

Formwork ties

Requirements, testing, use

DIN
18 216

Schalungsanker für Betonschalungen;
Anforderungen, Prüfung, Verwendung

Supersedes August 1976 edition
withdrawn in July 1983.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

This standard, in clauses 3 and 7, includes safety requirements within the meaning of the *Gerätesicherheitsgesetz* (Equipment Safety Law).

Start of validity

This standard is valid from 1 December 1986.

The term "load" is used for forces acting on a system from outside; this applies equally to compound terms that include the component "load" (see DIN 1080 Part 1).

Dimensions in mm

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1 Concepts

1.1 Formwork tie

A formwork tie is a device for holding formwork together or for securing formwork on one side. It absorbs the stresses acting on the formwork until the concrete is hardened. It is composed of (see figure 1) anchor plate, anchor lock, anchor bolt, and distance piece.

The anchor lock and anchor plate and the distance piece and anchor bolt may be combined.

1.2 Anchor plate

The anchor plate transmits forces from the formwork to the anchor lock.

1.3 Anchor lock

The anchor lock transmits forces from the anchor plate to the anchor bolt.

A distinction is to be drawn between:

- a) wedge lock, which transmits forces by gripping the anchor bolt by means of a wedge;

- b) cam lock, which transmits forces by gripping the anchor bolt by means of a cam;

- c) wedge-cam lock, which transmits forces by gripping the anchor bolt by means of a wedge and cam;

- d) threaded lock, which transmits forces via a nut screwed on a threaded anchor bolt.

1.4 Anchor bolt

The anchor bolt acts as a tension member to absorb the forces exerted by the anchor locks at either end. In the case of formwork erected on one side only, it transmits the forces via special anchorages into the base.

1.5 Anchor bolt joint assembly

An anchor bolt joint assembly (including threaded cone, threaded socket, etc.) serves to connect butt-jointed anchor bolts.

1.6 Distance piece

The distance piece ensures the correct spacing in the formwork when the anchor bolt is tightened. It may be connected to the anchor bolt.

Continued on pages 2 to 11

2 Designation

2.1 The standard designation of wedge, cam and wedge-cam locks shall include name of component, DIN number, the diameter of the anchor bolt and a symbol denoting the type of lock, K (wedge lock), E (cam lock) or KE (wedge cam lock).

Designation of an anchor lock for an anchor bolt of 8 to 12 mm diameter in the form of a cam lock (E):

Anchor lock DIN 18 216 – 8-12 E

2.2 The standard designation of anchor bolts, threaded locks and screwed anchor bolt joint assemblies shall include the name of product, DIN number, load group, thread size and a symbol denoting the particular component 1 (anchor bolt), 2 (threaded lock) or 3 (threaded anchor bolt butt joint assembly).

Designation of an M 20 anchor bolt (1) of load group 25:

Anchor bolt DIN 18 216 – 25 – M 20 – 1

2.3 The standard designation of anchor plates shall include the name of product, DIN number, the letter identifying the support material, S (steel) or H (timber), and the load group.

Designation of an anchor plate timber support (H), of load group 30:

Anchor plate DIN 18 216 – H 30

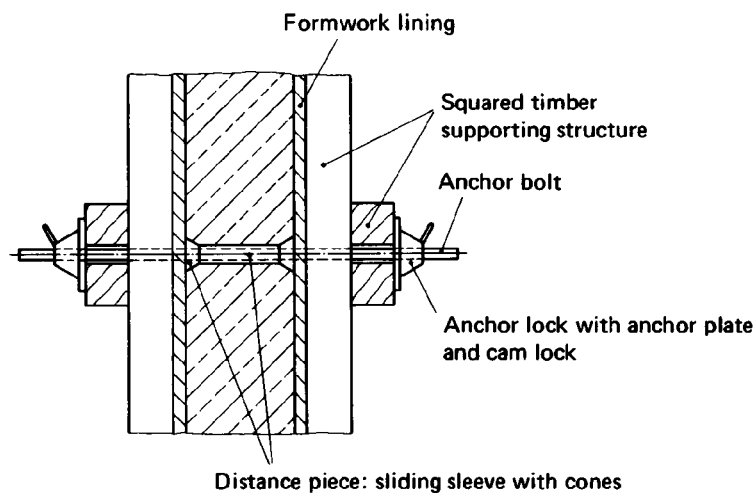
3 Safety requirements

3.1 Formwork ties with wedge, cam or wedge-cam lock

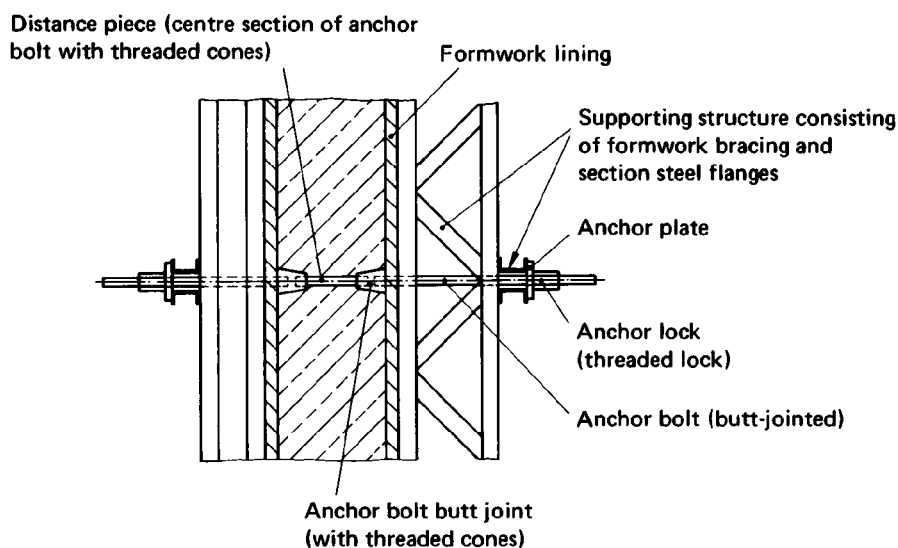
3.1.1 Anchor bolts

Anchor bolts shall be made from round or flat bars or sections in St 37-2 or St 37-3 steel (as specified in DIN 17 100) whilst the use of wire, strands or prestressing cable is not permitted.

Note. This ensures sufficient friction between anchor bolt and locks.



a) Formwork tie with cam lock



b) Formwork ties with threaded locks

Figure 1. Examples of fitting of formwork ties

3.1.2 Anchor locks and anchor plates

All components shall be so designed that the likely stresses do not give rise to any lasting deformation which might impair the serviceability. The dimensions and quality of the materials shall be so selected that, when the formwork tie is stressed, the anchor bolt is the first to fail.

The anchor plate shall be large enough to ensure that the permissible stresses in the supporting structure (e.g. timber or steel) and in the anchor plate are not exceeded. As a departure from DIN 1052 Part 1, a compressive strength of 3 N/mm² may be assumed for timber supports, a deduction for recesses or openings in the anchor plate up to a total area of 1 cm² when determining the supporting area not being required.

3.2 Formwork ties with threaded locks

3.2.1 Anchor bolts

Only the steel grades listed in tables 2 and 3 shall be used for anchor bolts. If steel grades as listed in table 3 are used and the anchor bolts are marked unambiguously and registered in accordance with subclause 6.2.1, the manufacturer shall inform the user of the load group of the anchor bolt as given in table 4, and of the marking details. Bolts with a yield point, β_s , of not less than 500 N/mm² shall be not less than 10 mm in diameter.

3.2.2 Anchor locks and anchor plates

Subclause 3.1.2 shall apply for anchor locks and anchor plates. Friction locking and ease of screwing of the anchor locks shall be retained, even after repeated use. The minimum length and width of anchor plates shall be taken as 110 mm.

Note. This ensures, for spacing of up to 50 mm between the supports, a minimum extension of the anchor plate beyond the edges of the support of 10 mm.

3.3 Distance pieces

Distance pieces shall not buckle or suffer uncontrolled deformation when subjected to contact pressure.

Note. When applying a force of up to 1,5 kN, the area of contact between the distance piece and formwork lining shall be not less than 5 cm².

Distance pieces which are to remain in the hardened concrete shall not be made of materials liable to damage the concrete.

3.4 Anchor bolt joint assemblies

Subclause 3.1.2, first paragraph, and subclause 3.2.2 shall apply.

4 Testing

4.1 General

The suitability of components of formwork ties which are subject to mandatory marking shall be verified by tests carried out by an accredited materials testing institute ¹⁾.

Test pieces shall be taken at random by a representative of the testing institute from a batch of not less than 100 units.

The test pieces shall be free of surface discontinuities, bends, contamination, pitting and grease, the grade of

the material shall be in accordance with the marking on the test pieces.

The dimensions and strength of the test pieces and their compliance with safety requirements shall be checked prior to testing. In the case of formwork ties with threaded locks, the manufacturer shall inform the testing institute of the thread manufacturing tolerances.

Should it not be possible to take a tensile test piece, a hardness test will suffice to determine the material strength.

