



**Industrieverband**  
Gitterroste



# THE GRATINGS MANUAL



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# Preface



## Arguments for gratings

Gratings meet high technical and design-related demands. Gratings are innovative by virtue of the very wide range of different ways in which they can be used. In addition many areas of application have not yet been realised and await the creativity of architects.

## Advantages at a glance

- Prefabricated elements that can be mounted easily
- Slip-resistant surface
- Fluids and dirt cannot form surface deposits
- High load-bearing capacity in combination with low self-weight; size, shape and colour able to be selected flexibly
- Good transmission of light and air
- Visual uniformity offering innumerable opportunities for aesthetic concepts
- Infinite number of opportunities for use: catwalks, landings, bridges, stairs, balconies, guard rails, shelves, lightwells, facade elements, sight and sun screens, claddings for ceilings and roofs and many, many more.
- Resource-friendly, long-lasting and economically efficient.

## Accordingly: gratings

Gratings permit innovative solutions through their ability to be used in so many different ways; virtually no limits are placed on the architect's creativity. To match this opportunity for design freedom, the members of the Industrieverband Gitterroste e.V. (IGI) (Grating Manufacturers Industrial Association) offer their products in exactly the form desired by the customer - with bearing bars of different heights and variations in the mesh size - practically everything is possible. In addition association members offer first-class technical advice right from the beginning, the very highest product quality and delivery reliability.

The Industrieverband Gitterroste e.V. (IGI) (Grating Manufacturers Industrial Association) is made up of the leading German and European manufacturers and these firms have also participated in the preparation of the RAL-GZ 638 quality assurance. Clearly defined in this are the stringent requirements in respect of quality to be met by gratings. Maintenance of these requirements is ensured by continuous monitoring by independent test institutes.

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# CHAPTER 1

## Introduction



## 1. Introduction

To trace the history of the development of gratings back to the time of Roman Empire would be certainly overdoing things. Nevertheless it is worth taking a look at coverings and deckings over the course of history. The Romans held the leading position in the paving of roads for the Roman highway system. Here of course it was stones that were placed one after another. But the desired objective was achieved, namely that goods could be transported regardless of the weather.

Later trade often continued to flow along the Roman roads because trade requires that the highways are reliably passable.

### The history of gratings

Over the course of time the coverings of highways and floors were matched ever more precisely to the particular requirements and the Roman system of stone paving became totally superseded. Coverings were required no longer just for roads for trade and the passage of goods. In particular within the framework of industrialization the requirements to be met by coverings and floorings, e.g. for production areas, factories etc. and finally - in our time today - for office and residential areas (in general the „public area“), became ever more specific.

With this specialization the serviceability limit state (fitness for purpose) came centre stage in the planning. The requirements in terms of serviceability limit state and price became more exacting and in addition were linked with one another to a greater extent. Thus today a factory, a market place or an office building gets precisely the floor or other covering that is most appropriate.



And precisely here is where the innovation of the grating starts. A functional, very variable and extremely hard-wearing and resilient covering or flooring that can be precisely matched to the particular requirements. Thus there are naturally very good reasons why gratings are to be found in factories and machine facilities as well as also on/in buildings where the design needs this effective covering. For example gratings are frequently used for escape and rescue paths. But these examples should not give the impression that the development of gratings and of their applications has been completed. On the contrary gratings are enjoying increasing popularity with architects who are using them as design elements.

This manual brings together the knowledge and experience of all the members of the Industrieverband Gitterroste e.V. (IGI) (Grating Manufacturers Industrial Association) and is aimed at facilitating the selection of gratings and deciding on their use - in all their different facets. Furthermore it provides useful background information. In addition to the technical fundamentals, it provides tips and tricks on the correct and appropriate use of gratings.

We are certain that this gratings manual will help you.



## 1.1 What precisely is a grating?

Gratings are self-supporting, panel-shaped bodies with a large number of open-ended, regularly-arranged openings; gratings are designed for particular loadings (e.g. so that they can be walked on or driven over). Gratings are used in industry, in storage facilities and road construction as well as in all areas of structural and civil engineering, in each case in a very wide range of forms and types.

In modern residential and real-estate architecture gratings solve important functional and design-related tasks; thus, for example, they are used for facades and for covering ventilation shafts and lightwells as well as for surface drainage systems, grating-type floorings, convector covers able to be walked over, balcony guard rails and design elements.

Every grating is made up of bearing bars, cross bars and bandings.

### Types of grating

As a rule gratings are classified as forge-welded gratings, pressure-locked gratings and interlocked gratings.

## 1.2 Forge-welded gratings

Forge-welded gratings consist of bearing bars, cross bars and bandings. The bearing bars and cross bars are arranged at right angles to one another. The cross bars, which are generally twisted square-bar steel, are pressed into the bearing bars and welded homogeneously at each intersection. Forge-welded gratings are generally manufactured of steel but in individual cases also of stainless steel.

## 1.3 Pressure-locked gratings

Pressure-locked gratings consist of bearing bars, cross bars and bandings, the bearing bars and cross bars being arranged at right angles to one another. As a rule the height of the cross bars is less than that of the bearing bars. The unweakened cross bars are pressed into slots in the bearing bars.

For special cases of application (e.g. with architectural or anti-glare requirements) pressure-locked gratings, in which the height of the cross bars is the same as or greater than that of the bearing bars, are manufactured. These gratings are termed full-cell gratings. In these cases both the bearing bars and the cross bars have slots. Different angles of inclination of the cross bars can be selected. As a rule pressure-locked gratings are manufactured of steel, stainless steel or aluminium.

## 1.4 Slotted gratings

With slotted gratings either the bearing bars or the bearing bars and the cross bars are slotted. Rigid intersections can be created by positive locking produced by compression deformation, friction locking or jamming and/or by welding. As a rule slotted gratings are manufactured of steel, stainless steel or aluminium.

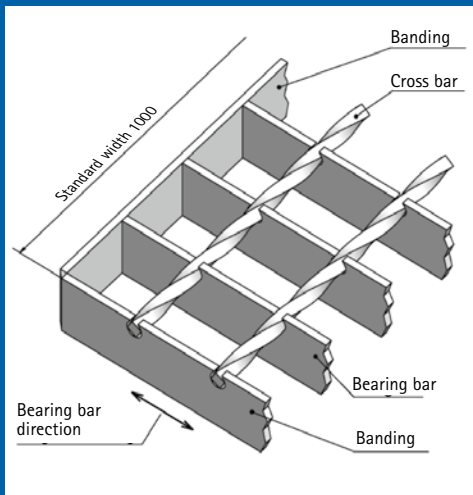


Fig. 1: Forge-welded grating, type SP

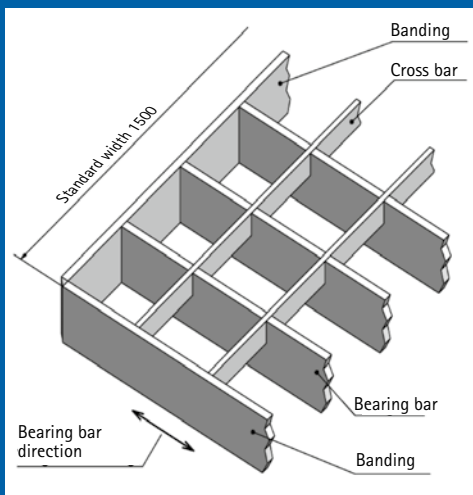


Fig. 2: Pressure-locked grating

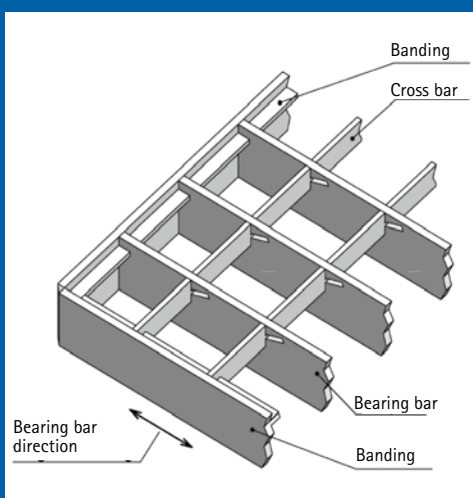


Fig. 3: Slotted grating



## 1.5 Surface

The future use for or the purpose to which a grating is to be put have a decisive influence on the surface to be selected for a grating. The surface of a grating will vary in accordance with the surface treatment selected whereby account must be taken of the base material.

Table 1: Composition of the surface

Grating material	Steel	Stainless steel	Aluminium
Crude <sup>1</sup>	✓	✓	✓
Hot-dip galvanized	✓		
Coated <sup>2</sup>	✓		
Pickled		✓	✓
Electrochemically polished		✓	
Colour-coated <sup>3</sup>	✓	✓	✓
Anodized			✓

1: untreated

2: bituminized

3: as a rule powder-coated or with a painted coating



*In other words the composition of the surface depends on the material of the grating.*

# CHAPTER 2

## Requirements



## 2. Requirements to be met by gratings

Attention must be paid to the proper selection of the grating as early as the planning of work areas and/or traffic paths (e.g. catwalks, stairs, pit covers). If they are to be selected properly, it is essential that account is taken of all the requirements the gratings should fulfil when they have been mounted in the particular situation where they are needed. To aid in ensuring that planning is carried out correctly, the decisive terms are clarified below. These provide the well-founded basis and planning security permitting the correct grating to be selected.

### 2.1 Pitch / mesh size / openings with gratings

#### Pitch

With pitch one designates the distance from the centre of one bearing bar to the centre of the next one and the centre of one cross bar to the centre of the next cross bar.

#### Mesh size

The mesh size results from the pitch of the grating and the thickness of the bars used and describes the dimensions of the openings.

#### Openings with gratings

There are dimensional limits for the mesh size which take account of the following factors:

- Ability of the grating to be walked over safely
- Ability of the grating to be driven over safely
- Size of objects which should be prevented from falling through
- Transmission of light, air, fluids, dirt, precipitation
- Psychological effect when a grating is employed at a considerable height (e.g. the view downwards)

Over the course of time pitches of 33 x 33 mm with pressure-locked gratings and 34 x 38 mm with forge-welded gratings have established themselves and these pitches are also laid down as standard values in DIN 24357-1.

#### Worldwide ...

In particular for work platforms and catwalks the selection of a covering with openings depends on the evaluation of the particular risk:

- The maximum size of the openings in the covering of a work platform or catwalk must be such that a spherical object with a diameter of 35 mm cannot fall through.
- The maximum size of the openings in a covering under which there are places where persons work must be such that a spherical object with a diameter of 20 mm cannot fall through unless the same degree of protection is provided by other measures.

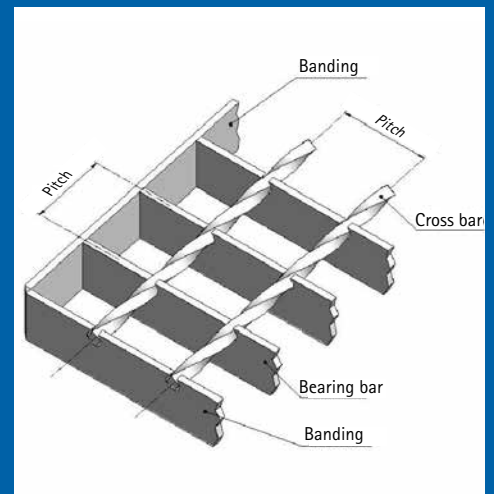


Fig. 4: Pitch with a forge-welded grating (centre bearing bar to centre bearing bar)

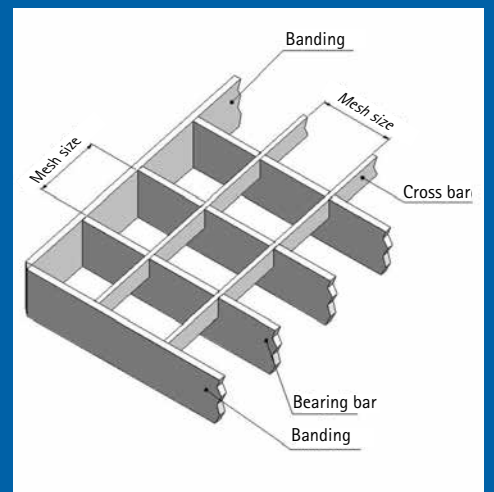


Fig. 5: Mesh size with a pressure-locked grating (dimensions of opening)

## *In Germany ...*

### Openings with gratings in traffic paths

Holding good in Germany is the rule that the mesh size of gratings, that should be installed on public traffic paths (e.g. in front of the entrances to generally accessible buildings or in front of shop-windows), must be kept small. For such areas gratings are required, the mesh size of which in one direction is not greater than 10 mm in order to avoid the risk of a pedestrian stumbling through his/her shoe heel becoming stuck.

