UDC 624.21.042 : 625.745.1 DEUTSCHE NORM December 1985

Road and foot bridges

Design loads

DIN 1072

Straßen- und Wegbrücken; Lastannahmen

Supersedes November 1967 edition.

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.

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Contents

1 Field of application

(1) This standard deals with the effects to be taken into consideration for the design and construction of road and foot bridges, and specifies the design loads which are to be used in the calculation instead of the effects actually arising.

(2) The design loads are also to be used for reclassifying existing road and foot bridges. They are also intended to be used, as appropriate, in respect of other structures associated with highways, which are subject to highway traffic loads, such as culverts and retaining walls.

(3) Exceptional loads, such as those due to rail vehicle collision, icing, ship collision, seismic action, as well as design loads for exceptional cases are not covered in this standard. If allowance has to be made for such loads, then the approval of the responsible authority shall be sought (see Supplement 1 to DIN 1072*)).

(4) For railway bridges, the building regulations and operating instructions applicable to the railway track concerned shall also be observed (see Supplement 1 to DIN 1072).

2 Classification of loads and load cases

(1) The design loads shall be classified as follows (see Supplement 1 to DIN 1072):

a) Main loads (H):
   - dead loads (see subclause 3.1);
   - prestress (see subclause 3.2);
   - standard imposed loads (see subclause 3.3);
   - loads due to shrinkage of concrete (see subclause 3.4);
   - loads due to probable foundation settlement (see subclause 3.5);
   - loads arising from lifting for the purpose of replacing the bearings (see subclause 3.6).

b) Additional loads (Z):
   - thermal effects (see subclause 4.1);
   - wind loads (see subclause 4.2);
   - snow loads (see subclause 4.3);
   - loads due to braking and starting of vehicles (braking loads) (see subclause 4.4);

*) December 1985 edition.

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resistances to movement and deformation of bearings and carriageway expansion joints (see subclause 4.5);
dynamic effects on movable bridges (see subclause 4.6);
loads acting on safety fences (see subclause 4.7);
loads caused by inspection trolleys (see subclause 4.8).

c) Exceptional loads (S):
exceptional loads arising during erection (see subclause 5.1);
loads due to possible foundation settlement (see subclause 5.2);
road vehicle collision loads (see subclause 5.3);
loads arising from lateral impact against raised kerbs and safety fences (see subclause 5.4).

(2) Consideration shall be given to the effects of creep and relaxation and their respective causes.

(3) For the purposes of calculating carriageway expansion joints and by way of departure from paragraph 1, item b), the braking load shall be taken as the main load.

(4) In their least favourable combination, the main loads constitute load case H; in their least favourable combination, the main loads plus the additional loads constitute load case HZ.

(5) If the stress in a structural component arising from one individual additional load is greater than the stress arising from the main loads minus the dead loads, and minus the prestress if applicable, then this additional load is to be regarded as the main load. Load case H shall in this case be taken as including this additional load and the dead loads, and the prestress, if applicable.

(6) The exceptional loads dealt with in subclauses 5.1 to 5.4 shall be considered separately in each case, or, if applicable, in conjunction with the main loads and additional loads.

3 Main loads

3.1 Dead loads

3.1.1 Self weight of structural components

(1) The self weight of structural components shall be determined as specified in the relevant standards and codes of practice, such as DIN 1055 Parts 1 and 2.

(2) The self weights determined on the basis of the dimensions shown on the working drawings shall be compared with the assumed self weights. If the stresses and/or factors of safety resulting from incorrect assumptions with regard to load and cross section are not more than 3 % less favourable than the permissible values, then it will not be necessary, as a rule, to repeat the calculation on the basis of the corrected assumptions, unless the system is exceptionally susceptible to such inaccuracies.

(3) An additional load of 0,5 kN/m^2, assumed to act on the total carriageway area, shall be considered, to take account of an additional deck surfacing applied to create a levelling gradient (see Supplement 1 to DIN 1072).

(4) For bascule bridges, instead of the load specified in paragraph 3 above, an additional load of $\pm$ 0,25 kN/m^2, assumed to act on the total deck surface, shall be considered when calculating drive mechanisms including locking devices, to allow for inaccuracies in the determination of the self weight at the various intermediate positions.

(5) If more unfavourable load conditions should occur in special cases as a result of the partial or total removal of the deck surfacing and/or of the caps, these are to be taken into consideration (see also subclause 3.3.5 paragraph 1 and Supplement 1 to DIN 1072).

3.1.2 Permanent earth loads

(1) The effects arising from soil surcharges and earth pressures shall be determined as specified in DIN 1055 Parts 1 and 2. Relieving effects arising herefrom shall not be taken into consideration if a temporary or permanent removal of the soil masses is to be expected. If soil masses are installed at a later date, the intermediate conditions are to be taken into consideration (see Supplement 1 to DIN 1072).

(2) The effects from soil surcharges and earth pressures on the freedom of movement of structural elements shall be taken into consideration.

3.1.3 Loads from utility lines and other dead loads

Loads arising from utility lines and other dead loads shall also be considered. If it is possible that the effect of such loads may be temporarily or permanently interrupted, any more unfavourable loading conditions arising therefrom are to be taken into consideration.

3.2 Prestress

Prestress can be generated by prestressing tendons, by the systematic modification of the bearing conditions, by preloading or by other means.

3.3 Standard imposed loads

3.3.1 Bridge classes

(1) Road and foot bridges shall be classified into bridge classes according to their loadability. In this connection, a distinction is to be drawn between standard bridge classes (see table 1) and revised bridge classes (see table 2). The standard imposed loads shall be used in the calculation in accordance with table 1 or table 2, their least favourable position being assumed (see Supplement 1 to DIN 1072).

(2) The standard classes assigned to the various types of highway and unclassified road are specified in table 1, line 4 (see Supplement 1 to DIN 1072).

(3) See subclause 3.3.7 for the standard imposed loads to be assumed for foot bridges and cycle track bridges.

3.3.2 Subdivision of carriageway into notional lanes

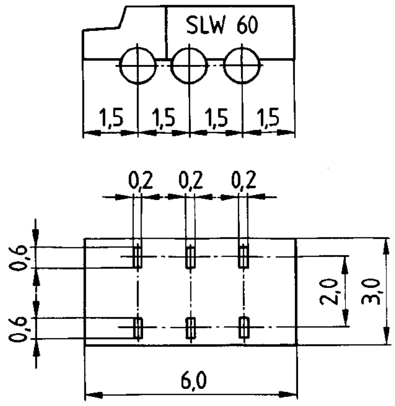
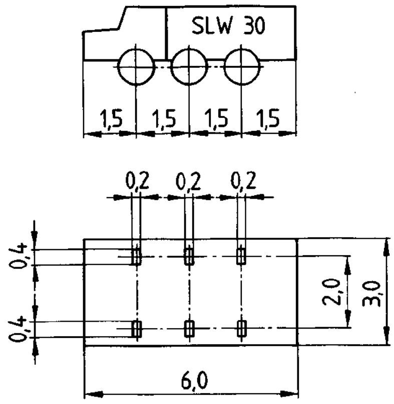
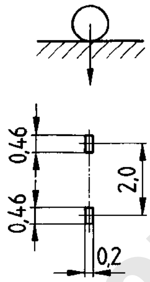
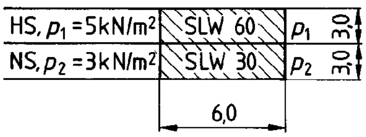
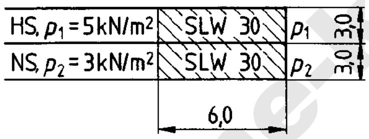
(1) The deck surface area shall be subdivided into adjacent notional lanes, a main traffic lane and a secondary traffic lane each 3 m in width, and into the section of the deck situated outside the above-mentioned notional lanes, which comprises the verge (footways and cycle tracks) including the raised kerbs, and the central reserve (see Supplement 1 to DIN 1072).

