DEUTSCHES INSTITUT FÜR BAUTECHNIK

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Ref No.: I 19-1.1.1-5/06

National Technical Approval

Approval number:	Z-1.1-106
Applicant:	Stahlwerk Annahütte Max Aicher GmbH & Co.KG 83404 Ainring
Generic type of construction product:	Concrete reinforcing steel bar BSt 500 S (B) with thread ribs SAS 500 nominal diameter: 40 and 50 mm
Valid until:	31 December 2009

The aforementioned construction product is herewith generally approved by the Deutsches Institut für Bautechnik in accordance with German building legislation.
This National Technical Approval comprises ten pages and seven annexes.

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* This National Technical Approval supersedes the National Technical Approval dated 17 August 1999, validity extended vide notification dated 17 December 2004.
The first National Technical Approval of the aforementioned construction product was issued on 1 February 1987.

I. GENERAL PROVISIONS

1. This National Technical Approval attests to the usability and applicability of the aforementioned construction product in accordance with German federal state building regulations.

2. This National Technical Approval does not replace the permits, licences and certificates required by German law for the execution of construction projects.

3. This National Technical Approval is granted without prejudice to third party rights, in particular private property rights.

4. Irrespective of further provisions laid down in the “Specific Provisions” section, the manufacturer and supplier of the aforementioned construction product shall provide users and appliers of the construction product with copies of the National Technical Approval and inform them that the National Technical Approval must be available at the construction site. On request, copies of the National technical Approval shall be submitted to all authorities involved.

5. Reproduction of this National Technical Approval shall be in full. However, partial reproduction can be made with the written consent of the Deutsches Institut für Bautechnik. Texts and drawings of advertising brochures shall not contradict the National Technical Approval. Translations of the National Technical Approval shall include the note “Translation from the German original text not certified by Deutsches Institut für Bautechnik”.

6. This National Technical Approval is not granted irrevocably. The provisions of the National Technical Approval may be subsequently amended or modified, particularly if made necessary as a result of new technical developments.

II. SPECIFIC PROVISIONS

1 Definition of product and intended use

1.1 Definition of the construction product

(1) This National Technical Approval applies to concrete reinforcing steel bars BSt 500, hot rolled and heat-treated by utilizing the rolling heat, with thread ribs (BSt 500 S (B) – SAS 500).

(2) The cross section is nearly circular. Nominal diameters are 40 mm and 50 mm.

(3) Two rib rows are rolled onto the bar surface to form a single left-hand thread (see Annex 1).

1.2 Intended use

(1) Unless otherwise specified in this National Technical Approval, BSt 500 S (B) - SAS 500 with d_s= 40 and 50 mm may be used for the reinforcement of reinforced concrete according to DIN 1045-1:2001-07 in compliance with the same provisions as specified for BSt 500 S.

(2) The threaded concrete reinforcing steel bar may only be installed in concrete grades C20/25 to C60/75. This reinforcement has not been approved for installation in lightweight concrete.

(3) The concrete reinforcing steel bar BSt 500 S (B) – SAS 500 may be classified as high-ductile concrete reinforcement steel (ductility class B) according to DIN 1045-1, Table 11.

2 Provisions for bar anchors AWM 1100

2.1 Characteristics and composition

2.1.1 Surface design and cross section

(1) Rib geometry, nominal cross section and nominal weight must comply with the specifications given in Annex 1.

(2) The 5% fractile of the cross section area of all bars of one production batch must correspond to at least 0.96 times the nominal cross section.

(3) The mean cross section may not be smaller than the nominal cross section.

(4) The cross section is determined by weighing and calculating volume. Thereby, the apparent density is assumed to be 7.85 g/cm^3.

2.1.2 Mechanical-technological properties

The requirements for the mechanical-technological properties specified in Annex 2 shall be met.

2.1.3 Chemical composition

(1) The provisions for BSt 500 S specified in DIN 488-1:1984-09 shall be met.

(2) The chemical limit values used in production have been submitted to the approved body responsible for continuous surveillance (see 2.3.3 (2)) and the Deutsches Institut für Bautechnik.

2.2 Production and marking

2.2.1 Production

(1) BSt 500 S (B) is hot-rolled and heat-treated by utilizing the rolling heat. The parent material (melt or billet) shall meet the requirements specified in section 2.1.3.

(2) The threadbars shall be produced in technically straight lengths and cut to specification.

2.2.2 Marking

(1) The concrete reinforcement steel shall be classified as concrete reinforcing steel bar BSt 500 S (B) - SAS 500 identifiable through thread ribs rolled onto both sides and forming a continuous left-hand thread.

(2) The manufacturing plant shall be identified by raised lines rolled onto the rib-free bar surface at a distance of 12 thread ribs apart. This manufacturer's mark shall be rolled onto each running metre of the concrete reinforcing steel bar.

(3) The manufacturer shall affix the conformity marking (Ü-mark) on the delivery note of the construction product in accordance with the conformity marking regulations of the German federal states. The Ü-mark may only be affixed, if the requirements according to section 2.3 for the attestation of conformity are met.

