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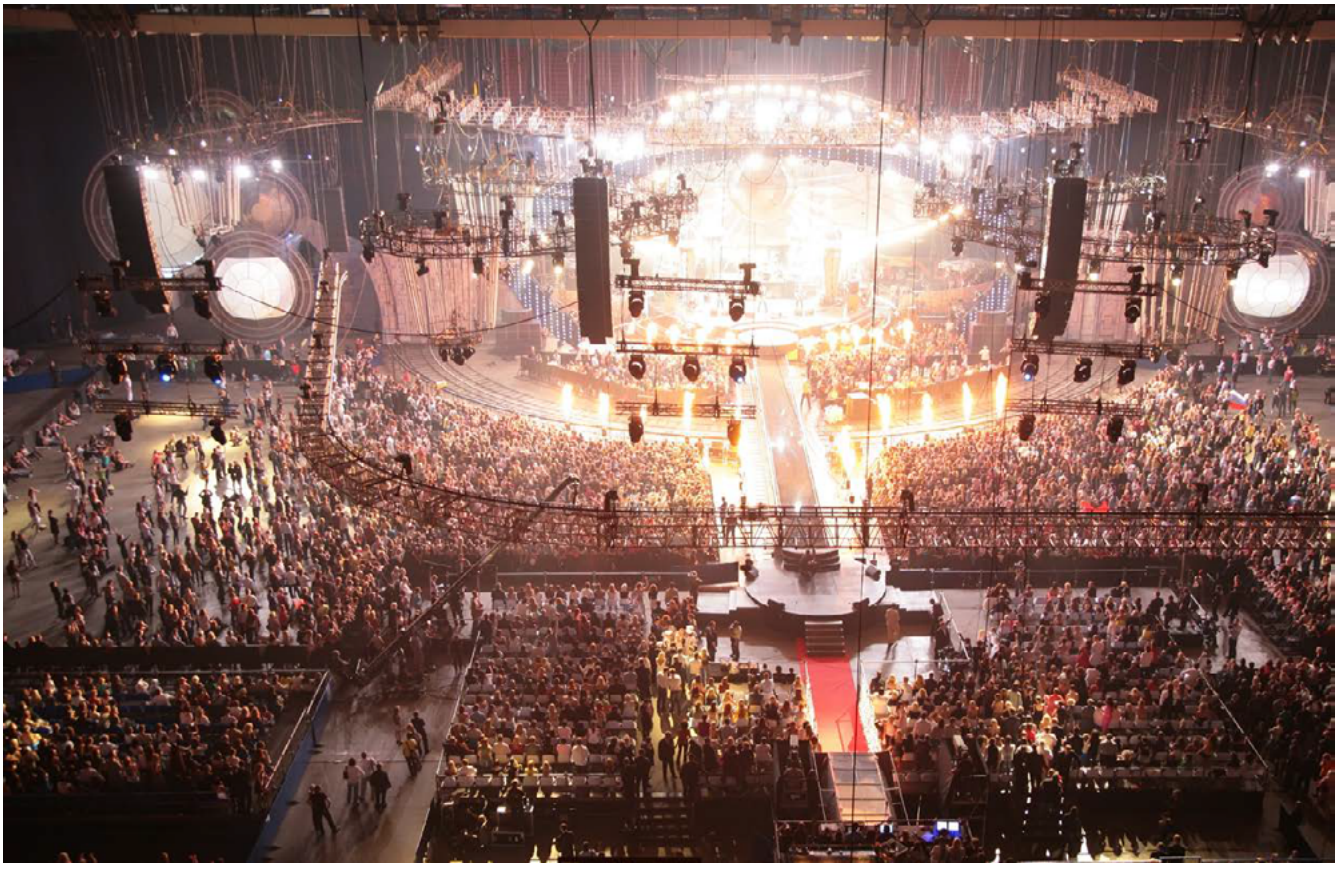
DGUV Information Guide 215-313

Overhead Loads

Safety for events and productions in television, radio, film, theatre, trade fairs and events



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Contents

Introduction

This DGUV information guide describes safety methods for handling overhead loads. It is intended for persons responsible for the organisational and technical aspects of productions and events.

It defines the level of safety required for the work processes specific to the field of event technology and for situations and procedures involving similar risks.

Events and productions

Companies and service providers for productions and events are enterprises that stage or are involved in productions and events in areas such as:

- film, radio, television – studios and other production venues
- drama and musical performances – theatres, multi-purpose halls, open-air theatres, acting and performance areas in concert halls, stages in cabarets, music halls and schools
- events – shows, open-air events, concerts and discotheques
- trade fairs and exhibitions

These companies and service providers will be referred to as “production and event companies” for the remainder of this guide.

Protection objectives relating to safety when holding overhead loads in place are defined in legal requirements and in the regulations issued by the social accident insurance institutions (see Annex 1).

This guide does not cover the design-based protection built into mechanical equipment for events and productions, for example, scenery hoists, barrel hoists and stands, to prevent loads from falling. Such protection is subject to the requirements of the German Product Safety Act (“Produktsicherheitsgesetz”) and the relevant DIN and DIN EN standards.

The information guide was drawn up jointly by the Stages and Studios Department of the DGUV’s Administration Division and the following organisations:

- the working group of safety engineers from ARD.ZDF.medienakademie, ARTE, Bavaria, BR, DeutschlandRadio, DW, HR, IRT, MDR, NDR, RBB, ORF, RB, RBT, Mediengruppe RTL Deutschland, SF, SR, SRG, SSR, Studio Hamburg, SWR, WDR and ZDF
- DTHG – Deutsche Theatertechnische Gesellschaft e.V.
- EVVC – Europäischer Verband der Veranstaltungs-Centren e.V. (European Association of Event Centres)
- ver.di – Vereinte Dienstleistungsgewerkschaft
- VPLT – Verband für Medien- und Veranstaltungstechnik e.V. (Professional Lighting and Sound Association of Germany)

Generally speaking, its contents reflect these organisations’ joint views, shared by the following associations:

- BVB – Bundesverband Beleuchtung und Bühne e.V.
- Deutscher Bühnenverein – Bundesverband der Theater und Orchester
- Deutscher Städtetag
- FAMAB – Fachverband aktive Wirtschaftskommunikation e.V.
- VDSI – Verband Deutscher Sicherheitsingenieure e.V.

1 Essential safety requirements

Work equipment for holding overhead loads in place must be selected and operated in such a way that the loads are held safely for the entire period of use.

Employers may only use persons with adequate skills to use, maintain and test work equipment for holding overhead loads in place. The employer specifies the required skills by means of a risk assessment for the use of work equipment for holding overhead loads in place. This specification must take into account the requirements set out for these persons' qualifications in the appropriate regulations and technical rules (see the Ordinance on Industrial Safety and Health ("Betriebssicherheitsverordnung"), the TRBS 1203 technical rule on industrial safety, DGUV regulations 17 and 18 on "Staging and production facilities for the entertainment industry", DGUV Rule 115-002 on "Staging and production facilities for the entertainment industry", the Model Ordinance on the Construction and Operation of Places of Assembly ("Muster-Versammlungsstättenverordnung") and the IGVW SQO2 and IGVW SQQ2 quality standards.

1.1 Design requirements

All load-carrying elements in a load strand and the safety elements must be designed in such a way that the materials and shape comply with the following essential requirements:

Design requirements for load-bearing elements and safety elements:
- All connections must be positive ("form-fitting"/"form-locking").
- All elements must meet all of the following criteria as a minimum:
  - Dimensional stability
  - Standardised or known strength properties
  - Assured production/manufacturing quality (e.g. in the form of a test report as specified in EN 10204)
  - Clearly visible indication of whether connections which are relevant to safety (e.g. connections which lock into place, are self-locking or are bolted or screwed) are functioning correctly
  - Secured connections to prevent them loosening or coming undone of their own accord
  - Damage can be detected merely by means of a visual inspection
- Depending on the expected conditions of use, the materials to be used must possess the following characteristics:
  - weather resistance
  - temperature resistance
  - ageing resistance and
  - resistance to other harmful factors.

The work equipment must be marked in an appropriate manner, have information for use supplied with it and be uniquely identifiable (e.g. in terms of manufacturer, type, load-bearing capacity, year of manufacture and CE mark).

The intended use of the work equipment must be indicated clearly (e.g. load-bearing capacity, details of impermissible use, if applicable, and warnings).

Furthermore, the testing and removal-from-service criteria specified in the technical rules and the information supplied by the manufacturer must be observed.

1.2 Inherently safe design of work equipment

The generally accepted principle that adequate risk reduction can be achieved by inherently safe design of work equipment stems from the specifications made in technical rules.

The specifications are based on many years of experience in quality-oriented production at a high level of industrial development. Compliance with these specifications considerably decreases the risk of parts failing.