(2) The carriageway shall be deemed to comprise the total running surface situated between the raised kerbs, irrespective of any marker strips which may exist (see Supplement 1 to DIN 1072).

(3) Irrespective of the actual number of traffic lanes and of the existence of a central reserve, each bridge shall be assumed to comprise only one single main traffic lane and one single secondary traffic lane. In the case of separate superstructures, one main traffic lane and one secondary traffic lane shall be assumed for each superstructure. In the case of non-divided substructures, only one single main traffic lane and one single secondary traffic lane shall be considered in all cases (see Supplement 1 to DIN 1072, subclause 3.3.3).

(4) The main traffic lane and the secondary traffic lane shall in each case be assumed to be situated so as to cause the most adverse effect in the structural element considered, on the carriageway or carriageways; as a general rule, this is parallel to the direction of the carriageway axis. For bridges on which the carriageway width is not the same throughout, the main traffic lane and secondary traffic lane shall be assumed either parallel to the raised kerb or in an intermediate direction, if this causes the more adverse effect.

Table 1. **Standard imposed loads assigned to standard bridge classes** Dimensions in m

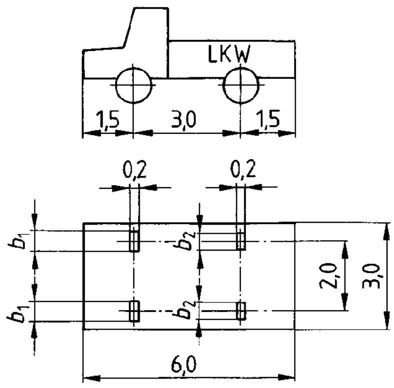
	Bridge class 60/30	Bridge class 30/30	
1	Heavy lorry (SLW)		
	 Total load: 600 kN. Wheel load: 100 kN. Substitute area load $p' = 33{,}3\ \mathrm{kN/m^2}$.	 Total load: 300 kN. Wheel load: 50 kN. Substitute area load $p' = 16{,}7\ \mathrm{kN/m^2}$.	One individual axle  Axle load: 130 kN (see Explanatory notes relating to subclause 3.3.1 in Supplement 1 to DIN 1072).
2	Loading of deck surface between the raised kerbs (carriageway)		
			
	HS – main traffic lane, allowance being made for the vibration coefficient, φ. NS – secondary traffic lane, no allowance being made for the vibration coefficient. For remaining areas, $p_2 = 3\ \mathrm{kN/m^2}$, no allowance being made for the vibration coefficient. (See subclause 3.3.4 for φ.)		
3	Loading of deck surface except for carriageway (footways and cycle tracks, verges, central reserve): the least favourable value given in line 3, items a) to c) below, shall be considered, no allowance being made for the vibration coefficient.		
	a) $p_2 = 3\ \mathrm{kN/m^2}$, together with the remaining loads as in line 2, HS to be considered with allowance being made for φ.		
	b) $p_3 = 5\ \mathrm{kN/m^2}$, loads as in line 2 not being considered (only applicable to the loading of individual structural elements such as footway slabs, longitudinal girders, cantilever slabs, cross girders).		
	c) For the parts of the bridge not protected against collision by means of a safety fence (applicable only to the loading of individual structural elements as described in line 3, item b) above), the following shall apply: The wheel load, P, shall be taken as 50 kN and the tyre contact area as 0,2 × 0,4, no allowance being made for the loads as in line 2. Where existing bridges of former classes 30, 45 and 60 can be reclassified into classes 30/30 or 60/30, the wheel load can be taken as 40 kN and the tyre contact area as 0,2 × 0,3, no allowance being made for the loads as in line 2.		
4	Correlation of revised bridge classes and types of road or highway[1]) Bridge class 60/30: BAB, B, L, K, S. Bridge class 30/30: K, S, G, W.		

[1]) BAB: federal motorways; B: federal highways; L: provincial (*Land*) highways; S: urban or municipal thoroughfares, town streets; K: district roads, county roads; G: municipal unclassified roads; common ways; parish roads; W: farm tracks.

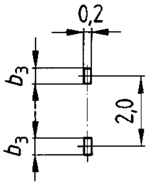
Table 2. **Standard imposed loads assigned to the revised bridge classes** Dimension in m

Bridge classes 16/16, 12/12[1]), 9/9, 6/6 and 3/3

1 Lorry (LKW)

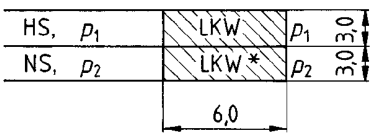


One individual axle



Bridge class		16/16	12/12	9/9	6/6	3/3
Total load, in kN		160	120	90	60	30
Substitute area load p', in kN/m^2		8,9	6,7	5,0	4,0	3,0
Front wheels	Wheel load, in kN	30	20	15	10	5
	Tyre contact width, b_1	0,26	0,20	0,18	0,14	0,14
Rear wheels	Wheel load, in kN	50	40	30	20	10
	Tyre contact width, b_2	0,40	0,30	0,26	0,20	0,20
One individual axle	Load, in kN	110	110	90	60	30
	Tyre contact width, b_3	0,40	0,40	0,30	0,26	0,20

2 Loading of deck surface between the raised kerbs (carriageway)



Bridge classes	16/16[2])	12/12	9/9	6/6	3/3
p_1, in kN/m^2	5,0	4,0	4,0	4,0	3,0
p_2, in kN/m^2	3,0	3,0	3,0	2,0	2,0

*) If necessary, individual wheel loads may be considered instead.
HS – main traffic lane, allowance being made for the vibration coefficient, φ.
NS – secondary traffic lane, no allowance being made for the vibration coefficient.
For remaining areas, p_2 shall be assumed, no allowance being made for the vibration coefficient.
(See subclause 3.3.4 for φ.)

3 Loading of deck surface except for carriageway (footways and cycle tracks, verges, central reserve): the least favourable value given in line 3, items a) to c) below, shall be considered, no allowance being made for the vibration coefficient.

a) p_2 in accordance with line 2, together with the remaining loads as in line 2, HS to be considered with allowance being made for φ.

b) $p_3 = 5$ kN/m^2, loads as in line 2 not being considered (only applicable to the loading of individual structural elements such as footway slabs, longitudinal girders, cantilever slabs, cross girders).

c) For the parts of the bridge not protected against collision (applicable only to the loading of individual structural elements as described in line 3, item b) above), the following shall apply:
For existing classes 12/12 and 16/16 bridges, the wheel load shall be taken as 40 kN and the tyre contact area as 0,2 × 0,3, no allowance being made for the loads as in line 2.
For new class 12/12 bridges[1]), the wheel load shall be taken as 50 kN and the tyre contact area as 0,2 × 0,4, no allowance being made for the loads as in line 2.