Anchor plates and anchor locks designed for use with different types of formwork tie shall be tested as specified in subclause 4.2 or subclause 4.3. Tests to be carried out as specified in subclauses 4.2 and 4.3 may be combined provided that, in so doing, displacements of both the anchor plates and the anchor locks can be measured. Formwork ties made up of components not designed for use with different types of formwork tie shall be tested as specified in subclause 4.4.

Formwork ties the anchor plates of which are designed for mounting with timber supports shall additionally be tested as specified in subclause 4.5.

Anchor bolt joint assemblies shall be tested as specified in subclause 4.6.

4.2 Testing of anchor plates

The test arrangement shall be as shown in figure 2. The diameter, d , of the ram shall be twice that of the largest anchor bolt. Not less than three tests shall be carried out.

Rectangular anchor plates shall be tested in their least favourable position which, if necessary, is to be determined by preliminary tests.

The load shall be increased steadily up to the rated working load, F , as specified in table 1, 2 or 4. The resultant displacement, s_t , shall be read off to the nearest 0,05 mm. The load shall then be released and the permanent displacement, s_p , determined. To avoid unwanted effects on measurement, the zero reading shall be taken at a preload equal to 5 % of the working load. When determining the residual displacement, the working load shall be released down to this preload. Following this, the load on the anchor plate shall be steadily increased to the point of failure, at least up to 1,75 times the working load.

The maximum load, F_u , shall be deemed to be the load at which failure occurs or when the test is stopped. A deflection of the plate of 10 mm minimum shall also be regarded as failure.

¹⁾ The following are accredited materials testing institutes:

Staatliches Materialprüfungsamt Nordrhein-Westfalen, Marsbruchstraße 186, D-4600 Dortmund-Aplerbeck;
Materialprüfungsamt für das Bauwesen der TU München, Prüfamt und Forschungsinstitut für Baustoffe und Bauarten, Arcisstraße 21, D-8000 München 2;
Amtliche Forschungs- und Materialprüfanstalt für das Bauwesen (Otto-Graf-Institut), Pfaffenwaldring 4, D-7000 Stuttgart 80.