(4) Each dispatch unit shall be provided with a weather-resistant label showing the manufacturing plant, melt number, approval number, concrete reinforcement steel grade and conformity marking.

2.3 Attestation of Conformity

2.3.1 General

(1) To attest the construction product's conformity with the provisions of this National Technical Approval a certificate of conformity shall be issued for each manufacturing plant based on factory production control and continuous surveillance including initial type-testing of the construction product in accordance with the following provisions.

(2) The manufacturer of the construction product shall involve an approved certification body to issue the certificate of conformity and an approved inspection body to perform continuous surveillance including product inspection.

2.3.2 Factory production control

(1) Each manufacturing plant shall establish and implement a factory production control system. Factory production control entails the permanent internal control of production exercised by the manufacturer in order to ensure that the construction product produced by him is in conformity with the provisions of this National Technical Approval.

(2) Factory production control shall be carried out as specified for concrete reinforcing steel bars BSt 500 S in DIN 488-6:1986-06. Thereby, the following modification shall however be observed:

For the 50 mm threadbar diameter, rebend testing is not required. Instead, a bend test shall be performed: $d_{br} = 6 \cdot d_s$, bend angle 90° (residual).

(3) The results of factory production control shall be recorded and evaluated. The records shall include at least the following information:

- Identification of the construction product or parent material and components
- Type of control or test
- Date of production and testing of the construction product or parent material or components
- Results of controls and tests and comparison with requirements, as applicable
- Signature of the person responsible for factory production control

(4) The records shall be kept for at least five years and shall be submitted to the inspection body responsible for continuous surveillance. On request, these records shall be submitted to the Deutsches Institut für Bautechnik and the relevant supreme building control authority.

(5) In case of unsatisfactory test results, the manufacturer shall take immediate measures to eliminate the deficiency. Construction products that do not comply with the requirements shall be handled such that they cannot be mistaken for products complying with the requirements. After elimination of the deficiency the respective test shall be immediately repeated as far as is technically possible and necessary to verify that the deficiency has been eliminated.

2.3.3 Continuous surveillance

(1) Factory production control of each manufacturing plant shall be verified by continuous surveillance. The frequency of the controls is specified in DIN 488-6:1986-06, section 5.1.2. In addition, samples for audit testing shall be taken in accordance with DIN 488-6:1986-06, section 5.1.3. The respective approved body is responsible for sampling and testing.

(2) Continuous surveillance shall include initial type testing to be performed at the beginning of production in accordance with DIN 488-6:1986-06, section 3.

(3) The results of certification and continuous surveillance shall be kept for at least five years. On request, they shall be submitted by the certification body or approved body to the Deutsches Institut für Bautechnik and the relevant supreme building control authority.

3 Provisions for design and dimensioning

DIN 1045-1:2001-07 shall apply, unless otherwise specified below.

3.1 Design

(1) The thickness of the structural member must be at least $h = 15 \cdot d_s$.

(2) According to DIN 1045-1, section 7.3.1 (7) and 10.3.2, structural members reinforced with BSt 500 S (B) – SAS 500, 40 or 50 mm diameter, must be directly supported. Consequently, the bearing force must be introduced normal to the lower edge of the structural member through compressive stresses. A rigid suspension, e.g. using anchor plates in accordance with 4.1.3.2, is equatable to a direct support.

3.2 Dimensioning

3.2.1 Dimensioning for compression

Correct load introduction into the two construction materials concrete and steel must be ensured using structural measures in accordance with section 4.3 (6).

3.2.2 Dimensioning for shear load and torsion

To verify the shear load capacity according to DIN1045-1, section 10.3.3 and the torsional load capacity according to DIN 1045-1, section 10.4, the design value of the shear load capacity $V_{Rd,ct}$ must be multiplied by a factor of 0.9 for 40 mm threadbar diameters and by a factor of 0.8 for $d_s = 50$ mm.

3.2.3 Verification of bond stresses

Bond stresses must always be verified, based on the following equation:

$$f_{b1} = \frac{\Delta Fs}{\sum u \cdot \Delta s} \leq f_{bd}$$

Where:

ΔFs Difference of the tensile or bending load in the respective structural member cross section within distance Δs

Δs Partial length in the longitudinal direction of the bar: $10 \cdot d_s$

$\sum u$ Combined circumference of all bars in the structural member cross section area under consideration for transferring the tensile and bending load.

f_{bd} Permissible bond stress: Calculated using the bond stress f_{bd} according to DIN 1045-1, Table 25, multiplied by a factor of 0.9 for d_s = 40 mm and by a factor of 0.8 for d_s = 50 mm.

3.2.4 Crack width limitation under service load

(1) To ensure acceptable cracking behaviour on the structural member surface, a surface reinforcement must be installed in accordance with the provisions specified in DIN 1045-1, section 13.2.5.

(2) The layout of the surface reinforcement in the cross section is specified in section 4.2.4.

3.2.5 Dimensioning for not predominantly static loading

(1) The characteristic value of the fatigue strength at a load rate of $2 \cdot 10^8$ load cycles is specified in Annex 2.