Inherent safety is achieved by doubling the working coefficients and adhering to the following requirements:
- proper use,
- regular inspections so that faults or damage are detected in good time and
- special care during storage, transport, assembly and disassembly.

1.3 Single-fault tolerance provided by safety elements/secondary safety components

Single-fault tolerance is achieved by using additional safety elements (known as “safeties”). (The requirements for these safety elements are described in Section 2.3).

This method can compensate potential errors and defects, for example:
- errors in use or assembly,
- self-loosening connections and
- use of work equipment which does not fully meet the design requirements (as set out in Section 1.1).

In practice, it is the quality of the way in which the equipment is installed that influences the safety of suspension systems for lighting, PAs, monitors, decorations and other objects in the production and event business which are installed using fixing devices intended to allow the equipment to be used in different places (e.g. spigots and sleeves or C hooks). Such applications thus require a secondary safety component.

Safeties must be attached in such a way that there is no drop. Where that is not possible, the drop must be kept to a minimum. In the case of work equipment that has to have its position adjusted after it has been installed, e.g. luminaires, the maximum permitted drop is 20 cm.

An additional safety component (secondary safety component) is not necessary if the fixing device is inherently safe, can only be loosened using a tool and is secured to prevent it loosening of its own accord.

If the safety element (safety rope) is such that the load can drop, the force which develops when the load drops into the safety element must also be taken into account. The length of the drop is the crucial factor. Tests have shown that a drop of 20 cm can result in a force as high as 50 times the falling load.

Maximum permitted drop
In the case of work equipment that has to have its position adjusted after it has been installed, e.g. luminaires, the maximum permitted drop is 20 cm.

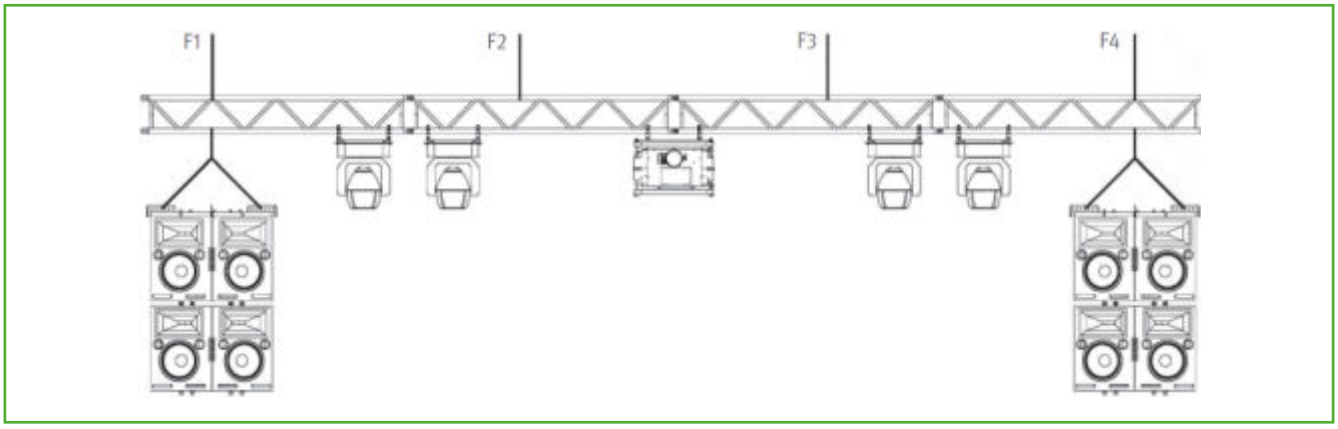


Fig. 1: Diagram of load distribution on a truss with several suspension lines

1.4 Required load-bearing capacity of work equipment

Manufacturers usually indicate the load-bearing capacity or the minimum breaking load for work equipment used as attachment gear or load-carrying devices. The following principles apply when holding overhead loads in place:
- if the load-bearing capacity (e.g. WLL) is indicated, the load applied to the equipment must not exceed half of the figure given; and
- if the minimum breaking load is indicated, it has to be divided by the necessary working coefficient in order to calculate the maximum permissible load-bearing capacity.

Work equipment whose load-bearing capacity for holding overhead loads in place has been proven is used in accordance with the information supplied by the manufacturer (see Table 1).

The technical rules define working coefficients and partial safety factors as follows:

Working coefficient
Put simply, the working coefficient is the ratio between the minimum breaking load and the load-bearing capacity of an element. Item 4.1.2.5 of Annex 1 of Directive 2006/42/EC (Machinery Directive) specifies working coefficients for attachment gear (referred to as “lifting accessories” in the directive). The term “working coefficient” replaces the old term “factor of safety”/“safety factor”.

Partial safety factor
The EN 1990: 2010-12ff. series (Eurocode) defines partial safety factors for supporting structures.

If several load strands are required in order to hold or move a load, the load applied to each single strand must be calculated. The calculated maximum load determines the load-bearing capacity of all elements used in all load strands.

If the working coefficients of all elements used are doubled, the load strands are regarded as inherently safe.

When determining the forces which occur where moving loads are involved, the dynamic forces (acceleration and deceleration of the load) must also be taken into account.

An extra allowance of at least 20 % has proved a good reference value for these dynamic forces.

1.5 Attaching loads to building structures

Where information is provided on the load-bearing capacity of building structures, it usually relates to vertical static loads (rated load without any dynamic load components). Load-attachment points on the supporting structure are regarded as intersections with the building structure and must be able to carry loads safely.

Load-attachment points are defined positions on the supporting structure, e.g. truss nodes or eyes permanently fixed to the supporting structure. Below this intersection with the building structure, all elements in the load strand must be inherently safe. In addition, where necessary, measures to ensure single-fault tolerance are carried out.

Loads may only be attached to building structures if the operator is able to give precise details concerning the rated load capacity of the load-attachment points. In particular, the following details are required:
- the rated load capacity figure and
- the rated load capacity based on the direction of force.

Only the load-attachment points approved by the operator may be used. The rated load capacity of the load-attachment points cited by the operator must not be exceeded during assembly, dismantling or operation. To ensure this is the case, a load-measuring device can be used.

When planning the production or event, consideration must be given to dynamic forces, potential loads caused by failures and additional loads during operation, assembly and dismantling, in addition to the equipment's self-weight. For instance, additional forces develop due to diagonal rigging, acceleration of loads and abrupt stopping of moving loads.

Loads may only be directly attached to supporting structures using attachment gear if doing so does not interfere with preventive fire safety measures, for example, fire-protection coating.

1.6 Deviations from the essential safety requirements

Deviations from the essential safety requirements are only permitted if an assessment of the risks, performed by a competent person, provides clear evidence that loads cannot cause injury if they fall. This can be the case, for example, when curtains are hung using straps or when the cord grip of a microphone cable carries the load.

2 Selection and use of work equipment

"Use of work equipment" refers to any activity with equipment. In particular, this includes assembly and installation, operation, maintenance, testing, disassembly and transport. Risk assessments by competent persons must be carried out as part of the process of selecting and using work equipment with which to hold overhead loads in place.

The aim of such assessments is to ensure that the work equipment chosen is suitable in terms of type and load-bearing capacity and to specify measures to ensure it is used safely.

The assessment takes the entire load strand into account, from the intersection with the building structure through to and including the load itself.

If the load-bearing capacity of the work equipment has been specifically calculated and the equipment manufactured specifically for use in the field of event technology, and if proof of this has been furnished, the equipment can be used as specified by the manufacturer and the information marked on it.

Depending on the intended use specified by the manufacturer, work equipment can be a product within the meaning of the Machinery Directive. Where this is the case, a CE mark and EC Declaration of Conformity are required, in accordance with the Machinery Directive.

A CE mark as defined in the Machinery Directive is not permitted if the product does not fall within the scope of the Machinery Directive. This is true, for example, of safety ropes and turnbuckles.

2.1 Attachment gear

Attachment gear must be appropriately designed and have sufficient load-bearing capacity to cope with the loads which occur during operation.

Based on the requirements set out in Section 1, "Essential safety requirements", attachment gear for productions and events must adhere to the principle of inherent safety. If there is a possibility that people might be below the loads, the load on the attachment gear must not exceed half of the load-bearing capacity specified by the manufacturer. This ensures that the working coefficient is doubled.

Table 1: Minimum requirements for working coefficients

	No persons under load	Persons under load
	Working coefficient Directive 2006/42/EC (Machinery Directive), Annex 1*	Working coefficient doubled to achieve inherent safety as specified in DGUV regulations 17 and 18
Wire ropes	5	10
Round slings with a wire-rope core	5	10
Round slings and webbing slings made of man-made fibres	7	14**
Chain slings	4	8
Shackles as specified in EN 13889	5	10
Other metal elements in the leg***	4	8

* If applicable
** May only be used in combination with a secondary safety component as described in Section 2.3
*** E.g. turnbuckles, load-measuring devices, beam clamps or O-rings

Various types of attachment gear are used in the load path between the load-attachment point on the building structure and the actual load. Attachment gear is also used where there are secondary safety components.

