

General Certificate of Approval

DIBt

German Institute of Construction Engineering
(*DIBt Deutsches Institut für Bautechnik*)

Approval Body for Construction Products and Methods
Inspection Board for Construction Technology
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Date: Ref no.:
6th December 2018 I23-1.21.5-51/18

Approval no. Z-21.5-1758

Valid from: 24th October 2018

Valid until: 24th October 2023

Applicant:

Halfen GmbH

Liebigstraße 14,
40764 Langenfeld,
GERMANY

Subject of the approval:

HALFEN HAB MH Anchor bolt

The above-mentioned product is hereby granted general certificate of approval.
This general certificate of approval includes seven pages and seven annexes.
This article was first General Building approved on the 6th May 2004

Note: This translation of the original German version has not been verified by the Deutsches Institut für Bautechnik.

I. GENERAL PROVISIONS

1. The general certificate of approval confirms the usability or fitness for use of the object of approval pertaining to building regulation issued by the German federal states.
2. The general certificate of approval does not replace the statutory approvals, permits and certificates required for construction projects.
3. The general certificate of approval is issued regardless of the rights of third parties, and in particular private proprietary rights.
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7. This approval covers information and documents submitted by the applicant. Any change to the fundamentals is not covered by this approval and must be declared to the German Institute of Construction Engineering immediately.
8. The general type-approval covered by this document is also valid as a general building authority type approval.

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II. SPECIAL PROVISIONS

1. Object of approval and area of application

1.1 Object of Approval

The HALFEN HAB MH Anchor bolt (hereafter referred to as 'Anchor bolt') is made from a steel bolt, two hexagonal nuts and two washers, with a rolled thread at one end of the bolt. Ribbed reinforcement-steel bars with a swaged-head are welded to the other end of the bolt.

Table 1.1 is a compilation of the anchor bolt types.

Table 1.1

Anchor bolt type HAB MH (Thread diameter of the bolt)	22	27	36	39	45	52	60
Number of bolt heads diameter ϕ	2 $\times$ ϕ 20	2 $\times$ ϕ 25	4 $\times$ ϕ 20	3 $\times$ ϕ 25	4 $\times$ ϕ 25	4 $\times$ ϕ 32	4 $\times$ ϕ 32

The anchor bolt is cast in concrete up to the embedment mark.

In annex 1 the Anchor bolt is shown in an installed state.

1.2 Area of application

The Anchor bolts may only be used for the connection of precast reinforced concrete columns with the respective HALFEN Column Shoes and steel/composite columns with appropriate foot-plates. The Anchor bolts may be used under predominantly static loads or quasi-static loads in normal concrete with a minimum strength class of at least C12/15 and a maximum strength class of C50/60 in accordance with DIN EN 206: 2017-01. The Anchor bolts may be used in cracked and non-cracked concrete.

To ensure that the Anchor bolts are protected from corrosion, the joint between the reinforced concrete precast column, and the installation recesses for the Anchor bolts in the Column shoe must be completely grouted after installation with a flush-finished, high-strength, low-shrinkage mortar or concrete according to the specifications set by the German Committee for Structural Concrete (DAfStb *Deutscher Ausschuss für Stahlbeton*) "Production and use of cementitious, grouting concrete and grouting mortar". Ensure the concrete cover values specified in DIN EN 1992-1-1 :2011-01 and DIN EN 1992-1-1/NA:2013-04 as well as DIN EN 1992-1-1/NA:2013-04 are met.

Anchor bolts used for connecting steel columns shall only be used in interior rooms, e.g. flats, apartments, offices, schools, hospitals, commercial projects – except for wet rooms.

2 Regulations for the construction product

2.1 Properties and composition

The anchor bolts' dimensions must comply with the values given in table 1, annex 2.

The dimensions of the Anchor bolts must comply with the values listed in table 1 annex 2.

Any material properties, dimensions and tolerances of the Anchor bolts which are not specified in this general certificate of approval must comply with the specifications submitted to the DIBt, German Institute of Construction Engineering, the certification authority and the third-party auditor.