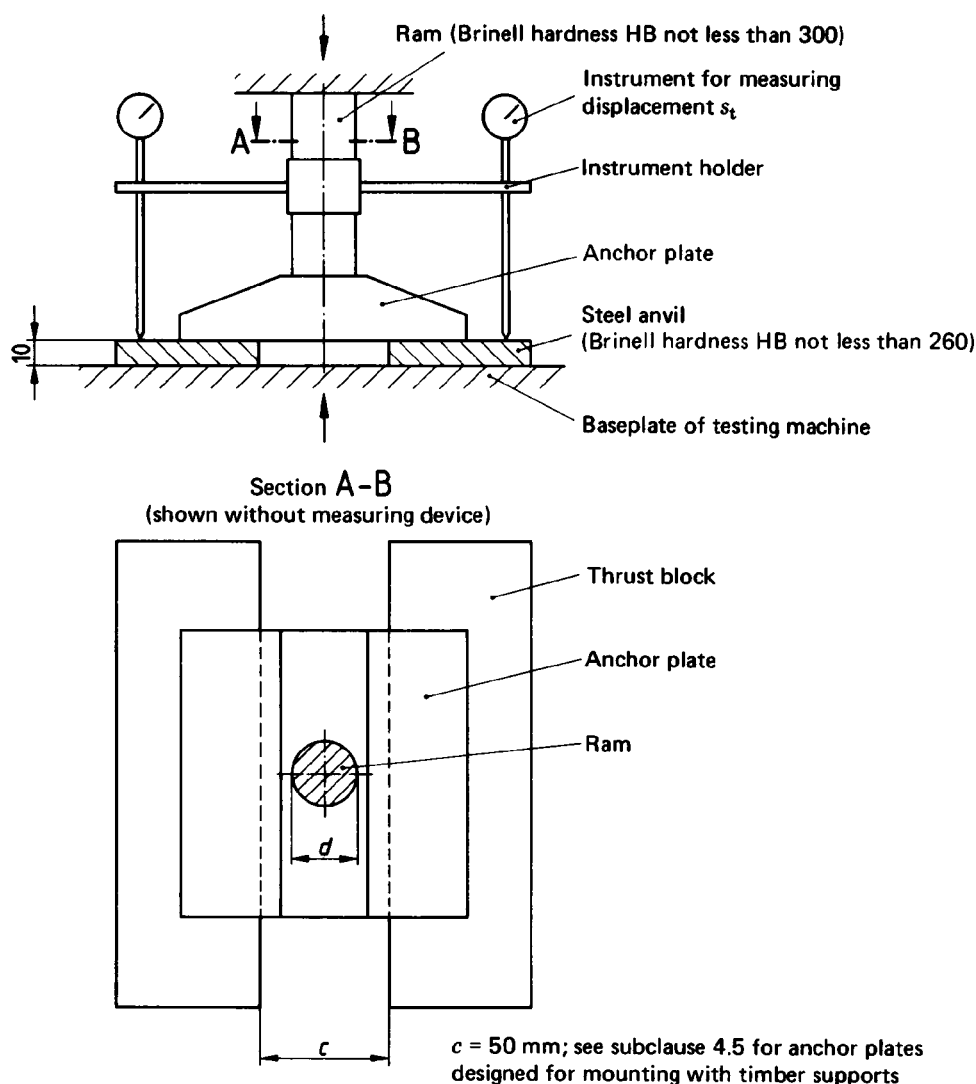


Figure 2. Test arrangement for testing anchor plates

The test shall be deemed to have been passed if conditions (1), (2) and (3) are met in each of the three tests:

$$s_t \leq 1,5 \text{ mm} \quad (1);$$

$$s_b \leq 1 \text{ mm} \quad (2);$$

$$F_u \geq 1,75 \text{ zul. } F \quad (3);$$

where

s_t is the overall displacement, in mm;

s_b is the permanent displacement, in mm;

F_u is the maximum force applied, in kN.

4.3 Testing of anchor lock/anchor bolt assembly

The test arrangement shall be as shown in figure 3. The diameter of the hole in the anvil shall correspond to that of the anchor bolt plus 5 mm.

Note. Only threaded locks not combined with an anchor plate can be tested in this way.

Displacements s_t and s_b shall be determined as specified in subclause 4.2 on not less than three locks.

By way of departure from subclause 4.2, condition (4) shall be met in each test, i.e. $s_b \leq s_t \leq 1 \text{ mm}$ (4).

The locks tested in this way, together with seven unused locks, shall then be loaded until they fracture or otherwise fail. In the case of not less than three test pieces, the difference between the external diameter of the anchor bolt thread and the internal diameter of the lock thread shall lie in the least favourable third of the tolerance zone. To ensure this, the required number of test pieces shall be machined accordingly, where necessary. The test shall be deemed to have been passed if condition (5) is met in each test, i.e.

$$F_u = 0,95 \cdot \text{vorh } \beta_z \cdot \text{vorh } A \quad (5).$$

Vorh β_z shall be determined as the mean from six test pieces in the tensile test as described in DIN 50 145; it shall be not less than β_n .

In equation (5),

F_u is the maximum force applied, in kN;

vorh β_z is the actual tensile strength of the anchor bolt, in kN/mm²;

vorh A is the actual cross section of the anchor bolt, in mm²;

β_n is the nominal tensile strength of the anchor bolt, in kN/mm².

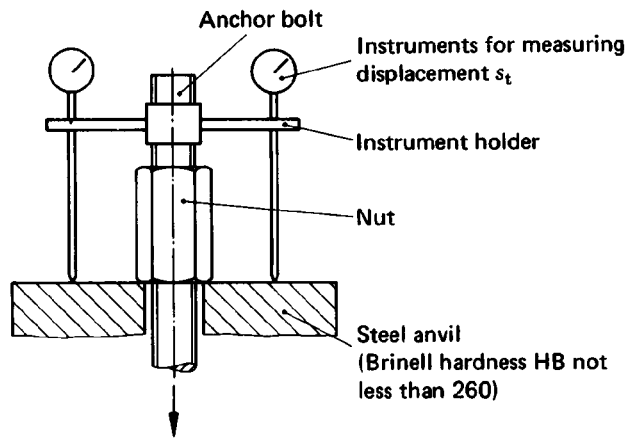


Figure 3. Test arrangement for testing anchor lock/anchor bolt assemblies

4.4 Testing of complete formwork ties

4.4.1 Formwork ties with threaded locks

The test arrangement shall be as shown in figure 4. s_t and s_b shall be determined as specified in subclause 4.2 on not less than three formwork ties.

