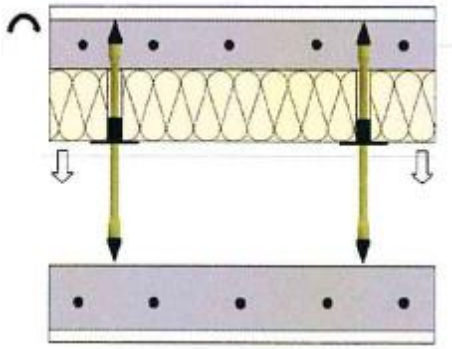
7)  Add concrete for the load-bearing shell	8)  Compress concrete. Suitable safety devices must be used to guarantee that the position of the ThermoPins is not altered during compression.
9) Observe curing times in  accordance with DIN EN 1992-1-1 with DIN EN 1992-1-1/NA and EN 206-1.	10) Erect sandwich wall. Prevent displacement between facing and load-bearing shell.
11) Top  Transport wall elements to site in vertical or slightly sloping position. Movement of the facing shells relative to the load-bearing shell must be prevented by suitable measures.	

ThermoPin - Tie anchor	Annex 9
Installation instructions - Sandwich wall	

1)  Reinforce facing shell, pour concrete in facing shell and pre-compress.	2)  Pre-drill holes with Ø 11-13 mm drill bit. Place insulation panels with pre-drilled holes for the ThermoPins free from drilling dust as tightly as possible on the wet concrete of the facing shells.
3)  At the latest 60 minutes after adding the mixing water, insert ThermoPins through the drilled holes until the sleeve makes contact on the insulation in the wet concrete of the facing shell.	4)  Recompress the concrete of the facing shell. Secure thermal insulation to prevent sideways displacement.
5)  Observe curing times in accordance with DIN EN 1992-1-1 with DIN EN 1992-1-1/NA and EN 206-1.	6)  Reinforce load-bearing shell, pour concrete for the pre-cast load-bearing shell and pre-compress.

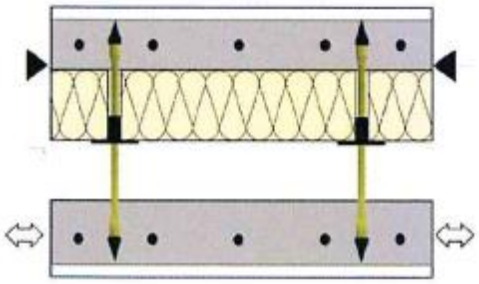
Installation instructions - element wall	Annex 10
ThermoPin - Tie anchor	

7)



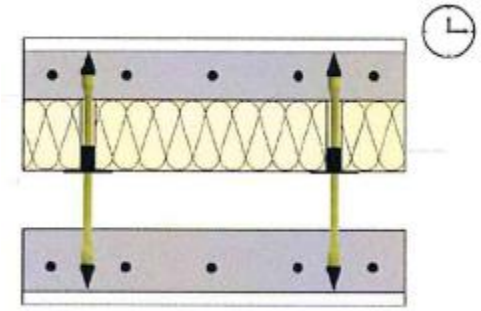
At the latest 60 minutes after adding the mixing water, place facing shell in the wet concrete of the pre-cast load-bearing shell.

8)



Re-compress. Prevent displacement of the facing shell and the load-bearing shell by fixing the facing shell in a horizontal direction.

9)

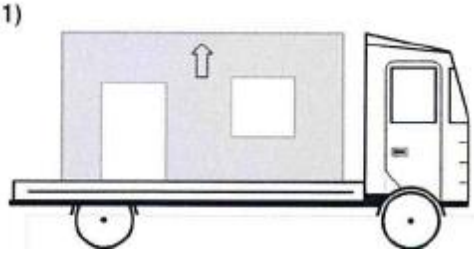


Observe curing times in accordance with DIN EN 1992-1-1 with DIN EN 1992-1-1/NA and EN 206-1.

10)

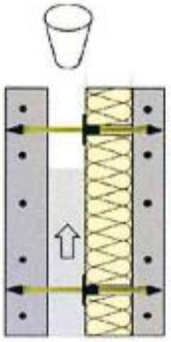
Erect element wall. Prevent displacement between facing and load-bearing shell.

11)



Transport wall elements to site in vertical position. Movement of the facing shells relative to the load-bearing shell must be prevented by suitable measures.

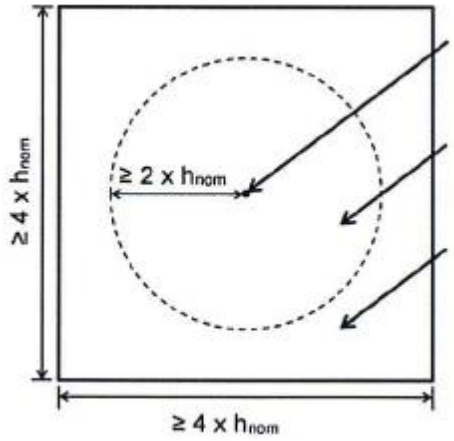
12)



Concreting on site, taking speed of concreting into account, in accordance with static calculations. Prevent separation.

ThermoPin - Tie anchor	Annex 11
Installation instructions - element wall	

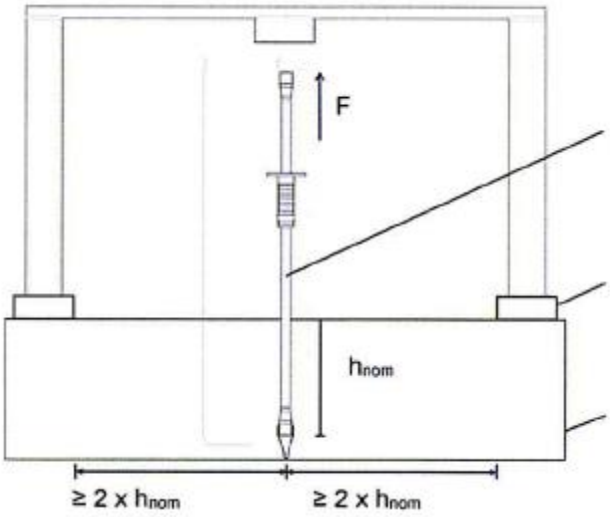
See description of pull-out tests in accordance with section 4.3.



ThermoPin Type H

Free surface without support

Concrete panel



ThermoPin Type H

Tensile test machine

Concrete panel

ThermoPin - Tie anchor	Annex 12
Check on anchorage capacity	