Ribbed, B500B concrete reinforcing steel according to DIN 488-1 :2009-01 with a 0.2% yield strength of 500 N/mm² and a minimum tensile strength of 550 N/mm² must be used for Anchor bolts with 20 and 25 mm diameter.

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For welded Anchor bolts of type 32, ribbed B500B concrete-reinforcing steel in accordance with a general certificate of approval, with a 0.2% yield strength of 500 N/mm² and a minimum tensile strength of 550 N/mm² is used.

The Anchor bolts are made from class A, non-flammable construction material in accordance with DIN 4102-1:1998-05 "Fire Behaviour of Construction Materials and Structural Elements; Construction Materials, Terms, Requirements and Tests".

2.2 Packaging, Storage and identification

2.2.1 Packaging and Storage

The Anchor bolts must only be packaged and supplied as one fixing unit.

2.2.2 Identification

The manufacturer must ensure the packaging, packaging-documents and delivery note display the conformity symbol (Ü) in accordance with the conformity regulations of the German federal states for said symbol. The manufacturer's identification mark, the approval number and a full description of the Anchor bolts must also be included. The label may only be applied after the requirements according to Section 2.3 have been met.

The Anchor bolts must be labelled according to their type and thread diameter, e.g. HAB MH 22.

Each Anchor bolt must be marked with the manufacturer's identification mark and thread diameter in accordance with annex 4. The maximum anchorage depth is indicated by the end of the thread.

2.3 Verification of conformity

2.3.1 General information

Confirmation of compliance of the Anchor bolt with the provisions of this general certificate of approval must be confirmed for each manufacturing plant with a certificate of conformity based on factory production control and by a certificate of conformity from a recognized certification body as well as by regular third-party monitoring by a recognized certification body in compliance with the following provision:

To gain issue of a Certificate of Conformity and for the purpose of third-party tests, which shall include the required product tests, the manufacturer of the anchor bolts is required to involve a recognized certification body and a recognized monitoring body.

The manufacture is required to label the product with the conformity system (Ü-Symbol = Übereinstimmungszeichen) with reference to its application.

The certification body shall forward a copy of the awarded certificate of conformity to the German Institute of Construction Engineering (DIBt *Deutsches Institut für Bautechnik*).

2.3.2 Factory production controls

Factory production control must be set up and carried out at each manufacturing plant. Factory production control is understood to mean a system of continual monitoring of the production process set up by the manufacturer to ensure that the manufactured construction products comply with the provisions of this general certificate of approval.

The extent, method and frequency of factory production control is determined by the test and inspection documents deposited with the German Institute of Construction Engineering (DIBt *Deutsches Institut für Bautechnik*) and the third-party inspection body.

The results of the factory production control must be documented and evaluated.

The documents must contain at least the following details:

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- Description of the construction product, i.e. the raw material, the individual components
- Method of control or test
- Date of manufacture and tests of the construction product, raw material, components
- Result of the control and tests and where appropriate, comparison with the specifications
- Signature of the person responsible for factory production control.

These records must be archived for at least five years and submitted to the auditor selected for third-party monitoring. On request, the documents must be made available to the German Institute of Construction Engineering and the responsible building control authority (Bauaufsichtsbehörde).

If the test results are unsatisfactory, the manufacturer must take the necessary action immediately to eliminate the problem. Construction products that do not satisfy the requirements must be handled so as to prevent them from being confused in any way with parts which do conform. After the defect has been eliminated, the relevant test must be repeated without delay where this is technically feasible and necessary to prove that the defect has been eliminated.

2.3.3 Third-party auditing

Factory production control at each manufacturing location must be evaluated by an third-party auditor on a regular basis, at least once a year.

Third party monitoring must include an initial inspection of the anchor bolts and random samples to be taken. Sampling and testing are the responsibility of the recognized inspection body.

The inspection and supervision plan on record at the Deutsches Institut für Bautechnik and the external auditor are authoritative for the scope, type and frequency of the external auditing.

The certification and external auditing results must be archived for at least five years. They must be submitted on request to the certification body or auditor to the German Institute of Construction Engineering and the responsible building control authority (Bauaufsichtsbehörde).

