

Safety Standards

of the

Nuclear Safety Standards Commission (KTA)

KTA 3205.2 (2018-10)

**Component Support Structures with Non-Integral Connections;
Part 2: Component Support Structures with Non-Integral Connections for Pressure and Activity-Retaining Components in Systems Outside of the Primary Circuit**

(Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen)

Teil 2: Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen für druck- und aktivitätsführende Komponenten in Systemen außerhalb des Primärkreises)

The previous versions of this safety standard were issued in 1990-06 and 2015-11

If there is any doubt regarding the information contained in this translation, the German wording shall apply.

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KTA SAFETY STANDARD

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Component Support Structures with Non-Integral Connections;
Part 2: Component Support Structures with Non-Integral
Connections for Pressure and Activity-Retaining
Components in Systems Outside of the Primary Circuit

KTA 3205.2

Previous versions of the present safety standard: 1990-06 (BAnz No. 41a of February 28, 1991)
2015-11 (BAnz of January 8, 2016, Corrigendum of April 29, 2016)

Contents

Basic Principles.....	5
1 Scope	5
2 Definitions	5
3 Documents, Documentation, Design Approval, and Inspection	5
3.1 Documents and Documentation.....	5
3.2 Design data sheets.....	5
3.2 Design Review and Inspection.....	6
4 Analysis	6
4.1 General Requirements.....	6
4.2 Verification Procedure Based on Partial Safety Factors	7
4.3 Verification Procedure Based on Allowable Stresses	8
5 Design and Construction	10
5.1 General Requirements.....	10
5.2 Requirements	10
6 Materials and Product Forms.....	11
7 Manufacture.....	12
7.1 General Requirements.....	12
7.2 Manufacturer Qualification.....	12
7.3 Personnel Requirements	12
7.4 Principles for Performing Welding Tasks	12
7.5 Heat Treatment.....	13
7.6 Identification Marking.....	13
7.7 Corrosion Protection and Cleanliness.....	13
7.8 Final Inspection.....	13
8 Inservice Inspections	13
Appendix A Omega Procedure	26
Appendix B Symbols and Nomenclature.....	29
Appendix C Regulations Referred to in the Present Safety Standard	30
Appendix D (<i>informative</i>) Changes with Respect to Version 2015-11.....	35

PLEASE NOTE: Only the original German version of the present safety standard represents the joint resolution of the 35-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in Bundesanzeiger (BAnz) of December 14, 2018 (Corrigendum of January 14, 2020).

Copies of the German versions of KTA safety standards may be mail-ordered through Wolters Kluwer Deutschland GmbH (info@wolterskluwer.de). Downloads of the English translations are available at the KTA website: www.kta-gs.de

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Comments by the Editor:

Taking into account the meaning and usage of auxiliary verbs in the German language, in this translation the following agreements are effective:

shall	indicates a mandatory requirement,
shall basically	is used in the case of mandatory requirements to which specific exceptions (and only those!) are permitted. It is a requirement of the KTA that these exceptions - other than those in the case of shall normally - are specified in the text of the safety standard,
shall normally	indicates a requirement to which exceptions are allowed. However, exceptions used shall be substantiated during the licensing procedure,
should	indicates a recommendation or an example of good practice,
may	indicates an acceptable or permissible method within the scope of the present safety standard.

Basic Principles

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the objective to specify safety-related requirements, compliance of which provides the necessary precautions in accordance with the state of the art in science and technology against damage arising from the construction and operation of the facility (Sec. 7, para. (2), subpara. (3) Atomic Energy Act - AtG) in order to achieve the fundamental safety functions specified in the Atomic Energy Act (AtG), in the Radiological Protection Ordinance (StrlSchV) and further detailed in the Safety Requirements for Nuclear Power Plants (SiAnf) as well as in the Interpretations of the Safety Requirements for Nuclear Power Plants (Interpretations of SiAnf).

(2) Certain requirements regarding passive systems are specified in the Safety Requirements for Nuclear Power Plants (SiAnf), namely in its Sec. 3.1, para. (1) and Sec. 6, para. (4). Within its scope the present safety standard, KTA 3205.2, details the measures to be met to fulfill those requirements. In this context, a number of standards from conventional technology, in particular DIN standards, were considered and are individually referenced.

(3) Component support structures have the safety-related function of transferring the loads from the supported component parts and components into the load-carrying parts of the power plant.

(4) This safety standard covers component support structures with non-integral connections for pressure and activity-retaining components outside of the primary circuit. Components with non-integral connections for primary circuit components (scope in accordance with KTA 3201) are dealt with in safety standard KTA 3205.1. Qualification tested standard supports are dealt with in KTA 3205.3. Component support structures with integral connections for components of systems outside of the primary circuit are dealt with particularly in KTA 3211.2 and KTA 3211.3.

1 Scope

(1) This safety standard applies to non-integral component support structures of Steel Construction Category S2 for pressure and activity retaining components outside of the primary circuit with design temperatures up to 350 °C in nuclear power plants with light-water reactors. The requirements apply out to and including the connections to the anchor plates or other structural components that are within the jurisdiction of construction supervision.