By way of departure from subclause 4.2, the test shall be deemed to have been passed if conditions (6) and (7) are met:

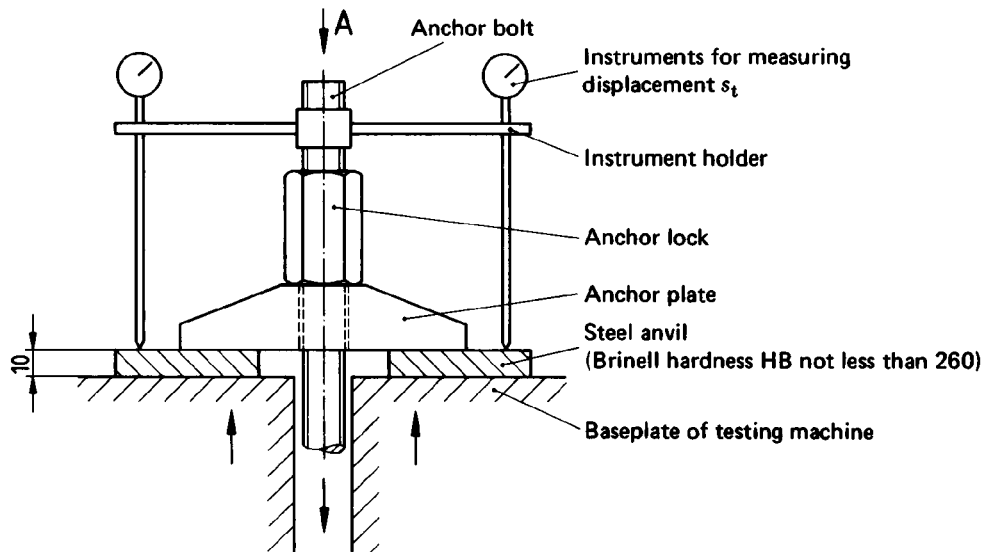
$$s_t \leq 2 \text{ mm (6);}$$

$$s_b \leq 1,5 \text{ mm (7).}$$

Loading to failure shall then be carried out in accordance with subclause 4.3, the test arrangement being as shown in figure 4.

4.4.2 Formwork ties with wedge, cam or wedge-cam locks

The test arrangement shall be as shown in figure 4, the formwork ties being positioned relative to the edges of the anvils in the same way as in practice.



View A
(shown without measuring device)

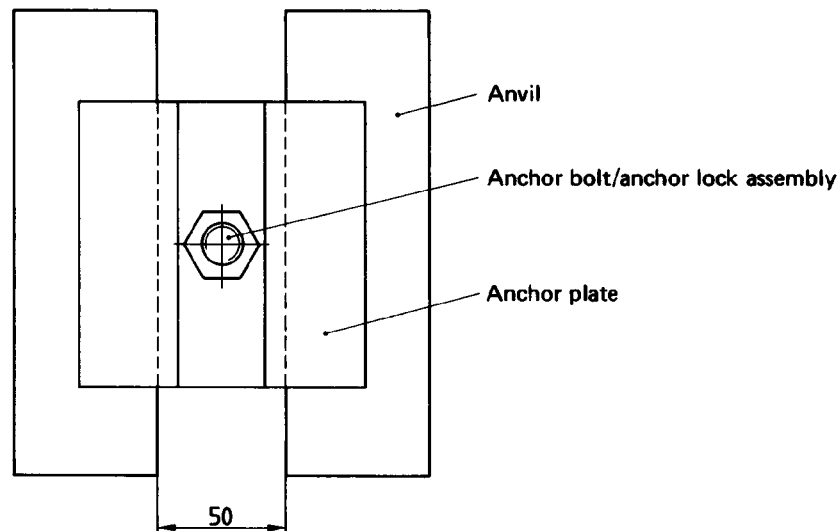


Figure 4. Test arrangement for testing a complete formwork tie

s_t and s_b shall be determined as specified in subclause 4.2 on not less than three formwork ties, condition (8) being met in each test, i.e. $s_b \leq s_t \leq 3 \text{ mm}$ (8).

The following test shall be carried out 30 times on three further unused formwork ties.

The load shall first be increased steadily to working load and s_t measured as specified in subclause 4.2. The load shall then be reduced to about half the working load and the measuring instrument detached. Following this, the formwork tie shall be unloaded the lock being loosened in the same way as in practice. The lock shall then be moved along the anchor bolt far enough to ensure that any damage suffered by the anchor bolt during the test cannot affect the result of the following test. s_t is to be measured in the 1st to the 5th and the 26th to the 30th test, the highest value from these tests being evaluated. Condition (9) shall be met, i.e. $s_1 \leq s_e + 0,5 \text{ mm}$ (9),

where

s_1 is the highest value obtained from the last five tests;

s_e is the highest value obtained from the first five tests.

The six locks tested and four unused locks shall then be loaded until they fracture or otherwise fail. The test shall be deemed to have been passed if, in each test, one of conditions (5) and (6) is met.

4.5 Additional testing of formwork ties intended for mounting with timber supports

s_t and s_b shall be measured on three formwork ties intended for mounting with timber supports at half the design working load. By way of departure from figures 2 and 4, the anchor need only extend 10 mm beyond the edges of the supports. In other respects, the procedure to be followed and the criterion for judging whether the tests have been passed shall be as in subclauses 4.2 and 4.3.