In particular, the following attachment gear is used to hold overhead loads in place in the field of production and event technology:
- Attachment gear specifically intended for holding overhead loads in place in the event industry (see Table 2a)
- Attachment gear for general lifting operations, to which only half of the load-bearing capacity specified by the manufacturer may be applied (see Table 2b)

Table 2a: Attachment gear specifically intended for holding overhead loads in place in the event industry

Type: Quick link for the event industry	Attachment gear with a working coefficient of 10 and clearly identifiable marking
 Fig. 2	The load applied to quick links of the type specified in DIN 56927 can be as given in the load-bearing capacity figure. **Caution:** Quick links that have no marking or information concerning load-bearing capacity must not be used.
 Fig. 3	The load applied to specially designed quick links can be as given in the load-bearing capacity figure, e.g. 90 mm x 8 mm, 200 kg proven load-bearing capacity as specified in DGUV regulations 17 and 18

Table 2b: Attachment gear for general lifting operations and other industrial applications

Attachment gear	Usually, only loads weighing half of the load-bearing capacity specified by the manufacturer may be applied to this attachment gear when used in the field of event technology
Shackle, high-strength, rounded shape • with eyebolt:  Fig. 4 • with a lock nut and cotter pin:  Fig. 5	Shackles of the type specified in EN 13889: 2009-02 have a working coefficient of 5. **Note:** A shackle with a lock nut and cotter pin is always necessary when the conditions of use are such that bolts might come loose. This is the case, for example, when overhead loads are moved, when loads are repeatedly applied and removed from the shackle or where the conditions of use vary. **Caution:** Shackles whose load-bearing capacity and working coefficient are not known must not be used.
O-ring, oval  Fig. 6	O-rings of the type specified in DIN 5688-3: 2007-04 have a working coefficient of 4. **N.B.:** It should be borne in mind that the load-bearing capacity might decrease when used with multiple legs (in a bridle).
Load hook, self-locking  Fig. 7	Self-locking load hooks of the type specified in EN 1677-3: 2008-06 have a working coefficient of 4. Only load hooks whose features are guaranteed in a declaration by the manufacturer may be used. Normative specifications are contained in: EN 1677-3: 2008-06, “Forged steel self-locking hooks, grade 8” **Note:** It must be ensured that the load hook can move freely, as necessary for safe operation. This can be done, for example, by using swivel load hooks.
Beam clamp  Fig. 8	Only beam clamps whose load-bearing capacity is known and which have a restricted-guidance closing mechanism, e.g. a threaded spindle, may be used. Where the load-bearing capacity provides inherent safety and the design prevents self-release, there is no need for a secondary safety component, provided the installation has been carried out properly. **N.B.:** The load applied to a beam clamp must always be perpendicular to the beam axis (there must not be any diagonal tension). Beam clamps must only be installed on suitable beams that provide sufficient load-bearing capacity. Beams with a fire-protection coating are not suitable under any circumstances.
Turnbuckle  Fig. 9	Turnbuckles should not be used to lift loads under any circumstances and they do not usually have a marking. In the event industry, turnbuckles may be used to hold overhead loads if the manufacturer provides information on their load-bearing capacity and working coefficients. Turnbuckles must not be able to loosen by themselves.

Manufacturers of attachment gear must provide a declaration of conformity as specified in Directive 2006/42/EC (Machinery Directive) and mark the gear with the following:

- Manufacturer
- CE mark
- Standard (if applicable) or working coefficient
- Load-bearing capacity

Use

When selecting interlocking parts of a connection, for example, the shackle and thimble of a rope termination, it must be ensured that they are mechanically compatible and can move freely when the connection is closed. The risk of notching when materials of different hardness are used in combination must also be borne in mind.

2.1.1 Using wire ropes for attachment purposes

Wire ropes for use as attachment gear must comply with the EN 13414 series of standards, “Steel wire rope slings – Safety”.

Unlike the requirements for general lifting operations (EN 13414-1: 2009-02, DGUV Rule 109-005 on the “Use of wire ropes for attachment purposes”), wire ropes used for attachment purposes in the event industry can have a diameter as small as 4 mm. The round strand ropes used in this way must comply with EN 12385-4: 2008-06 “Steel wire ropes – Safety, Part 4: Stranded ropes for general lifting applications”. For instance, wire ropes with diameters between 4 mm and 6 mm are used to hold decorations and sets in place. The marking for wire ropes with diameters between 4 mm and 6 mm should take the form of, for example, a tag because marking the ferrule is impracticable.

Fig. 10

Wire ropes used as attachment gear for general lifting purposes as specified in EN 13414-1: 2009-02 have a minimum diameter of 8 mm and are marked with at least the manufacturer’s mark, load-bearing capacity, a CE mark and, normally, the year of manufacture.

Where the angle of inclination is between 0° and 45°, the load-bearing capacity decreases by 30 %; where the angle is between 45° and 60°, the decrease is 50 %. Inclination angles of more than 60° are not permitted under any circumstances.

When calculating the load-bearing capacity of a double leg with a non-symmetrical load, only one leg should be assumed to be carrying the load. If there are more than two legs, only two may be assumed to be carrying the load.

This does not apply if it is ensured that the load is evenly distributed across other legs too.

Where a load is unevenly distributed, the permitted load on each leg must not be exceeded.

Table 3: Load-bearing capacity of wire ropes used to attach overhead loads

Round strand rope 6 x 19 with fibre core Rope termination with thimble and ferrule (efficiency 0.9) Rope grade 1960 (corresponding to a rated strength of 1,770 N/mm² to 1,960 N/mm²)			
	Load-bearing capacity in kg for overhead loads		
	Single leg	Double leg with inclination angles	
		from 0° to 45°	from 45° to 60°
Rated diameter [mm]	 Fig. 11	 Fig 12	 Fig. 13
4	80	120	80
5	130	190	130
6	190	270	190
8	350	490	350
10	500	700	500
12	750	1050	750
14	1000	1400	1000
16	1350	1890	1350

Preventing heavy bending and bending across sharp edges

Heavy bending also reduces a wire rope's load-bearing capacity. The radius of the bend (r) must be larger than the rope's diameter (d).

Effective edge protectors or beam clamps used must be in order to prevent the rope bending across sharp edges (r ‹ d).

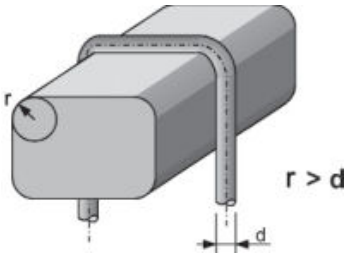


Fig. 14: Load-bearing capacity of a wire rope

Use

- Use of wire ropes with a fixed (immovable) protective plastic hose is not permitted.
- Wire ropes must be protected against harmful influences whilst in storage and during transport.
- The ropes must not be attached in a way that could cause damage to the rope terminations.
- Wire ropes must not be knotted.
- Damaged wire ropes must not be used again under any circumstances.

Removal from service

Removal-from-service criteria for wire ropes used for attachment purposes include, for example:

- Visible wire ruptures
- Crushing
- Bird-caging
- Corrosion damage
- Damage to the rope termination
- Protruding or damaged fibre core

For further information, please consult DGUV Rule 109-005, “Use of wire cable slings” (Section 5, “Removal from service”).

Rope terminations for wire ropes

The rope terminations used for wire ropes are mainly ferrules and rope clamps of the type specified in the EN 13411 series of standards, “Terminations for steel wire ropes”.

Rope terminations can be formed in accordance with the following standards:

- EN 13411-1: 2009-02: “Thimbles for steel wire rope slings”
- EN 13411-2: 2009-02: “Splicing of eyes for wire rope slings”
- EN 13411-3: 2011-04: “Ferrules and ferrule-securing”
- EN 13411-4: 2011-06: “Metal and resin socketing”
- EN 13411-6: 2009-04: “Asymmetric wedge socket”
- EN 13411-7: 2009-04: “Symmetric wedge socket”

Aluminium ferrules on fibre-core ropes may only be used in temperatures of no higher than 100 °C; for steel-core ropes, the limit is 150 °C. When luminaires are secured, higher temperatures can occur on or near the casing.

Wire-rope eyes without thimbles must not be used under any circumstances.

Non-standardised, adjustable rope terminations

Non-standardised, adjustable rope terminations which provide a non-positive connection may only be used to hold overhead loads in place if it is possible to verify beyond doubt that they are functioning safely and if the load-carrying rope is not damaged. The information for use supplied by the manufacturer must be heeded.

Rope grips

Rope grips of the type specified in the former DIN 1142 or EN 13411-5: 2009-02 may not be used to form rope terminations. Due to the rope’s elasticity, the diameter of wire ropes fluctuates significantly if the load is frequently changed. This can cause the rope grips to loosen, making it impossible to guarantee a safe termination in the long run.