(2) The assignment of steel construction categories to component support structures is specified in **Table 1-1** based on the comparable safety-related significance of the components. Steel Construction Category S2 is basically assigned to all components dealt with under safety standard series KTA 3211. The exceptions are specified in **Table 1-1**.

(3) Standardized parts which are loaded or used in other ways than described in the qualification test appendices of KTA 3205.3 or that are not qualification tested standardized constructions or components require verifications specified in the present safety standard and – if necessary – their functionality shall be verified based on KTA 3205.3

(4) Structural steel components in Steel Construction Category S3 that need to be designed against earthquakes shall fulfill the requirements of **Table 1-1**.

(5) Pipe whip restraints are dealt with under KTA 3205.1, Appendix D.

(6) The design criteria, the verifications for the individual load case categories as well as the design situations are defined in **Table 1-2**.

2 Definitions

(1) The present safety standard relies on

- a) the definition of non-integral support structure presented in KTA 3205.1,
- b) the nomenclature presented in Appendix B,
- c) the service limit levels as specified in KTA 3201.2 and KTA 3211.2

and the following definitions.

(2) Final document file

The final document file is that part of the accrued documents that is stored over the lifetime of the power plant or of the documented parts of the power plant.

(3) Authorized expert

An authorized expert is the expert person appointed in accordance with § 20 AtG by the proper licensing or supervisory authority for the performance of the tests specified in the present safety standard.

(4) Protective and special structures

Protective and special structures include, e.g., the steam generator pressure equalization port, storage facilities for new fuel elements, energy-absorbing structural elements.

(5) Equivalent yield stress

The equivalent yield stress, $R_{v0.2}$, is determined from the yield strength or from the yield strength and ultimate strength; it is a fictive yield strength.

(6) Interim document file

The interim document file is that part of the quality documentation that is stored at the manufacturing plant for the duration of component fabrication until delivery of the component and checking of the documents that will become part of the final file. The interim file comprises such documents that are important for the verification of the fabrication stages but not necessary for the description of the final condition of the power plant and its parts. These documents include, e.g.,

- a) certificates of tests and inspections that will be repeated in the final condition of the power plant or its parts,
- b) records concerning the quality assurance system.

3 Documents, Documentation, Design Approval, and Inspection

3.1 Documents and Documentation

(1) The documents to be created for the components of Steel Construction Category S2 and their documentation shall be as listed in **Table 3-1**.

(2) **Table 3-1** shall also be applied to components in Steel Construction Category S3 that require a seismic design of seismic Class I or Class IIa as specified in KTA 2201.1, Sec. 4.1.1.

3.2 Design data sheets

The design data sheets shall present information regarding the following points:

- a) type of component support structure, steel construction category, seismic classification, execution class for welds (in accordance with DIN EN 1090),
- b) plant facility, plant component,
- c) compartment number,
- d) level elevation,
- e) system designation, e.g., designation of the pipelines in accordance with the Identification System for Power Plants (KKS),
- f) material or material group,
- g) characteristic values of possible actions (without partial safety factors) or loads including the load direction, load superposition and load classification,
- h) components to be supported,
- i) design temperature, operating and design-basis accident temperatures of the component support structures,
- k) marks of approval, and
- l) if necessary, the required movement capabilities (degrees of freedom) and the deformation limits.

3.3 Design Review and Inspection

(1) The documents specified under Serial Nos. 1 through 6 in **Table 3-1** for the component support structures in accordance with **Table 1-1** shall be submitted for design review prior to beginning fabrication. The handling of the documents under Section 3.1 specifically for pipe supports is listed in **Table 3-2**.

(2) Where pipe supports are constructed from catalogue parts, these parts shall be subjected to a design review or shall be subjected to a qualification test as specified in KTA 3205.3.

(3) The design review or the on-site tests and inspections regarding proper and professional design and construction shall be performed by the authorized expert (cf. Section 7.8.3).

(4) Regarding the steel platforms of Steel Construction Category S3 under Ser. No. 1 of **Table 1-1** or the anchoring devices under Ser. No. 4 of **Table 1-1** that are subject to construction supervision, the proper building authority shall specify the inspection requirements. The specifications of loads and actions of the components on the steel platforms shall be checked by the authorized expert.

4 Analysis

4.1 General Requirements

4.1.1 Choosing the verification procedure

(1) Within the scope of the present safety standard two verification procedures are allowable:

- a) verification procedure using partial safety factors in accordance with the Eurocode (DIN EN 1990, DIN EN 1991 and DIN EN 1993) - Load and Resistance Factor Design (LRFD),
- b) certification procedure using a global safety factor (σ_{zul} -concept - Allowable Strength Design (ASD)).

The application of these procedures is detailed in the following subsections.