1) The design loads assigned to bridge class 12/12 used for reclassifying existing road and foot bridges may also be permitted by the responsible authority for the design of new bridges.

2) Values featured in computation tables may also be used, with a 1 : 2 split-up of the wheel loads between the front axle and the rear axle.

3.3.3 Loading of bridge deck

(1) The main traffic lane shall be assumed to be loaded at the least favourable point with a standard vehicle (heavy lorry (SLW) in accordance with table 1 or lorry (LKW) in accordance with table 2). Area load p_1 shall be assumed to act in front of and to the rear of this lorry in accordance with table 1 or table 2 (line 2 in each case). As a rule, the longitudinal axis of the standard vehicle is to coincide with the axis of the main traffic lane. By way of departure therefrom, for individual structural elements such as slabs, longitudinal and cross girders which are situated at the edges of the carriageway, the standard vehicle shall be assumed to be moved sideways into their least favourable position so that one wheel comes into contact with the raised kerb; this shall also apply to the specified individual axle loads (see Supplement 1 to DIN 1072).

(2) The secondary traffic lane is to be assumed to be loaded with an SLW 30 heavy lorry in the case of standard class bridges, next to the standard vehicle placed on the main traffic lane; in the case of revised class bridges, the lane shall be taken as being loaded with the appropriate lorry featured in table 2, if this gives a less favourable result, it being assumed that the two vehicles are standing side by side so as to act as a single load. Load p_2 in accordance with table 1 or table 2 (line 2 in each case) shall be assumed to act in front of and to the rear of the standard vehicle. If the deck surface situated outside the main traffic lane is not wide enough for a complete secondary traffic lane, then the individual wheel loads of the second standard vehicle shall be considered in the case of bridge classes 16/16, 12/12, 9/9, 6/6 and 3/3 (see Supplement 1 to DIN 1072).

(3) The parts of the deck surface situated outside the above-mentioned traffic lanes shall be assumed to be loaded with load p_2 in accordance with table 1 or table 2 (line 2 in each case).

(4) For the loading of the deck surface area, all standard imposed loads which have a relieving effect, including individual axle and wheel loads, shall be ignored.

(5) Influence areas, more than 30 m long, allocated the same sign (plus or minus), may be evaluated on the basis of area load p' in accordance with table 1 or table 2 (line 1 in each case), instead of on the basis of the individual loads of standard vehicles. This load may also be adopted for vaults in the cases featured in DIN 1075, April 1981 edition, subclause 6.2, and for abutments.

(6) Load p_2 shall be assumed as the minimum load on footways and cycle tracks and on verges and the central reserve. For the loading of individual structural elements (footway slabs, longitudinal girders, cantilever slabs, cross girders, etc.), this load shall be increased to load $p_3 = 5\ \mathrm{kN/m^2}$ unless load p_2, in conjunction with the loads on the carriageway zone, is the determining factor. In cases where footways, cycle tracks and verges and the central reserve are not protected against vehicle collision by means of a safety fence, a load case corresponding to a single wheel load of 50 kN shall be assumed in addition for classes 60/30, 30/30 and 12/12 bridges. When reclassifying existing bridges, the calculation may be based on a single wheel load of 40 kN in accordance with table 1 or table 2 (line 3, item c) in each case). This calculation may be dispensed with in the case of classes 9/9, 6/6 and 3/3 bridges (see Supplement 1 to DIN 1072).

3.3.4 Vibration coefficients

(1) The standard imposed loads assumed to act on the main traffic lane, and in the case of rail tracks[1]), the loading for one rail track in addition, shall be multiplied by the vibration coefficient, φ (see Supplement 1 to DIN 1072) when designing the bridge components, including bearings, support plinths, supporting benches and columns, but excluding abutments, piers and foundation structures including foundation joints.

(2) The following loads shall be used in the calculation, no allowance being made for the vibration coefficient: standard imposed loads which arise outside the main traffic lane, standard imposed loads on foot bridges and cycle track bridges, and standard imposed loads acting on the backfill of structures.

(3) For road bridges of all types, the vibration coefficient shall be:

a) for structures not embedded in fill,

$$\varphi = 1{,}4 - 0{,}008\, l_\varphi \geq 1{,}0; \qquad (1)$$

b) for structures embedded in fill,

$$\varphi = 1{,}4 - 0{,}008\, l_\varphi - 0{,}1\, h_{ü} \geq 1{,}0. \qquad (2)$$

In the above equations,

l_φ is the relevant length, in m;

$h_{ü}$ is the height of fill covering the structure, in m.

(4) The following lengths shall be taken for l_φ (see Supplement 1 to DIN 1072):

a) when calculating the stress resultants from the direct loading of a structural element, the span or the cantilever length of said structural element, or the shorter span in the case of cross-tensioned slabs;

b) when calculating the stress resultants from the indirect loading of a structural element, either the span of said element or the span of the loadbearing members via which the loading is transmitted onto the structural element; in this connection, the greater of the two values may be used for l_φ;

c) for loadbearing members which are stressed by components of both indirect and direct loading, the relevant value for each of these components shall be used for l_φ;

d) for continuous girders (including hinged girders), the arithmetic mean of all the spans; for loads acting directly on cantilever arms, and in panels with spans shorter than 0,7 times the longest span, the cantilever length or the shorter span shall be used for l_φ, irrespective of the position of the cross section under investigation.

3.3.5 Exceptional imposed loads

(1) With the deck surfacing partially removed and/or with the caps removed (see subclause 3.1.1, paragraph 5), the standard imposed loads may be treated as additional loads; in this case, clause 2, paragraph 5 is not applicable (see Supplement 1 to DIN 1072).

(2) With the bridge lifted for the purpose of replacing the bearings (see subclause 3.6), the standard imposed loads may be reduced by half, the vibration coefficient being taken into consideration.

3.3.6 Standard imposed loads on bridges subject to railway loading

(1) If, on railway bridges, railway trains circulate on a separate rail track that cannot be travelled over by road vehicles, both the railway loading or the relevant load patterns and the road standard imposed loads shall be assumed to be in their least favourable position.

(2) If the rail track area can be also travelled over by road vehicles, the following load cases shall be considered separately and individually in respect of the standard imposed loads.

a) Simultaneous loading by road and rail loads. In this connection, either two rail tracks shall assumed to be

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1) It may become necessary in some cases to use different calculation principles as a result of the data provided by the rail traffic organization.

loaded with rail vehicles in their least favourable configuration, and the remaining deck surface area loaded with load p_2 in accordance with table 1 or table 2 (line 2 in each case), or rail vehicles shall be assumed to be in their least favourable position on one rail track and the remaining deck surface area shall be assumed to be loaded in accordance with subclause 3.3.3 as for road bridges without rail tracks.

b) Loading exclusively by road loads on the total deck surface, as for road bridges without rail tracks.