### Openings in gratings used, for example, for bulk goods

Gratings, through which bulk goods should be able to pass but which persons should be able to walk over, i.e. conveyors etc., must be manufactured in such a way that the sizes of the meshes or openings are not greater than 60 x 60 mm (square shape) or 120 x 40 mm (rectangular shape).

### Openings in gratings used for work platforms

When gratings are used on work platforms - and the approaches to these - the pitch may not be greater than 34 x 50 mm with forge-welded gratings or 33 x 55 mm with pressure-locked gratings in so far as none of the conditions named in the previous paragraph apply.

## 2.2 Design loads

The load-bearing capacity of a grating is influenced to a significant extent by a variety of factors. Each grating must be able to transmit the load it is expected to carry in a reliable manner to the substructure. The height of the grating bars and the grating pitch (design determination) are decisive for the load-bearing capacity of a grating of a particular material while the tensile strength of the material used for a particular grating also affects the grating's load-bearing capacity.

The design load for a grating is an important component when calculating the load-bearing capacity of the grating.

In addition the types of load to be expected in each case have to be taken into account as early as the planning of the load-bearing capacity. In addition to the normal loading to be expected, account must also be taken of greater loads which may occur only briefly, e.g. braking loads or dynamic loads.

In addition particular types of grating can lead to a reduction in the load-bearing capacity (see also 2.3).

With gratings the bearing bars of which have surface notches in their walked-over side (to increase slip resistance), the reduction of the cross-section of the bars and of the section modulus brought about by the notches must be taken into account when calculating the load-bearing capacity.

**!** *Fundamentally the following holds good:  
The higher the bearing bars and the closer the pitch, the greater the load-bearing capacity will be*



Fig. 6: Load and loading types

## 2.3 Load and loading types

It is important that the load-bearing capacity of a grating is observed (see also 2.2).

As a rule the following different types of loading have to be taken into account:

- Uniformly distributed live load
- Stationary, ambulant or rolling individual loads

The loads can occur statically or dynamically!

For the calculation of the braking loads the wheel loads are to be multiplied where appropriate with the factor  $\varphi = 1.4$  or  $2.0$ .

Apertures in gratings, e.g. as made so that pipes can pass through, bring about a local reduction in the load-bearing capacity. This reduction must be compensated for by means of suitable measures.



Section 4.5 produces further useful information on this area ...

## 2.4 Statics / dimensioning

The dimensioning of forge-welded, pressure-locked and slotted gratings of steel, stainless steel and/or aluminium is carried out as a rule in accordance with the instructions in the RAL-GZ 638 quality assurance for gratings.

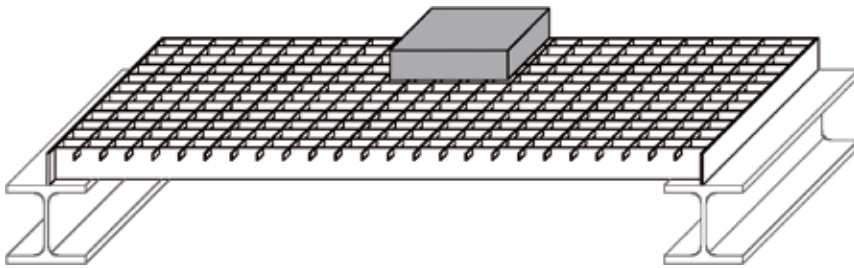


Fig. 7: Static system

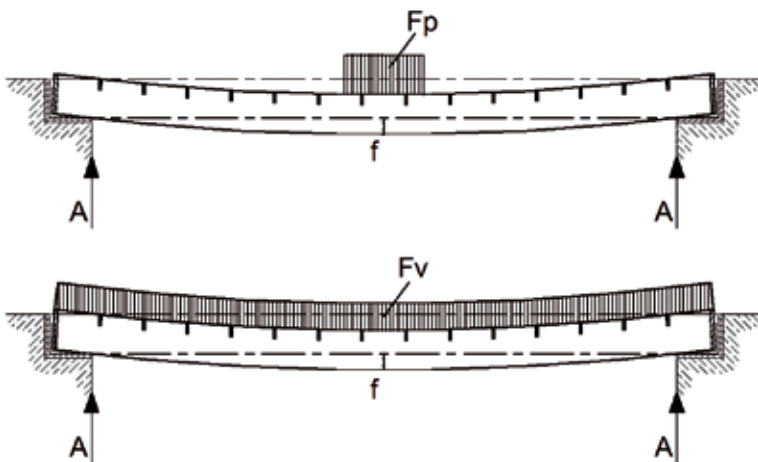


Fig. 8: Static system

Legend for Fig. 8:

- A = abutment
- $F_p$  = point load [kN]
- $F_v$  = surface load [kN/m<sup>2</sup>]
- f = deflection [mm]



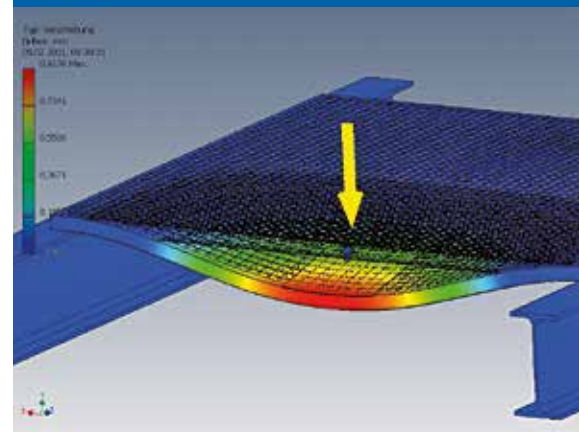
Do you already know about the „RAL-GZ 638“ quality assurance compendium for gratings? In this you will find the calculation fundamentals for quality products! Have a look too at [www.gitterroste-online.de](http://www.gitterroste-online.de) ...



The purpose for which a grating is to be used determines the design loads to be taken into account - and vice-versa.



Supporting a load are not only the bearing bars located directly beneath the load contact area but also - thanks to the load distribution brought about by the cross bars - load transfer. Relevant examples and values are to be found in RAL-GZ-638.



The proof is carried out in accordance with the partial safety factor concept. With this fundamentally two design values have to be investigated:

- Load-bearing capacity or, as the case may be, limit state of the load-bearing capacity
- Serviceability limit state

### Load-bearing capacity

With the load-bearing capacity the failure of the grating has to be checked. The design value of the loading must be less than or at maximum the same as the design value of the bearing capacity.

### Serviceability limit state

In the case of the serviceability limit state the maximum elastic deformation under a defined load has to be determined. The RAL-GZ-638 describes this calculation methodology using a number of examples. For the dimensioning of gratings a number of factors of influence are relevant. The factors of influence

- Material (2.4.1)
- Bearing bar (2.4.2)
- Pitch (2.4.3)
- Bearing span (2.4.4)
- Loading case (2.4.5)
- Deflection (2.4.6)

are clarified in the following sections.

▶ [Statics and dimensioning in detail ...](#)

### 2.4.1 Material

Selection of what is the most suitable material depends to a great extent on the particular case of application (loading case). Account is to be taken as early as the planning stage (i.e. in advance) of which requirements need to be covered for the loading condition.

Resulting from the material selected - as needed for the calculations - are the permissible stress  $\sigma$  and the modulus of elasticity  $E$ .

As a rule a steel capable of being galvanized is selected for economic reasons.

### 2.4.2 Bearing bars

Of relevance for the dimensioning of gratings is the number  $n$ , the height  $h$  and the thickness  $b$  of the bearing bars that are loaded and effective.

! *The design value of the loading must be less than or at maximum the same as the design value of the bearing capacity.*

*The design value of the maximum deflection must be less than or at maximum the same as the design value of the permissible deflection.*

! *Gratings of steels with higher tensile strength give greater load-bearing capacities but also at the same time greater levels of deflection.*

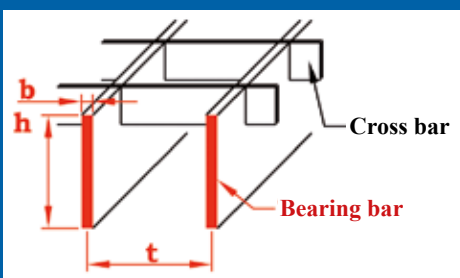


Fig. 9: Dimensioning of a bearing bar – bearing bars under a load cube

### 2.4.3 Pitch

Designated as pitch is the distance between two bearing bars, measured bar centre to bar centre. The pitch influences the number  $n$  of the bearing bars that are loaded.

For the pitch of gratings there are dimensional limits which depend on the purpose of use. Of importance for the planner is the fact that the following factors, namely

- Safety for foot traffic
- Safety for wheeled traffic
- Size of objects which should be prevented from falling through
- Transmission of light, air, fluids, dirt, precipitation, but also
- Psychological effect when a grating is employed at a considerable height (e.g. the view downwards)

are taken into account.

▶ Section 2.1 provides supplementary information ...

### 2.4.4 Bearing span

The bearing span  $L$  is the distance the grating must cross in a self-supporting manner (i.e. without the opportunity to transfer the load to the substructure).

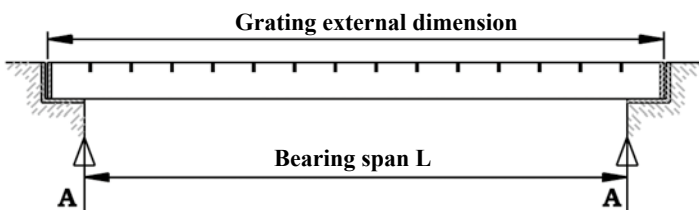


Fig. 10: Bearing span

▶ Section 4.1 provides further useful information ...

### 2.4.5 Loading case

Differentiation is made between point and surface loads.

If necessary dynamic special loadings produced by, for example, rolling, oscillating or impinging loads are to be taken into account by increasing the load to be set (oscillation coefficient = 1.4).

▶ Section 2.2 provides further useful information ...

#### 2.4.5.1 Load contact area

Defined as the load contact area is that area on which a defined load acts, e.g. for gratings which are able to be driven on the contact area of one wheel.

The most unfavourable load position is to be taken for the proof with rectangular load contact areas.

**!** Since the self-weight of a grating is generally small in relation to the live or traffic load, only the traffic load is considered for the calculation. The self-weight of the grating is ignored as a rule.