(2) Component support structures for newly to be constructed systems shall be calculated by applying the verification procedure using partial safety factors in accordance with Eurocodes (DIN EN 1990, DIN EN 1991 and DIN EN 1993). New component support structures for existing systems, the latter of which were calculated by applying the procedure using a global safety

factor (σ_{zul} -concept), either one of the procedures (paragraph (1), item a) or item b)) may, coequally, be applied.

(3) Component support structures fabricated from ferritic steels which, in addition to simple column-buckling, require additional certifications of stability (lateral torsional buckling or buckling in case of plate and shell structures), shall be verified by the verification procedure using partial safety factors.

(4) Component support structures fabricated from austenitic materials that require proofs of stability shall be verified applying the certification procedure using partial safety factors.

(5) A simultaneous application of both procedures within the overall verification procedure for a component support structure is basically not tolerable. The exception is if the dimensioning of component parts occurs in accordance with a different body of technical standards, provided, the respective component parts are not monolithically connected to the overall support structure and neither the transfer of the stress resultants within the overall support structure nor the overall stability are affected.

(6) Within the framework of design, the loads or actions shall be allocated (cf. **Table 1-2** and the exemplary allocation in **Table 4-1**) to the

- a) design situations related to civil engineering (permanent, variable, accidental) or
- b) load case categories (H, HZ, HS1, HS2/HS3).

Note:

The allocation to the design categories A1, A2 and A3 in accordance with DIN 25449 are shown in **Table 4-1**.

4.1.2 Extent of the certification process

(1) The certification process shall deliver information on

- a) actions and combinations of actions, design values for the resistances and certification of the limit conditions, or
- b) loads and load combinations, allowable stresses and stress analyses.

(2) A fatigue analysis shall be performed on mounting supports for highly dynamic loads (e.g., vibration dampers). In case of predominantly static loadings, the cyclic strength analysis or fatigue analysis may be waived. Predominantly static loads exist if the component support structures are not affected by highly dynamic loads (caused by, e.g., pressure pulses, external vibration excitation, turbulences).

Note:

Fatigue analyses are detailed, e.g., in DIN EN 1993-1-9.

4.1.3 Basics of the certification process

(1) The analytical certifications shall basically be performed based on the beam bending theory and the rod and bar statics. Numeric methods (e.g., finite element method) may also be applied.

(2) Utilization of the plastic behavior is allowable. In these cases, the reaction on the supported component shall be taken into consideration. Additional details are specified in Sections 4.2 and 4.3.

(3) Dynamic loads may be accounted for by static equivalent loads. Additional details are specified in Sections 4.2 and 4.3.

(4) The analytical certifications may be replaced or supplemented by experimental certifications.

(5) The yield strength, R_{eH} , and the 0.2 % proof stress, $R_{p0.2}$, may be considered as being equivalent unless otherwise specified in **Table 4-4** and **Table 4-5**.

(6) In the case of T-joints of hollow sections the failure mechanisms of DIN EN 1993-1-8 shall be taken into account.

(7) The slenderness ratio of component parts subjected to compressive loadings may not be larger than 150.

4.1.4 Friction forces

(1) Friction forces shall be verified only for the combinations of actions 0, 1 and 2 listed in **Table 4-2** or for the load cases H and HZ listed in **Table 4-3**. The friction coefficient, μ , to be applied – without a more detailed certification – for ferritic steels is:

- a) $\mu = 0.45$ for steel on steel, unmachined, without lubricant, with coating, or
- b) $\mu = 0.30$ for steel on steel, machined (e.g., brushed), no coating.

(2) Smaller friction coefficients are allowable, provided, suitable measures (e.g., provision of sliding plates) are taken. Certificates of these friction coefficients shall be provided.

(3) The friction coefficient, μ , for the certification of positional stability of a construction – without a more detailed verification – shall be $\mu = 0.15$. Other friction coefficients are allowable, provided, they are verified.

(4) For slip-resistant bolted connections the minimum friction coefficients to be used shall be in accordance with technical standards (e.g., DIN EN 1993-1-8, Sec. 3.9). Stainless steel bolts may not be used for slip-resistant connections unless verified by experiment in the individual case.

4.1.5 Temperature influence

(1) In the case of steels S235 (St 37) and S355 (St 52) the yield strength and tensile strength for temperatures higher than 80 °C shall be reduced by the temperature dependent reduction factor, k , shown in **Figure 4-1**. In the case of other materials for which the yield strength at elevated temperatures is not available, the reduction factor to be used shall be that for S355 (cf. Section 6).