4.6 Testing of anchor bolt joint assemblies

Screwed anchor bolt joint assemblies shall be tested as specified in subclause 4.3. The test shall be deemed to have been passed if condition (5) is met in each test.

4.7 Test certificate

In addition to the results obtained from testing as specified in subclauses 4.2 to 4.6, the test certificate shall include the following information:

- a drawing of the formwork tie, with the dimensions, tolerance zones and characteristics of the materials used, or the corresponding standard designation;
- test piece dimensions;
- test piece strength;
- a statement of whether the formwork ties or anchor components tested are properly and unambiguously marked in accordance with clause 6;
- a statement of whether the tests have been passed;
- in the case of formwork ties with a threaded lock, the load group as given in table 4, for which purpose rounding up by 5 % is permitted.

Details of the tolerance zones need not be given if they have been made available to the testing institutes.

5 Inspection

5.1 General

In every manufacturing works, the correct manufacture of formwork ties and their components shall be ensured by inspection in accordance with DIN 18 200, comprising internal control and third party inspection.

5.2 Internal control

Type, scope and frequency of tests to be carried out within the framework of internal control shall be taken from table 5.

5.3 Third party inspection

Third party inspection shall be based on an inspection contract with one of the accredited testing institutes listed in subclause 4.1, footnote 1.

6 Marking

6.1 Formwork ties with wedge, cam or wedge-cam locks

The dimensions of anchor bolts together with which the anchor locks were successfully tested as described in clause 4 shall be marked on the locks along with the DIN symbol.

Marking of an anchor lock designed for anchor bolts of 8 to 12 mm in diameter:

8 – 12 DIN

Note. Anchor bolts need not be marked (see subclause 7.2).

6.2 Formwork ties with threaded locks

6.2.1 Anchor bolts of the materials listed in table 3 shall be marked with the load group as given in table 4, column 4, and with the DIN symbol, anchor bolts in St 37-2 and St 37-3 steel (specified in DIN 17 100) requiring no marking.

Marking of a load group 20 anchor bolt:

20 – DIN

Bolt shape, type of thread, thread pitch or a diameter, which clearly differentiate the anchor bolt from other types of anchor bolt already registered with an accredited testing institute as listed in subclause 4.1, footnote 1 may also be used for marking purposes. Such anchor bolts shall be provided at intervals of not more than 500 mm with a manufacturer's symbol registered with the above-mentioned accredited materials testing institute.

6.2.2 Threaded locks and screwed anchor bolt butt joint assemblies, except for those for anchor bolts in St 37-2 or St 37-3 steel (as specified in DIN 17 100) shall be marked with the load group as given in table 4, column 4, and with the DIN symbol.

Marking of a load group 30 threaded lock:

30 – DIN

6.2.3 Anchor plates shall be marked with the material of the supporting structure, the load group as given in table 4 and the DIN symbol.

Marking of a load group 30 anchor plate intended for mounting with steel supports:

S 30 – DIN

Marking of a load group 90 anchor plate intended for mounting with steel supports, and load group 50 anchor plate intended for mounting with timber supports;

