TECHNICAL MANUAL ON METAL CEILINGS

November 2003 Issue

TAIM
Technical Association of Industrial Metal Ceiling Manufacturers (TAIM) e.V.

Technical Manual on Metal Ceilings (TMMC)

Whether for new constructions or refurbishments, long-lived, visually attractive metal ceilings are a „must“ for every modern building.
Metal ceilings are known for their inspection-friendliness, enabling flexible and economically efficient use of real estate. In addition to this come the high degree to which they are prefabricated on an industrial basis, their robustness and their recyclability.

Products that comply with TAIM's TMMC-guidelines certainly live up to expectations placed on contemporary interior finishing work. Only members are entitled to use the TAIM symbol of quality.

This Technical Manual on Metal Ceilings (TMMC), which is published by TAIM, provides the fundamental principles that have to be taken into account when lightweight suspended metal ceilings are used.
This brochure is to be considered as an application guideline for metal ceilings and is not a complete reference of existing standards.Users shall be responsible for meeting the requirements of applicable standards.

The TMMC applies to lightweight suspended ceilings made of metal, with a mass of up to 50 kg/m². The designs described do not have any load-bearing capacity for other components and must be attached to supporting building parts. They shall not be walked on. The manual deals with suspended ceilings which are offered as complete kits, sub-constructions kits, individual components of the sub-construction and metal ceiling membranes. The respective manufacturer's recommendations for built-in fittings of all types shall be complied with. These fittings shall not lead to additional loads on the suspended metal ceiling.
The TMMC cannot deal with all details (refer also to 2.6 of this document on this) and does not absolve users from complying with project-specific specifications or national regulations. The explanations and instructions given in this manual result from experiences of the ceiling manufacturers participating. These are guidelines and recommendations of a general nature and cannot be considered as contractual, detailed instructions. They are only binding for a respective manufacturer to the extent that the manufacturer has expressly confirmed them. This confirmation shall always be asked for.
This Technical Manual on Metal Ceilings (TMMC) is continuously adjusted and further developed to adapt to technical progress. The most important quality specifications are summarised in an abridged version in the quality standards listed in the appendix.

The editorial team of the TMMC is always very thankful for constructive criticism and makes an effort to take such into account.
The presently valid version can be obtained from TAIM e.V., P.O. Box 1842, D-64608, Bensheim, or can be downloaded at www.taim.info.

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1. Definitions: Terminology, constructions and examples

1.1 Terminology

The definitions according to ISO 6707 as well as the terms described below apply in the TMMC.

1.1.1 Building designer

The planner of the entire building, usually the architect or a technical planner contracted by the architect.

1.1.2 Manufacturer

Producer of sub-constructions or of parts of sub-constructions, connecting components, profiles, fasteners, ceiling membranes etc.

1.1.3 Installation company

The individual/organisation that carries out and/or is responsible for the proper installation of a metal ceiling. The installation company is responsible for the agreement of the used components with the requirements of the TMMC.

1.1.4 Special agreements

These are agreements made that differ from specifications according to the TMMC or in addition to the specifications according to the TMMC.
When special agreements are made, which shall only affect individual points, the sections of the TMMC not affected shall continue to apply unaltered.

1.1.5 System conformity

Permissible use of all elements in a particular ceiling system from the same manufacturer or from a different one.

1.1.6 Load-bearing structure, supporting building part

Load-bearing structures are statically supporting constructions, onto which metal ceilings are fastened. Load-bearing structures may be made of various materials, such as reinforced concrete, steel or wooden constructions. These are broken down into:
Horizontal bearing structures:

- These are supporting floors, roof constructions and the like.
- Vertical bearing structures:
  These are interior walls, external walls, façades, support posts, etc.

1.1.7 Suspended ceiling

A ceiling that is connected to the supporting building parts (ceilings, roofs, beams or walls) by means of suspensions or a sub-construction fastened directly onto the supporting building part or onto a support at the edges such that there is a clearance between the ceiling and the roof above.

1.1.8 Suspended ceiling for indoor applications

A suspended ceiling for areas of use not exposed to any external effects of weather (wind, rain, humidity, pollution loads, etc.). Refer also to 3.5.

1.1.9 Ceiling kit

A kit consisting of at least two components, which have to be assembled and remain in the building permanently.

1.1.10 Joints in ceiling membranes

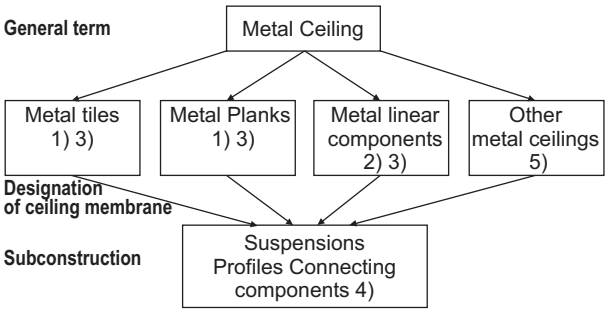
Abutment joint:
A joint formed at the direct abutment of an element to another.