3 Specifications for planning, calculation and application

3.1 Planning

3.1.1 General information

The Anchor bolt connections must be designed according to standard engineering principles. Taking the expected anchor loads into consideration, verifiable calculations and design drawings shall be prepared which contain the position of the anchorages including possible dimensional tolerances.

3.1.2 Minimal axial spacing and edge distances

The minimum centre and edge distances specified in annex 3, table 3 must be observed.

3.1.3 Minimal thickness for the building component

The minimum component thickness $h_{\min}$ is derived from the anchoring depth l_2 according to annex 2 and the required concrete cover c_{nom}

$$h_{\min} = l_2 + c_{\text{nom}} \quad [\text{mm}] \quad (3.1)$$

$$l_2 = \text{Anchorage depth according to annex 2, table 1}$$

$$c_{\text{nom}} = \text{Nominal dimension of the concrete cover according to DIN EN 1992-1-1 :2011-01 as well as DIN EN 1992-1-1/NA:2013-04}$$

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3.2 Design

3.2.1 General information

Anchor design is according to DIN SPEC 1021-4:2009-08 "Design of fastenings for use in concrete", part 1 and 2. The corresponding characteristic values are provided in annex 4 and 5.

Verification of the immediate, local load transfer into the concrete is provided.

Transfer of the anchored loads into the building member must be verified.

Loads that may occur in the anchorage or in connected components caused by constrained deformation (for example from temperature fluctuation) must be considered.

In addition to table 1 of DIN SPEC 1021-4:2009-08, part 1, section 5.2.3.1, table 3.1 of this approval must be observed.

Table 3.1 Diameter of the clearance holes in the footplate.

Anchor bolts HAB MH Thread diameter	22	27	36	39	45	52	60
Diameter of the clearance holes in the footplate [mm]	24	30	39	42	48	55	63

3.2.2 Displacement behaviour

Displacement caused by tensile loads are in annex 4, table 5.

Displacement caused by shear loads are in annex 5, table 7.

3.3 Application

3.3.1 Installation of the anchor bolt and fixing the column

The anchors must be installed as shown in the mandatory design drawings. These design drawings must include the exact position and design details (position, size and lengths of the anchor bolts) of the anchorages.

The manufacturer's installation instructions must be followed, see annexes 6 to 7.

The anchors must be securely fixed to the formwork to ensure they are not displaced when the reinforcement is installed and when the concrete is poured and compacted.

When pouring the concrete, ensure the concrete is properly compacted especially under the Anchor bolts' heads.

When connecting precast reinforced concrete columns with the corresponding HALFEN Column shoes, the connection joint between the concrete member and the column shoe as well as the recesses for the nuts must be subsequently completely sealed with a flush-finished, high-strength, low-shrinkage mortar or grouting concrete according to the specifications in the DAfStb guideline "Production and use of cementitious, grouting concrete and grouting mortar".

The maximum torque T_{inst} at installation according to table 3, annex 3, must be met.

It is not required to apply a specific torque for the anchor bolts' load capacity.

3.3.2 Checking installation

The contractor entrusted with the installation of the anchor bolts or the site manager appointed by him, or a competent representative of the site manager must be present on site when the anchorage(s) is installed. He must ensure that installation is carried out properly. In particular, he is responsible for checking the execution and position of the anchorage(s) as well as any reinforcement that may be required.

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The respective documentation must be kept on site during the period of construction and on request must be available for inspection by the responsible engineer. These documents must be kept by the contractor, with the delivery documents, for at least 5 years after completion of work.

Beatrix Wittstock
Head of division (*Referatsleiterin*)

Figure 1. Reinforced prefabricated concrete column (B)