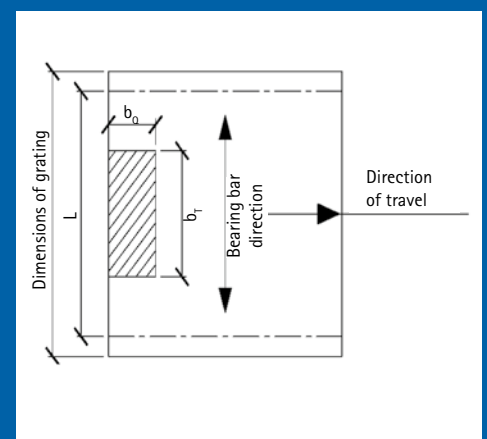


Fig. 11: Load arrangement 1

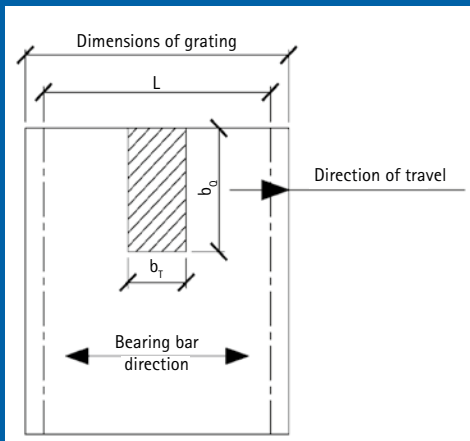


Fig. 12: Load arrangement 2

Legend for figures 11 and 12:

$b_1$  = load width in bearing bar direction

$b_0$  = load width in cross bar direction

L = clear bearing span

## 2.4.5.2 Use approach

The loads to be set are described in the relevant technical rules and regulations. The following tables provide an overview of the values to be set:

**Table 2: Gratings subjected to foot traffic, use approach**

Design load	Standard	Load [kN]	Load contact area [mm]
Platform areas able to be walked on	DIN EN ISO 14122-2	$F_p = 1,5$ ( $F_v = 2 \frac{kN}{m^2}$ )	200 x 200
Grating steps, step width $\leq 1200$ mm	DIN EN ISO 14122-3	$F_p = 1,5$	100 x 100 <sup>b</sup>
Grating steps, step width $> 1200$ mm	DIN EN ISO 14122-2	$F_p = 1,5^a$	100 x 100 <sup>b</sup>

<sup>a</sup> a number of load points at distances apart of 600 mm

<sup>b</sup> acting at nosing

**Table 3: Gratings able to be driven on**

Design load	Standard	Load [kN]	Load contact area [mm]
Able to be driven on	DIN EN 1991-1-1/NA	10	200 x 200
Able to be driven on (vehicle category F)	DIN EN 1991-1-1	10 - 20	100 x 100
Able to be driven on SLW 3 <sup>c</sup>	DIN 1072*	10	200 x 200
Able to be driven on SLW 6	DIN 1072*	20	200 x 200
Able to be driven on SLW 9	DIN 1072*	30	200 x 260
Able to be driven on SLW 12	DIN 1072*	40	200 x 300
Able to be driven on SLW 16	DIN 1072*	50	200 x 400
Able to be driven on SLW 24 <sup>d</sup>		40 <sup>d</sup>	200 x 300 <sup>d</sup>
Able to be driven on SLW 30	DIN 1072*	50	200 x 400
Able to be driven on SLW 45 <sup>d</sup>		75 <sup>d</sup>	200 x 500 <sup>d</sup>
Able to be driven on SLW 60	DIN 1072*	100	200 x 600

<sup>c</sup> SLW 3 = heavy goods vehicle with 3 ton permissible overall weight

<sup>d</sup> these values are no longer usual today

\* Note: Up to the present time the fundamentals of DIN 1072 are still used in practice for the static calculations of gratings. For calculations in accordance with EN 1991 the fundamentals are to be laid down in each individual case with the manufacturer.



**Tabelle 4: Gratings able to be driven on with a forklift truck**

Category / class (design load)	Standard	Wheel load [kN] (* 1/2 axle load $Q_k$ )	Load contact area [mm]
FL1 (2,1+1) <sup>f</sup>	DIN EN 1991-1-1	13*	200 x 200
FL2 (3,1+1,5)	DIN EN 1991-1-1	20*	200 x 200
FL3 (4,4+2,5)	DIN EN 1991-1-1	31,5*	200 x 200
FL4 (6,0+4,0)	DIN EN 1991-1-1	45*	200 x 200
FL5 (9,0+6,0)	DIN EN 1991-1-1	70*	200 x 200
FL6 (11,0+8,0)	DIN EN 1991-1-1	85*	200 x 200

<sup>e</sup> The figures in brackets are the statement of the permissible overall weight of the forklift truck in tons

<sup>f</sup> Self-weight (net) + gross load (in accordance with DIN EN 1991-1-1)

The dynamic increase factor  $\varphi$  for forklift trucks takes into account the inertia effects resulting from acceleration and braking of the forklift truck and should be set with

$\varphi = 1.40$  for pneumatic tyres, and

$\varphi = 2.00$  for solid rubber tyres.

### 2.4.5.3 Snow and ice loads

Snow and ice loads (in accordance with DIN EN 1991-1-3) are to be taken into account in the calculation in their full amount without reduction.

### 2.4.6 Deflection

Designated as deflection is the elastic deformation of the gratings brought about under load.

After the load has been removed the grating must return to its original shape again.

With gratings that can be walked on the maximum permissible deflection is 1/200 of the bearing span but in any case maximum 4 mm so that edges that can be tripped over are avoided.

The permissible deflection  $f$  for steps of gratings is 1/300 of the bearing span but in any case maximum 6 mm.



*In many cases the increasing bearing span is more relevant for dimensioning than the permissible deflection.*

*The deflection is depending from modulus of elasticity, which is the same for all steel grades.*

## 2.5 Slip resistance

For normal use outdoors gratings provide an adequate level of slip resistance as a rule.

Where however there is an increased risk of slipping and in certain circumstances a risk of accidents through the handling or presence of substances promoting slipping (e.g. dirt, oils, greases, water, food etc.), increased requirements must be placed on the gratings in respect of slip resistance.

The profiling of the bearing bars and cross bars is carried out in different ways in accordance with the class of slip resistance required as the following examples show:

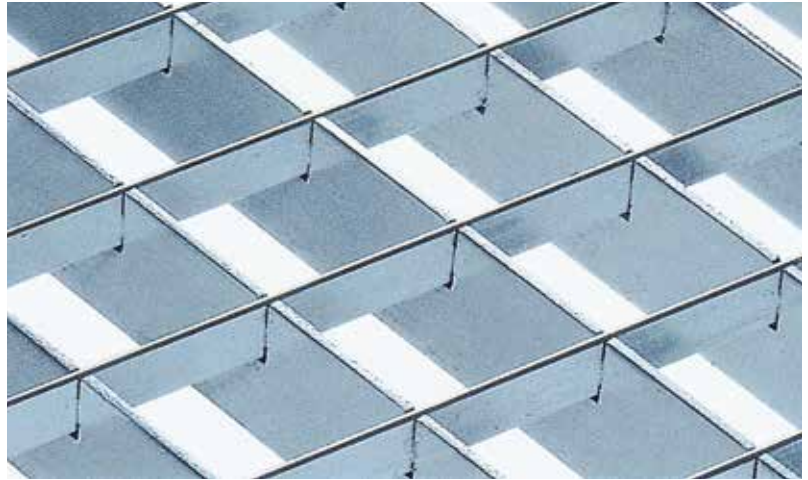


Fig. 13: Grating with plain top surface

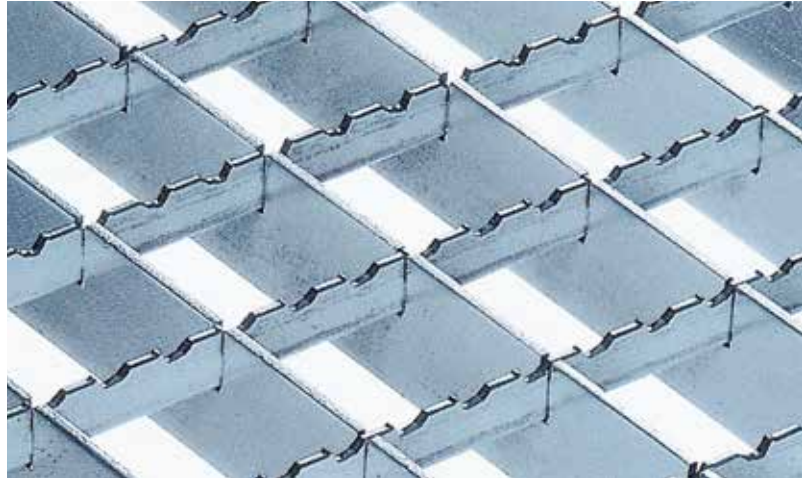


Fig. 14: Grating with notches in the cross bars

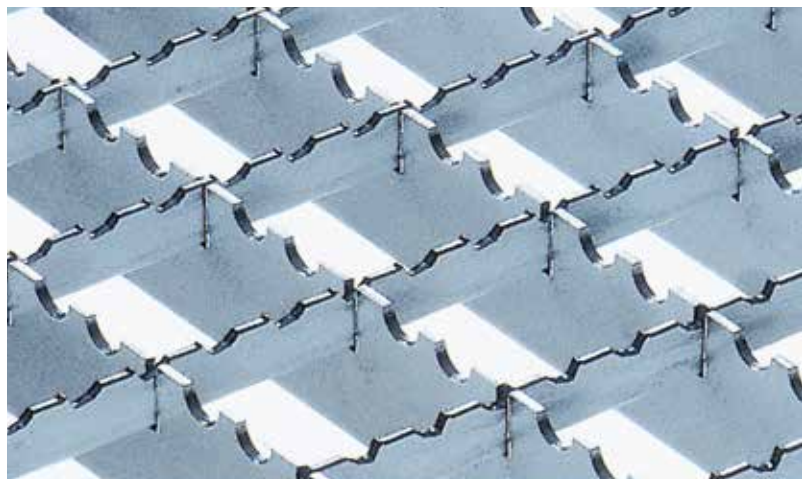


Fig. 15: Grating with notches in both the bearing and the cross bars

## 2.5.1 Acceptance angle

Brought in to check the slip-resistance properties of gratings are normative rules (DIN 51130).

With this test method the covering to be assessed is walked over by a test person. For the test the test person walks backwards and forwards with an upright posture on the covering to be tested, the angle of which to the horizontal is increased from level (horizontal) up to the acceptance angle. The average acceptance angle achieved is used to evaluate the degree of slip resistance.

Subjective factors of influence on the acceptance angle are limited by a calibration process.

## 2.5.2 Evaluation groups

The average total acceptance angle is classified as coming under one of the groups in accordance with the following table.

**Table 5: Classes of slip resistance – acceptance angle**

Total acceptance angle	Slip resistance class (evaluation group)
$> 6^\circ \leq 10^\circ$	R 9
$> 10^\circ \leq 19^\circ$	R 10
$> 19^\circ \leq 27^\circ$	R 11
$> 27^\circ \leq 35^\circ$	R 12
$> 35^\circ$	R 13

See also German Social Accident Insurance Rule 108-003, issue 10-2003, table 1

## 2.5.3 Displacement space

In addition to the slip resistance evaluation group, the displacement space (V 4 to V 10), i.e. the ability of the covering to lead away fluids downwards, is also measured with the test method described above.

By reason of their nature, gratings always achieve the maximum displacement space class V 10.

The evaluation groups of the slip resistance and displacement space are defined in a manner dependent on the place of use.



See also German Social Accident Insurance Rule 108-003, issue 10-2003, table 2, „Assignment of the designation of the displacement space to the minimum volumes“

Examples on the slip resistance classes to be selected can be found in German Social Accident Insurance Rule 108-003.

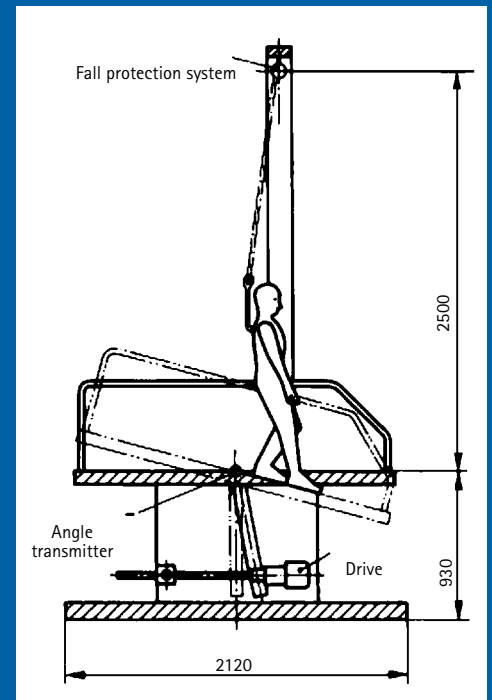


Fig. 16: Test arrangement for determining the slip resistance



*The acceptance angle is not be equated with the angle of tilt.*



*Gratings are especially suitable for applications where slippery substances (e.g. oils and fluids) are to be considered.*



Gratings, which for example are removed for cleaning purposes, must be replaced correctly. Only in this way can the slip-inhibiting effects of gratings be ensured!