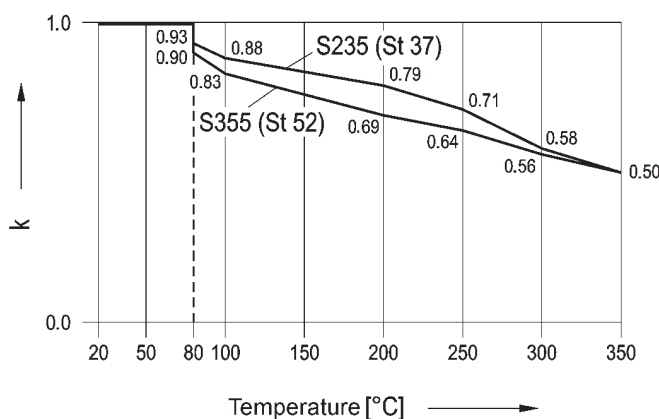


Figure 4-1: Temperature dependent reduction factor, k , for determining both the yield strength at elevated temperatures and the tensile strength

The following equations shall be applied:

$$R_{eHT} = k \cdot R_{eH} \quad (4-1)$$

$$R_{p0.2T} = k \cdot R_{p0.2} \quad (4-2)$$

$$f_{yT} = k \cdot f_y \quad (4-3)$$

$$f_{uT} = k \cdot f_u \quad (4-4)$$

Nomenclature:

f_{yT}	nominal value of yield strength at temperature, T
f_y	nominal value of yield strength at room temperature, RT
f_{uT}	nominal value of tensile strength at temperature, T
f_u	nominal value of tensile strength at room temperature, RT
R_{eHT}	yield strength at temperature, T
R_{eH}	yield strength at room temperature, RT
$R_{p0.2T}$	0.2 % proof stress at temperature, T
$R_{p0.2}$	0.2 % proof stress at room temperature, RT

(2) The temperature dependence of the elastic modulus, of the shear modulus and of the coefficient of thermal expansion does not need to be considered.

(3) In case structural measures (e.g., expansion bushings, slotted holes) are provided that create sufficient expansion possibilities, then no restraint loadings within the component support structure need to be analytically certified. Likewise, no restraint loadings within the component support structure need to be considered, provided, it is verified that the fictive free thermal expansion of the respective component part does not exceed a value of 1 mm.

(4) Forces due to a restrained thermal expansion of the component support structure shall be considered in connection with the building structure interaction loads.

(5) The range of thermal stress shall be verified based on 1.0 times ΔT as the secondary stress from a twofold yield strength as specified in safety standard KTA 3211.2. A superposition with loadings from external loads is not required.

(6) For bolts at temperatures higher than 80 °C, the allowable stress limits shall be determined from the engineering product standard or the materials standard. In the case of bolts of Property Classes 4.6, 5.6, 8.8, 10.9 the temperature dependent reduction factors, k , for steel S235 (St 37) shown in **Figure 4-1** may be applied.

Note:

The temperature distribution in the pipe enclosing component parts is dealt with in, e.g., in KTA 3205.3, Sec. 4.2.

4.1.6 Load transfer through direct contact

Compressive forces perpendicular to the contact joint may be considered to be transferred completely through the contact, provided, the following requirements are met:

- a) The surfaces of the abutting contact joints shall be flat and parallel to each other.
- b) Local instabilities due to fabrication imperfections can be excluded.
- c) Lateral shifting of the component parts at the abutting contact joint can be excluded.
- d) The relative position of the joined abutting components shall be secured; friction forces may not be considered when verifying that the relative position of abutting component parts is secured.
- e) A possible gap may not be larger than 0.5 mm.

4.2 Certification Procedure Using Partial Safety Factors

(1) The following certificates shall be provided – as far as individually applicable – for all combinations of actions that are simultaneously effective:

- a) certificate of the ultimate limit state

- b) certificate of stability (column buckling, lateral torsional buckling, buckling),
- c) certificate of positional stability (lateral tilting, sliding, lifting off),
- d) certificate of the serviceability limit state. The data – as far as applicable – shall be specified in the design data sheet. All specifications shall be function oriented.

(2) When determining limit values of the resistance in accordance with DIN EN 1993, the material property values listed in **Table 4-4** shall be used for the yield strength, f_y , and the tensile strength, f_u .

4.2.1 Types of actions

Note:

The terms *actions* (permanent, variable, accidental), *action types*, *combinations of actions*, *design situations*, *partial safety factor*, *ultimate limit state* and *serviceability limit state* are applied as defined in accordance with DIN EN 1990 and DIN EN 1993.

All actions that are effective individually or in combination with other actions shall be specified. Partial actions may be neglected, provided, they are comparatively minimal. Typical actions include:

- a) Permanent actions, G, (permanent standard loads): Dead-weight of the support structure and weight of the components with filling and insulation (if applicable) – such as, e.g., pipelines – as far as they are not contained in the component loads A through D as specified in KTA 3201.2.
- b) Variable actions, Q, (temporary standard loads): B1 – Longer lasting loads effective during operating hours, e.g., stacking or construction loads, B2 – Short temporary loads effective outside of operating hours or only for a short time during operating hours, e.g., stacking loads, test or traffic loads, component loads A, B or P.
- c) Accidental actions, A, (special loads): E.g., component loads C and D; external events such as earthquakes; internal events such as pipe rupture loads, jet impingement forces; pressures and temperatures from design basis accidents.

4.2.2 Certification of limit states

4.2.2.1 Ultimate limit state

The combinations of actions for certifying the ultimate limit state shall be as listed in **Table 4-2** unless deviating values are specified in the design data sheet.