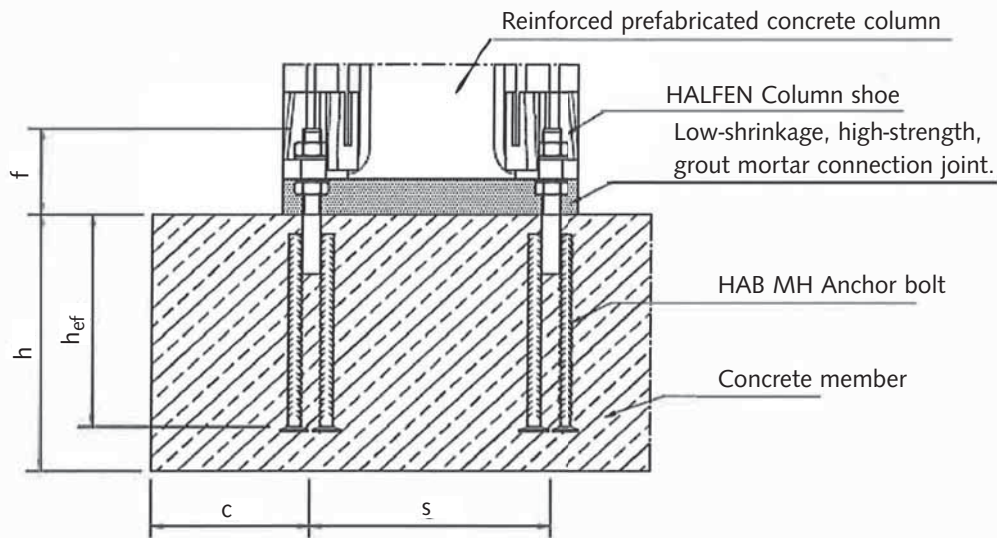


Figure 2. Steel/concrete composite column, with grout connection (B)

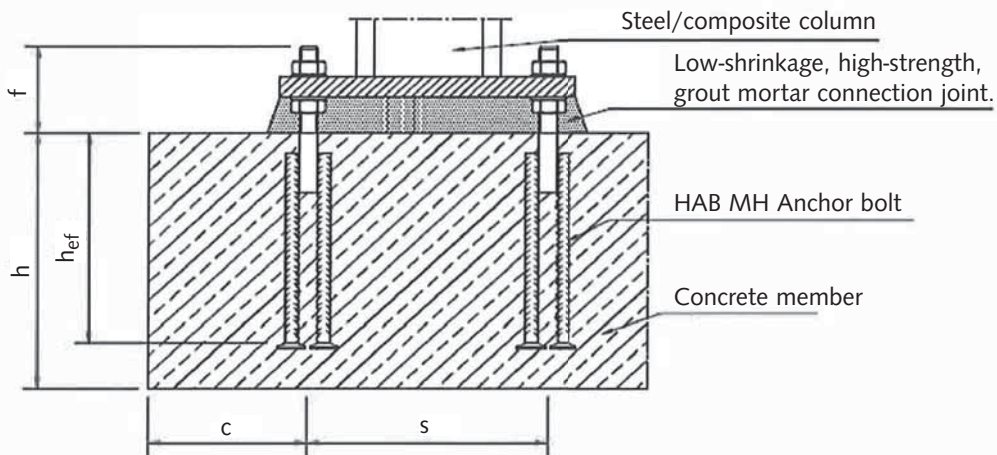
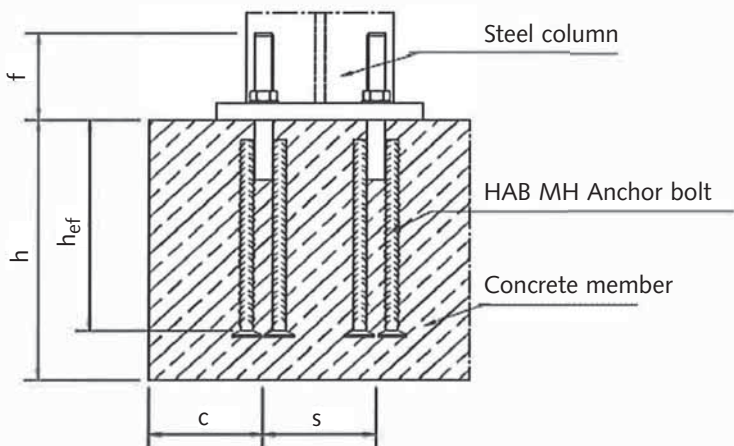


Figure 3. Steel column, without grout connection (A)