**Table 6: Evaluation groups and displacement space (extract)**

No.	Work rooms and work areas and areas with operational traffic	Evaluation group of slipping hazard (R-group)	Displacement space with code for the minimum volume
0	General work rooms and areas		
0.1	Entrance areas, indoors	R 9	
0.2	Entrance areas, indoors	R 11 oder R 10	V 4
0.3	Stairs, indoors	R 9	
0.4	Stairs, outdoors	R 11 oder R 10	V 4
0.5	Sanitary rooms (e.g. toilets, changing rooms and washrooms)	R 10	
	Break rooms (e.g. recreation rooms, works canteens)	R 9	
	Sanitary rooms	R 9	
1	Production of margarine, cooking fats, edible oil		
1.1	Grease melting	R 13	V 6
(...)			



See also German Social Accident Insurance Rule 108-003, issue 10-2003, Appendix 1. The complete table can be seen there.



The measurement results from the test method for the determination of the slip resistance of coverings in their operating state in accordance with DIN 51131 (coefficient of dynamic friction) cannot be compared directly with the measurement results from the test in accordance with DIN 51130 (angle of inclination (tilt) from the sloping plane test). Accordingly the coefficient of dynamic friction cannot be brought in for classification to an R-group.

Higher evaluation groups (e.g. R 11 to R 13) can be achieved with gratings through notches on the bearing and/or cross bars. The manufacturers have appropriately tested gratings for the different particular areas of application.

## 2.5.4 Angle of inclination of a ramp

Catwalks that are at an angle (e.g. ramps on conveyor systems or similar operational systems) with an angle of inclination of up to 6° can be equipped with standard gratings. Gratings that have an angle of inclination of from 6° to 10° should be equipped with slip-resistant gratings.

Prescribed where the angle of inclination is from 10° to 20° are gratings with step bars, each of which extends over the full effective width of the catwalk (e.g. U 20/20/20/2.0).

In the case of an angle of inclination in excess of 20°, the inclination is to be bridged with steps.

The distance between the step bars or, as the case may be, the dimensions of the steps are to be matched to a normal pace. The formula used for stairs ( $600 \leq g + 2 \cdot h \leq 600$  where  $g$  = tread depth and  $h$  = rise height) is also used here.

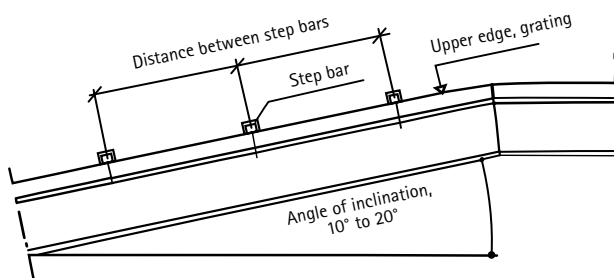


Fig. 17: Angle of inclination of a ramp



Fig. 18: Step bars

## 2.6 Special features of the form of execution

Amongst others, the following forms of execution or arrangements are possible to enable gratings to be matched to the particular local circumstances:

### Mounting bracket

A mounting bracket (angle flange or Z-flange) is a bracket that is welded to the ends of the bearing bars and serves for the suspension of the grating.

### Cut-outs

With cut-outs on gratings, the original shape of the grating is changed by sections being cut out whereby the cut edges are then given a banding. The cut-outs may be located either at the edge of a grating or within the contour of a grating.

▶ Please observe the further information on cut-outs in section 4.5 ...



Fig. 22: Gratings with angled cut-outs

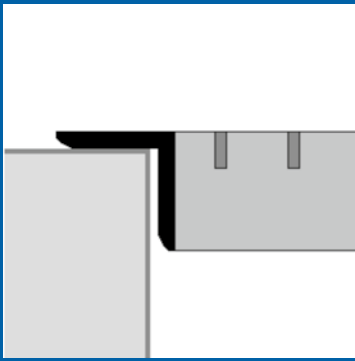


Fig. 19: Mounting bracket (angle flange)

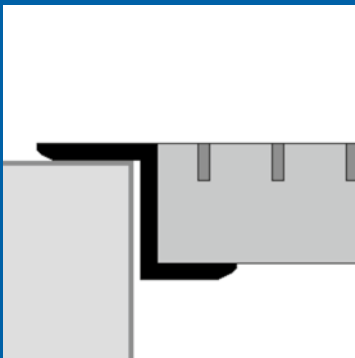


Fig. 20: Mounting bracket (Z-flange)

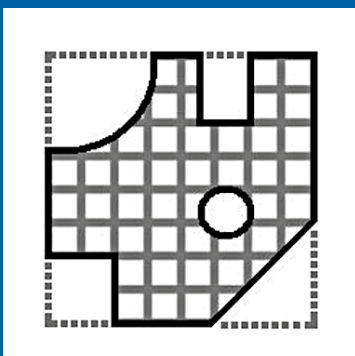


Fig. 21: Examples of different cut-outs

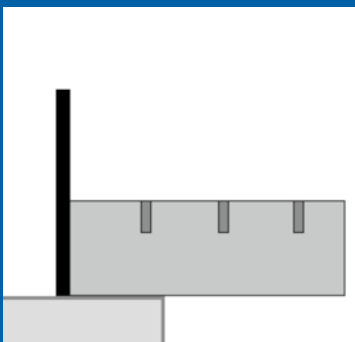


Fig. 23: Example of a toe-plate

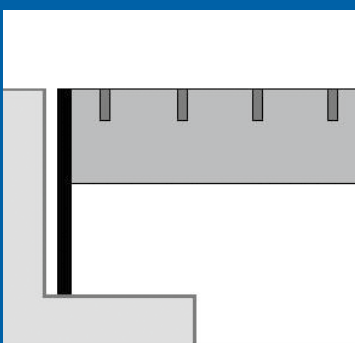


Fig. 24: Example of stiling

### Toe-plate (kick-plate)

The purpose of a toe-plate is to prevent objects slipping down or falling down at the edge of gratings. As a rule a toe-plate consists of a banding welded to the grating which extends to a height of around 100 mm above the surface of the grating.

▶ You will find further information in sections 4.1 and 4.4 ...

### Stilting

With stiling a banding, which protrudes downwards, is welded to the grating in order to permit levelling.

### Perforated plates / butt straps

Perforated plates or butt straps welded to gratings serve to permit gratings to be secured directly (positive fit or non-positive) to a structural element.

### Notches in the bearing area

Notching in the support area serves to permit levelling in cases where there is not sufficient construction height. Such cases of application must be checked in respect of statics; in such situation the grating manufacturer will provide assistance.

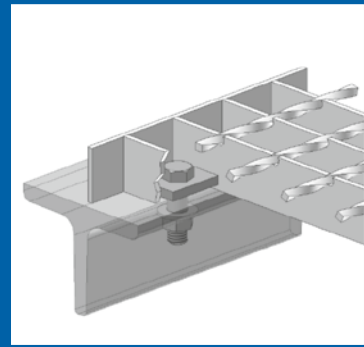


Fig. 25: Perforated plate (arranged horizontally relative to the grating)



Fig. 26: Butt strap

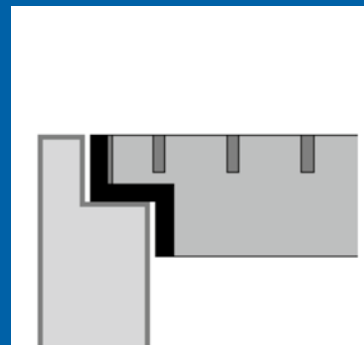


Fig. 27: Notching



# CHAPTER 3

## Requirements





### 3. Requirements to be met by grating steps

#### 3.1 Fundamentals

Grating steps - to DIN 24531-1 - consist of

- a safety nosing, the tread surface of which is slip-resistant at least to evaluation group R 10 German Social Accident Insurance Rule 108-003, and whereby the lower edge of the nosing must be executed in such a way - e.g. by chamfering - that the risk of injuries is minimized. The safety nosing may be perforated.
- a tread of a grating which may be executed as a forge-welded grating or a pressure-locked grating.



Fig. 28: Image of a tread (isometric view)

- Sideplates which permit the grating to be bolted to the existing structure. The sideplates are manufactured of flat strip and have a hole pattern in accordance with Fig. 29 and dimensions in accordance with the following table:

**Table 7 Tread depths and the related n-value**

Grating tread depth [mm]	n [mm]
240	120
270	150
305	180

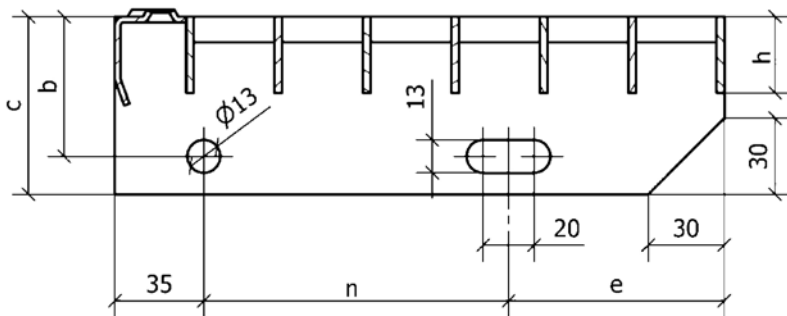


Fig. 29: Image of a tread with details of the sideplates (section)

The dimension n is adjusted in the case of grating steps, the tread depths of which differ from those listed in the table.

The width of grating steps is selected in accordance with the type of use of the building and the number of persons using the stairway.

Listed in DIN 24531-1 as standard widths are 600 mm, 800 mm, 1000 mm and 1200 mm. Other widths or variations are possible.



### 3.2 Types of grating steps

The types of grating steps will not be gone into in more detail here. Statements on the different types are to be found, for example, in the following standards: DIN EN ISO 14122, DIN 18065, German Social Accident Insurance Rule 108-003 and German Social Accident Insurance Information 208-007.e.

### 3.3 Securing / fastening

Steps must be secured in a permanent manner. At installation attention is to be paid to the fact that tolerance gaps between stair stringer and the tread sideplates are eliminated with suitable spacers. This is to ensure that the steps are not damaged when being installed or in the course of use.

### 3.4 Permissible loading

Grating steps to be installed for machines and/or mechanical systems must satisfy the requirements of DIN EN ISO 14122-3.

Non-standard loads are to be agreed when grating steps are being ordered. Under a defined load the deflection permissible in accordance with DIN EN ISO 14122-3 may not be exceeded.

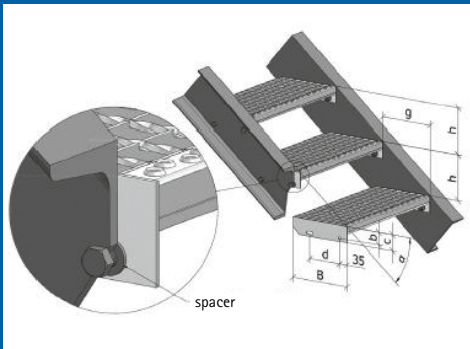


Fig. 30: Fastening of a step in a permanent manner



Fig. 31: Test arrangement prior to the application of a load

The horizontal stiffening of the steps is not taken into account for the calculation of the design of the steps.