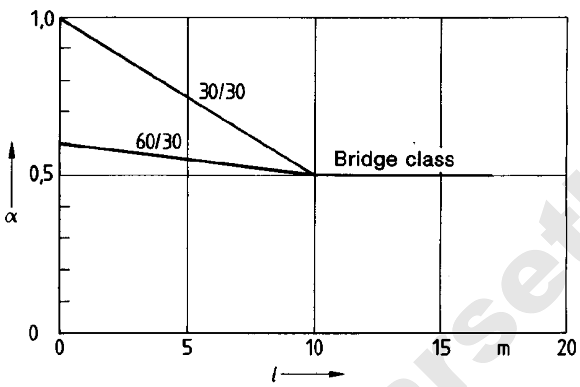
3.3.7 Standard imposed loads on foot bridges and cycle track bridges

(1) Foot bridges and cycle track bridges shall be loaded with an area load, p_3, of 5 kN/m². Where loadbearing members have a clear span exceeding 10 m, the area load in kN/m², for such members and for their supports may be reduced to $p_4 = 5{,}5 - 0{,}05\,l$, with l in m, but shall not be lower than 4 kN/m².

(2) In addition to the structural analysis in respect of the loads in accordance with paragraph 1, it may be necessary, especially in the case of slender, slightly dampened structures, to carry out vibration studies.

3.3.8 Imposed loads for the assessment of fatigue life

As regards the verification of the vibration displacement amplitude required in the relevant design standards, the stress fluctuations caused by frequently varying imposed loads shall be calculated on the basis of the standard imposed loads (including vibration coefficient), allowing for a reduction factor α in accordance with figure 1. As regards loads arising from rail vehicles, α shall be equal to 1,0, unless the rail traffic organization gives any particular instructions in this respect (see Supplement 1 to DIN 1072).



In the diagram, l is the span or cantilever length (see Supplement 1 to DIN 1072).

Figure 1. Reduction coefficient α

3.3.9 Standard imposed loads on structure backfills

Traffic areas situated behind abutments, abutment walls and other structural components contiguous with the ground shall be assumed to be loaded with the standard imposed loads in accordance with subclause 3.3.3 in their least favourable arrangement. Instead of using the individual loads (single or concentrated loads) of the standard vehicles, the calculation may be based on load p' in accordance with table 1 or table 2 (line 1 in each case). For the purpose of determining the load components due to the earth pressure, the load may be assumed to act at a 30° angle to the descending vertical.

3.4 Loads due to shrinkage of concrete

The effects arising from shrinkage of concrete may be taken into consideration. This is mandatory, however, if the stresses caused by shrinkage have a more adverse effect.

3.5 Loads due to probable foundation settlement

The translational and rotational movements of supports to be expected as a result of foundation settlement which may arise shall be taken into consideration. If a complete or partial re-establishment of the design supporting conditions is planned, the temporarily permitted translational and rotational movements shall be allowed for in the calculation (see Supplement 1 to DIN 1072).

3.6 Loads arising from lifting for the purpose of replacing the bearings

The lifting of the supported element concerned in its individual support lines shall be taken into consideration in each case in connection with the replacement of bearings or of bearing components. The lifting height shall be taken as 1 cm, unless the type of bearing used demands a greater value (see subclause 3.3.5, paragraph 2 and subclause 4.4, paragraph 3 for the standard imposed loads and the braking load, which both have to be used in the calculation; see also Supplement 1 to DIN 1072).

4 Additional loads

4.1 Thermal effects

4.1.1 General

(1) The following definitions shall apply.

A temperature fluctuation is a uniform change in the centre of gravity temperature of all the structural elements.

A temperature difference is a temperature gradient running between opposite edges of a structural element.

Uneven heating is a discontinuity between the centre of gravity temperatures of individual structural elements which do not have a continuous connection or joint.

(2) The specifications relating to composite bridges shall also apply to steel bridges with a concrete slab lying on top, and those relating to concrete bridges shall also apply to bridges with concrete-encased rolled steel girders.

4.1.2 Loads due to temperature fluctuations

(1) Temperature fluctuations relating to steel bridges, composite bridges and concrete bridges shall be taken into consideration in accordance with table 3, column 2, in relation to an assumed erection temperature of +10 °C. Temperature fluctuations may be ignored in the case of wooden bridges (see Supplement 1 to DIN 1072).

(2) For concrete components with a minimum thickness of not less than 0,7 m, or for concrete components which are less exposed to temperature fluctuations because of the provision of fills or other precautionary measures, the values specified in table 3, column 2 may be reduced by 5 K in each case (see Supplement 1 to DIN 1072).

4.1.3 Loads due to temperature differences

(1) Temperature differences shall generally be taken into consideration by assuming a linear temperature gradient between the outer faces of a structural element lying at opposite ends, which may exhibit differing temperatures by virtue of their location. Temperature differences may be ignored in the case of wooden bridges (see Supplement 1 to DIN 1072).

(2) The temperature differences to be assumed for the superstructures are governed by the basic shape of the cross section. For deck bridges, the temperature differences between the upper and underside shall be obtained

Table 3. **Temperature fluctuations; linear differences in temperature for deck bridges between top surface and underside**

	1	2	3	4	5	6
		Temperature fluctuations about +10 °C, in K	Linear temperature differences, in K			
			Top surface side warmer than underside		Underside warmer than top surface	
			Conditions during erection, no deck surfacing, unprotected	Final condition, with deck surfacing	Conditions during erection, no deck surfacing, unprotected	Final condition, with deck surfacing
1	Steel bridges	±35	15	10	5	5
2	Composite bridges	±35	8	10	7	7
3	Concrete bridges	+20 −30	10	7	3,5	3,5

from table 3, columns 3 to 6, for steel bridges, for composite bridges and for concrete (reinforced concrete, prestressed concrete) bridges. These temperature differences shall be taken into consideration in respect of the longitudinal direction, and also in respect of the transverse direction if this is of any significance. As a rule, however, a temperature gradient across individual structural elements may be ignored (see Supplement 1 to DIN 1072).

(3) In the case of the simultaneous effect of temperature differences as in paragraph 2 and a standard imposed load as in accordance with subclauses 3.3.1 to 3.3.7, acting unfavourably, the following cases shall be verified (see Supplement 1 to DIN 1072):

a) full standard imposed load, 70 % of temperature difference;

b) 70 % of standard imposed load, full temperature difference.

(4) If significant, a temperature gradient of 5 K across individual structural elements shall be assumed for columns, piers and similar concrete structures.

4.1.4 Non-uniform heating of associated bridge components

In special cases, the non-uniform heating of associated bridge components shall be taken into consideration. ±15 K shall be taken as a non-uniform rise in temperature of associated components of steel bridges and composite bridges (for example tie rod and arch, cables and stiffening beams, top chord and bottom chord of trusses). The same value shall apply for differences in temperature between concrete or timber structures on the one hand and exposed steel elements on the other (for example, a prestressed concrete bridge with diagonal cables which are not concrete-encased, or a wooden bridge with steel tie rods). A non-umiform heating of ±5 K shall be considered for associated components made of concrete (for example tie rod and arch of a two-centred arch).