4.2.2.2 Serviceability limit state

The project- and system-oriented combinations of actions for certifying the serviceability limit state shall be as specified in the design data sheet.

4.2.2.3 Static equilibrium

The positional stability (lateral tilting, sliding, lifting off) shall be verified in addition to the two limit states.

4.2.3 Resistance

The characteristic resistance parameters shall be determined on the basis of the partial safety factors, γ_M , in accordance with DIN EN 1993-1 and the associated national annexes, e.g.,

- a) γ_{M0} for the resistance of cross-sections,
- b) γ_{M1} for the resistance in case of loss of stability,

- c) γ_{M2} for the resistance of cross-sections in case of fracture due to tensile loading.

4.2.4 Certificates

4.2.4.1 General requirements

(1) The certifications required for the limit states of steel components or steel component parts shall be according to DIN EN 1993-1-1, DIN EN 1993-1-3 through DIN EN 1993-1-10 and DIN EN 1993-1-12. In the case of stainless-steel component parts, the requirements in accordance with DIN EN 1993-1-4 and additionally the general building supervisory approval Z 30.3-6 shall be considered. The deviations specified in the present safety standard with respect to the technical standards cited above shall be observed.

(2) Force transfers into sections shall be designed in accordance with DIN EN 1993-1-8.

(3) The plastic analysis of the support structure in accordance with DIN EN 1993-1-1, Sec. 5.4.3, is only allowable for a cross-section of Class 1 and for the materials listed under Ser. Nos. 1 and 2 of **Table 4-4** and then only for the combinations of actions 4 through 7 of **Table 4-2**. The procedure and application of other materials shall be specified in agreement with the authorized expert. This method may not be applied to the dynamic analysis based on static equivalent loads.

(4) The stress evaluation of plate and shell structures shall be performed according to DIN EN 1993-1-5, DIN EN 1993-1-6 and DIN EN 1993-1-7.

4.2.4.2 Design value for the support capacity of qualification tested component parts

(1) Equation (4-5) shall be used for calculating the design value for the load capacity of component parts that were qualification tested as specified in KTA 3205.3 and that have a load ratio H : HZ : HS equal to 1 : 1.15 : 1.5.

$$F_{Rd} = 1.5 F_{(Load\ Case\ H)} \quad (4-5)$$

(2) Equation (4-6) shall be used for component parts that were qualification tested as specified in safety standard KTA 3205.3 and that have a load ratio H : HZ : HS equal to 1 : 1.5 : 1.7.

$$F_{Rd} = 1.7 F_{(Load\ Case\ H)} \quad (4-6)$$

4.2.4.3 Certification of serviceability

(1) The limit states of deformations shall be determined and evaluated in accordance with DIN EN 1993-1-1, Sec. 7, if required with regard to fulfilling the function.

(2) In case a plastic analysis of the support structure is performed, the limit states of deformation shall always be determined and certified.

4.3 Procedures Using Allowable Stresses

(1) The following certifications shall be provided – as far as individually applicable – for all load cases and load case combinations with simultaneously effective loadings:

- a) general stress analysis (certification of strength),
- b) certification of stability,
- c) certification of positional stability (lateral tilting, sliding, lifting off),

d) certification of the deformation limits. The data – as far as necessary – shall be as specified in the design data sheet. All specifications shall be function oriented.

(2) The stresses (including reference stresses) shall be determined in accordance with KTA 3205.1, Appendix E.

(3) In the case of Load Case HS2/HS3, the advantage of plastic behavior may be utilized. The procedure shall be specified in agreement with the authorized expert. The deformations shall be verified and evaluated.

(4) Dynamic loads may be dealt with by static equivalent loads. In this case no advantage of the global plastic behavior (e.g., plastic hinge) may be utilized. The consideration of a local plastic behavior shall be agreed upon by the authorized expert.

4.3.1 Loads and load cases

All loadings shall be specified that will be effective individually or in combination with other loadings. Partial loads may be neglected, provided, they are comparatively small. Typical loadings to be considered include:

- Permanent standard loads: Dead-weight of the support structure and weight of the components with filling and insulation (if applicable, e.g., pipelines) as far as they are not included in the component loads A through D as specified in KTA 3211.2.
- Temporary standard loads: B1 – Longer lasting loads during operation, e.g., stacking or construction loads, B2 – Short temporary loads effective outside of operating hours or effective only for a brief time during operation, e.g., stacking, test or traffic loads.
- Component loads A through D: Loads emanating from the supported component as far as they are not already accounted for as permanent standard loads under item a).
- Accidental loads (Special loads): These are, e.g., external events such as earthquakes, or internal events such as pipe rupture loads, jet impingement forces; pressure and temperature from design basis accidents.

4.3.2 Categorization of loadings

(1) The load combinations shall be specified in the design data sheet in a project- and system-oriented way.