On the basis of the series of tests that have been carried out, the common grating steps of the member firms satisfy the requirements of DIN EN 1991-1-1.

### 3.5 Slip-resistance of grating steps

The surfaces of the treads must be slip-resistant. The evaluation and classification of the coverings is carried out in accordance German Social Accident Insurance Rule 108-003 „ Work rooms and work areas with risk of slipping“.

▶ Section 2.5 provides further useful basic information on slip-resistance ...

Within buildings the surface of treads should possess slip-resistance at least to evaluation group R 9. In areas in which as a result of the work the occurrence of substances promoting slipping (e.g. oils, greases, moisture, dusts wastes etc.), has to be considered, then more stringent evaluation groups (R 10 to R 13) will be necessary depending on the type and quantity of the afore-mentioned substances.

**!** *The permissible loadings must be checked by the operator following constructional changes or other subsequent changes.*

Additional constructional measures may be necessary with outdoor steps in order to provide protection against weather-conditioned slippery conditions (e.g. from rain, leaves, ice and snow). Such constructional measures could be – for example – an adequately large roof or screen over the steps.

### 3.6 Special points in respect of types

#### Steps as fixed-location modes of access to mechanical systems

Steps to mechanical systems are often used as modes of access to work platforms, intermediate platforms, catwalks and other raised devices. Used as the material for such applications are, for example, steel, stainless steel, aluminium or also plastic..

When selecting the material attention should be paid to the fact that:

- impairment of the strength of the material through corrosion or other factors of influence from the ambient atmosphere is excluded or, as the case may be, hindered;
- the steps provide an adequate level of slip-resistance;
- the bearing structure is dimensioned in accordance with the loads to be expected.



Please see also the information  
in sections 2.5 and 5 ...

#### Use and maintenance of steps

Repair measures to restore a safe and harmless state are necessary if the edges of steps become worn or damaged as well as if the treads become uneven.



*Damaged steps must be replaced  
without delay.*

# CHAPTER 4

## Laying / installation



## 4. Laying / installation

### 4.1 Substructure / support

A support length  $L$  of at least 30 mm must be provided when planning the substructure.

When a grating has been installed, the support length may not be less than 25 mm.

Exceptions are only permissible where slipping of a grating away from the substructure is positively prevented by technical measures.

The following technical measures are useful means of ensuring this:

- Provision of a peripheral angle frame into which the gratings are inserted.
- Welded-on stops

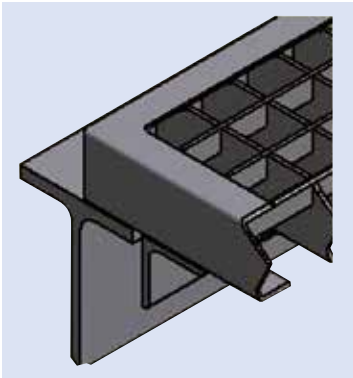


Fig. 34: Welded-on stop

### Toe-plates



Fig. 35:  
Toe-plate on the substructure

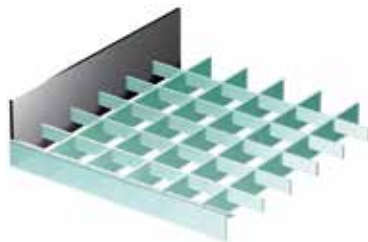


Fig. 36:  
Toe-plate on the grating

In order to permit the design loadings of the grating stated by the manufacturer to be transferred to the substructure, it is necessary that the ends of all the bearing bars are supported. Suitable measures, e.g. reinforcing of the bandings, must be taken if there are interruptions in the support structure.

The substructure must be dimensioned in such a way that lateral torsional buckling is reliably excluded. A substructure is not stiffened through gratings being placed on and secured to it.

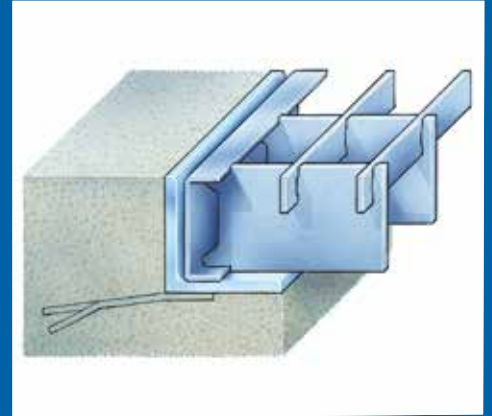


Fig. 32: Schematic of a grating support in an angle frame

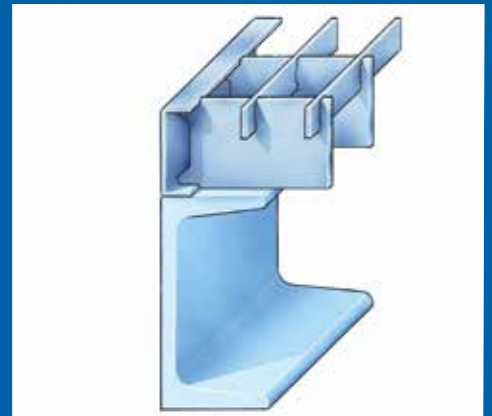


Fig. 33: Schematic of a grating support in its installed state

## 4.2 Laying plan / clearance between gratings

A laying plan must be prepared in advance where gratings are to be used to cover a larger area. As a rule these laying plans are prepared by the grating manufacturer.

### Basic information

To prepare a laying plan the manufacturer requires - amongst other things - statements on the following:

- Location of the bearers (substructure)
- Outer edge closures
- Static conditions of the edges, and
- Statements on possible special points

### Technical drawings

Freehand sketches or drawing can serve as the pattern provided they contain the most important information.

When electronic drawings (e.g. via CAD programs) are used, the data formats that can be used must be clarified with the particular grating manufacturer in advance.

### Information from the laying plan

The laying plan should provide the necessary information on contours, item numbers, direction of the bearing bars and execution details.

### Clearance between gratings

The clearance or gap between individual gratings should not exceed 4 mm (when the gratings are installed).

Generally this clearance or gap is not shown in the laying plan.

### Square individual gratings

Individual gratings that are square are to be avoided in general in order to exclude the possibility of a mistake being made with the bearing bar direction at installation!

Exceptions are only permissible when the square individual gratings are supported on all sides or incorrect installation is prevented by a technical measure.

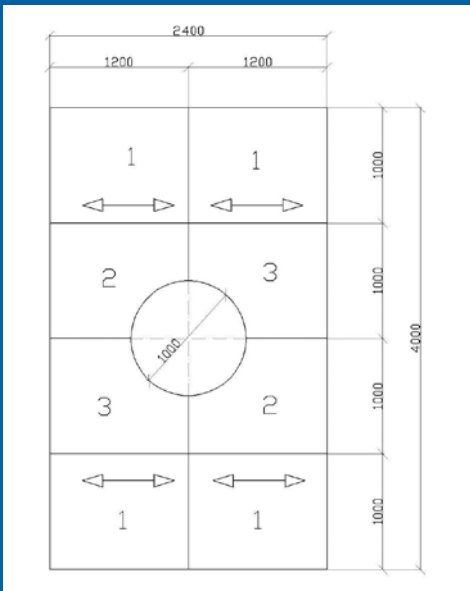


Fig. 37: Installation plan

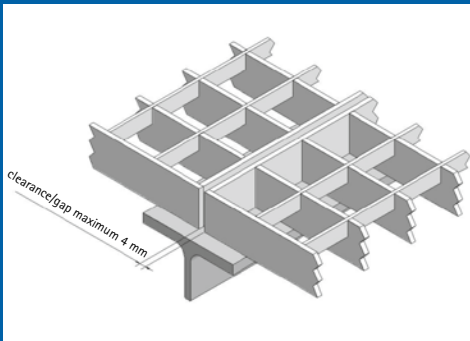


Fig. 38: Clearance/gap between two pressure-locked gratings

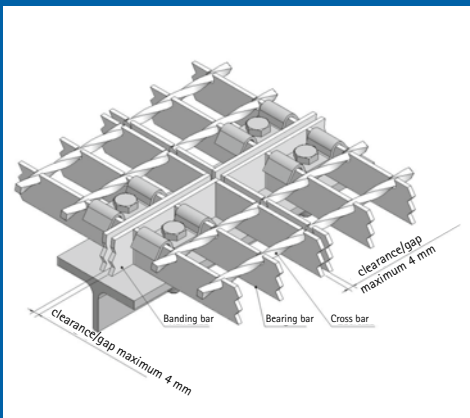


Fig. 39: Clearance / gap between four forge-welded gratings

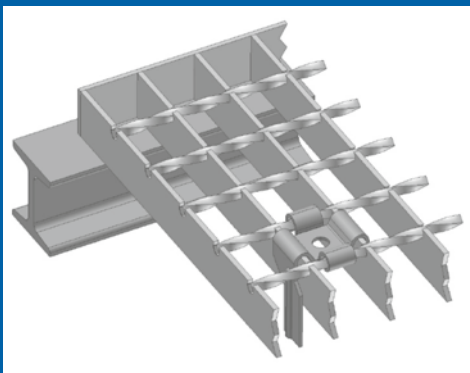


Fig. 40: Example of a technical measure (to be fitted after laying) to prevent a square grating being laid incorrectly.

## 4.3 Securing systems

Gratings must always be secured to prevent them being moved or displaced. In areas where there is a risk of falling (height difference > 1000 mm), gratings must be secured in a positive manner – at least at their four corners – in order to prevent them being slid laterally or lifted up.

Gratings must be secured immediately after being laid.

In the afore-mentioned areas the securing of the gratings must be checked regularly for effectiveness.

In practice it often happens that individual gratings have to be removed for a short time from an area completely covered with gratings in order, for example, to create a hole for transportation purposes. In such a case the surrounding gratings must be prevented from being able to be displaced by a reliable mode of securing arranged around the hole in the grating area.

Unless such a precaution is taken, forces acting horizontally (that arise through the gratings being walked or driven over) can cause the gratings to be displaced. This increases the risk of accidents.

The grating manufacturers have available a wide range of devices for securing gratings. The most commonly used securing devices are described below.

### 4.3.1 Standard securing device

The standard securing device only prevents a grating being lifted up.

It is a not safety securing method!

It consists of a clamp or plate upper part, a matching lower part and a M8 screwed union. When this method of securing is employed, the mode of preventing gratings being displaced laterally (as required for safety reasons) must be achieved by other constructional measures.

With a grating pitch of 33 x 33 mm (and greater), these securing devices can be fitted from above through the meshes. They should be tightened up hand-tight to a torque of approx. 5 – 8 Nm.

As a rule the lower parts of the clamp are designed for flange thicknesses of up to 15 mm. In the case of flanges of greater thickness appropriately modified clamp lower parts are needed. The grating manufacturer will make these available.

### 4.3.2 Safety securing device

A safety securing device provides a safeguard against a grating being lifted up and against it being displaced laterally. They consist of a special clamp upper part with a locking device extending downwards, a clamp lower part with a finger hole and a M8 screwed union.

Exactly as with the standard securing devices, these devices can be fitted from above through the meshes provided that the mesh pitch is 33 x 33 mm (and greater). Care is to be taken that the clamp upper parts are connected positively with the grating.

When these devices are used with pressure-locked gratings, this is achieved by bending one of the two arms extending downwards around the relevant bearing bar.

With forge-welded gratings, the two shaped parts that cover the cross bars are bent over so that the upper part is firmly connected with the grating.

The system with both methods of securing is based on the fact that – even if the securing device becomes loose – the clamp upper part will remain firmly connected to the grating.

Should a grating – as a result of horizontally-acting forces – be displaced in the bearing bar direction, the locking device extending downwards will prevent the grating being able to fall from the supporting beam. As a rule the clamp lower parts are designed for flange thicknesses of up to 15 mm.

With greater flange thicknesses modified clamp lower parts are needed.

The grating manufacturer will provide these.