(2) The permissible stress amplitudes of couplings and anchor bodies are specified in the respective National Technical Approvals.

4 Provisions for installation

4.1 General

4.1.1 Concrete cover and bar spacing

DIN 1045-1, sections 12.2 and 12.9, shall apply, with $d_{sV} = d_s$ = 40 mm rsp. 50 mm.

4.1.2 Mandrel diameter for rebend test

BSt 500 (B) - SAS 500 with d_s = 40 mm and 50 mm may be used as straight or circularly bent bars; DIN 10451, Tables 23 and 24 shall apply respectively. Columns 1 and 2 of Table 23 do not apply. The mandrel diameter d_{br} must be at least $25 \cdot d_s$.

For reinforcements bent after welding, the values according to DIN 1045-1, Table 24 shall apply, however with a mandrel diameter d_{br} of at least $25 \cdot d_s$ for columns 1 and 2.

4.1.3 Anchorage

The following provisions apply to the anchorage of compression as well as tension bars. Anchorages may be installed using

a) straight bar ends

b) straight bar ends and/or anchor bodies

Details regarding the layout of the anchorages are specified in section 4.2 for structural members under bending stress and in section 4.3 for structural members under compressive stress.

4.1.3.1 Anchorage using straight bar ends

For anchorages using straight bar ends, the basic anchorage length l_b shall be calculated according to DIN 1045-1, section 12.6.2 equation (140). Thereby, for 40 mm diameter bars 0.9 times and for 50 mm diameter bars 0.8 times the values specified in DIN 1045-1,

Table 25 are applicable for the bond stress serviceability limit state. In the area of the anchorage length (see Annex 5, Fig. 3a) an additional reinforcement, to be anchored within the structural member, must be installed over an area of 0.25 • A_s (A_s = cross section area of a longitudinal bar), at least however the steel cross section specified in section 4.2.3, to absorb the local splitting forces induced by bursting, i.e. to ensure bonding. The bar spacing of the shear reinforcement may not exceed 20 cm. In addition, with regard to the layout, the provisions specified in section 4.2.3 shall apply.

4.1.3.2 Anchorage using straight bar ends and anchor bodies

(1) The anchor bodies (end anchorages) must have a National Technical Approval specifying, among others, the following:

- minimum concrete strength
- straight bar length (required anchorage length) $l_{b,net}$ capable of transferring the load in front of the anchor body
- centre and edge distances and
- bursting reinforcement to be installed in the area of the anchor body to absorb the local splitting forces induced by bursting

(2) With compression members, anchor bodies may also be installed as intermediate anchorages at any position to introduce loads.

(3) The anchorage length according to DIN 1045-1, section 12.6.2 is calculated based on the coefficient $\alpha_a = 0.4$.

(4) In the area $l_{b,net}$ (see Annex 5, Fig. 3a), an additional reinforcement shall be installed over an area of 0.18 • A_s (A_s = cross section area of a longitudinal bar), at least however over the area specified in section 4.2.3, to ensure bonding. The bar spacing may not exceed 20 cm. In addition, with regard to the layout, the provisions specified in section 4.2.3 shall apply.

(5) For the tensile force Z_s to be anchored through the anchor body, the anchorage must be tied back into the concrete behind the anchor plate following Annex 3, Fig. 1 so as to be able to absorb tensile forces of 0.2 • Z_s. If the anchor body is located within an area of tensile or lower compressive stresses, a tieback anchorage is not required if the concrete compressive stress is ≥ 2.0 MN/m^2.

(6) The layout of the anchorages must ensure that the force flux can be deduced correctly using a truss model. The truss model chosen must be acceptable in terms of conforming to the theory of elasticity.

4.1.4 Splices

(1) Normally, splices may only be designed as couplings. The couplings must have a National Technical Approval specifying centre and edge distances and permissible stresses.

(2) In massive structural members with $b_0 \geq 20 \cdot d_s$, tension couplings may also be designed to overlap the anchor bodies according to section 4.1.3.2 (see Annex 4, Fig. 2). The couplings must be installed in areas subjected to lower stresses.

For 40 mm diameter threadbars coupled in one section, the requirement $n \leq 0.50 \cdot n_m \cdot A_{serf}/A_{svorh}$ shall apply. For 50 mm diameter threadbars, $n \leq 0.25 \cdot n_m \cdot A_{serf}/A_{svorh}$ shall apply.

Where:

n_m number of bars in the area of the respective support or midspan moment.

(3) Couplings are to be considered longitudinally offset if the longitudinal spacing of the coupling centres is at least 1.5 • l_s. The overlap length l_s must be at least 0.75 • l_b. For spacing s_1 of bars to be coupled and the couplings' transverse spacing s_2, the data specified in Annex 4, Fig. 2 shall apply.

(4) In the area of the overlap length l_s, a shear reinforcement $A_{st} \geq 1.0 \cdot A_s$ according to DIN 1045-1, section 12.8.3 must be installed (A_s = cross section area of longitudinal bar).

For bond and tieback reinforcements, section 4.1.3.2 (4) and (5) shall apply.