Design joint:
A joint between elements that serve design purposes. To accentuate or guarantee a constant clearance, sealing tape, spacing nubs, spacers or punch-outs can be used in the primary profiles, etc.

1.1.11 Principle suspended ceiling components

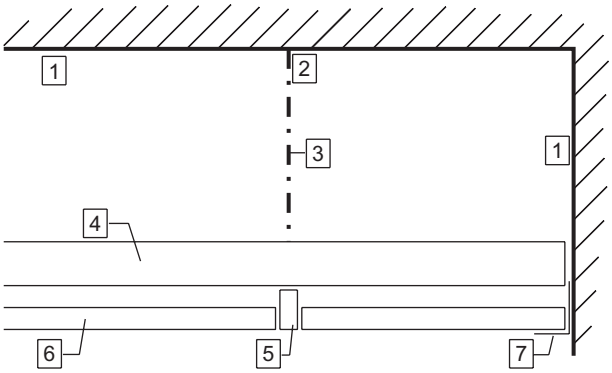
Ceiling components that match one another such that they can be put together to form a matching system. The various system structural elements may originate from various sources and are put together at the manufacturer's premises or at the construction site.
System structural elements are all parts released by the manufacturer that are to be used to meet the properties assured by the manufacturer. If an installation company uses parts different to these, then the installation company is responsible for verifying their equivalence.

Fig. 1 Principle suspended ceiling components of a metal ceiling



Notes:
1) Made of steel
2) Made of aluminium
3) Other materials possible, TMMC then not applicable or to be agreed on separately in whole or in parts
4) Fasteners such as anchors/bolts are not dealt with
5) TMMC not applicable or to be agreed on separately in whole or in parts

Fig. 2 General elements



1 Supporting building part
Structural ceiling/wall
2 Top fixing
3 Suspension
4 Secondary profile
5 Primary profile
6 Ceiling membrane
7 Perimeter trim

1.1.12 Ceiling membranes

The building component that forms the visible surface on the room side of the ceiling, unless this is a visible part of the sub-construction.

The ceiling membrane consists of thin-gauge parts, i.e. components the edges of which are formed by shaping panel-like or linear materials and the thickness of which allows permanent shaping. The TMMC only applies to thin-gauge ceiling membranes with a material thickness of up to 1.25 mm.

Ceiling membranes in accordance with the TMMC are, among other subjects, a part of EN 13964.

1.1.12.1 Ceiling membrane made of metal planks and metal tiles

Tiles are square and planks are rectangular. The individual elements for the ceiling membrane are shaped on all sides.

1.1.12.2 Ceiling membranes made of metal linear components

Ceiling membranes with a max. width of 400 mm, which are only shaped on the longitudinal sides and the length of which is many times that of the width. The design of the joints and edges is variable.

Fig. 3 View of the front

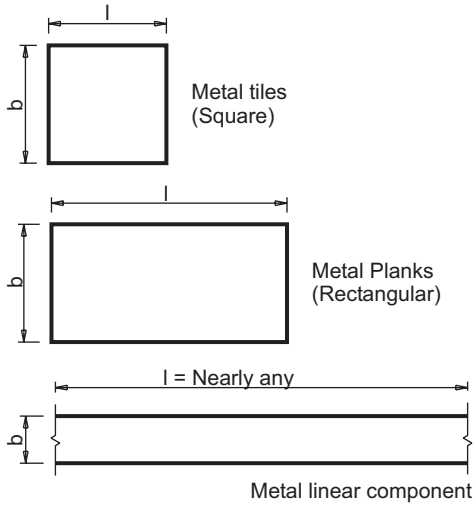
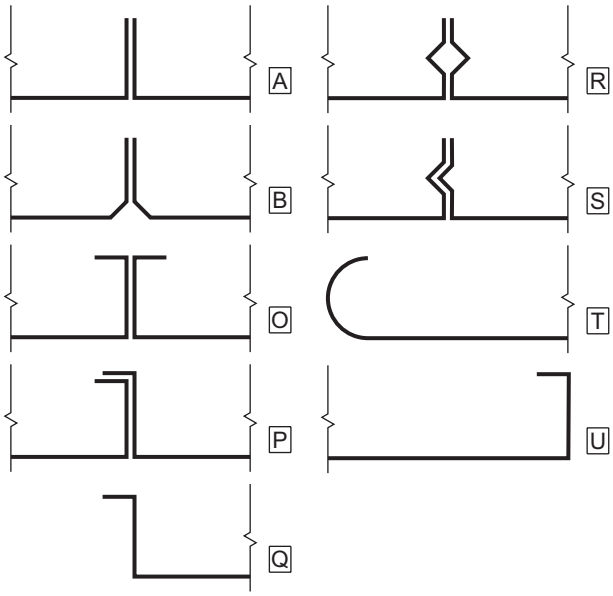