- h – thickness of concrete member
- h_{ef} – effective embedment depth
- c – edge distance
- s – axial spacing
- f – anchor protrusion

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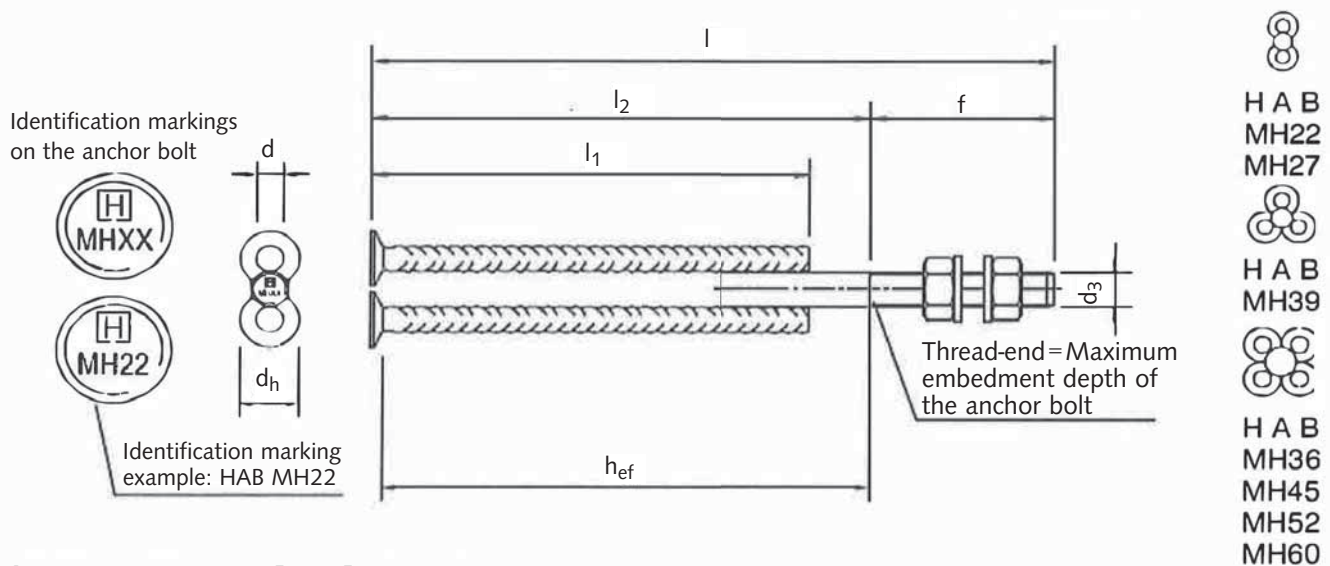


Table 1: Dimension [mm]

Anchor bolts type			HAB MH						
			22	27	36	39	45	52	60
Anchor bolts									
Total length	l	[mm]	510	650	740	880	980	1140	1330
Number of Anchor bolts	n	[-]	2	2	4	3	4	4	4
Embedment depth	l ₂	[mm]	380	500	575	695	785	900	1020
Protusion length of the Anchor bolt above the concrete surface	f	[mm]	130	150	165	185	195	240	310
Effective embedment depth	h _{ef}	[mm]	368	487	563	682	772	885	1000
Swaged-anchor length	l ₁	[mm]	320	450	520	640	730	860	1000
Diameter ribbed anchor rod	d	[mm]	20	25	20	25	25	32	32
Diameter anchor head	d _h	[mm]	46	55	46	55	55	70	70
Diameter threaded rod	d ₃	[mm]	22	27	36	39	45	52	60
Tensile cross-section of thread	A _{sp}	[mm ²]	303	459	817	976	1306	1758	2362
Anchor bolt head load bearing area	A _h	[mm ²]	2695	3770	5391	5655	7540	12177	12177
Washer									
Outer diameter	d ₂	[mm]	39	50	80	90	105	110	110
Inner diameter	d	[mm]	23	28	38	41	48	55	66
Thickness	t _{wh}	[mm]	3	4	8	10	12	12	10
Nut									
SW / Height			According to DIN EN ISO 4032:2013-04						