4.2 Reinforcement layout in structural members subjected to bending load

4.2.1 Longitudinal reinforcement within the midspan region

(1) Normally, the midspan reinforcement must extend beyond the end bearings and be anchored according to DIN 1045-1, sections 13.1.1 and 13.2.2 taking section 4.4 into consideration.

(2) In massive structural members with $b_0 \geq 20 \cdot d_s$, the reinforcement may be staggered using anchor bodies. The anchor bodies must be installed at a distance of ≥ d/4 or ≥ $l_{b,net}$ from the calculated end point.

(3) For the number of bars ending in one section, the relation specified in section 4.1.4 (2) shall apply. Bar ends with a spacing of $l_v \geq l_b/2$ are to be considered longitudinally offset. Only internal bars may end before the end bearing. At least one third of the largest midspan reinforcement must extend beyond the end bearing and be anchored according to 4.2.1 (1). The specifications in section 4.1.3.2 shall be observed.

4.2.2 Longitudinal reinforcement in the area of cantilever and support moments

(1) The reinforcement installed to absorb support moments may only be anchored in the area of concrete compressive stresses.

(2) To anchor straight bars, the basic anchorage length l_b is required. The first ending bars must however extend beyond the zero point of the tensile load graph by at least dimension d (Annex, Fig. 3a).

For the number of bars ending in one section, the expression specified in section 4.1.4 (2) shall apply. Bar ends with a spacing of $l_v \geq l_b/2$ are to be considered longitudinally offset.

(3) Anchor bodies must be installed behind the calculated end point of the bar by at least dimension d or $l_{b,net}$ and behind the zero point of the tensile load graph by at least dimension d/2 (Annex 5, Fig. 3a).

For the number of bars ending in one section, the expression specified in section 4.1.4 (2) shall apply. Bar ends with a spacing of $l_v \geq l_b/2$ are to be considered longitudinally offset. In addition, section 4.1.3.2 shall apply.

(4) In massive structural members with $b_0 \geq 20\ d_s$, the reinforcement may be staggered using anchor bodies. The anchor bodies must be installed at a distance of ≥ d/4 or ≥ $l_{b,net}$ from the calculated end point. For the number of bars ending in one section, the relation specified in section 4.1.4 (2) shall apply. Bar ends with a spacing of $l_v \geq l_b/2$ are to be considered longitudinally offset. Only internal bars may be anchored. 25% of the reinforcement must cover the overall negative moment region and extend beyond the zero point of the tensile load graph by at least dimension d/4 or $l_{b,net}$ (see Annex 5, Fig. 3b). The specifications in section 4.1.3.2 shall be observed.

4.2.3 Reinforcement to ensure bonding

4.2.3.1 Plates with and without calculated required shear reinforcement

(1) To ensure bonding, an additional reinforcement must be installed over the entire threadbar length. Both in the area of positive and negative moments, it must be so anchored within the structural member that maximally 3 bars are enclosed by one stirrup (Annex 6, Fig. 4a). The stirrup cross section must be $A_{sw} \geq 0.1 \cdot A_s$ [cm^2/m and bar] and the spacing $s_w \leq 20cm$. For structural members with calculated required shear reinforcement this requirement is met, if at least 50% of the required shear reinforcement is installed in the form of stirrups.

(2) If at least 50% of the shear reinforcement (1/5 A_s) required according to DIN 1045-1 lies on the outside, the horizontal reinforcement share $A_{st} \geq 0.1 \cdot A_s$ [cm^2/m] to ensure bonding is thereby covered. Thereby, the surface reinforcement (see section 3.2.4) may be taken

into account.

4.2.3.2 Beams

(1) To ensure bonding (absorption of bursting forces), an additional reinforcement of 0.1 • A_s [cm^2/m] must be installed in the transverse direction over the entire beam length. It must enclose the tensile reinforcement and be anchored within the beam web. For this, the transverse bars of the surface reinforcement according to section 3.2.4 may be used. Alternatively, the stirrup cross section required due to shear loading must be so enlarged that the horizontal stirrup share is additionally at least 0.1 • A_s [cm^2/m].

(2) Every second longitudinal bar with d_s = 40 mm and each bar with d_s = 50 mm must be supported by a stirrup leg both in the area of positive as well as negative moments and be anchored within the structural member. The longitudinal bars must always be installed in the stirrup corners (Annex 6, Fig. 4b).

4.2.3.3 Multilayer reinforcement

(1) In plate-like structural members with multilayer reinforcement, the shear reinforcement (1/5 A_s) must be distributed as evenly as possible between the individual bar layers.

(2) With beams and plates with multilayer reinforcement, the bars installed at the web sides must be restrained against lateral movement from the 3rd layer on by installing an appropriate reinforcement. This can consist of stirrups anchoring the side bars of maximally 2 layers within the structural member. The cross section of the stirrups must be at least 0.18 • A_s [cm^2/m] (A_s = cross section area of longitudinal bar) relative to a leg leading into the structural member (see Annex 6, Fig. 4b).