(2) The load combinations shall be allocated to the load case categories (service limit levels) as shown in **Table 4-3** unless deviations from this requirement are specified in the design data sheet.

4.3.3 Allowable stresses

(1) The values for the equivalent yield stress, $R_{v0.2}$, shall be specified depending on the material used as listed in **Table 4-5**. In the case of load cases H, HZ and HS, the allowable stresses relative to the equivalent yield stress are those listed in **Table 4-6**, **Table 4-7**, **Table 4-9**, and **Table 4-10**.

(2) If the construction is verified as a plate and shell structure, e.g., by the general shell theory, the allowable stresses may be calculated as specified in KTA 3205.1.

4.3.4 Bolts as fasteners

(1) The values to be used for the allowable stresses of bolts

in Property Classes 4.6, 5.6, 8.8 and 10.9 at temperatures lower than 80 °C shall be as listed in **Table 4-8**.

(2) In the case of other bolts than in Property Classes 4.6, 5.6, 8.8 and 10.9, the allowable stresses shall basically be calculated as shown in **Table 4-10**. Alternatively, the allowable stresses may be calculated as specified in KTA 3205.1.

(3) The allowable shear force of the bolt shall be determined by multiplying the allowable shear stress of the bolt with the cross-section of the shear area as listed in **Table 4-11**. The allowable traction force of the bolt shall be determined by multiplying the allowable normal stress of the bolt with the stress cross-section as listed in **Table 4-11**.

(4) In the case of shear bearing bolted connections without (SL) and with (SLP) fit bolts the individual verifications of simultaneously effective shear and tensile loadings shall be performed mutually independent of each other. In this case, the allowable values for the individual loadings may be fully utilized without the need of verifying a reference stress.

(5) Bolts of Property Classes 8.8 and 10.9 may be specified as regularly pre-loaded bolts (pre-loaded slip-resistant bolted connection). The allowable tensile force and the allowable shear force may not exceed the values listed in **Table 4-12** and **Table 4-13**.

(6) In the case of a simultaneous loading of an outer (external) load parallel and perpendicular to the direction of the bolt axis, the allowable transferrable lateral force in slip-resistant bolted connections without (GV) and with (GVP) fit bolts shall be reduced as follows

$$\text{zul. } Q_{GV,Z} = \left(0.2 + 0.8 \cdot \frac{\text{zul. } Z - Z}{\text{zul. } Z} \right) \cdot \text{zul. } Q_{GV} \quad (4-7)$$

$$\text{zul. } Q_{GVP,Z} = 0.5 \cdot \text{zul. } Q_{SLP} + \left(0.2 + 0.8 \cdot \frac{\text{zul. } Z - Z}{\text{zul. } Z} \right) \cdot \text{zul. } Q_{GV} \quad (4-8)$$

Nomenclature:

Z : available traction force of the bolt

zul.Z : maximum allowable traction force of the bolt as listed in **Table 4-12** and **Table 4-13**

zul.Q : maximum allowable lateral force as listed in **Table 4-12** and **Table 4-13**

4.3.5 Load introduction without stiffeners

(1) In the case of rolled sections with an H-shaped cross-section, forces may be introduced without requiring stiffeners, provided,

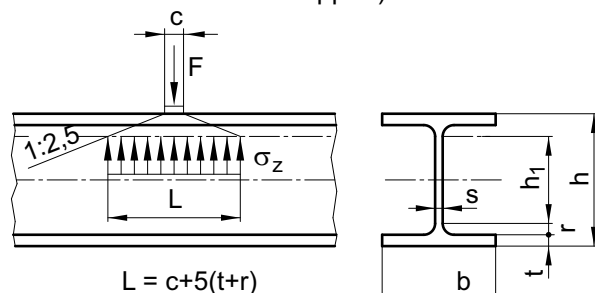
- the cyclic strength certification is not the determining factor, and
- the girder (beam) cross-section is secured against twisting and lateral movements, and
- the certification is provided that a load introduction without stiffeners is feasible from the viewpoint of statics.

(2) The effective length shall be calculated assuming a 1 : 2.5 incline of the load distribution. Hereby, both the chord of the girder (beam) as well as the curved areas may be considered. The calculation of the effective lengths for the individual cases under items a), b) and c) is shown in **Figure 4-2**.

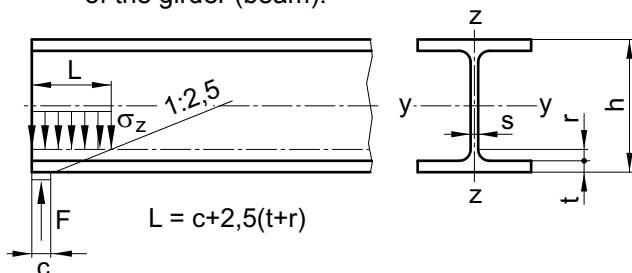
Note:

Figures 4.2a, 4.2b and 4.2c do not show all forces that lead to an equilibrium state.