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Table 2: Materials

Anchor bolts	Diameters 16-40 B500B according to DIN 488-2:2009-8
Threaded rod	S690 according to DIN EN 10025-6:2009-08 and IMACRO M
Washers	S355J0 according to DIN EN 10025-2:2005-04
6 KT Nuts	Hexagonal nuts according to DIN EN ISO 4032:2013-04 Strength class 8 according to DIN EN ISO 898-2:2012-08

Table 3: Installation parameters for Anchor bolts

Anchor bolt type			HAB MH						
			22	27	36	39	45	52	60
Effective embedment depth	h_{ef}	[mm]	368	487	563	682	772	885	1000
Minimum axial spacing	s_{min}	[mm]	130	130	160	180	200	280	280
Minimum edge distance	c_{min}	[mm]	100	120	140	150	160	180	180
Protusion of the anchor bolts above the concrete surface	f	[mm]	130	150	165	185	195	240	310
Thickness of the concrete member	h_{min}	[mm]	$h_{ef} + t_h + c_{nom}^{1)}$						
max. installation moment; general (A) ²⁾	$T_{inst,A}$	[Nm]	90	170	400	520	800	1250	1800
max. installation moment; steel-steel (B) ³⁾	$T_{inst,B}$	[Nm]	250	550	1200	1400	2000	3300	3800

¹⁾ Nominal dimension of the concrete cover according to DIN EN 1992-1-1 :2011-01 as well as DIN EN 1992-1-1/NA:2013-04

²⁾ Connected component is in contact with concrete surface (See annex 1, figure 3)

³⁾ Connected component is clamped between the two nuts (See annex 1, figure 1 and 2)

Minimum reinforcement

Reinforcement, which limits the crack width to $w_k \leq 0.3$ mm, must be installed to absorb splitting tensile forces. See DIN SPEC 1021-4-2:2009-08, part 6.2.6.2

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HALFEN Anchor bolt HAB MH
Annex 3
Materials and installation parameters for the Anchor bolts

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Table 4: Characteristic resistances under tensile load

Anchor bolt type			HAB MH						
			22	27	36	39	45	52	60
Steel failure									
Characteristic resistance to steel failure	N _{Rk,s}	[kN]	242	367	654	781	1045	1406	1769
Partial safety factor	γ _{Ms}	[-]	1.4						
Pull-out failure									
Characteristic tensile resistance to pull-out failure for concrete strength class C20/25	N _{Rk,p}	[kN]	404	565	809	848	1131	1827	1827
Partial safety factor	γ _{Mp}	[-]	1.5						
Concrete failure									
Effective embedment depth	h _{ef}	[mm]	368	487	563	682	772	885	1000
Characteristic axial spacing	s _{cr,N}	[mm]	3 * h _{ef}						
Characteristic edge distance	c _{cr,N}	[mm]	1.5 * h _{ef}						
Partial safety factor	γ _{Mc}	[-]	1.5						
Factor to take into account the influence of load transfer mechanism									
in cracked concrete	k _{cr}	[-]	8.5						
in non-cracked concrete	k _{ucr}	[-]	11.5						
Splitting failure									
Reinforcement, which limits the crack width to w _k ≤ 0.3 mm, must be installed to absorb splitting tensile forces. See DIN SPEC 1021-4-2:2009-08, part 6.2.6.2									
Localized concrete (Blowout) failure									
Partial safety factor	γ _{Mcb}	[-]	1.5						

Table 5: Displacement under tensile load

Anchor bolt type		HAB MH						
		22	27	36	39	45	52	60
Tensile load	[kN]	112	171	212	283	340	418	502
Respective displacement	[mm]	0.6	1.6	3.7	3.9	5.4	3.7	5.2

¹⁾ under continuous load, displacements may increase by up to twice the given values.