4.2.3.4 Compression bars in structural members subjected to bending load

Calculated required compression bars made of BSt 500 S (B) – SAS 500 with 40 and 50 mm diameters must be stirruped and anchored according to section 4.3.

4.2.4 Surface reinforcement

(1) With beams and at plate edges, the surface reinforcement according to section 3.2.4 must extend beyond the top layer of the tensile reinforcement by 0.4 x d, at least however by 30 cm (Annex 6, Figs. 4a and b).

(2) The surface reinforcement must be installed on the upper or lower side of the structural member between the respective tensile load zero-points.

4.3 Reinforcement of compression elements

For the reinforcement of compression elements according to DIN 1045-1, sections 3.1.19 and 13.5 to 13.7, the following shall be observed (see Annex 3, Fig. 5):

(1) Longitudinal bars must be installed in the stirrup corners.

(2) The nominal diameter of the stirrup bars must not be lower than 12 mm.

(3) Stirrup spacing must be $s_w \leq h/2 \leq 30$ cm (h = smallest thickness of compression element).

(4) The concrete cover must be at least $c_1 \geq 1 \bullet d_s$.

(5) Couplings must be designed according to section 4.1.4.

(6) Structural design and execution must ensure a correct load introduction. This includes not only the introduction of end loads but also of intermediate loads through continuous BSt 500 S (B) – SAS 500 reinforcing bars with 40 and 50 mm diameters in multi-storey construction. With bond anchorages, the bursting forces must be absorbed through the reinforcement taking Annex 7 into consideration. With regard to additional reinforcement due to peak pressure, section 12.9 (9) of DIN 1045-1 shall be observed. If anchor plates are used, the specifications in the approval certificate for end anchorages and the specifications

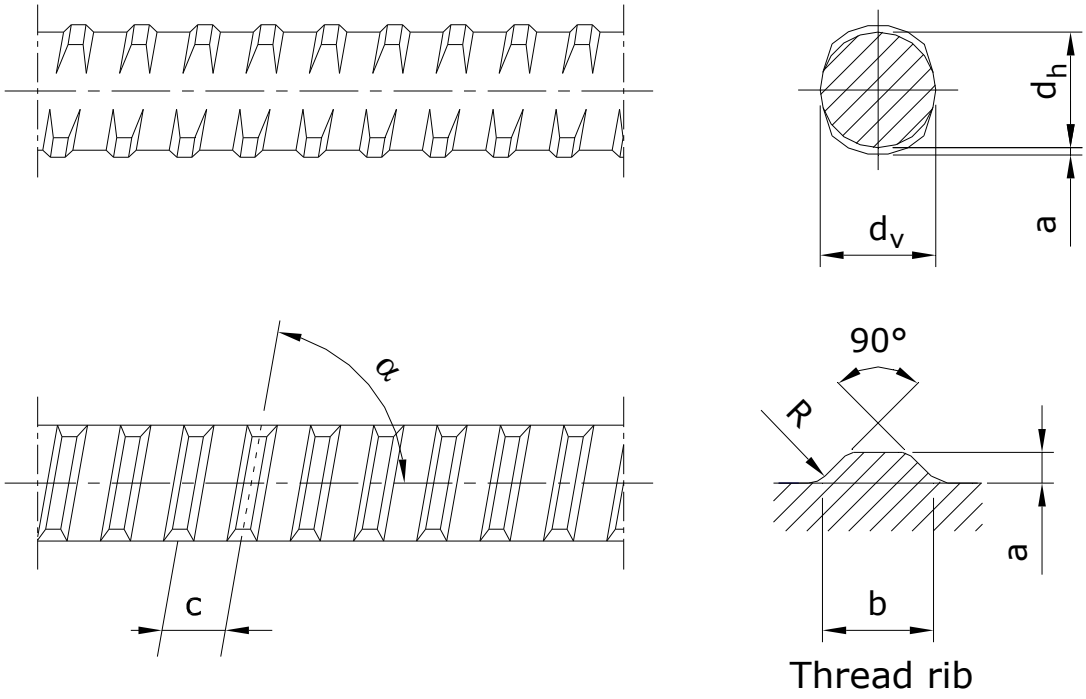
in section 4.1.3.2 of this approval shall be observed. In addition, settling of the concrete beneath the anchor bodies must be prevented using concrete technology measures.

4.4 Welding

For welding operations on the reinforcement, DIN 4099:1985-11 shall apply on condition that sample work pieces according to DIN 4099, section 7 are first produced. These shall be tested by an approved monitoring body for concrete reinforcement steel.