- a) introduction of a concentrated load (identical to the introduction of a bearing force at an intermediate support):



- b) introduction of a bearing load at the end of the girder (beam):



- c) girder on girder (beam on beam):

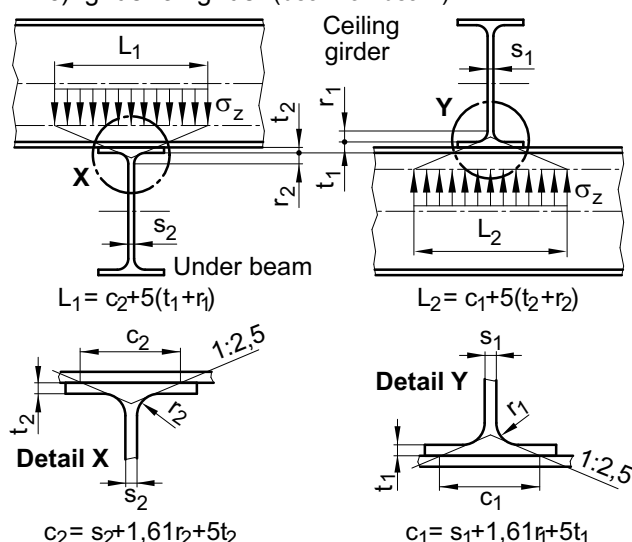


Figure 4-2: Load introduction without stiffeners in case of rolled sections with an H-type cross-section

- (3) The stresses shall meet the following requirements:

- a) in case σ_x and σ_z have different algebraic signs and

$$|\sigma_x| > 0.5 \cdot \sigma_{zul} \quad (4-9)$$

then

$$\sigma_z = \frac{F}{s \cdot L (1.25 - 0.5 |\sigma_x| / \sigma_{zul})} \leq \sigma_{zul} \quad (4-10)$$

- b) in all other cases

$$\sigma_z = \frac{F}{s \cdot L} \leq \sigma_{zul} \quad (4-11)$$

Nomenclature:

- σ_x : normal stress in the decisive cross-section of the girder (beam) as shown in **Figure 4-2**
 s : web thickness of the girder (beam)
 L : effective length as shown in **Figure 4-2**

- (4) In case of a slenderness ratio of the web (ratio of web height to web thickness) that is larger than 60, the safety against buckling shall be verified for the web.

4.3.6 Certification of stability

- (1) Simple certifications of stability (column buckling) for compression struts of ferritic steels shall be performed as specified in Appendix A.

- (2) The positional stability shall be verified as specified in KTA 3205.1, Sec. 4.3.3.8 and KTA 3205.1, Appendix E, Sec. E 5.

5 Design

5.1 General Requirements

- (1) Steel structures shall be designed and constructed observing the acknowledged technical standards (in particular the DIN EN 1090 and DIN EN 1993) and such that the design is ensured to be

- functional,
- load conform,
- appropriate to the material,
- suited for manufacturing (i.e., fabrication and testing), and
- maintenance friendly

and that interactions between these requirements are taken into account.

- (2) For the component support structures in Steel Construction Category S2 dealt with in the present safety standard, the execution class to be applied shall be EXC2 in accordance with standards series DIN EN 1090. In the case of highly dynamically loaded component support structures in Steel Construction Category S2 (cf. Section 4.1.2, para. (2)) the execution class to be applied shall be EXC3 in accordance with standards series DIN EN 1090 unless deviations from this requirement are specified in the design data sheet.

5.2 Requirements

- (1) Expansions due to elevated temperatures shall be observed. If necessary, measures allowing for these expansions shall be provided.

- (2) The design (bearing conditions, function of mounting supports, mutual interaction) shall be such that the assumptions applied in the design analysis of the pipelines are met.

- (3) The building structure tolerances and anchoring location tolerances shall be observed.

- (4) A sufficient accessibility of the components (including pipelines) shall be ensured.

- (5) The requirements regarding the ability to be decontaminated shall be observed.

- (6) The movement of the components due to thermal expansion shall be considered.

- (7) Structural tolerances shall be specified in accordance with DIN ISO 2768-1 and DIN ISO 2768-2 and for welded constructions in accordance with DIN EN ISO 13920. The tolerance category shall be chosen with special regard to the individual application. In exceptional cases, adjustment tolerances that are well-founded by design reserves may individually be specified.

(8) The design shall consider the possibility for higher-load support conditions due to plastic deformations. Stability-critical designs that could lead to a sudden failure of the component part shall be avoided (e.g., by lateral-tilt protection or other stiffeners).

(9) In particular, the load transfer locations and the load bearing locations shall be secured against local instabilities (e.g., by verifications as specified under Section 4.3.5 or by stiffeners).

(10) The support structures of pipelines shall be arranged taking the testability (including inservice inspections) of the welds into consideration.

(11) The minimum dimensions for load-bearing parts shall basically be as follows:

- a) wall thickness 4 mm,
- b) bolts M 12.

Exceptions are allowable in well-founded cases.