S 90/H – 50 DIN

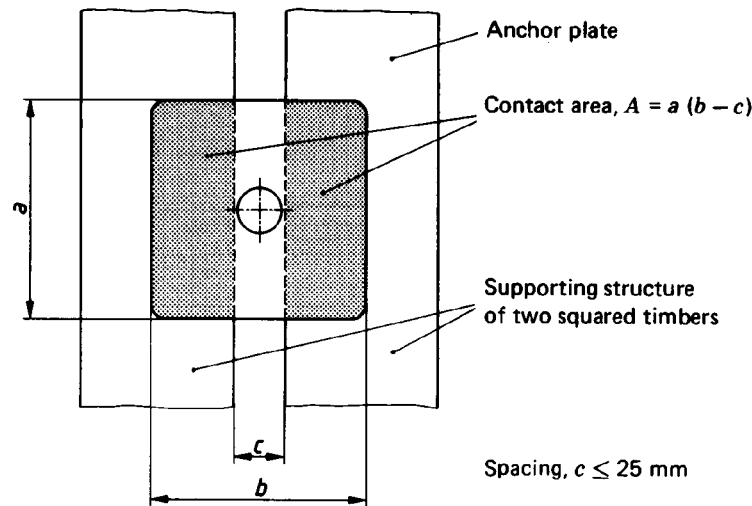


Figure 5. Contact area between anchor plates and timber supports

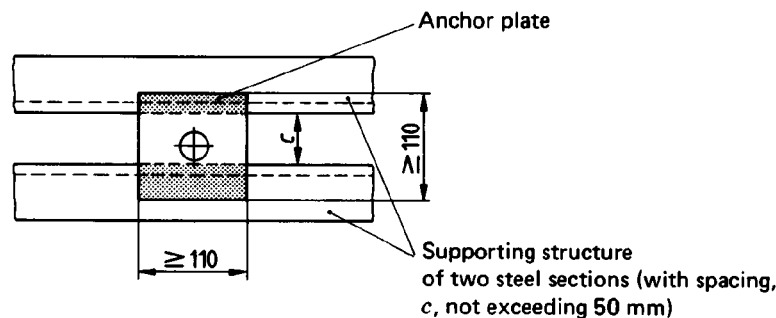


Figure 6. Minimum contact area between anchor plates and steel supports

6.3 Stamping

The marking required shall be stamped by the manufacturer, together with his trade mark, on the components.

If threaded lock and anchor plate are combined, both components are to be marked.

7 Use

7.1 Only undamaged components shall be used, meaning that they shall largely be free of contamination, bends and pitting; anchor locks and anchor bolts (see subclause 3.1) shall additionally be free of grease.

7.2 The marking of formwork ties with wedge, cam or wedge-cam locks shall be used for identifying the associated anchor bolts.

7.3 Threaded locks, anchor bolt butt joint assemblies and anchor plates shall be used only in conjunction with anchor bolts assigned to the same or to a lower load group. The actual load on the formwork tie shall not exceed the permissible load for the anchor bolt.

7.4 The anchor plates selected shall be large enough to ensure that the permissible stresses of the supporting structure (e.g. metal or timber supports) are not exceeded (see figures 5 and 6). When determining these stresses,

a deduction for recesses or openings in the anchor plate of a total area of less than 1 cm² is not required. By way of departure from DIN 1052 Part 1, a compressive stress of 3 N/mm² may be assumed when timber supports (see figure 5) are employed. The spacing of the supports shall not exceed 50 mm when using steel and 25 mm when using timber.

7.5 The type, number and position of formwork ties shall be selected taking the permissible load into account which is specified in the tables 1, 2 and 4.

Where anchor bolts are unambiguously identified by their shape and registration number in accordance with subclause 6.2.1, information on the appropriate load group can be obtained from the accredited testing institutes listed in subclause 4.1, footnote 1.

7.6 In the case of formwork erected on one side only, the stress in the formwork tie may, by way of departure from subclause 7.5, be assumed to be not more than the permissible stress relevant for the anchorage.

7.7 In the case of formwork ties intended for mounting with supports made of materials other than steel or timber, the permissible loads for timber may be assumed.

7.8 For formwork ties in system formwork, the assembly instructions issued by the formwork manufacturer shall be observed.

Table 1. Permissible load for formwork ties with wedge, cam or wedge-cam locks

Diameter of anchor bolt, in mm	Cross-sectional area, A , in cm^2	Load, zul. F , in kN
6	0,28	3
8	0,50	6
10	0,79	10
12	1,13	14
14	1,54	20
16	2,01	25

Anchor bolts with non-circular cross section shall be assigned, according to their smallest loadbearing cross-sectional area, to the next lowest line in table 1.

Table 2. Permissible load for formwork ties with threaded locks and anchor bolts in St 37-2 or St 37-3 steel, not subject to mandatory marking

Thread diameter 1), in mm	Load, zul. F , in kN
10	6
12	8
16	16
20	25
24	35
27	45

1) Coarse thread as specified in ISO 898 Part 1, or anchor bolts with corresponding cross section

Table 3. Steel grades, property classes and factors of safety for marked anchor bolts

Line	Range of yield point, β_s , in N/mm^2	Property class/ steel grade	Material	Factor of safety, V , against reaching the nominal yield point, β_s			Cross section to be used in the calculation		
				Thread			Thread		
				Cut	Rolled	Milled	Cut	Rolled	Milled
1	Between 220 and 500	St 37-2 St 37-2 4.6 4.8	DIN 17 100 ISO 898 Part 1	2,1	1,75	—	Cross section in tension	Cross section in tension	—
2		BSt 420 S BSt 500 S	Reinforcing steel as in DIN 488 Part 1 or material approved by the building inspectorate	—	1,75	1,75	—		Nominal cross section ²⁾
3	Between 500 and 940	8.8 9.8	ISO 898 Part 1 ¹⁾	—	1,75	1,75	—		Nominal cross section ²⁾
4		Prestressing steel, subject to being generally approved by the building inspectorate		—	—	1,75	—	—	

1) The mechanical properties of the steels used shall be ensured and verified in an initial inspection made in accordance with clause 4, the scope of testing being as specified in table 5. The tests, to be based on ISO 898 Part 1, April 1979 edition, table 3, shall cover the tensile strength, stress at permanent set limit and the elongation at fracture, A_5 , or, alternatively, strength under oblique load using a hexagon nut with a flat bearing surface (instead of an anchor lock). In addition, bend tests shall be carried out bending the bolt by 180°, the bending radius being equal to 6 times the bolt diameter; in the case of threaded flat bars, bending shall be diagonal so as to stress the threaded edges.