Fig. 15: Rope grip as specified in the former DIN 1142 or EN 13411-5: 2009-02

2.1.2 Using round slings for attachment purposes

In the area of event technology, round slings are primarily used for rigging trusses. Normative requirements are set out in EN 1492-2: 2009-05 “Round slings made of man-made fibres, for general purpose use”.

Round slings are marked (on a label) with the following information:
- Manufacturer
- Load-bearing capacity
- CE mark
- Length
- Material
- Standard
- Traceability code
- Year of manufacture

Round slings which do not have any information marked on them must not be used.

In the case of round slings for holding overhead loads in place, the load applied to the sling must not exceed half of the load-bearing capacity (WLL) specified by the manufacturer.

Table 4 takes into account the 30% decrease in load-bearing capacity when the angle of inclination is between 7° and 45° and the 50% decrease when the angle is between 45° and 60°. Inclination angles of more than 60° are not permitted under any circumstances.

When calculating the load-bearing capacity of a double leg with a non-symmetrical load, only one leg should be assumed to be carrying the load. If there are more than two legs, only two may be assumed to be carrying the load. This does not apply if it is ensured that the load is evenly distributed across other legs too.

Where a load is unevenly distributed, the permitted load on each leg must not be exceeded.

Wedge sockets

Asymmetric wedge sockets:	Symmetric wedge sockets:	
 Fig. 16  Fig. 17	 Fig. 18	Only wedge sockets that comply with EN 13411-6: 2009-04 or 13411-7: 2009-04 may be used. The manufacturer must supply details of the diameter, the construction class and the strength class of the rope for which the wedge socket is designed. When wedge sockets are used in the event industry, the load applied to them is usually not allowed to exceed half of the load-bearing capacity calculated on the basis of those details. Wedge sockets may only have loads attached to them when they are under tension. They must also be secured, in line with the conditions of use, so as to prevent unintended loosening. The end of the rope which is not carrying the load should be fixed in place, but the load-carrying rope must not be clamped as well. **Markings:** • Manufacturer • Nominal size/size range

Table 4: Load-bearing capacity of round slings for overhead loads

Load-bearing capacity for overhead loads								
Load-bearing capacity WLL as specified in EN 1492-2: 2009-05	Colour code as specified in EN 1492-2: 2009-05	Single leg  Fig. 19	Choke  Fig. 20	Basket up to β = 6°  Fig. 21	Basket Inclination angle β		Double choke Inclination angle β	
					7° to 45°  Fig. 22	45° to 60°  Fig. 23	7° to 45°  Fig. 24	45° to 60°  Fig. 25
1 t	Purple	500 kg	400 kg	1000 kg	700 kg	500 kg	560 kg	400 kg
2 t	Green	1000 kg	800 kg	2000 kg	1400 kg	1000 kg	1120 kg	800 kg
3 t	Yellow	1500 kg	1200 kg	3000 kg	2100 kg	1500 kg	1660 kg	1200 kg
4 t	Grey	2000 kg	1600 kg	4000 kg	2800 kg	2000 kg	2240 kg	1600 kg

Contrary to the colour codes specified in EN 1492-2: 2009-05, round slings with different load-bearing capacities for use in the event industry are also manufactured in black.

When using round slings, it must be ensured that they do not run across edges whose radius is too small (i.e. sharp edges). The radius (r) of the edges must be larger than the thickness (d) of the slings. d is the thickness of the round sling under load. If there are sharp edges (r ‹ d) or abrasive surfaces, the areas of the round slings which are at risk of damage must be protected.

This is done by using a suitable form of edge protection on all sharp edges.

RIGHT
Fig. 26

WRONG
Fig. 27

Use

- Round slings must be stored in a dry place where they are protected against atmospheric influences (particularly UV radiation) and aggressive substances, e.g. solvents.
- No repairs must be carried out on, nor any other changes made to, round slings.
- Round slings must not be knotted or hitched to each other.

Removal from service

Examples of removal-from-service criteria for round slings are:

- Damage caused by heat, e.g. radiation, friction or contact
- Damage to the seams or the coating, causing the core to become visible
- Damage caused by chemical agents, e.g. solvents
- Embrittlement caused by physical factors, e.g. UV radiation
- Removal-from-service criteria specified by manufacturer

For more information on round slings, please consult the DGUV Information Guide 209-061 on “Use of webbing slings and round slings made of man-made fibres”. The load-bearing capacities given therein relate to general lifting operations (not overhead loads).

2.1.2.1 Round slings made of synthetic fibres

Due to their material properties, round slings made of synthetic fibres may only be used for overhead loads if combined with a secondary safety component that has an adequate load-bearing capacity and is made of metal.

2.1.2.2 Round slings with a wire-rope core

Round slings with a wire-rope core are made of endless grommet with a polyester coating.

Since there are no standards for round slings with a wire-rope core, they are usually not colour-coded in accordance with EN 1492: 2009-05.

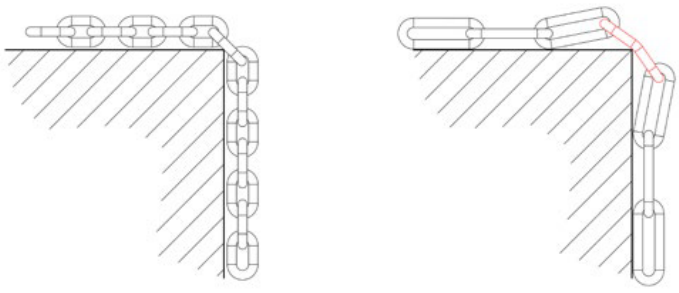
The load-bearing capacity, use, testing and removal-from-service criteria are as specified by the manufacturer.

Users must bear in mind the minimum bend radius specified by the manufacturer.

Preferably, round slings with a wire-rope core that have been tested and certified by an accredited body should be used.

2.1.3 Using chains for attachment purposes

Steel chains are available in many forms and grades. Only short-link round-steel chains (pitch T=3 x d; pitch equal to three times the diameter of a chain link) which have welded chain links and whose quality has been verified are suitable for holding loads in place.



RIGHT WRONG

Fig. 28 and 29: Use of chains on edges

Preferably, grade 8 chain slings (that comply with the EN 818 series of standards) should be used for overhead loads. Higher-grade chain slings are also permitted and bear a manufacturer-specific marking.

Other chains (e.g. hoist chains or lashing chains for securing loads) must not be used as chain slings.

Chain slings are marked at least once per metre with the manufacturer’s stamp and their grade is indicated on a tag.

Chain slings for lifting loads are classified by rated size and marked with the rated chain thickness and the first digit of the stress-at-break figure, e.g. RS 8-8 rated chain thickness 8 mm, stress at break 800 N/mm².

Fig. 30: Manufacturer's chain stamp

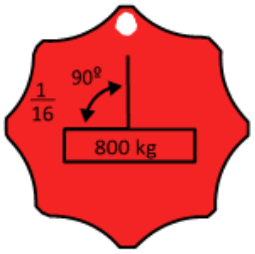


Fig. 31 Tag on a 1-leg 16 mm chain › red = grade 8

Table 5: Load-bearing capacity of chain slings

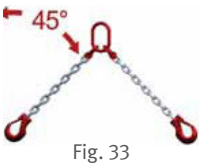
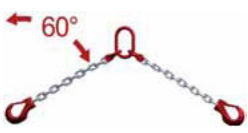
Load-bearing capacity for overhead loads				
Rated chain thickness	Load-bearing capacity WLL	Single leg  Fig. 32	Double leg with symmetric load  Fig. 33  Fig. 34 with inclination angles	
			7° to 45°	45° to 60°
6 mm	1120 kg	560 kg	784 kg	560 kg
8 mm	2000 kg	1000 kg	1400 kg	1000 kg
10 mm	3150 kg	1575 kg	2205 kg	1575 kg

Table 5 takes into account the 30 % decrease in load-bearing capacity when the angle of inclination is between 7° and 45° and the 50 % decrease when the angle is between 45° and 60°. Inclination angles of more than 60° are not permitted under any circumstances.

When calculating the load-bearing capacity of a double leg with a non-symmetrical load, only one leg should be assumed to be carrying the load. If there are more than two legs, only two may be assumed to be carrying the load.

This does not apply if it is ensured that the load is evenly distributed across other legs too. Where a load is unevenly distributed, the permitted load on each leg must not be exceeded.

Shortening clutches for adjusting the chain length are available in various designs. The information for use supplied with the clutch must be strictly adhered to. Shortening clutches may only be used in the intended operating position.

If there is a risk that a shortening clutch might come loose unintentionally, e.g. when the load is changed or in the case of non-vertical installation, only shortening clutches which have safeguards to prevent unintended unhooking may be used.