*Securing systems must be checked regularly.*

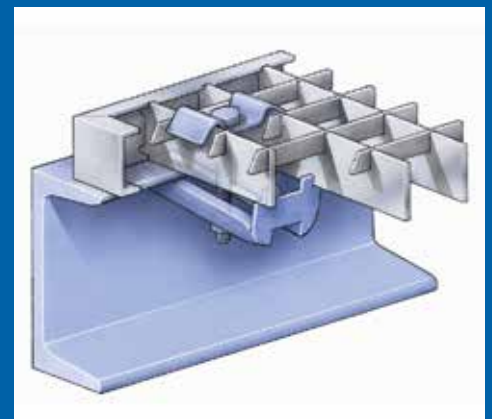


Fig. 41: Standard securing device

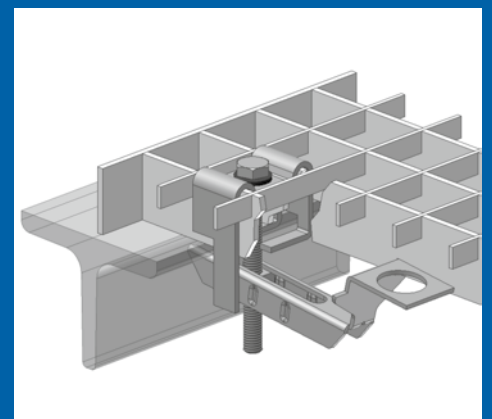


Fig. 42: Example of a safety securing device on a pressure-locked grating

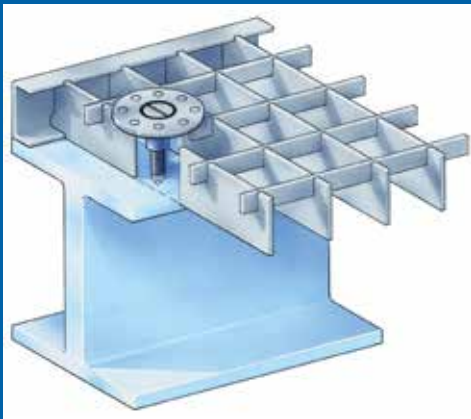


Fig. 43: Cartridge-fired pin securing system

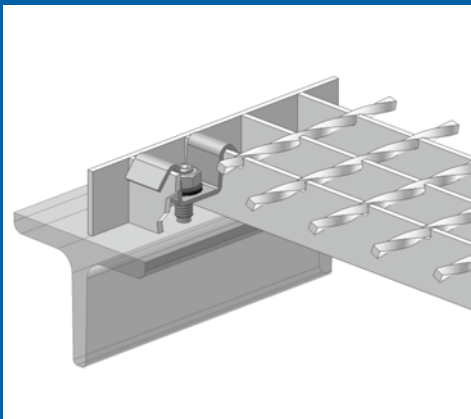


Fig. 44: Welding stud securing system

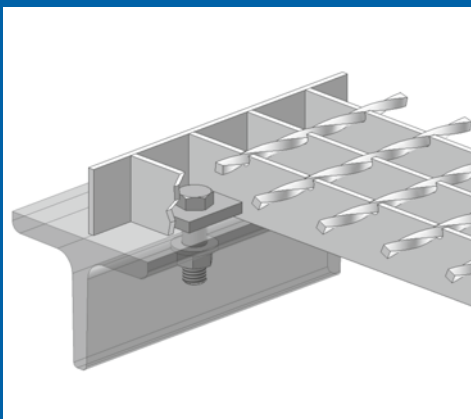


Fig. 45: Welded-on perforated plates

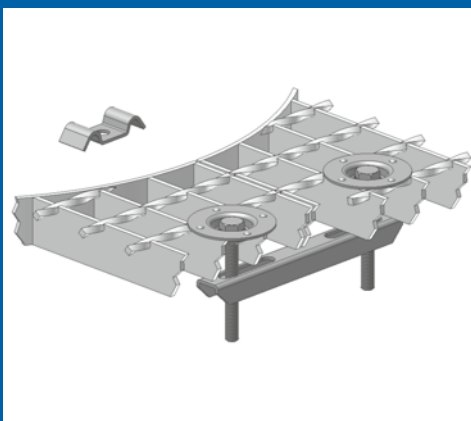


Fig. 46: Double-clamp securing system

### 4.3.3 Cartridge-fired pin securing devices

The cartridge-fired pin mode of securing provides a safeguard against a grating being lifted up and against it being displaced laterally. With this system a threaded bolt is driven into the steel substructure. An appropriate upper part can be screwed on to the end of the bolt.

The instructions of the manufacturers of cartridge-fired pins and cartridge-fired pin devices are to be read and observed before cartridge-fired pin devices are used; in particular attention is to be paid to the prescriptions on safety, e.g. , German Social Accident Insurance Regulation 56D 9 (formerly BGV D 9). and DIN EN 15895.

In particular the suitability of the substructure in respect of strength, thickness and edge distances must be checked.

As a guide-line value, a minimum substructure thickness of 6 mm has been laid down.

The securing devices can be fitted from above through the grating mesh with mesh sizes in excess of 18 mm.

### 4.3.4 Welding stud securing devices

The welding stud securing device provides a safeguard against a grating being lifted up and against it being displaced laterally.

With the system a M8 stud is first welded to the substructure. Then a clamp upper part is placed over the stud and a bearing bar. A M8 locking nut completes this securing method.

This mode of securing is suitable above all for cases of application where dynamic loadings (e.g. oscillation) is to be reckoned on.

### 4.3.5 Welded-on perforated plates

This mode of securing achieved with a welded-on perforated plate and screwed union provides a safeguard against a grating being lifted up and against it being displaced laterally.


A perforated plate - the holes in accordance with the grating pitch - is welded horizontally on to the grating when the grating is being manufactured. Then, when the grating is being installed - it can be bolted directly to the substructure. This method of securing is suitable in particular for areas with gratings that are driven over. With this securing system forces acting horizontally can be transferred to the substructure. In addition this method of securing is particularly suitable for application where gratings are mounted vertically (e.g. wall coverings).

### 4.3.6 Double-clamp securing devices

A double-clamp securing device serves to connect two neighbouring gratings. It does not provide a safeguard against a grating being lifted up or displaced laterally!

It frequently happens that gratings are laid with cut-outs. As a rule these cut-outs bring about a local reduction in the load-bearing capacity. Double-clamp securing devices are suitable for preventing raised edges representing a tripping hazard (more than 4 mm) at the areas that are not supported. They consist of a clamp or disk upper parts, a clamping rail and M8 screwed unions.

However this system is suitable for use only within defined border areas. The advice of the grating manufacturer should be sought for individual cases.

 Please observe the recommendations on the theme of cut-outs in section 4.5 ...



### 4.3.7 Self-tapping screws


This mode of securing provides a safeguard against a grating being lifted up and against it being displaced laterally. Attention must be paid to the thickness of the material of the substructure when using self-tapping screws. In addition the instructions of the screw manufacturer are to be observed!

### 4.4 Distances away from components

A toe-plate is necessary in order to prevent objects falling down between the bandings or cut-out edges of gratings and the adjacent components or the components that pass through the cut-outs (e.g. pipes, containers or pillars) if the space between grating and component is more than 20 mm.

**Table 8: Distances away from components – protective measures**

Space between grating edge and adjacent component [mm]	Protective measure to be selected [example]
$0 \leq 20$	A measure is not essential
$> 20 \leq 120$	Toe-plate
$> 120$	Guard rail

 You will find further information in section 2.4.3 and the following section ...

### 4.5 Recommendations with cut-outs

Cut-outs in metal gratings, e.g. to permit pipes to be passed through them, bring about a localized reduction in the load-bearing capacity. In order to counteract such a reduction, it is necessary that the cut edges are banded again. In addition the following additional measures must be carried out:

- Supporting of the gratings through additional substructures provided on site
- Reinforced banding of the grating cut-out with the aid of, for example welded-on toe plates
- Section steel welded or bolted on beneath the gratings
- Connections with the neighbouring gratings with the aid of screw-on butt connections or double clamps

Examples of cut-out - for gratings subject to foot traffic - are represented in the following images.

All the examples or, as the case may be, recommendations are based on the following assumptions:

- The grating/s is/are are to be secured at all four corners to prevent the possibility of their being slid laterally or lifted up
- Grating type: pressure-locked grating
- Dimensions: pitch 33 x 33 mm, bearing bar 30 x 2 mm
- Material: S235JR
- Surface: hot-dip galvanized

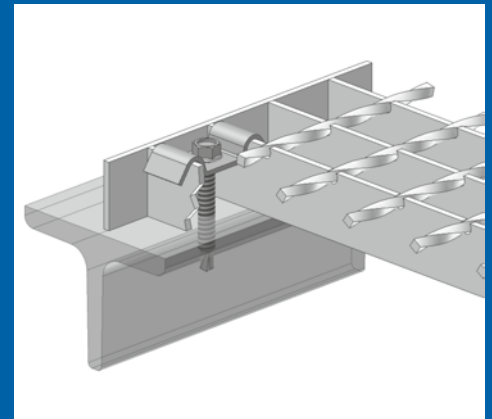


Fig. 47: Self-tapping screws

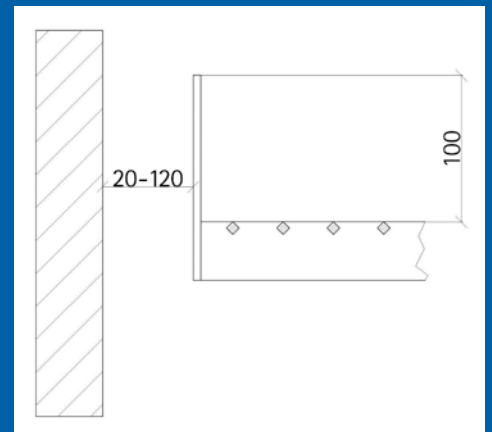


Fig. 48: Additional protective measure (plinth) with a gap to the adjacent components of  $> 20 \text{ mm} \leq 120 \text{ mm}$



*The gaps must be checked again if necessary, e.g. following constructional measures.*

U-shaped cut-outs in one grating or, as the case may be, between two gratings

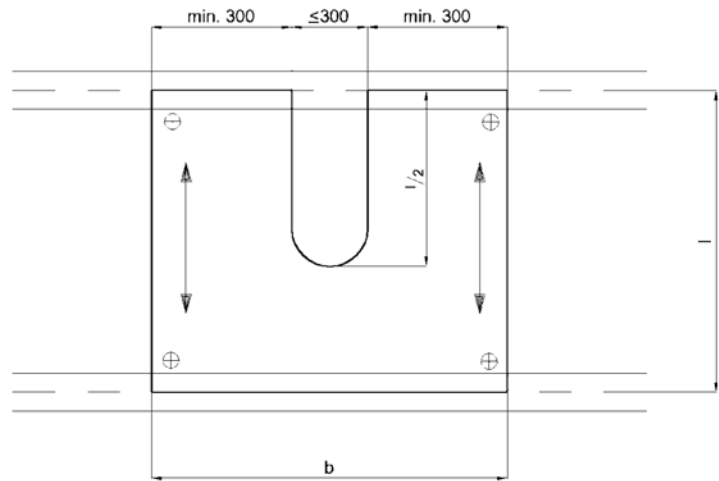


Fig. 49: U-shaped cut-out in one grating (without grating separation)