2) To be determined from the mass in accordance with approval or on the occasion of initial inspection.

Table 4. Permissible load for formwork ties with marked anchor plates, threaded locks and anchor bolts

1	2	3	4
Anchor plates for mounting with steel supports mounting with timber supports Marking as in subclause 6.2		Threaded locks and anchor bolts	Load group (load zul. F , in kN)
S 20 - DIN	H 20 - DIN	20 - DIN	20
S 30 - DIN	H 30 - DIN	30 - DIN	30
S 50 - DIN	H 50 - DIN	50 - DIN	50
S 80 - DIN	-	80 - DIN	80
S 90 - DIN	-	90 - DIN	90
S 150 - DIN	-	150 - DIN	150
S 200 - DIN	-	200 - DIN	200
S 250 - DIN	-	250 - DIN	250
S 300 - DIN	-	300 - DIN	300
See also subclause 3.2.1 for anchor bolts registered in accordance with subclause 6.2.1 and bearing the manufacturer's symbol.			

Table 5. Type, scope and frequency of testing to be carried out within the framework of inspection

Object of test	Properties/ items tested	Requirements	Types of proof	Scope and frequency of testing		
				Initial inspection	Internal control	Third party inspection
Materials of anchor locks and anchor plates subject to mandatory marking	Mechanical properties	Materials to comply with test certificate as specified in subclause 4.7	Delivery note and test report as specified in DIN 50 049	In accordance with the relevant standards, e.g. DIN 17 100 for St 37-2 or St 37-3 and St 50-2 steel, or DIN 1692 for malleable cast iron.		
Materials of anchor bolts assigned to property classes as listed in table 3 for β_s between 220 and 500, and between 500 and 940 N/mm ²	Mechanical properties	For St 37-2 or St 37-3 steel as in DIN 17 100 (example)	Delivery note and test report as specified in DIN 50 049	In accordance with DIN 17 100.		
		For BST 420 S, as in DIN 488 Part 1 (example)		In accordance with DIN 488 Part 6.		
		For prestressing steel, subject to general building inspectorate approval		In accordance with approval.		
Anchor locks and anchor plates	Dimensions, marking, function (assembly)	a) Compliance with subclauses 3.1.2, 3.2.2, 4.1, 4.7 and 6;	Certificate of compliance with the order as specified in DIN 50 049	As in subclauses 4.2 and 4.3.	1 %	By random sampling
	Loadbearing capacity	b) Compliance with conditions (1) to (5);			0,5‰ ¹⁾	
Anchor bolts	Diameter, cross section, surface condition, marking	a) Compliance with tolerances as in subclauses 4.1 and 4.7; b) As in subclauses 3.2.1 and 6.2.1;	Certificate of compliance with the order as specified in DIN 50 049	10 items per cast	1 ‰	By random sampling
	Mechanical properties ²⁾	c) Compliance with table 3 or ISO 898 Part 1.			3 items per cast	1 per inspection

1) Only testing to failure as specified in subclause 4.3, condition (5) being complied with.

2) Where the mechanical properties have changed (e.g. by threading), as compared with the materials test (see line 2 of this table).

Standards referred to

DIN 488 Part 1	Reinforcing steel; grades, properties, marking
DIN 488 Part 6	Reinforcing steel; inspection
DIN 1052 Part 1	Timber structures; design and construction
DIN 1080 Part 1	Quantities, symbols and units used in civil engineering; principles
DIN 1692	Malleable cast iron; terminology, properties
DIN 17 100	Steels for general structural purposes; quality standard
DIN 18 200	Inspection of construction materials, structural members and types of construction; general principles
DIN 50 049	Materials testing certificates
DIN 50 145	Testing of metallic materials; tensile test
ISO 898 Part 1	Mechanical properties of fasteners; bolts, screws and studs

Previous edition

DIN 18 216: 08.76.

Amendments

In comparison with the August 1976 edition, which was withdrawn in July 1983, the content of the standard has been completely revised and brought into line with the present state of the art.

International Patent Classification

E 04 G 17/06
G 01 M 19/00