4.1.5 Superposition of thermal effects

When superposing the temperature fluctuations, temperature differences and the effects of non-uniform heating of associated bridge components, the maximum differences between the temperatures in the border zone of any two arbitrarily selected structural components shall not exceed:

a) 20 K for steel bridges, composite bridges and concrete bridges with exposed steel elements;

b) 10 K for concrete bridges, between different concrete structural elements.

4.2 Wind loads

The following specifications shall apply for bridges, the superstructures of which are not to be regarded as being susceptible to vibration under the effect of wind. For superstructures which are susceptible to vibration (these may for example include suspension bridges, guyed (cable-stayed) girder bridges, narrow girder bridges with very long spans), more detailed investigations are recommended; this shall also apply to exceptional conditions during erection (see Supplement 1 to DIN 1072).

4.2.1 Wind direction and wind load

(1) The wind direction shall be assumed to be horizontal.[2] The wind load shall also be assumed, as a general rule, to act horizontally (see Supplement 1 to DIN 1072).

(2) The magnitude of the wind load on bridges, including piers and columns, shall be taken from table 4. For superstructures, the height of the wind-loaded area shall be deemed to be the difference in height of the deck surface and ground level, or the mean water level (see Supplement 1 to DIN 1072).

(3) The wind load shall be assumed to act separately either transverse to, or along the longitudinal axis of the bridge.

(4) The wind load acting on the superstructure may, for simplicity, generally be assumed to act as a load uniformly distributed over the total wind-loaded area. It shall be superposed on other loads so as to cause the most adverse effect. For calculations of bridges with traffic, the vertical imposed loads may be taken as acting in a relieving manner, as knife edge loads in the axis of the main traffic lane with not more than 5 kN/m.

(5) The wind load shall be assumed as a moving load when calculating the web members of the wind bracings.

4.2.2 Wind-loaded areas

(1) The areas exposed to wind shall be determined as an approximation from the actual dimensions of the bridge components. The following specifications shall apply in respect of the wind-loaded areas (see Supplement 1 to DIN 1072).

(2) For load cases exclusive of imposed loads, the following shall be considered wind-loaded areas:

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2) In some cases, for example in the case of suspension bridges and cable-stayed girder bridges, it may become necessary to consider also wind directions which deviate from the horizontal.

Table 4. **Wind loads on bridges**

	1	2	3	4
	Height of wind-loaded area above ground	Load case exclusive of imposed loads		Load case inclusive of imposed loads
		Superstructure without noise protection wall, piers, columns	Superstructure with noise protection wall	Superstructure with or without noise protection wall, piers, columns
1	0 up to 20 m	1,75 kN/m^2	1,45 kN/m^2	0,90 kN/m^2
2	Over 20 up to 50 m	2,10 kN/m^2	1,75 kN/m^2	1,10 kN/m^2
3	Over 50 up to 100 m	2,50 kN/m^2	2,05 kN/m^2	1,25 kN/m^2

a) for superstructures with solid web main girders, the windward faces of the front main girder, those of parts of other main girders higher than the front girder, and any parts of the carriageway profile exposed to the wind;

b) for superstructures with braced main girders, any parts of the carriageway profile and of all main girders situated above and below the carriageway profile, however in total not more than the windward face of the carriageway profile plus the parts of the superstructure assumed to be of solid web construction, situated above and below it;

c) for superstructures with noise barriers, in addition the windward face of one single noise barrier per superstructure, if it is higher than the above-mentioned faces;

d) for superstructures with several main girders in the erection stage, the windward faces of two main girders as long as there is no continuous deck surface.

(3) For load cases inclusive of imposed loads, the following shall be considered wind-loaded areas:

a) for superstructures with solid web main girders, the windward faces of the front main girder, those of parts of other main girders higher than the front girder, and any parts of the carriageway profile with and without traffic, exposed to the wind;

b) for superstructures with braced main girders, any parts of the carriageway profile with and without traffic and of all main girders situated above and below that profile, however in total not more than the windward face of the carriageway profile with and without traffic plus the parts of the superstructure assumed to be of solid web construction, situated above and below it; arched girders with a spandrel-braced or attached carriageway shall be treated like braced main girders;

c) as regards the traffic lanes on road bridges with and without rail traffic, a height of 3,50 m shall be assumed, and in the case of foot bridges and cycle track bridges, a height of 1,80 m. If a noise barrier is taller than the carriageway profile with traffic, the height of the former shall be used in the calculation.

(4) In the case of bridges with separate superstructures, each of the superstructures shall be design for the full wind load acting from both directions.

(5) The wind-loaded areas to be assumed for the calculation of the loadbearing structure shall also be taken into consideration when calculating the abutments and piers. In addition, the windward faces of all pier and lift tower walls shall be considered.

(6) The wind load shall be assumed to act upon the centre of gravity of the wind-loaded area (see, however, subclause 4.2.3, paragraph 4 in respect of conditions during erection); for deck bridges, and for bridges with noise barriers, the wind load shall be assumed to act on a point no lower than the level of the deck surface (see Supplement 1 to DIN 1072).

4.2.3 Erection loads

(1) When considering the erection loads, the wind load may be taken as 0,7 times the values given in table 4, column 2 (see Supplement 1 to DIN 1072).

(2) When considering a state of erection which is not likely to last more than one day, the wind load may be reduced to 0,2 times the values given in table 4, column 2, if it is firmly established that the wind speed will remain less than 20 m/s during this time. In this connection, it will be necessary to check the meteorological conditions and follow the trend of weather development and to prepare safety measures in good time for the case that the wind speed exceeds the above value.

(3) When considering the erection loads, it may also become necessary to take the downward components of the wind load into account also, particularly in the case of structures which jut out to a considerable extent.

(4) In the case of cantilevered erection of the superstructure in two directions, and of similar sensitive conditions during erection, in respect of which the assumption of wind loads distributed over the wind-loaded areas in a non-uniform manner will result in less favourable stresses, the one part of the wind-loaded area shall be assumed to be loaded with the full wind load and the other part with half the wind load. The two parts shall be selected in such a way that the least favourable stress is generated in each case.

4.2.4 Wind loads on movable bridges

(1) For movable bridges in the fully open position, the calculation shall be based on 0,7 times the values given in table 4, column 2 for the final position, viz.:

a) for bascule bridges, the wind load shall be assumed to act along the longitudinal bridge axis on the total surface of the bascule (flap), or at right angles to this direction, the wind load shall be assumed to act on the wind-loaded areas specified in subclause 4.2.2;

b) for lift bridges, the wind load shall be assumed to act on the wind-loaded areas specified in subclause 4.2.2;

c) for swing bridges, the wind load shall be assumed to act on the wind-loaded areas of one cantilever arm in each case, in accordance with subclause 4.2.2.