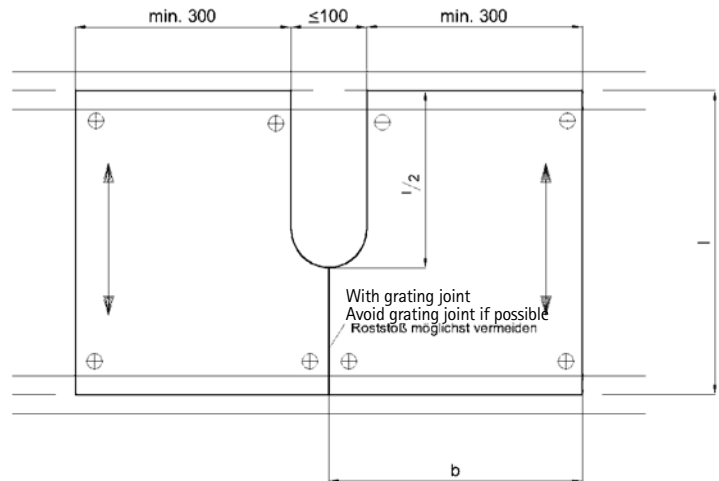


Fig. 50: U-shaped cut-out ( $\leq 100$  mm) between two gratings (with grating separation)

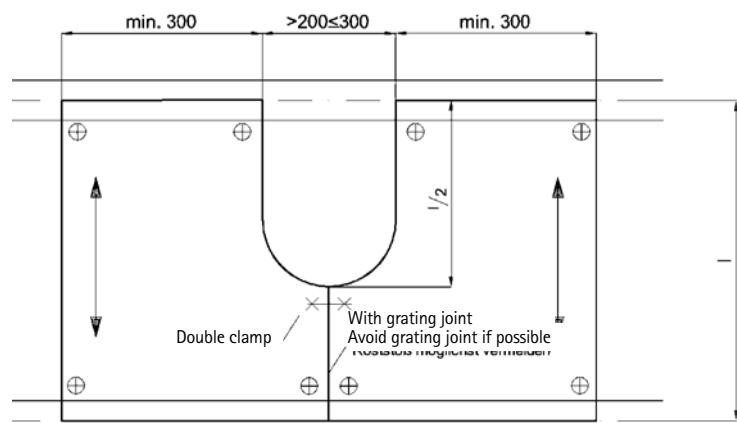


Fig. 51: U-shaped cut-out ( $> 200$  mm  $\leq 300$  mm) between two gratings with securing with double clamps (with grating separation)



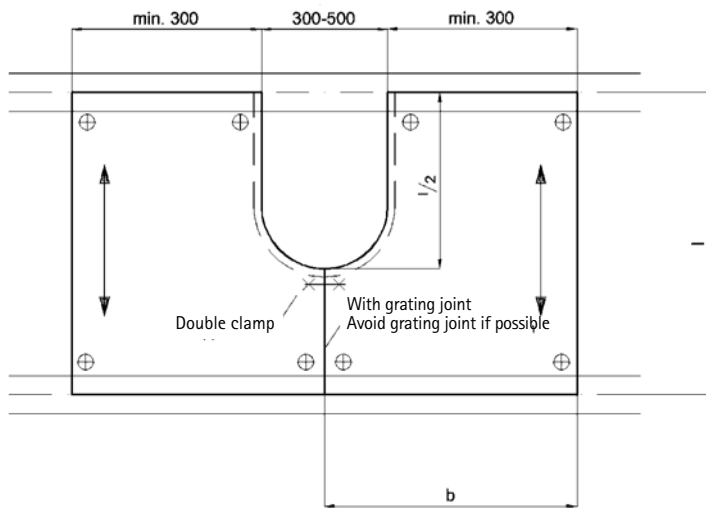


Fig. 52: U-shaped cut-out ( $> 300 \text{ mm} \leq 500 \text{ mm}$ ) between two gratings with securing with double clamps (with grating separation)

### Circular cut-outs between two gratings

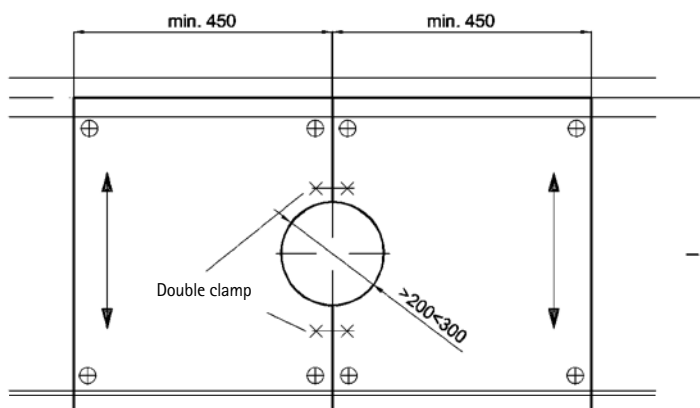


Fig. 53: Circular cut-out ( $> 200 \text{ mm} < 300 \text{ mm}$ ) between two gratings (symmetrical position) with securing with double clamps (cut-out in centred position)

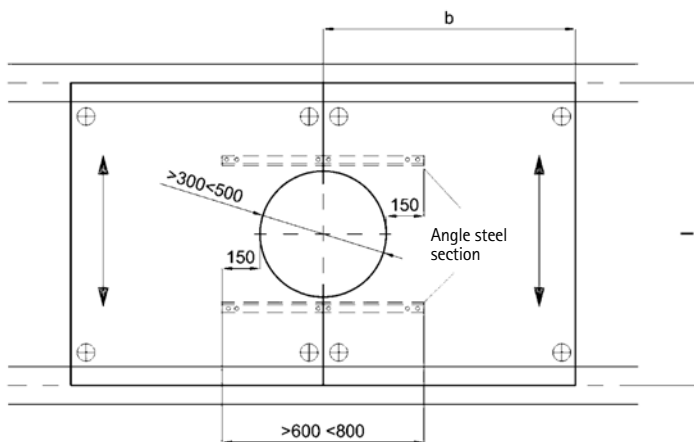
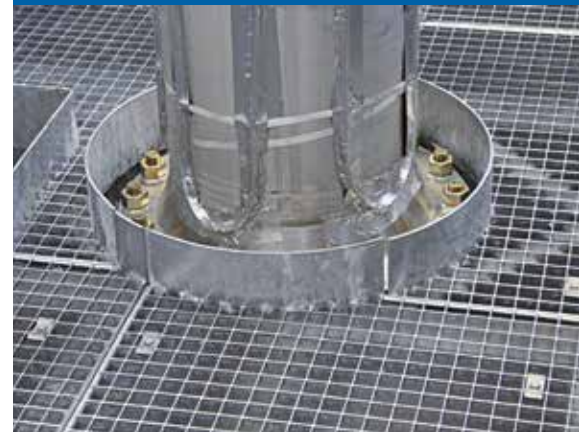


Fig. 54: Circular cut-out ( $> 300 \text{ mm} < 500 \text{ mm}$ ) between two gratings (symmetrical position) with angle steel section connection between the gratings (cut-out in centred position)



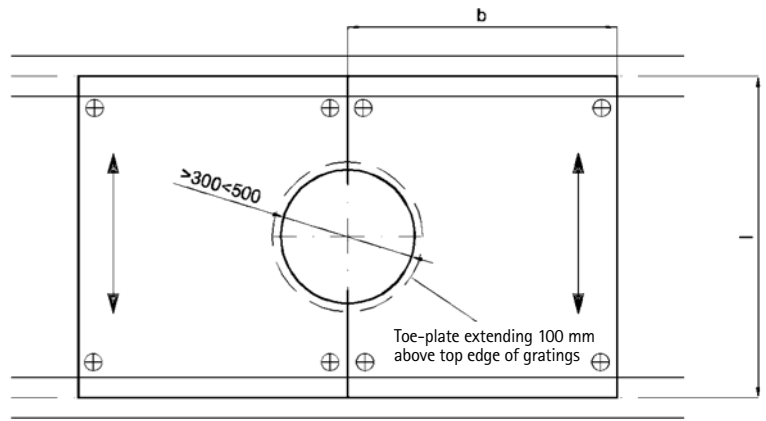


Fig. 55: Circular cut-out (> 300 mm < 500 mm) between two gratings (symmetrical position) with toe-plate (cut-out in centred position)

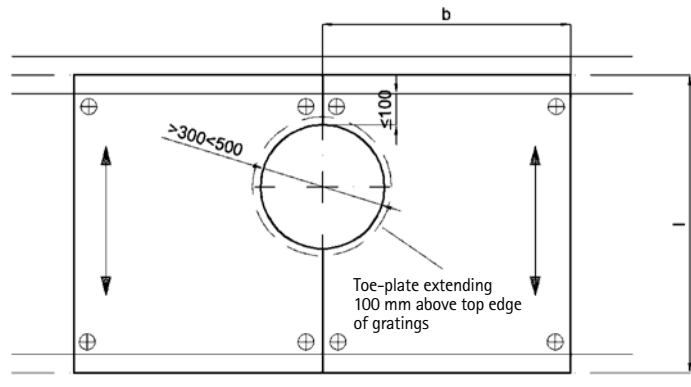


Fig. 56: Circular cut-out (> 300 mm  $\le$  500 mm) between two gratings (asymmetrical position) with toe-plate (cut-out in vicinity of support)

### Rectangular cut-outs between two gratings

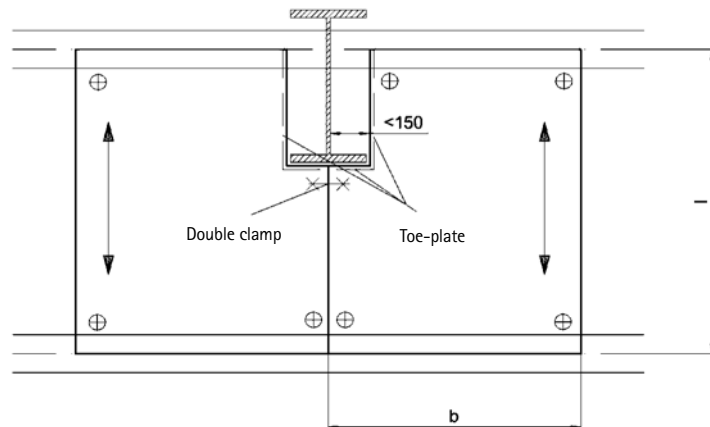


Fig. 57: Cut-out between two gratings (for example necessary due to double-T steel girder) with plinth and without support at the grating joint (grating cut-out with plinths)

### Example of reinforcing of gratings with cut-outs, the reinforcement achieved with a screwed union from below

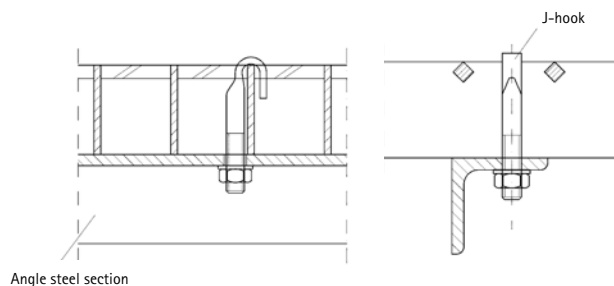


Fig. 58 and 59: J-hook



## CHAPTER 5

# Corrosion protection through hot-dip galvanizing



## 5. Corrosion protection through hot-dip galvanizing

### 5.1 Process

Hot-dip galvanizing produces a zinc coating providing the longest protection against corrosion.

In the process steel - which has been previously appropriately pretreated - is alloyed with zinc on its surface by being immersed in a bath of molten zinc (melting point of zinc: 419 °C) and is coated in this way with zinc.

### 5.2 Layer thicknesses

The thickness of zinc coatings is primarily determined by its layer thickness and is measured or, as the case may be, stated in  $\mu\text{m}$  ( $1 \mu\text{m} = 1/1000 \text{ mm}$ ). The relevant standard DIN EN ISO 1461 lays down - amongst other things - the minimum layer thicknesses for zinc coatings that are to be provided with piece galvanizing for different thicknesses of the material to be coated.

In practice, however, the layer thicknesses of zinc coatings that are generated are above the minimum thicknesses laid down in the standard.

**Table 9: Layer thicknesses**

Steel and thickness (mm)	Local layer thickness (minimum value) in $\mu\text{m}$	Average layer thickness (minimum value) in $\mu\text{m}$
$\leq 1,5$	35	45
$> 1,5 \leq 3$	45	55
$> 3 \leq 6$	55	70
$> 6$	70	85

According to recent studies, the average amount of zinc removed from a zinc coating through corrosion (corrosion resistance) in Germany is still only approx. 1  $\mu\text{m}$  per annum.