For special applications, e.g. bridles, long-link chains may be used, in conjunction with a shackle, to adjust the length of a leg, provided the load-bearing capacity of the chains is known.

Use

- Safeguards, e.g. locking bolts on shortening clutches, must be checked before each use to ensure they function properly.
- Chains must not be knotted.
- Chains must be placed around the load's sharp edges in such a way that no chain links are bent.
- Twisted chains must not be used for attaching loads.
- Hoist chains must not be used as chain slings.

Removal from service

Removal-from-service criteria for chains are, for example:

- Wear
- Cracks
- Broken chain link
- Corrosion damage
- Deformation of chain links or chain components

2.2 Load-carrying devices

The load-carrying devices typically used in the field of event technology are:

- Trusses
- Load bars
- Specially constructed load-carrying devices, e.g. for suspending PAs, trusses or image projectors

In the field of event technology, **trusses** are bracing structures, intended for setting up load-bearing structures for mounting luminaires, loudspeakers and similar equipment.

The requirements for selecting, using and inspecting trusses are described in IGVW SQ P1 ("Trusses"). The IGVW quality standards can be found at www.igvw.de.

Structural analyses and/or records of type examinations must be provided for the truss elements used in the field of event technology.

In some cases, these analyses and records may also include specifications for standardised mounting methods. In the case of non-standardised mounting methods, separate analyses must be carried out.

Truss load-bearing capacity is usually calculated in accordance with the requirements set out in Eurocode 0-9, not in line with the principle of a double rated load.

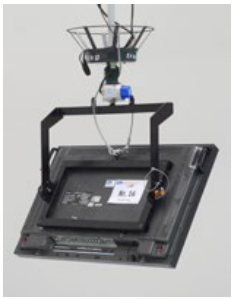
When selecting trusses, it must be ensured that their load-bearing capacity is such that they cannot be overloaded. It makes sense not to utilise the full load-bearing capacity.

Lifting bars are mainly used with scenery battens. They are designed in accordance with DIN 56950-1: 2012-05. Load-bearing capacity details are provided for these types of load bar. They specify the possible total load and permissible line loads as well as maximum point loads. The load-bearing capacity details take into account the higher level of safety described in Section 1. Dynamic forces must also be taken into consideration.

Special-purpose load-carrying devices must be designed in such a way that a positive connection is used to hold the load and the anticipated loads can be held safely.

Special-purpose load-carrying devices must be marked with their load-bearing capacity, type designation, manufacturer and the year of manufacture or a serial number. If proof has been furnished that they are suitable for overhead loads, the load applied can be as specified by the manufacturer. If no proof has been furnished, only half of the load specified by the manufacturer may be applied. If there are no markings on the elements, they must not be used.

Table 6: Special-purpose load-carrying devices in the field of event technology

Load-carrying device	Requirements
Load-carrying device for trusses  Fig. 35	Load-carrying devices especially designed for trusses often consist of a combination of various components. The markings on the components that make up the load-carrying device do not provide any information about the overall load-bearing capacity of the load-carrying device. In the case of load-carrying devices supplied ready for use, the manufacturer must indicate the permitted load-bearing capacity.
Load-carrying devices for sound and lighting systems  Fig. 36	Suspension systems for sound and lighting often comprise a variety of components and load-carrying devices. Only components approved by the manufacturer may be used in such systems. Inherently safe sound and lighting systems and their **inherently safe suspension systems** (e.g. flying frames) do not require any additional anti-fall protection within the system.
Standardised hooks and clamps for luminaires and luminaires as specified in DIN 15560-24: 1996-12 plus fixing element and transition pieces as specified in DIN 15560-25: 1987-01  Fig. 37	Luminaire, base plate, pipe clamp, pivot plug, socket for pivot plug for photo luminaires and reportage luminaires. Rotary base, sockets with fixing screws for suspended luminaires, stand socket, stand support, closed pipe clamp with joint, open pipe clamp, transition pieces. These load-carrying devices have an inherently safe design and are used for loads weighing no more than 60 kg. The portable luminaires which are fixed into place in this way are also secured with a safety rope (see Sections 1.3 and 2.3). **Note** If the additional locking pin is used when fixing a luminaire with a ZC pivot plug and a HB socket with fixing screw, a secondary safety component is not required.
Load-carrying devices not manufactured in accordance with a standard  Fig. 38	Examples of load-carrying devices not manufactured in accordance with a standard are hooks and clamps for luminaires and projector or monitor brackets. They must be designed in accordance with the essential safety requirements and have an inherently safe load-bearing capacity (see Sections 1.1 and 1.2). The information for use supplied by the manufacturer must be adhered to.

2.3 Safety elements

A safety element (secondary safety component or second independent safeguard) usually consists of a wire rope, rope termination and quick link. In certain special cases, round-steel chains are used. It is preferable to use quick links of the type which are attached to the safety rope or chain in such a way that they cannot be lost. In principle, safety ropes and chains and rope terminations are subject to the same requirements and conditions of use as those described in Sections 1.1 to 1.3.

The following requirements also apply:
- A safety rope is made of a wire rope manufactured in accordance with EN 12385-4: 2008-06 with a rated wire strength of at least 1770 N/mm². The following requirements are based on this rope grade (see also DIN 56927: 2013-07). Wire ropes with a different rated strength and different materials must be separately assessed.
- Rope terminations for safety ropes must comply with EN 13411-3: 2011-04

The load-bearing capacity of the elements must be calculated in such a way that the dynamic forces which occur when the load is absorbed are taken into account.

Both safety ropes without a shock absorber and safety ropes with a shock absorber can be used as secondary safety components.

Load-bearing capacity of the safety element
When a load is arrested by the safety element, the rope is subjected to a shock. This can cause damage to elements in the load path, e.g. the safety rope, the securing eye on the luminaire, the load-attachment point on the building structure or the ropes carrying the barrel hoists. The weakest component of the secondary safety component determines the load-bearing capacity required for the overall secondary safety component.

Fig. 39: Example marking

Marking

Since safety ropes are not considered attachment gear within the meaning of the Machinery Directive, they cannot have a CE mark. Consequently, the manufacturer must affix a mark to them in accordance with the legal requirements (German Product Safety Act (“Produktsicherheitsgesetz”)). The maximum permitted mass that can be secured and the rope diameter must also be indicated.

Rope slings within the meaning of the Machinery Directive may be used as safety ropes.

Maximum permitted weight for which the safety rope or safety chain is designed to secure loads in the event of them falling
Individual elements, e.g. quick links or ferrules, can have their own specific load-bearing capacity information (the WLL, for example) marked on them. This information usually refers to scenarios in which loads are lifted. It does not describe the maximum permitted weight for which the safety rope or safety chain is designed to secure loads in the event of them falling.

2.3.1 Safety ropes without a shock absorber

Safety ropes without a shock absorber must be selected based on the criteria shown in Table 7.

The dimensions given in Table 8 are based on the specifications in DIN 56927: 2013-07. In addition, the testing method described in the Annex to DIN 56927: 2013-07 can be used to verify whether the dimensions of safety ropes are correct.

Table 7: Safety ropes used as secondary safety components

Rope diameter for rope type 6 x 19 M with a rated strength of 1770 N/mm² [mm]	Quick-link diameter as specified in DIN 56927: 2013-07 [mm] Fig. 40 	Maximum mass that can be secured with safety rope in the event of falls from a height of 20 cm max.	
		Length 0.6 m [kg]	Length 1.0 m or longer [kg]
3	4	5	9
4	4	10	16
5	5	15	25
6	6	22	36
8	8	40	64
10	10	62	100

The values shown in the table above have been calculated on the basis of DIN 56927: 2013-07.

The specifications in DIN 56927: 2013-07 give different dimensions for the one-leg and two-leg securing methods. However, the differences are so small that this differentiation is not important in practice.

If connection elements other than those listed in the table are used, it must be ensured that
- their breaking strength is at least equal to the rated breaking strength specified in DIN 56927: 2013-07. Sufficient load-bearing capacity can be calculated by multiplying the weight of the mass to be secured by factor 78 for a 0.6 m rope length or factor 48 for a rope length of 1.0 m and
- they are secured so as to prevent them loosening of their own accord.

For larger loads or where round-steel chains are used as safety elements, separate calculations must be carried out to determine the required load-bearing capacity, taking into account the drop movement. It must be ensured that the foreseeable drop distance of the load being secured is as short as possible. This is best achieved using chains that can be shortened.

2.3.2 Safety ropes with a shock absorber

As an alternative to the safety ropes described in Table 8, safety ropes fitted with a shock absorber can be used.

Safety ropes with a shock absorber can significantly reduce the shock that occurs when a load is arrested by the safety element. It is for this reason that safety ropes with a shock absorber have a smaller cross-section than safety ropes without a shock absorber.

Another advantage is the reduced load exerted on all of the elements in the load path (e.g. the suspension point, quick link and the securing eye on the load) in the event of a fault.