Häusler

Shaping



Thread rib

Nominal diameter Ø	Nominal weight	Nominal cross section [1)]	Core diameter		Thread ribs				
					Height	Width	Pitch	Incline	Radius
d_s mm	G Kg/m	A_s mm^2	d_h mm	d_v mm	a mm	b mm	c mm	β degree	R mm
40	9.87	1260	39.1 ± 0.5	38.5 ± 0.6	2.4 ± 0.3	9.5	20.0 ± 0.3	81.5	2.0
50	15.40	1960	48.9 ± 0.5	48.3 ± 0.6	2.7 ± 0.3	12.0	26.0 ± 0.3	81.0	2.5

1) 5% fractile according to DIN 488 Part 1, issue 9/84, section 5.2.2

Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Hammerau **BSt 500 S GEWI** **Ø 40 and Ø 50 mm**	**Concrete reinforcing bar with thread ribs** **Nominal dimensions and weight** **Rib geometry**	Annex 1 of National Technical Approval Z - 1.1 - 106 issued on 15 November 2006

	Properties and minimum requirements Concrete reinforcing steel bar BSt 500 S GEWI Ø 40 and Ø 50 mm				Value p [1] [%]
1	Nominal diameter	d_s	mm	40 50	---
2	Yield strength	R_e	N/mm^2	500	5
3	Tensile strength	R_m	N/mm^2	550	5
4	Ratio R_m/R_e			≥ 1.08	min. 5
5	Ratio $R_{e(Ist)}/R_{e(Nom)}$			≤ 1.30	max. 5
6	Elongation at fracture	A_{10}	%	10.0	5
7	Elongation at maximum load	A_{gt}	%	5.0	5
8	Rebend test for d_s = 40 mm Bending test for d_s = 50 mm		Mandrel diameter Mandrel diameter	$10 \cdot d_s$ $6 \cdot d_s$	1
9	Lower deviation of nominal cross section A_s			4	5
10	Characteristic value for fatigue strength of straight free bars at $N = 2 \cdot 10^6$ load cycles N/mm^2			135	10
	Welding suitability			21, 24, 111, 135	

1) Fractile for statistic probability of $W = 1 - \alpha = 0.90$ (one-side)
2) 21 = Resistance spot welding
24 = Flash welding
111 = Metal-arc welding
135 = Metal active gas welding

Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Hammerau **BSt 500 S GEWI** **Ø 40 and Ø 50 mm**	**Concrete reinforcing bar with thread ribs** **Mechanical properties**	Annex 2 of National Technical Approval Z - 1.1 - 106 issued on 15 November 2006

Fig. 1 Example of an anchor plate tieback

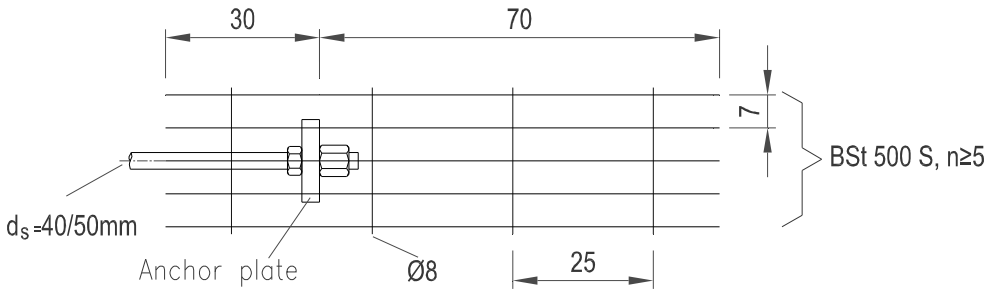
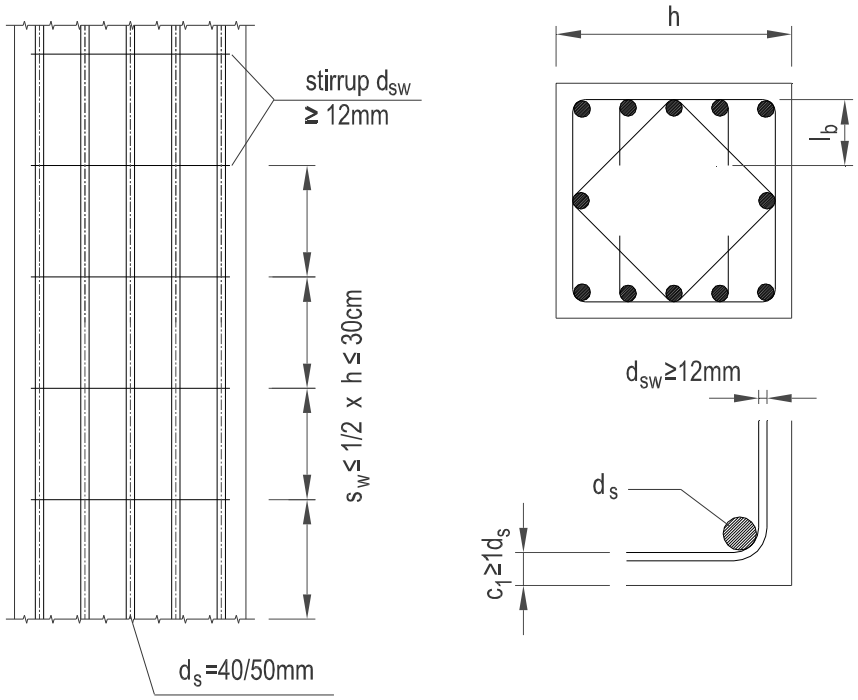
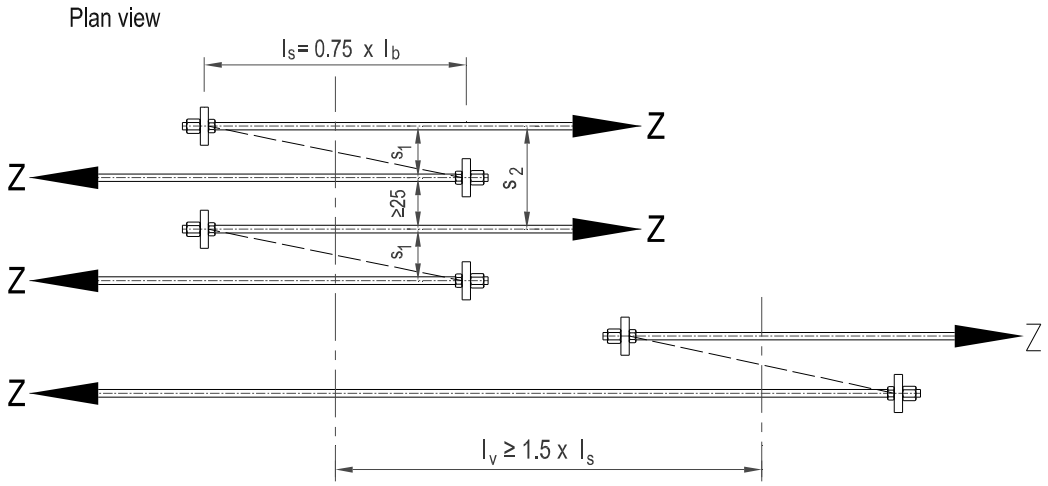