(2) For all intermediate positions of the bridge, the calculation shall be based on 0,3 times the values given in table 4, column 2, with the wind load assumed to act on the same areas as above; in the case of bascule bridges, these values shall be multiplied by sin α, α being the angle of inclination of the bridge to the horizontal. In addition, a wind load of $\pm 0{,}2\ kN/m^2$ acting vertically on the floor area or flap area shall be considered for all intermediate positions. Wind loads having a stress relieving effect shall be ignored (see Supplement 1 to DIN 1072).

4.3 Snow loads

(1) In most cases, snow loads may be ignored in respect of the structure in its final state. However, for movable bridges in the fully open position, with the exception of bascule bridges, a least favourable partial or full snow loading of the deck surface of 0,75 kN/m^2 shall be assumed. For roofed-over bridges, the snow load shall be taken as specified in DIN 1055 Part 5.

(2) For erection, the snow load shall generally be taken as 0,8 times the values specified in DIN 1055 Part 5. These values may be reduced to a minimum of 0,50 kN/m^2 provided that measures scheduled for snow clearance are effectively carried out. Except for cases where the stability has to be verified in accordance with subclause 6.2, the snow load may generally be taken as acting on the total deck surface area (see Supplement 1 to DIN 1072).

4.4 Loads due to braking and starting of vehicles (braking loads)

(1) The braking load of road vehicles shall be assumed to be 25 % of the main traffic lane loading consisting of the standard vehicle and of load p_1, but in any event it shall be assumed to be not less than one-third of the loads of the standard vehicles on the main traffic lane and on the secondary traffic lane; however, the maximum braking load to be used shall not exceed 900 kN, no vibration coefficient being taken into account (see Supplement 1 to DIN 1072).

(2) The loaded length relevant within the above limits is given by the load distribution resulting from the least favourable superposition of the braking load and the standard imposed load investigated in each case (see Supplement 1 to DIN 1072).

(3) When considering the replacement of bearings, the braking load of road vehicles may be reduced accordingly, in addition to the reduction of the standard imposed load (see subclause 3.3.5, paragraph 2).

(4) The braking load of rail vehicles[3] shall be assumed to be one-eighth of all the axle loads, no allowance being made for any vibration coefficient, up to a loaded length of 50 m; in the case of longer loaded lengths, it will suffice to assume a value of one-twentieth of the axle loads for those axles acting outside the 50 m length. In the case of twin-track rail tracks, the braking load shall be considered for both tracks as being of the same magnitude and acting in the same direction. The superposition of the braking loads of road and rail vehicles shall be effected on the lines of subclause 3.3.6.

(5) The braking load shall be assumed to act at the level of the deck surface or of the top surface of the rail. For simplicity, it may be assumed to act at the level of the supports, if this does not result in a significant change in stress.

(6) If braking forces above ground level act on the structure, a distribution of the load in the backfill at an angle of 30° in both the horizontal and vertical planes, i.e. both downwards and sideways, shall be assumed. In most cases, their action need only be calculated for the structural element directly affected (for example the wall of a chamber), including the connection to adjoining structural elements.

(7) The braking load may be ignored if it obviously exerts no influence on the safety of the structure or of the structural element. This shall apply, for example, to structures as described in DIN 1075, April 1981 edition, subclause 6.2 (vaults) and subclause 7.1.2 (abutments connected to the superstructure).

(8) Movement resistances of roller bearings and sliding bearings shall not be used for reducing the braking load.

(9) For carriageway expansion joints[4], a braking load equal to 0,6 times the maximum wheel loads applicable to these elements in accordance with the bridge class concerned (see tables 1 and 2) shall be assumed, with a maximum of 39 kN. The braking loads shall also be calculated for adjoining structural elements (see Supplement 1 to DIN 1072).

4.5 Resistances to movement and deformation of bearings and carriageway expansion joints

(1) The movement resistance parameters dependent on the type of construction of the bearings (i.e. rolling and sliding resistances) and the deformation resistance parameters are to be obtained from the relevant approval notifications or from the standards of the DIN 4141 series.

(2) Rolling and sliding resistances of bearings in respect of vertical loads shall be calculated with due allowance being made for the bearing force arising from dead loads; where the movement resistances do not have a relieving effect, half the standard imposed load in accordance with table 1 or table 2 and also the full imposed load of any rail vehicles present shall be additionally considered (without taking into account the vibration coefficient in each case).

(3) The sliding resistances of bearings or bearing components which are capable of moving in the longitudinal direction of the bridge and which have to absorb horizontal loads acting at right angles to the bridge axis shall be determined either from the sum of the constraining stresses, for example as a result of the thermal effects, foundation settlement, warping of the bridge, or shall be assumed to be equal to 0,3 times the wind loads; the greater of the two values shall be used in the calculation (see Supplement 1 to DIN 1072).

(4) The following shall apply to bearings, pendulums and elevated piles of conventional design, in respect of which no data are obtainable from either an approval notification or from standards of the DIN 4141 series.

a) In the case of roller bearings, the rolling resistance shall be assumed to be 5 % of the bearing force (see Supplement 1 to DIN 1072).
b) In the case of elevated pile bearings or pendulums with a rolling face radius equal to half the pendulum height, the rolling resistance shall be assumed to be the same as for roller bearings, for heights up to 0,3 m. For heights above 3 m, the rolling resistance may be reduced down to 1 % of the bearing force; intermediate values shall be linearly interpolated.
c) In the case of pendulums or elevated piles with a rolling face radius not equal to half the height, and in cases where the rotational movements are not effected by rolling faces but by elastic, plastic or hydraulic articulations, an unscheduled tilt of ±1 % shall be taken into consideration in addition to the tilt caused by the scheduled movements.

(5) In the case of deformation bearings, deformation resistances arising from a horizontal deformation of the bearings of not less than 1 cm shall be considered for each direction of movement, when dimensioning the structure.

(6) The reaction forces arising from rolling and sliding resistances, deformation resistances and tilts shall be assumed to act on the fixed bearings. DIN 4141 Part 1, September 1984 edition, subclause 3.3 shall apply to the superposition of the rolling and sliding resistances of several bearings, and also to the structural elements dealt with in paragraph (4), item b) of this subclause. For struc-

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[3] It may become necessary to consider different braking loads on the basis of data supplied by the rail traffic organization.

[4] The braking load shall be regarded in this case as a main load in accordance with clause 2, paragraph 5.

tural elements in accordance with paragraph (4), item c) of this subclause, the reaction forces arising from scheduled and unscheduled tilts shall be assumed to act fully on the fixed bearings so as to cause the most adverse effect.

(7) In the absence of a more accurate verification, the reaction forces on the fixed bearings arising from rolling and sliding resistances and from the braking load shall be superposed in full (see Supplement 1 to DIN 1072).

(8) Deformation resistances from carriageway expansion joints shall be considered in addition to the other load cases (see Supplement 1 to DIN 1072).

4.6 Dynamic effects on movable bridges

In the case of movable bridges, it will also be necessary to investigate the load conditions which arise as a result of the motion of the superstructures, caused by the acceleration or deceleration of their mass.

4.7 Loads acting on safety fences

Safety fences shall be assumed to be loaded with 0,8 kN/m horizontally at stringer height outwardly and inwardly. Where safety fences are subject to stressing by any additional loads, such as those caused by lighting fittings, or by roller loads of inspection trolleys, then these loads are also to be considered.