For the safety rope as a whole to function safely, it is crucial that the shock absorber is reliable. Consequently, the shock absorber's design plays an extremely important role. Safety ropes with a shock absorber must be manufactured in a quality-assured production facility and be type-examined.

Fig. 41: Example of a safety rope fitted with a shock absorber

2.3.3 Use of safety elements

Safety elements (or “safeties”) must be attached in such a way that there is no drop. Where that is not possible, the drop must be kept to a minimum.

In the case of work equipment that has to have its position adjusted after it has been installed, e.g. luminaires, the maximum permitted drop is 20 cm. This is true irrespective of how the equipment has been fixed into place.

The safety element must be attached to the fixing point defined by the manufacturer, e.g. the equipment’s eye or bow. The manufacturer should label the fixing point with, for example, a special colour or a pictogram. Safety elements must not be attached to parts of a piece of equipment which are not suitable for that purpose (handles, for instance).

Where quick links are used, safe functioning can only be achieved by ensuring the screw joint is completely closed and fastened finger-tight.

Ropes or webbings made of natural or man-made fibres must not be used as safety elements because they do not provide sufficient safety when subjected to thermal influences (such as those created by luminaires) or in the event of fire.

A safety element which has already been used to absorb a falling load or is visibly damaged must be removed from service.

Fig. 42: Example sign for the fixing point for a safety element

2.4 Exceptional loads

Examples of exceptional loads in the event industry include:
- PA systems
- Lighting and special effect systems
- LED walls
- Mirror balls
- Specially-built objects
- Acoustic sails
- Decorations

In principle, loads are not subject to the Machinery Directive or the working coefficients specified therein (see Table 1) because they are not part of load-carrying devices, attachment gear or lifting equipment. Nonetheless, the loads and the structures supporting them have to absorb safely any loads exerted on them. Calculation and design should be based on good engineering practice, as outlined in, for example:
- Eurocode 3/EN 1993-1-1:2010-12
- Eurocode 5/EN 1995-1-1:2010-12
- Eurocode 9/EN 1999-1-1:2014-03

In addition, the design requirements set out in Section 1.1 apply to loads and their supporting structures.

Fig. 43: PA systems mounted in a curved position

Fig. 44: LED decoration

When selecting supporting structures, the permitted operating conditions (indoors or outdoors) must be taken into account.

In the case of loads that are susceptible to wind damage, e.g. modular LED walls, decorations or PA arrays, the following information is required in particular:

- Max. wind speed and wind pressure
- Suspension heights
- Module set-ups (max. number of modules vertical and horizontal)
- Positioning and number of necessary fixings
- Weather event action plan (see also IGVW SQP5)

This information should be presented in a clearly structured form (e.g. table, selection matrix).

The design and manufacture of the supporting structures selected must be state of the art. The structures must be capable of safely absorbing and transmitting all loads that occur.

If software-based programs are used to calculate the dimensions of supporting structures, the program used must be suitable for the required calculations. The key details of the software, e.g. the version used, assumptions made, program settings and data entered, must be documented. It must be ensured that the persons using the software have the necessary skills. The results of this type of calculation method need to be assessed by experienced, qualified engineers or persons with comparable expertise. It is the employer's (or customer's) responsibility to ensure that the necessary expertise is available in all of the steps in the work processes.

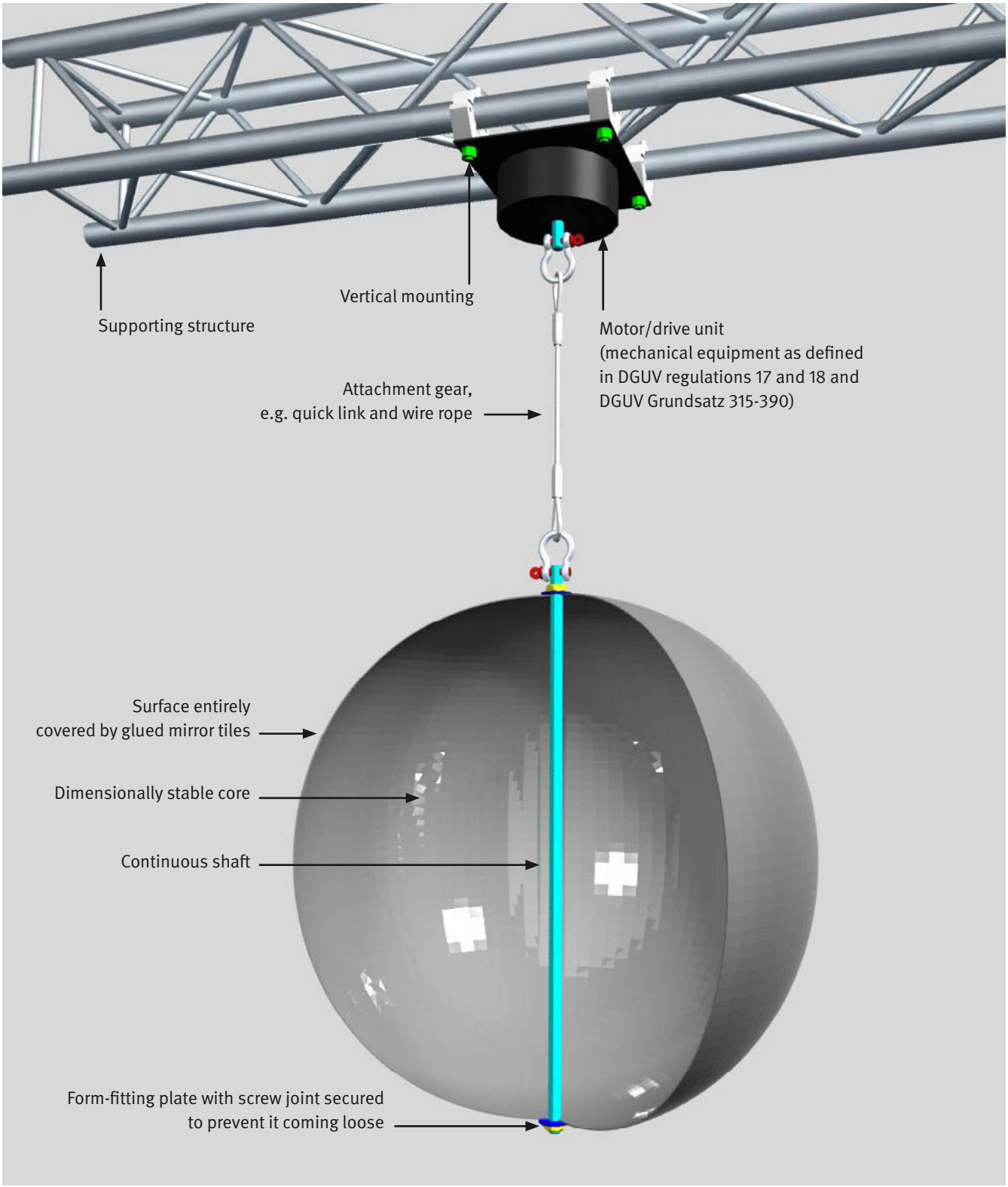


Fig. 45: Inherently safe mirror ball system

Example: Mirror ball systems

Mirror ball systems (i.e. the mirror ball, drive and mounting device) must comply with the essential safety requirements set out in Section 1. Their design should be inherently safe. See Fig. 45 for further details.

Use

Mirror ball systems must be suspended out of people's reach and at a safe distance to other objects. If they are not inherently safe, the principle of single-fault tolerance must be applied. This can be done, for instance, by using an arrester.

Mirror ball drives are classified as mechanical equipment. The essential testing requirements for mechanical equipment for the event and production industry are set out in DGUV regulations 17 and 18 "Staging and production facilities for the entertainment industry" and DGUV Grundsatz 315-390 BGG/GUV-G 912 "Principles regarding testing of mechanical equipment in theatres and studios". In particular, this means that the motor/drive unit must have a positive connection in the direction of force.

3 Inspection

The safety of any work equipment used must be maintained. Inspections can detect any damage in good time so that action can be decided on and taken. The factors causing the damage can be identified and assessed by means of a risk assessment by a competent person, taking into account the specific mode of use.

Before each use, the work equipment must be subjected to a visual check and, if applicable, a functional check by an instructed person who has been assigned to the task by the employer.

Work equipment should be inspected at least once a year by a person appointed by the employer, e.g. a qualified person. Depending on the conditions of use, additional inspections may be necessary. This may also be the case in the event of extraordinary circumstances. In addition, every three years, chains used in industrial applications must undergo non-destructive crack testing.

The inspections must cover the following as a minimum:
- visible damage and wear,
- proper functioning,
- safeness for use and
- legibility of markings.

If the inspections reveal defects detrimental to safety or if it is no longer possible to identify the markings clearly, the work equipment must be removed from service.