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HALFEN Anchor bolt HAB MH
Annex 4
Characteristic resistance and displacement under tensile load

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Table 6: Characteristic resistances under shear load

Anchor bolt type			HAB MH						
			22	27	36	39	45	52	60
Steel failure without cantilever									
Characteristic resistance to steel failure	$V_{Rk,s}^0$	[kN]	109	165	294	351	470	633	850
Partial safety factor	γ_{Ms}	[-]	1.5						
Steel failure with cantilever									
Characteristic bending resistance of a single fastener	$M_{Rk,s}^0$	[kN]	714	1330	3160	4130	6390	9980	15500
Partial safety factor	γ_{Mp}	[-]	1.5						
Concrete failure (Pryout failure)									
Factor for calculation according to DIN SPEC 1021-4-2:2009-08, Gl. (32)	k_3 ¹⁾	[-]	2.0						
Partial safety factor	γ_{Mcp}	[-]	1.5						
Concrete edge failure									
Effective anchor bolt length	$l_f = h_{ef}$	[mm]	368	487	563	682	772	885	1000
Thread diameter of the anchor bolt	$d_{nom} = d_3$	[mm]	22	27	36	39	45	52	60
Partial safety factor	γ_{Mc}	[-]	1.5						

¹⁾ If additional reinforcement is used, factor k_3 is multiplied by 0.75.

Table 7: Displacement under vertical load

Anchor bolt type		HAB MH						
		22	27	36	39	45	52	60
Shear load	[kN]	62	94	168	201	269	362	486
Respective displacement ¹⁾	[mm]	1.7	2.4	4.9	5.2	7.1	9.7	13.3

¹⁾ under continuous load, displacements may increase by up to 1.3 times the given values.

Combined tensile and shear loads

Factor according to DIN SPEC 1021-4-2:2009-08, part 6.4.1.3: $k_7 = 2/3$

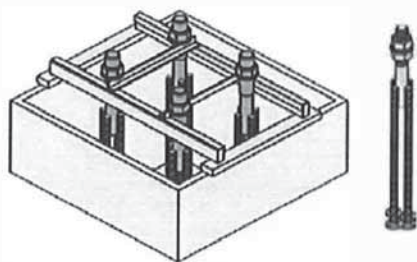
Note: This translation of the original German version has not been verified by the Deutsches Institut für Bautechnik.



HALFEN Anchor bolt HAB MH
Annex 5
Characteristic resistance and displacement under shear load

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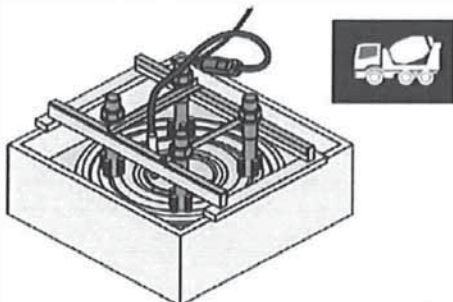
1: Position the anchors



Scope of delivery: Pre-assembled anchor bolts each with 2 hexagon nuts and custom washers

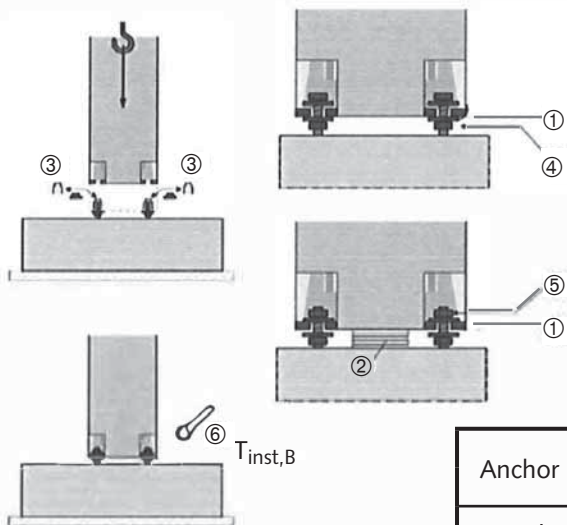
- Position the installation frame (reusable)
- Fit bolts to the installation frame
- Position the bolts and any additional reinforcement according to the structural engineer's specifications and reinforcement plans
- The anchor bolts must be correctly positioned and fixed in the specified axes and planes.