This means that the actual duration of protection provided by a zinc coating is significantly greater than the theoretical duration of a coating of the minimum thickness calculated in the standard.

### 5.3 Reworking / repairing

The repairing of a point where the zinc coating has been damaged is carried out by thermal spraying with zinc or by means of the application of a suitable zinc dust coating. In every case the thickness to be built up must be at least 30  $\mu\text{m}$  more than the required minimum thickness.



Fig. 60: White rust



Fig. 61: Bloom

**!** *The occurrence of white rust and/or bloom is not a reason for complaint.*

## 5.4 White rust or bloom

White rust (whitish or dark corrosion products) can form after hot-dip galvanizing through storage under moist conditions or relevantly high levels of relative air humidity.

To be understood as „white rust“ are the white and generally voluminous corrosion products of the zinc (zinc oxide) which can manifest themselves in general to different levels depending on the type of corrosion loading. To be understood as „bloom“ are greyish-white changes to the zinc or, as the case may be, zinc surface, i.e. a weak optical change without a voluminous character. These changes cannot be removed in a simple manner. However they do not impair the corrosion resistance.

The formation of white rust is not linked to the galvanizing process and in addition is not a parameter for the quality of the galvanizing.

## 5.5 Galvanic corrosion – hot-galvanized steel in combination with other metals

Hot-galvanized steel is generally selected for use on the grounds of its long service life, robustness and attractive metallic appearance whereby it is often employed in combination with other materials. If in this case different types of metals are used, corrosion may come about by reason of the fact that metals can react with one another in an „incompatible“ manner by reasons of differences in their electrochemical properties and by reason of the particular ambient conditions.

### 5.5.1 Background information

Different metals possess different physical and chemical properties. Amongst others, these differences include their electrochemical potential in relation to the standard hydrogen electrode.

These relationships are represented in the electrochemical potential series of the metals.

The farther apart two metals stand apart in electrochemical theory and practice, the greater is the potential difference between them. Zinc is a relatively base metal which – in the case of a corrosion loading – protects the electrochemically more noble steel. One talks of the zinc coating providing cathodic protection. In such a case the zinc coating is hardly impaired through the formation of covering layers of basic zinc carbonate. The latter effect is in fact desired and helpful (e.g. in the case of the corrosion protection coating being scratched or bruised).

However there are other pairs of metals, the presence of which – if they arise – must be taken into account in metal or steel structures; these include, for example, zinc and copper, zinc and aluminium and zinc and stainless steel. Here the particular pairing of metals can be unproblematic but nevertheless corrosion attack can come about, the so-called galvanic corrosion. With galvanic corrosion the ambient conditions also play an important role. Thus, whereas galvanic corrosion hardly plays a role in dry conditions indoors, with structures outdoors subjected to weathering the nature of the corrosion depends on the duration of the action of moisture. The most unfavourable conditions prevail where there is intensive humidification and an electrolyte with high conductivity, e.g. in marine air containing salt or in sea-water.

The ratio of the areas of the two metals, which are in contact with one another, also plays an important role. The ratio of the surface area of the metal with an anodic (positive) potential relative to that of the metal with a cathodic (negative) potential should be high. This means for practical applications that a situation, in which a large hot-dip galvanized surface is in contact with a small area of a more noble metal, is more favourable than the reverse situation. In addition this means that there are no objections to a hot-dip galvanized steel grating being secured with stainless steel screws.

Metal/Cation	$\epsilon_0$ [V]
Lithium Li <sup>+</sup>	-3,01
Magnesium Mg <sup>2+</sup>	-2,38
Aluminium Al <sup>3+</sup>	-1,66
Titanium Ti <sup>2+</sup>	-1,63
Chromium Cr <sup>2+</sup>	-0,91
Zinc Zn <sup>2+</sup>	-0,76
Iron Fe <sup>2+</sup>	-0,44
Nickel Ni <sup>2+</sup>	-0,23
Tin Sn <sup>2+</sup>	-0,14
Lead Pb <sup>2+</sup>	-0,13
Hydrogen H <sup>+</sup>	0
Copper Cu <sup>2+</sup>	+0,34
Silver Ag <sup>+</sup>	+0,8
Gold Au <sup>3+</sup>	1,42



Fig. 62: Electrochemical series of „noble“ and „base“ metals



The following table shows pairs of metals and their electrochemical reactions which can occur in combination with zinc or hot-dip galvanized steel.

S = severe corrosion of the material under consideration  
M = moderate corrosion of the material under consideration (in very humid atmospheres)  
I = insignificant or no corrosion of the material under consideration

Material considered in respect of galvanic corrosion	Surface area ratio	Magnesium alloy	Zinc	Hot-dip galvanized steel	Aluminium alloy	Cadmium coating	Structural steel	Low-alloyed steel	Cast steel	Chromium steel	Lead	Tin	Copper	Stainless steel
Magnesium alloy	small large		S M	S M	S M	S M	S S	S S	S S	S S	S S	S S	S S	S S
Zinc	small large	M I		I I	M I	M I	S I	S I	S I	S I	S I	S I	S I	S I
Hot-dip galvanized steel	small large	M I	I I		M I	M I	S I	S I	S I	S I	S I	S I	S I	S I
Aluminium alloy	small large	M I	I M	I M		I I	M I	I	S M	M	S S	S	S S	S M
Cadmium coating	small large	I M	I I	I M	I I		S I	S I	S I	S I	S I	S I	S I	S I
Structural steel	small large	I I	I I	I I	I I	I I		M I	S I	S I	S I	S I	S I	S I
Low-alloyed steel	small large	I I	I I	I I	I I	I I	I I		I I	S I	S I	S I	S v	S I
Cast steel	small large	I I	I I	I I	I I	I I	I I	M I		S I	S I	S I	S	S
Chromium steel	small large	I I	I I	I I	I I	I I	I I	I I			M I	M I	S	S I
Lead	small large	I I	I I	I I	I I	I I	I I	I I	I M	I I		I I	I	I
Tin	small large	I I	I I	I I	I I	I I	I I	I I	I	I M	I I			
Copper	small large	I I	I I	I I	I I	I I	I I	I I	I	M	M I	S M		I
Stainless steel	small large	I I	I I	I M	I I	I I	I	I I	I I	M	I M	I M	I	

Fig. 63: Corrosion with different pairs of material

## 5.5.2 Material pairs

Hot-dip galvanized steel in contact with ...

- Aluminium: The risk of galvanic corrosion between these two metals is low. One exception at the most is a situation in which large-area aluminium claddings are in a moist environment and the claddings are plugged in combination with a substructure of small area of hot-dip galvanized steel.
- Copper: By reason of the large potential difference between copper and zinc, direct contact between the two metals should be avoided.
- Stainless steel: The most frequent situation in which stainless steel comes into contact with zinc and galvanized coatings is when stainless steel screws and nuts are used in galvanized steel structures. Under normal atmospheric conditions this metal pairing is unproblematic. At the most insulation should be provided between the metals (e.g. plastic washers and a plastic film between the two metal surfaces) where highly conductive water is present.

## Conclusion ...

Contact between different metals is quite usual in structural engineering and is generally unproblematic. However galvanic corrosion can play a role when there is a large potential difference between the metals being used and when these metals are used in the presence of a highly conductive electrolyte (humidity / water). In every case the ratio of the areas of the metals being considered should always be in favour of the zinc or zinc coating. In exceptional cases where there is a risk of galvanic corrosion, the metals should be electrically insulated from one another, e.g. with plastic film.

## 5.6 Extraneous rust

To be understood by extraneous rust is the depositing of corrodible particles on hot-dip galvanized surfaces. This can occur, for example, where metal-cutting processes (sawing, drilling, grinding etc.) are carried out in the immediate vicinity of or at a greater distance from a galvanized surface and the particles can land on this. If then at the same time there is the effect of humidity, these particles form rust which acts in a corrosion-promoting manner and impairs the appearance of the surface through red-brown colouring.

Loose, air-carried sawing and drilling chips as well as other residues (e.g. dust from grinding) can be brushed off relatively easily. On the other hand hot particles of iron produced during cut-off grinding burn into the surface. These can destroy the corrosion protection and cannot be removed by simple means. In such cases the corrosion protection coating must be renewed.

Extraneous rust can be prevented by simple measures, e.g. by covering the hot-dip galvanized surface in a suitable manner or by removing the particles from the surface immediately.



## CHAPTER 6

# Terminology and index of standards



## 6. Terminology and index of standards

### 6.1 Index of the standards and technical rules

- RAL-GZ 638  
Quality assurance for gratings (issue: September 2008)
- German Social Accident Insurance Information 208-007  
(DGUV-I 208-007 formerly BGI/GUV-I 588-1)  
Gratings – Selection and operation  
(issue: January 1996, updated version: May 2013)
- German Social Accident Insurance Rule 108-003  
(DGUV-R 108-003, formerly BRG 181)  
German Social Accident Insurance Rule 108-003  
Floors in work rooms and work areas where there is a risk of slipping  
(issue: April 1994, updated version: October 2003)
- German Social Accident Insurance Regulation 56  
(DGUV-V 56, formerly BGV D 9, Work with bolt guns  
(issue: April 1990, updated version: January 1997)
- DIN 1072 supplement  
„Street and path bridges, design loads, clarifications“  
(issue: May 1988)
- DIN 18065  
Staircases in buildings – terms, measuring rules, principal dimensions“  
(issue: March 2015)
- DIN 24531-1  
„Gratings as steps – part 1: Gratings from metal materials“  
(issue: April 2006)
- DIN 24537-1  
„Gratings as floor coverings – part 1: Gratings from metal materials“  
(issue: April 2006)
- DIN 51130  
„Testing of floor coverings – determination of the slip-resistance  
properties – work rooms and work areas where there is a risk of  
slipping, inspection methods – inclined surfaces“  
(issue: February 2014)
- DIN 51131  
„Testing of floor coverings – determination of the slip-resistance  
properties – methods for the determination of the dynamic friction  
coefficients“ (issue: February 2014)
- DIN EN 1991-1-1  
Eurocode 1: Effects on bearing structures – part 1-1:  
„General effect on bearing structures – specific gravities, dead weight  
and live loads in civil engineering“  
(issue: 2002 + AC: 2009 / December 2010)
- DIN EN 1991-1-1/NA  
National appendix – parameters laid down nationally – Eurocode 1:  
Effects on bearing structures – part 1-1: „General effects on bearing  
structures – specific gravities, dead weight and live loads in civil  
engineering“ (issue: December 2010)

- DIN EN 15895  
„Cartridge-operated, hand-held tools - safety -  
securing and marking tools" (issue: August 2018)
- DIN EN ISO 1461  
„Zinc coatings brought on to steel by hot-dip galvanizing  
(piece galvanizing) - requirements and tests" (issue: October 2009)
- DIN EN ISO 14122-1  
„Safety of machines - non-portable modes of access to mechanical  
systems - part 1: Selection of a non-portable mode of access between  
two levels"  
(German version issue: October 2016)
- DIN EN ISO 14122-2  
„Safety of machines - non-portable modes of access to mechanical  
systems - part 2: Work platforms and catwalks"  
(German version issue: October 2016)
- DIN EN ISO 14122-3  
„Safety of machines - non-portable modes of access to mechanical  
systems - part 3: Steps, ladders and guard rails"  
(German version issue: October 2016)

## 6.2 Terminology / glossary

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Conversion table

- kg = kilogram
- t = ton
- kp = kilopond (out of date)
- N = Newton
- daN= dekanewton
- kN = kilonewton

Conversion table

1 kg	~ 1 daN	= 10 N	= 1 kp
100 kg	~ 1 kN	= 100 daN	= 1000 N
1 ton	~ 10 kN	= 1000 daN	= 10000 N

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