4.8 Loads caused by inspection trolleys

Loads caused by inspection trolleys shall be considered taking account of the scheduled utilization and mode of operation of the trolley.

5 Exceptional loads

5.1 Exceptional loads during erection

(1) Exceptional loads during erection comprise the following (see Supplement 1 to DIN 1072).

a) Effects arising during erection which are caused by items of construction equipment and scaffolding, and also by stored or transported building materials and structural elements. Such effects, if they are significant, and this includes a consideration of the dynamic components arising from the lifting and lowering of the items concerned, shall be determined systematically and considered in their least favourable position under all conditions possible during erection.

b) Unscheduled horizontal forces due to inevitable imperfections. The structure shall be protected against such forces in every stage of the erection, including protection in the longitudinal and transverse directions against lifting and lowering operations; these horizontal forces shall be considered for all the structural elements present, including auxiliary supports. In the absence of an accurate verification, these forces shall be calculated on the basis of a 1 % unscheduled tilt of the structural elements or of the auxiliary supports.

c) All effects arising during bridge assembly, such as lifting or lowering of supports.

(2) The exceptional erection loads shall be regarded as main loads or classified as dead loads in accordance with clause 2, paragraph (5).

5.2 Loads due to possible foundation settlement

The rotational and translational movements of supports caused by possible foundation settlement shall be taken into consideration in accordance with the data given in the design standards, in their least favourable composition and in superposition with the main loads, and additional loads if applicable, no allowance being made for probable foundation settlement. Subclause 3.5 shall apply if it is intended to re-establish the scheduled support conditions either wholly or partly (see Supplement 1 to DIN 1072, subclause 3.5).

5.3 Road vehicle collision loads

(1) Supports, frame legs, end members of trusses and similar members shall be dealt with as follows (see Supplement 1 to DIN 1072).

a) As a rule, they shall be designed to withstand collision by road vehicles and be protected by special measures[5]).

b) They shall be designed to withstand collision by road vehicles when situated on, or next to, roads and streets within built-up areas where the speed limit is 50 km/h or less, and in all cases when situated next to parish roads, unclassified roads and major farm tracks.[6])

c) They are not required to be designed to withstand collision by road vehicles nor shall they be protected by special measures if they are protected against the risk of collision by virtue of their location, or where concrete structural elements complying with DIN 1075, April 1981 edition, subclause 10.2, last but one and last paragraphs, are concerned.

(2) In addition to unfavourably acting main loads as specified in clause 3, the following horizontal loads shall be used in the calculation, assumed to act at a height of 1,2 m above the deck surface:

parallel to direction of travel: ±1000 kN;
normal to direction of travel: 500 kN.

The above two loads need not be assumed to act at the same time. The distribution of force in the structural elements directly affected, and into the bearings or connections arranged at their extremities shall be considered (see Supplement 1 to DIN 1072).

5.4 Loads arising from lateral impact against raised kerbs and safety fences

(1) Raised kerbs and safety fences on carriageways, such as parapet walls, shall be assumed to be loaded in each case with a load allowing for lateral impact in accordance with table 5, in addition to loading with unfavourably acting main loads. These loads shall not be superposed and they shall be used in the calculation with no allowance being made for the vibration coefficient (see Supplement 1 to DIN 1072).

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[5]) Special measures in accordance with subclause 5.3 shall be deemed to include safety fences which are to be installed with a distance of not less than 1 m between its front face and the front face of the structural element to be protected, and concrete plinths placed close to the structural elements to be protected; these plinths shall have a height of not less than 0,8 m and shall protrude from the outer edge of the structural element concerned not less than 2 m parallel to the direction of traffic, and not less than 0,5 m at right angles to the direction of traffic.

[6]) Existing structural elements not designed to withstand vehicular collision shall be protected by special measures.

Table 5. **Substitute loads arising from lateral impact**

	1	2	3
	Bridge class	Raised kerbs and safety fences which can be directly collided with	Parapets or similar which are situated more than 1 m behind the front edge of a safety fence
1	60/30	100 kN	50 kN
2	30/30	50 kN	25 kN
3	16/16, 12/12 9/9, 6/6, 3/3	Wheel load of a rear wheel	Half of wheel load of a rear wheel

(2) The load shall be assumed to act parallel to and normal to the carriageway, 0,05 m below the top edge of the structural element, at a height above the deck surface not exceeding 1,20 m. The concentrated load may be taken as a knife edge load evenly distributed over a length of 0,5 m. In rigid structural elements the load may be assumed to act at an angle of 45°. Imposed loads and additional loads with a relieving effect shall not be taken into account simultaneously.

(3) As a rule, the absorption of the lateral impact shall be verified in accordance with the design standards in respect of:

a) the impacted structural element itself;

b) the structural element immediately supporting it.

(See Supplement 1 to DIN 1072).

(4) For safety fences including posts and connections, verification in accordance with paragraph (3), item a) of this subclause may be dispensed with. If the design of the immediately supporting structural elements requires the specification of a load, a load of 25 kN acting on each post at the centre of the safety fence shall be assumed (see Supplement 1 to DIN 1072).

6 Special analyses

6.1 Movements at bearings and at carriageway expansion joints

(1) The movements at bearings and carriageway expansion joints shall be determined for the state of use, the following factors being taken into consideration in their least favourable combination in accordance with the specifications given in clauses 3, 4 and, if appropriate, in clause 5; the following conditions during erection shall also be taken into account.

a) Superstructure: thermal effects, prestress, shrinkage and creep of the concrete, and effects arising from deformation (for example from the tangent angles of rotation at the points of support);

b) Supports: translational or rotational movements (see Supplement 1 to DIN 1072).

(2) For bearings, the specifications relating to minimum values given in DIN 4141 Part 1, September 1984 edition, subclause 4.4 and clause 5 shall be taken into account.

(3) The following shall apply in addition for the determination of the movements at roller and sliding bearings and at carriageway expansion joints, and on pendulums and elevated piles (see Supplement 1 to DIN 1072).

a) Loads due to creep and shrinkage are to be taken into account with a factor of 1,3 if they act unfavourably.

Table 6. **Hypothetical limit values of temperature**

	1	2	3
	Type of bridge	Hypothetical maximum temperature	Hypothetical minimum temperature
1	Steel bridges and composite bridges	+75 °C	−50 °C
2	Concrete bridges and bridges with concrete-encased rolled steel girders	+50 °C	−40 °C

b) As regards the adjustment of bearings and of carriageway expansion joints, it is not the erection temperature of +10 °C as specified in subclause 4.1 which shall be regarded as relevant, but the actual mean temperature of the structure at the time the final connection to the fixed bearings is effected (see Supplement 1 to DIN 1072).

c) Hypothetical limit values of temperature in accordance with table 6 below shall be adopted for the temperature fluctuations (see Supplement 1 to DIN 1072).

d) Deviations from the values given in table 6 are permitted in the following cases (see Supplement 1 to DIN 1072).