2: Pour the concrete



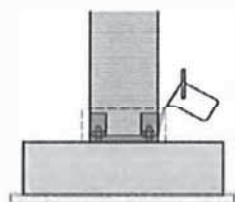
- Ensure the concrete is properly compacted around the anchor heads
- Ensure the anchor bolts do not move or are damaged
- Protect the thread of the anchor bolts against concrete or dirt
- The anchor bolts must only be subjected to load after minimum concrete strength has been reached

3: Place and adjust the column



- Adjust and fix the bottom nuts and washers of the anchor bolts to the required height ①. Keep the column connected to the crane during lifting and positioning
- Ensure the protection caps③ are on the threads
- Screw on the top nuts and adjust the column using the bottom nuts④
- Use stacked steel shims② for heavy columns; In this case fix the bottom nuts 5 mm lower. Place the column on the steel plates and adjust using the top nuts⑤.
- Use ring slogging spanners ⑥ according to DIN 7444 and open-end slogging spanners⑥ according to DIN 133
- The maximal installation torque $T_{inst,B}$ as specified in annex 3 must not be exceeded

4: Seal the connection joint



- Use a free-flowing low-shrinkage grouting mortar to fill the joint and the recesses in the column
- The mortar strength must be at least the same strength as the concrete used for the column concrete
- Full load capacity is only achieved after the mortar has fully cured

Anchor bolt type		HAB MH						
		22	27	36	39	45	52	60
max. installation torque; steel-steel	$T_{inst,B}$ [Nm]	250	550	1200	1400	2000	3300	3800

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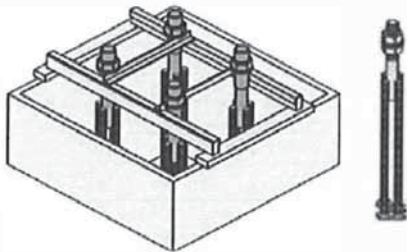
HALFEN Anchor bolt HAB MH

Annex 6

Installation instructions for precast concrete columns

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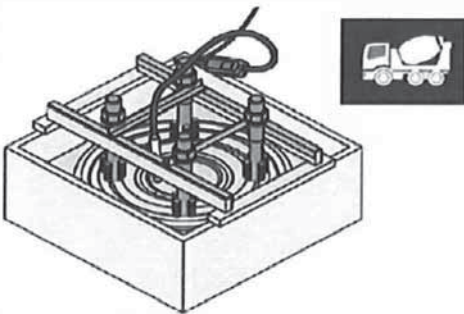
1: Position the anchors



Scope of delivery: Pre-assembled anchor bolts each with 2 hexagon nuts and custom washers

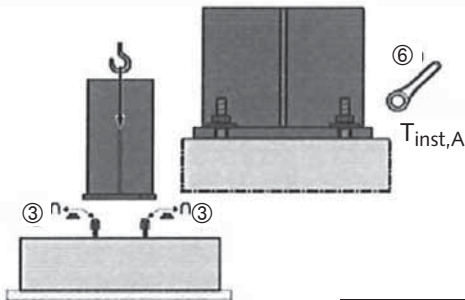
- Position the installation frame (reusable)
- Fit bolts to installation frame
- Position the bolts and any additional reinforcement according to the structural engineer's specifications and reinforcement plans
- The anchor bolts must be correctly positioned and fixed in the specified axes and planes.

2: Pour the concrete



- Ensure the concrete is properly compacted around the anchor heads
- Ensure the anchor bolts do not move or are damaged
- Protect the thread of the anchor bolts against concrete or dirt
- The anchor bolts must only be subjected to load after minimum concrete strength has been reached

3: Install the column



- Position the column, keeping it connected to the crane
- Ensure the protection caps ③ are on the threads
- Screw on the top nuts
- Use ring slogging spanners ⑥ according to DIN 7444 and open-end slogging spanners ⑥ according to DIN 133
- The maximal installation torque $T_{inst,A}$ as specified in annex 3 must not be exceeded

Anchor bolt type		HAB MH						
		22	27	36	39	45	52	60
max. installation torque; direct connection	$T_{inst,A}$ [Nm]	90	170	400	520	800	1250	1800

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HALFEN Anchor bolt HAB MH

Annex 7

Assembly instructions for steel columns

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