The inspection records must correspond to the type and scope of inspection. There is no obligation to keep a record of the visual and functional checks performed on the individual pieces of work equipment before use.

The building operator is responsible for ensuring that building structures are inspected.

Annex 1

Protection objectives and their legal basis

The act of holding overhead loads in place constitutes a special hazard, requiring special care. The compulsory protection objectives relating to the safety of the persons involved and those present are defined in laws, ordinances and the regulations issued by the social accident insurance institutions.

Minimum requirements concerning the use of work equipment for lifting loads are set out, on the basis of the Occupational Safety and Health Act ("Arbeitsschutzgesetz"), in the Ordinance on Industrial Safety and Health ("Betriebssicherheitsverordnung") and the Workplaces Ordinance ("Arbeitsstättenverordnung").

Ordinance on Industrial Safety and Health Act (Betriebssicherheitsverordnung), Annex 1, Item 2 (extract)

Special rules for the use of work equipment for lifting loads
The employer must ensure the permanent stability and strength of load-lifting work equipment, its load-bearing devices and any removable parts. This includes taking into account any special factors such as weather, transport, erection/dismantling, potential failures and planned inspections (including under test load).

If the risk assessment indicates a necessity to do so, the employer must furnish work equipment with a device that prevents the **permitted load-bearing capacity being exceeded**. The loads exerted on the **suspension or anchor points** of the supporting parts must also be taken into account.

Removable and mobile load-lifting work equipment must be set up and used in such a way as to ensure the stability of the work equipment and prevent it tipping, moving or slipping. The employer must ensure that **a specially instructed employee** checks that the measures have been implemented correctly.

The employer must ensure that load-lifting work equipment bears a clearly-visible indication of the **permitted load-bearing capacity.** If there are various possible operating modes, the permitted load-bearing capacity for each one must be indicated. Load-bearing devices must be marked in a way that shows the properties that are essential for safe use.

The employer must **take measures to prevent** loads
- accidentally moving in such a way as to cause danger, falling or
- becoming accidentally unhooked.

If it is not possible to prevent people from being present in the danger zone, it must be ensured that **movement-control devices automatically return to the zero position** after use and that the initiated movement is immediately stopped.

Employees who operate load-lifting work equipment controlled from the ground level must be able to control it at all times even **at maximum speed**.

The employer must ensure that load-lifting work equipment can be stopped during lifting, travel and rotating movements and that it can be prevented from **moving unintentionally**.

Power-operated **lifting movements** by load-lifting work equipment **must be limited**. Rail tracks must be equipped with barriers.

If there is a risk that the use of load-lifting work equipment could put employees in danger and if the control device is not located near the load, the work equipment must be fitted with **warning devices**.

The **kickback from control devices** for manually-operated load-lifting work equipment must be limited.

The employer must ensure that
- employees are not put in danger by suspended loads, particularly that **suspended loads are not moved above unprotected areas** where employees are usually present;
- loads are **attached securely;**
- loads, load-carrying devices and attachment gear cannot **come lose or move unintentionally;**
- **adequate information** is available to employees who use load-bearing elements and attachment gear about the properties of such elements and gear and the applications for which they are permitted;
- attachment-gear **connections** are **clearly marked** if they are not disconnected after use;
- **load-carrying devices and attachment gear** are **selected** in accordance with the loads to be handled, gripping points, attachment tackle, weather conditions and attachment method; and
- loads are **not** guided above unprotected employees with load-bearing elements that provide **a non-positive connection**.

Load-carrying devices and attachment gear must be **stored** in such a way that it cannot be damaged nor its functionality impaired.

Special rules for the use of work equipment for lifting non-guided loads

If there is an overlap between the working radii of work equipment for lifting non-guided loads, suitable measures must be taken to prevent hazards caused by **collisions between pieces of work equipment.** In addition, suitable measures must be taken to prevent the risk of collision between employees and non-guided loads.

Suitable measures must be taken to prevent employees being put in danger by **falling non-guided** loads. If the employee who is controlling the work equipment for lifting non-guided loads is unable to observe (either directly or using additional devices) the load throughout the entire path of travel, said employee must be **given instructions** by another employee.

The employer must ensure that
- non-guided loads can be **safely attached and detached by hand**,
- the employees can directly or indirectly **control** the lifting and transport process,
- all lifting processes with non-guided loads are planned and carried out in such a way as to ensure the employees' safety. If a non-guided load is to be **lifted simultaneously by two or more pieces of work equipment,** a procedure must be put in place and monitored to ensure the employees work together safely,
- all work equipment used for lifting non-guided loads is able to hold the loads safely even in the event of a partial or full **power failure**; if this is not possible, suitable measures must be taken to ensure the employees' safety. Suspended non-guided loads must be supervised at all times unless access to the danger zone is prevented and the load has been safely suspended and is held in place safely,
- outdoor use of work equipment for lifting non-guided loads is stopped if the **weather conditions** jeopardise its safe use, and
- the **measures specified by the manufacturer** of the work equipment for lifting non-guided loads are implemented, particularly the measures to prevent the work equipment from tipping over.

Workplaces Ordinance, Annex 1, Item 2.1

Protection against falls from a height and falling objects, access to danger zones
Workplaces and traffic routes where there is a risk of employees falling from a height or objects falling or which are located adjacent to hazard zones must be fitted with devices which prevent employees falling from a height or being injured by falling objects or entering hazard zones. Workplaces and traffic routes of the type described in sentence 1 must be secured against unauthorised access and clearly marked as hazard zones. Suitable measures must be taken to protect persons who have to access such zones.

These rules thus require suitable measures to be taken when employees are present below suspended loads. To reduce the risk of falls from a height, the design and load-bearing capacity of the work equipment have to meet higher-than-normal safety requirements to provide protection against failure on the part of the suspension systems.

The required increase in safety is determined by assessing the requirements concerning the design and operation of cranes and lifting equipment. However, persons are not intended to be present below the loads in such cases. One of the ways in which safety is ensured in those cases is to define working coefficients for machinery. Working coefficients are also specified for other work equipment, e.g. wire ropes, chains and trusses, in technical rules.

For overhead loads, the working **coefficient is doubled,** in accordance with the specifications in Directive 2006/42/EC (Machinery Directive), Annex 1, Item 6.1.1, concerning the lifting of persons.

Directive 2006/42/EC (Machinery Directive), Annex 1, 6.1.1 (extract)

The working coefficients for components set out in sections 4.1.2.4 and 4.1.2.5 are inadequate for machinery intended for the lifting of persons and must, as a general rule, be doubled.

Staging and Production Facilities for the Entertainment Industry DGUV regulations 17 and 18

DGUV regulations 17 and 18 on “Staging and Production Facilities for the Entertainment Industry” (“Veranstaltungs- und Produktionsstätten für szenische Darstellung”) contain protection objectives, taking into account special hazards in staging and production facilities for the entertainment industry, for the following:

- movements (e.g. scenery hoists moved for staging reasons),
- inadvertent movements (e.g. loads falling from a height) and
- falling objects (e.g. breaks in suspension systems).

The above protection objectives are achieved by various methods, including higher load-bearing capacity and suitable material properties or additional securing of work equipment.

- In the case of load-bearing equipment and attachment gear, the higher level of safety is achieved by doubling the working coefficients (see DGUV Rule 115-002 on “Staging and production facilities for the entertainment industry”).
- Portable suspended equipment (e.g. luminaires, projection equipment and PA systems) must be secured from falling by two devices which act independently of one another (see Section 7, Subsection 6, DGUV regulations 17 and 18).
- The equipment must be installed and used by specially-qualified workers.
- Inspections are required in order to guarantee that the equipment remains in a safe condition permanently.

Annex 2

Technical rules which contain safety requirements

The technical implementation of the protection objectives described in Section 1 is done by, for instance, applying event technology standards relating to work equipment.

- TRBS 2111: 2014-03 “Mechanical hazards – General requirements” Protective measures against unintended movement and changed position of work equipment, parts thereof or objects being worked on
  - positive-connection (“form-fitting”/“form-locking”) holding devices, clamps, fixing devices or limit stops
  - work equipment with adequate structural stability, i.e. the various parts of the work equipment and the connections between them must be able to withstand the loads from internal forces and external loads. DIN 56950-1: 2012-05 “Entertainment technology – Machinery installations – Safety requirements and inspections” contains requirements for all structural components and load-bearing equipment. The dimensions of the supporting structures between the fixture for the machinery installation and the termination of the load-bearing equipment must be calculated using a double rated load.
- TRBS 1203: 2019-03 “Persons qualified for testing”
- DIN 56950-2: 2014-09 “Entertainment technology – Machinery installations – Safety requirements for studio hoists” requires two pieces of load-bearing equipment per suspension point, which must be set up in such a way that the tensile force of each rope provides at least tenfold safety (i.e. ten times the minimum breaking strength) when subjected to the rated load.
- Series of standards
  - EN 13411 “Terminations for steel wire ropes – Safety”
  - EN 13411-1: 2009-02 “Thimbles for steel wire rope slings”
  - EN 13411-2: 2009-02 “Splicing of eyes for wire rope slings”
  - EN 13411-3: 2011-04 “Ferrules and ferrule-securing”
  - EN 13411-4: 2011-06 “Metal and resin socketing”
  - EN 13411-6: 2009-04 “Asymmetric wedge socket”
  - EN 13411-7: 2009-04: “Symmetric wedge socket”

Buyers who order products specified to this standard are recommended to specify in the purchase contract that the manufacturer must operate a quality assurance system. The aim of this measure is to ensure that products which are claimed to be standard-compliant do actually have the required level of quality.