When considering the stages of erection and in cases where bearings and carriageway expansion joints are adjusted accurately on the basis of measurements of the average temperature of the structure upon completion of the final connection to the fixed bearings, the limit values of temperature specified in table 6 may be decreased by 15 K each, both the maximum and the minimum values in the case of bridges of the types described in line 1, and by 10 K each in the case of bridges of the types described in line 2.

If the datum point is altered during erection, additional uncertainties shall be allowed for by increasing the specified upper and lower limit values of temperature by 15 K each or by 10 K each, in the calculation for the final condition.

(4) As regards structural analysis, the specifications of paragraph (3) above shall only be deemed relevant for bearings and bearing joints, and for carriageway expansion joints and their anchorages. As regards the structural analysis of all other structural elements in the design of which movement is an influencing factor, the movements concerned shall be determined in accordance with paragraph (1).

6.2 Verification of structural adequacy

(1) Verification of structural adequacy is to cover safety against sliding, lifting and overturning. The structural adequacy of bearing joints (with and without anchorages) and of foundation joints shall be verified in cases where it cannot be taken for granted (see Supplement 1 to DIN 1072).

(2) Safety against sliding in the bearing joint shall be verified in accordance with DIN 4141 Part 1, and safety against sliding in the foundation joint shall be verified in accordance with DIN 1054.

(3) Verification of safety against lifting and overturning shall be carried out in addition to the analyses required in the design standards for the state of use and/or the theoretical state of failure. Proof shall be deemed to have been provided if the absorbable stress resultants in the joints investigated, reduced by dividing them by the partial resistance factor, γ_m, are at least equal to those resulting from the loads multiplied by the partial load factor, γ_f.

(4) The partial load factor, γ_f, as in table 7 shall be used in the verification, taking the working loads in their least favourable combination. For the various stages of erection (see subclause 4.2.3, paragraphs 3 and 4), it may be necessary in some cases to consider vertical wind load components; snow loads shall be assumed to act on partial areas so as to cause the most adverse effect. The stress resultants shall be calculated on the basis of the stiffnesses in the state of use. The bearing positions to be considered in the analysis shall be allowed for using a factor of 1,0 in accordance with subclause 6.1, paragraph 1 (see Supplement 1 to DIN 1072).

(5) If the distance between the abutments or other supports provided to prevent any rotational movement of the superstructure exceeds 50 m, a load case in which the main traffic lane is loaded with load p_5 equal to 9,0 kN/m^2 (not allowing for any vibration coefficient) shall be adopted for the verification of safety against overturning in the case of bridge classes 60/30 and 30/30, instead of the standard imposed loads in accordance with table 1 and of the wind loads, provided that this load case is less favourable (see Supplement 1 to DIN 1072).

(6) The values of the partial resistance factor, γ_m, are to be obtained from Appendix A. Alternatively, if the calculation is carried out using the stresses permissible for the state of use, the verification shall be based on the increased permissible stresses as in Appendix A (see Supplement 1 to DIN 1072).

(7) If anchorages are necessary in the case of bearings which are susceptible to lifting by reason of their design and construction, the anchorages are to be prestressed so as to prevent any elongation when loaded with the loads multiplied by the partial safety factor, γ_f.

Table 7. **Values of γ_f to be used in the verification of safety against lifting and overturning**

	1	2
	Types of load	γ_f
1	All loads unless otherwise specified	1,3
2	Dead loads (except for those due to earth pressure) a) acting favourably b) acting unfavourably	 0,95 1,05*)
3	Favourable earth pressure loads if permitted as analysis factors	0,7
4	Prestress of loadbearing structure	1,0
5	Lifting for the purpose of renewing bearings	
6	Thermal effects (see table 3)	
7	Imposed loads with a relieving effect, in accordance with subclause 4.2.1, paragraph 4	
8	Loads due to possible foundation settlement (including loads due to probable foundation settlement)	
9	Loads arising during erection	1,5
10	Resistances to movement and deformation of bearings and carriageway expansion joints	0
11	Loads caused by inspection trolleys	

*) Differences in humidity may require a higher value in the case of wooden structures.

Appendix A

Additional information relating to the verification of structural adequacy

A.1 General

The information given below shall apply to the resistances for which allowance is to be made in the verification of safety against lifting and overturning of road and foot bridges in accordance with subclause 6.2.

Note. Following inclusion of this information in the relevant design standards when these are revised, this appendix may be withdrawn.

A.2 Additional information

(1) In the verification of safety against lifting and overturning in accordance with subclause 6.2, the following values of γ_m as specified in table A.1, or the stresses permissible for the state of use, applicable to load case H and multiplied by the coefficient given in table A.2, shall be adopted (see Supplement 1 to DIN 1072).

(2) Loads from constraint and due to anchoring forces shall be determined on the basis of the equilibrium conditions and the associated compatibility of deformation, taking account of the applicable material parameters. For prestressed anchors, (e.g. high-stress friction grip bolts or prestressing tendons), the initial strain shall be assumed with a factor of 1,0.

Table A.1 **Partial resistance factor, γ_m**

	1	2
	Structural material	γ_m
1	Reinforcing steel; γ_m related to yield point, β_s	
2	Prestressing steel; γ_m related to 0,2 proof stress, $\beta_{0,2}$ (see approval notification)	
3	Concrete; γ_m related to a theoretical value of compressive strength, β_R, of 0,6 β_{WN} as in DIN 4227 Part 1 (see also table A.2, line 4)	1,3
4	Subsoil, shear failure; verification in accordance with DIN 4017 Part 2, August 1979 edition, subclause 8.1. Reference parameter: loading with $\eta_p = \gamma_m$.	

Table A.2 **Coefficients to allow for the increase in the permissible stresses in the state of use for load case H**

	1	2
	Structural material	Coefficient
1	Structural steel	
2	Bearings in accordance with standards of the DIN 4141 series	
3	Bolts (based on the values specified in DIN 18800 Part 1, March 1981 edition, table 10)	1,3
4	Concrete partial area pressure (based on the values specified in DIN 1075, April 1981 edition, subclauses 8.2 and 8.3)	
5	Wood	

Standards referred to

DIN 1054	Subsoil; permissible loading of subsoil
DIN 1055 Part 1	Design loads for buildings; materials, building materials and structural members, dead load and angle of friction
DIN 1055 Part 2	Design loads for buildings; soil characteristics, density, angle of friction, cohesion, angle of wall friction
DIN 1055 Part 5	Design loads for buildings; imposed loads, snow load and ice load
Supplement 1 to DIN 1072	Road and foot bridges; design loads, explanatory notes
DIN 1075	Concrete bridges; design and construction
DIN 4017 Part 2	Subsoil; shear failure calculations for shallow foundations with oblique and eccentric loading
DIN 4141 Part 1	Structural bearings; general design rules
DIN 4227 Part 1	Prestressed concrete; partially or totally prestressed structural components made of normal weight concrete
DIN 18800 Part 1	Steel structures; design and construction

Previous editions

DIN 1183: 10.33; DIN 1072: 07.25, 10.27, 09.31, 10.39, 04.41, 09.44, 06.52, 11.67.

Amendments

In comparison with the November 1967 edition, the standard has been completely revised and brought into line with the present state of the art.

International Patent Classification

E 01 D 1/00