(12) The weld seams shall be arranged such that both the accessibility of the weld and the minimization of residual stress within the weld are considered. Over-head weldings and unfavorably angular weld seams shall be avoided as far as possible.

(13) The seams shall be welded such that they are in accordance with DIN EN 1090-2 and DIN EN 1993-1-8. Discontinued fillet welds are not tolerable.

(14) In the case of weld seams, the weld quality of which must be certified, their testability shall be ensured.

(15) Plug weldings are allowable, provided they conform with the specifications of DIN EN 1993-1-8.

(16) Welds welded from both sides shall be preferred to single-side welds (connections of open sections or metal plates to anchor plates, end plates and others).

(17) To avoid a chipping off the concrete due to high thermal input a sufficiently large edge distance shall be observed when welding sections to the anchoring elements, unless a low thermal input is assured by only applying minimally thick weld layers.

(18) Mechanical connection elements under a predominantly non-static loading shall always be secured. The choice of the securing measure shall consider the level of the dynamic loading. Securing by welds is only allowable in the case of steels and bolt materials that are suited for welding.

(19) At least two bolts shall be used for bolted bar connections.

(20) Slotted holes are allowed; a sufficiently large edge distance shall be observed.

(21) In the case of inclined loading surfaces (e.g., U-sections) the bolt heads or the nuts shall be provided with incline-equalizing (e.g., wedge-shaped) washers.

(22) The data required for tightening preloaded bolts (e.g., necked-down bolts) shall be noted in the construction drawings (e.g., minimum required and maximum allowable torque or rotation angle as well as lubricant).

(23) Shear areas within the threaded regions of bolts are allowable, provided, they are certified in accordance with DIN EN 1993-1-8.

(24) The thread engagement of the threaded parts shall normally be $0.8 \cdot d$ taking the material pairing into account. Here, d represents the outer thread diameter of the threaded part. Shorter thread engagement are allowable in well-founded cases.

Note:

Additional requirements are specified in DIN EN 1992-1-8/NA and VDI 2230 Sheet 1.

(25) In the case of hollow sections, the requirements in accordance with DIN EN 1993-1-8 shall be observed.

(26) In the case of tensile loading of welded components in their through-thickness direction the requirements in accordance with DIN EN 1993-1-10 shall be observed (cf. Section 6).

(27) In the case of sliding supports sufficient clearances shall be provided. No unallowed tilting shall be possible.

(28) Sliding supports shall be designed and constructed such that unallowed movements are impossible.

(29) Special friction certifications are required in the case of sliding supports with paired austenitic materials.

(30) Paired austenitic materials are allowed in the case of guide bearings for pipelines, provided, the surface pressure is low and sufficient play (2 to 3 mm) is available.

(31) Support structures with non-metallic components including lubricants shall normally not lose their functional capability up to a radiation dose of 10^5 J/kg over their specified lifetime.

6 Materials and Product Forms

(1) The allowable materials and corresponding test certificates regarding material tests in accordance with DIN 10204 are listed in **Table 6-1**. Other materials may only be used upon agreement with the authorized expert.

(2) Only such materials may be used for welded constructions for which the weldability has been verified.

Note:

This requirement is met for the steels S235 and S355 in their normalized or quenched and tempered rolled condition in accordance with DIN EN 10025-2 (purchase order for Delivery Condition +N).

(3) For ferritic plates subject to tensile loading in the through-thickness direction the requirements in accordance with DIN EN 1993-1-10 and DIN EN 10164 for determining the weld quality class (Z-class) shall be met. At least the requirements listed in **Table 6-2** shall be met. The connecting weld area shall be tested for laminar imperfections; no laminar imperfections are not tolerable.

(4) The weld filler materials and consumables shall be qualification tested in accordance with VdTÜV Guideline 1153 and shall be attuned to the respective welding procedure.

(5) Ferritic bolts and nuts in accordance with DIN EN ISO 898-1 and DIN EN ISO 898-2 are allowable, provided, the bolts are in Property Classes 4.6, 5.6, 8.8 or 10.9 and the nuts are in 4, 5, 8 or 10. Furthermore, austenitic bolts and nuts in accordance with DIN EN ISO 3506-1 and DIN EN ISO 3506-2 are allowable, provided, they are in Steel Types A2 through A5 and Property Classes 50, 70 and 80.

(6) It shall basically be considered to be sufficient as certification when the strength category or the material is stamped on the bolts and nuts in accordance with DIN EN ISO 898-1, DIN EN ISO 898-2, DIN EN ISO 3506-1 and DIN EN ISO 3506-2.

(7) In the case of ferritic bolts in Property Class 10.9 and austenitic bolts an Inspection Certificate 3.1 in accordance with DIN 10204 is additionally required.

(8) Structural elements not required to maintain the equilibrium of forces, e.g., stiffeners outside the points of main load application, may be certified, simply, by a Declaration of Compliance with the Order 2.1 in accordance with DIN 10204.

(9) Completely documented components (e.g., stored material) may be used, provided, no safety related concerns exist.