- DIN 56927: 2013-07 “Safety rope to secure objects up to 60 kg dead weight” defines dimensions, safety requirements and criteria for a test for safety ropes which are used to provide protection against falling portable objects.
- DIN VDE 0100 Part 718: 2014-06 (IEC 60364-7-718) “Low-voltage electrical installations – Part 7-718: Requirements for special installations or locations - Communal facilities and workplaces” contains the following requirements: Freely suspended equipment with a mass of over 5 kg must be secured by means of an additional, independent fixture. Each independent fixture must be designed to hold the total mass itself with a safety factor of 5:1.
- DIN VDE 0711-1: 2016-04 (EN 60598-1) “Luminaires – Part 1: General requirements and tests”: The mounting devices for suspended luminaires and fixed-position ceiling-mounted or wall-mounted luminaires must be designed to withstand a test load of five times the self-weight of the complete luminaire (no component deformation under test load).
- DIN VDE 0868-1: 2016-05 (DIN EN 62368-1) “Audio/video, information and communication technology equipment – Part 1: Safety requirements”: Specifies requirements for wall-mounting or ceiling mounting devices for equipment that is to be mounted at a height of over 2m or has a mass of more than 1kg. These mounting devices must withstand a defined test force whilst remaining mechanically intact. The test force corresponds to four times the weight of the piece of equipment or the weight of the equipment plus 880N, depending on which is the lower value.
- Eurocode 0: Basis of structural design, DIN EN 1990: 2010-12 (and national annex)
- Eurocode 1: Actions on structures, DIN EN 1991-1-1: 2010-12 (series and annexes)
- Eurocode 3: Design of steel structures: DIN EN 1993-1-1: 2010-12 (series and national annexes)
- Eurocode 5: Design of timber structures, DIN EN 1995-1-1: 2010-12 (series and national annexes) and DIN 1052-10: 2012-05, Part 10 Additional provisions
- Eurocode 9: Design of aluminium structures, DIN EN 1999-1-1: 2014-03 (series and national annexes)

The requirements concerning the specialist knowledge needed by individuals who are assigned the task of inspecting work equipment are set out in the Ordinance on Industrial Safety and Health (“Betriebssicherheitsverordnung”. More specific details are provided in the TRBS technical rules on industrial safety.

Annex 3

Terminology

To help explain the terminology, the following diagram shows all parts in the load path:

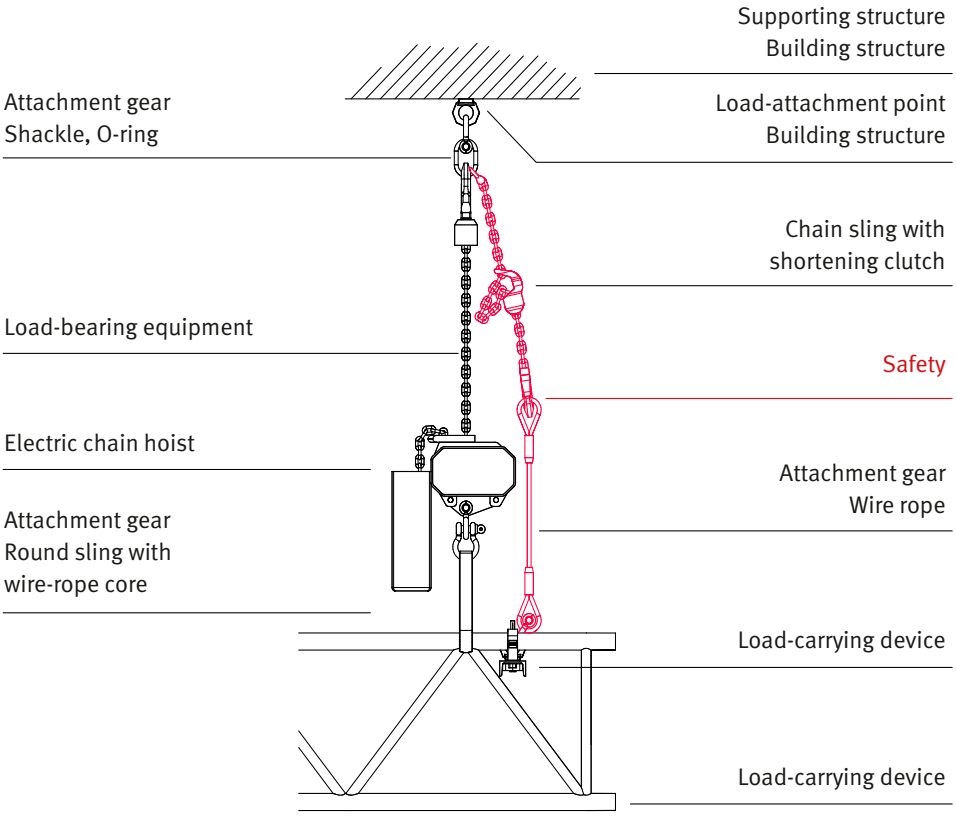


Fig. 46: Parts in the load path

Removal from service

“Ready for removal from service” means that the attachment gear is damaged so severely that it must not be re-used.

Attachment gear

A device that connects the supporting structure and the load-bearing equipment, the load-bearing equipment and the load or the load-bearing equipment and the load-carrying device.

Work equipment

For the purposes of this Information Guide, the term “work equipment” is defined as equipment that acts as a load-bearing element in the process of holding overhead loads in place.

Working coefficient

The term “working coefficient” replaces the old term “factor of safety”/“safety factor”.

Put simply, the working coefficient is the ratio between the size of the load which is just slightly too much for the machine or element to hold (breaking strength) and the rated load of the machine or element. Working coefficients for the safe use of technical products, such as wire ropes, chains, trusses and clamps, are defined in Annex 1 of the Machinery Directive and in standards for lifting gear and cranes (see Directive 2006/42/EC – Machinery Directive – Annex 1, Item 4.1.1.)

Bridle

Attachment method using multiple legs with flexible attachment gear in order to create attachment points on supporting structures in buildings or to distribute loads across load-carrying devices (trusses).

Inherently safe design
A piece of work equipment is deemed to have an inherently safe design if its design features have been specifically selected to prevent hazards and reduce risks (see EN ISO 12100: 2011-03).

Eurocode
Series of European standards for the structural design of buildings and other civil engineering works.

Positive ("form-fitting"/"form-locking") connections
Positive connections are created by at least two interlocking elements. The holding or load-bearing capacity is determined solely by the design and stability of the elements. Pin connections, e.g. trailer couplings, are typical examples.

Adequate risk reduction
Risk reduction which reflects the state of the art and at least meets the legal requirements (see DIN EN ISO 12100: 2011-03).

Non-positive connections
Non-positive connections are the result of the effect of pressure and friction within the connection system. The holding or load-bearing capacity depends on the initial tension, the shape and the material properties of the connection elements. A typical example is a clamp connection.

Load-bearing device
Consists of the lifting gear, load-carrying device and/or attachment gear.

Load-carrying device
A "load-carrying device" is a component or piece of equipment which is not part of the lifting gear, enables loads to be held and is attached between the machine and the load or to the load itself, or which is intended to be an integral part of the load and is placed on the market separately.

Overhead loads
"Overhead loads" is a generic term, covering the suspension of loads and all other processes for which terms such as attachment, lifting or carrying of loads are also used.
Measures to hold loads safely are intended to prevent both the load-carrying devices and the actual load from falling.

Load-bearing capacity
The maximum load that a piece of work equipment can bear when used as intended, without dynamic forces being taken into account (see DIN 56950-1: 2012-05).

Load-bearing equipment
Device (e.g. a chain, wire rope or steel band) permanently connected to a piece of lifting gear and used to carry load-carrying devices, attachment gear or loads.

Working Load Limit (WLL)
The international term used to describe the load-bearing capacity of attachment gear for industrial lifting purposes. The WLL is given either in kilograms (kg) or tons (t).

It is calculated by taking the minimum breaking strength of the attachment gear and dividing it by the working coefficient. In some cases, reduction factors, e.g. for the rope terminations, may be taken into account too.

Where attachment gear is used to hold overhead loads in place, the load applied to it must not exceed half of the WLL.

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