Fig. 5 Example of a column reinforcement



Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Hammerau **BSt 500 S GEWI** **Ø 40 and Ø 50 mm**	**Concrete reinforcing bar with thread ribs** Fig. 1, Fig. 5	Annex 3 of National Technical Approval Z - 1.1 - 106 issued on 15 November 2006

Fig. 2 Coupling design according to section 4.1.4(2)

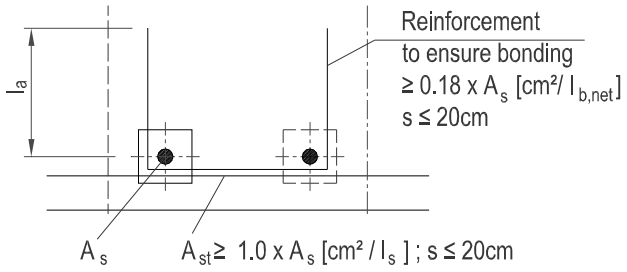


Requirements

$10cm \leq s_1 \leq 30cm$;
if $s_1 \geq 30cm$, then
$l_s \geq 0.75\, l_b \times s_1/30$ or
$A_{st} \geq 1.0 \times A_s \times s_1/30$

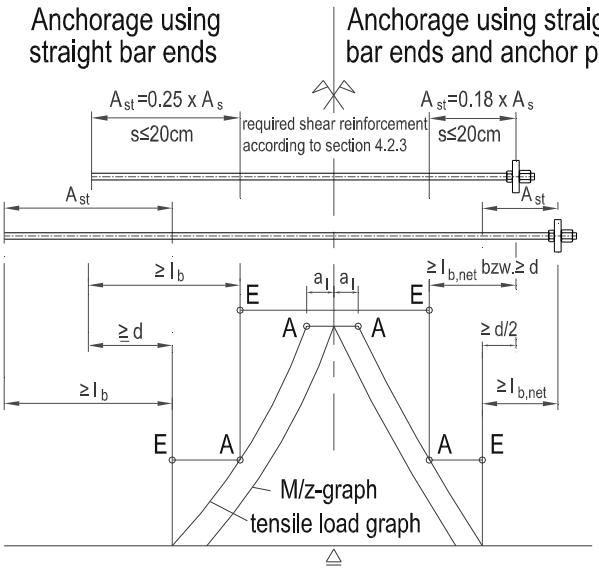
$s_2 \geq s_1 + 25cm$

Cross section



Stahlwerk Annahütte Max Aicher GmbH & Co. KG 83404 Hammerau **BSt 500 S GEWI** **Ø 40 and Ø 50 mm**	**Concrete reinforcing bar with thread ribs** Fig. 2	Annex 4 of National Technical Approval Z - 1.1 - 106 issued on 15 November 2006

Fig. 3a Example of a bar anchorage, d = 40 and 50mm, in the support region of structural members, standard design



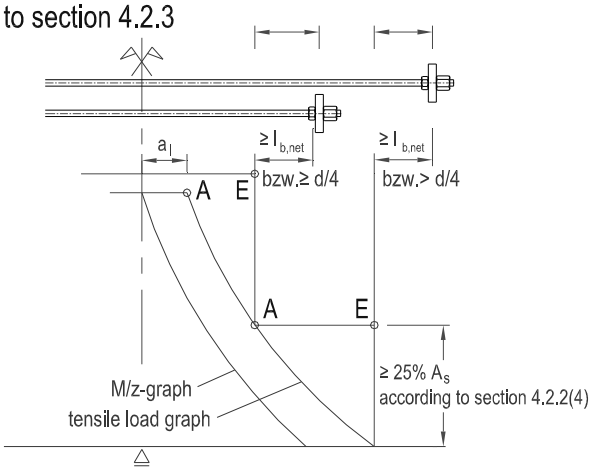
Legend:

A calculated starting point
E calculated end point
a_l horizontal displacement of tensile force
d statical effective depth
A_s area of longitudinal bar

Fig. 3b Example of a bar anchorage, d = 40 and 50mm, using straight bar ends and anchor plates in the support region of massive structural members according to section 4.2.2(4)

Required shear reinforcement: A_{st}=0.18 x A_s, s= 20cm rsp. according to section 4.2.3

Legend see Fig. 3a



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Example of a reinforcement in the cross section

Fig. 4a Plates with and without calculated required shear reinforcement

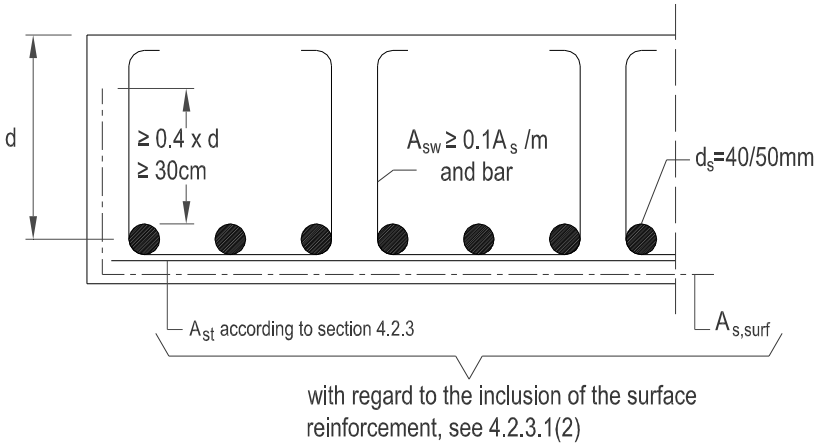
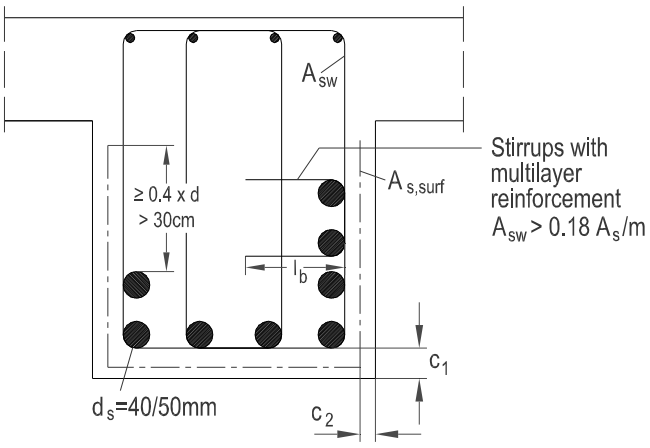


Fig. 4b Beams and stirrup layout with multilayer reinforcement



(c_1 concrete cover of longitudinal reinforcement)
(c_2 concrete cover of surface reinforcement)

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Example of a stirrup reinforcement strengthening in the anchorage zone of the column reinforcement

Fig. 6a

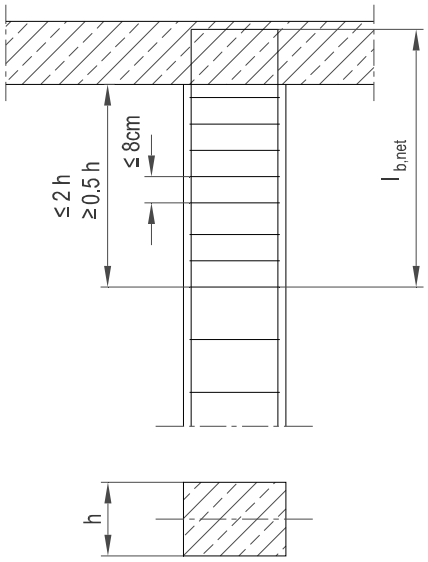
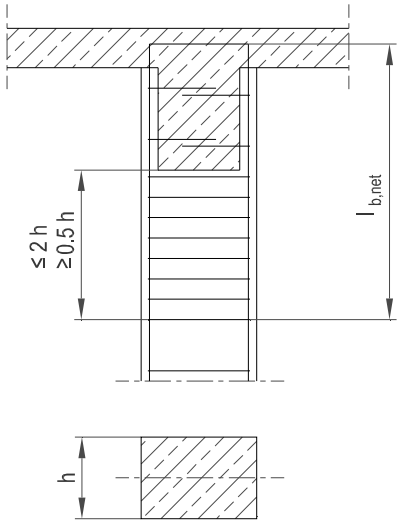


Fig. 6b



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