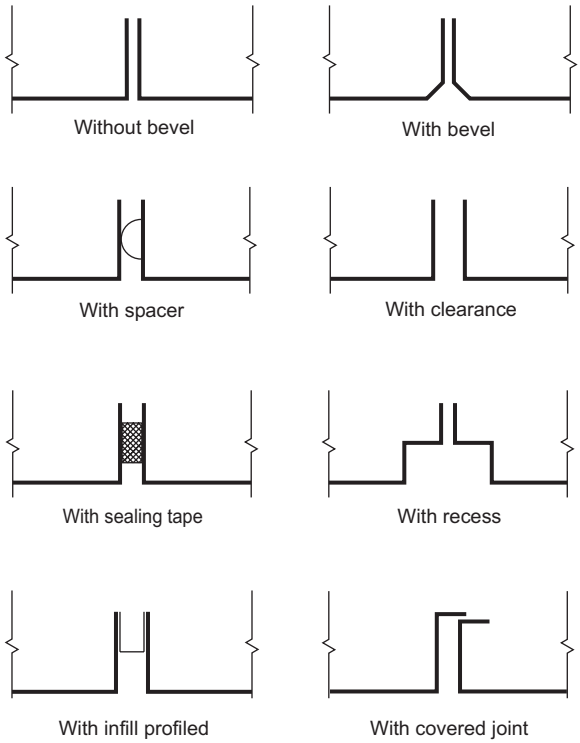
Fig. 4 Typical edge forms of thin-gauge ceiling membranes



A Squared
B Bevelled
O/U Return flanged (C- shape)
P/Q Rebated (Z- shape)
R/S Rilled or bumped/ tongued and grooved
T Rounded

Other manufacturer-specific edge forms are possible.

Fig. 5 Typical joint forms of thin-gauge ceiling membranes

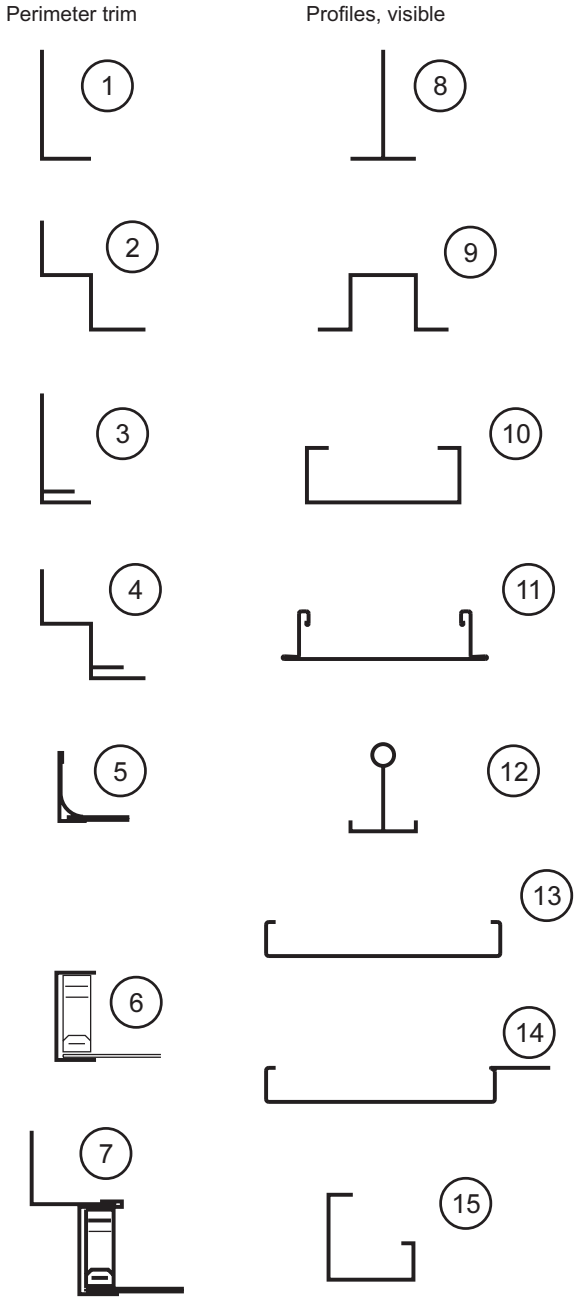


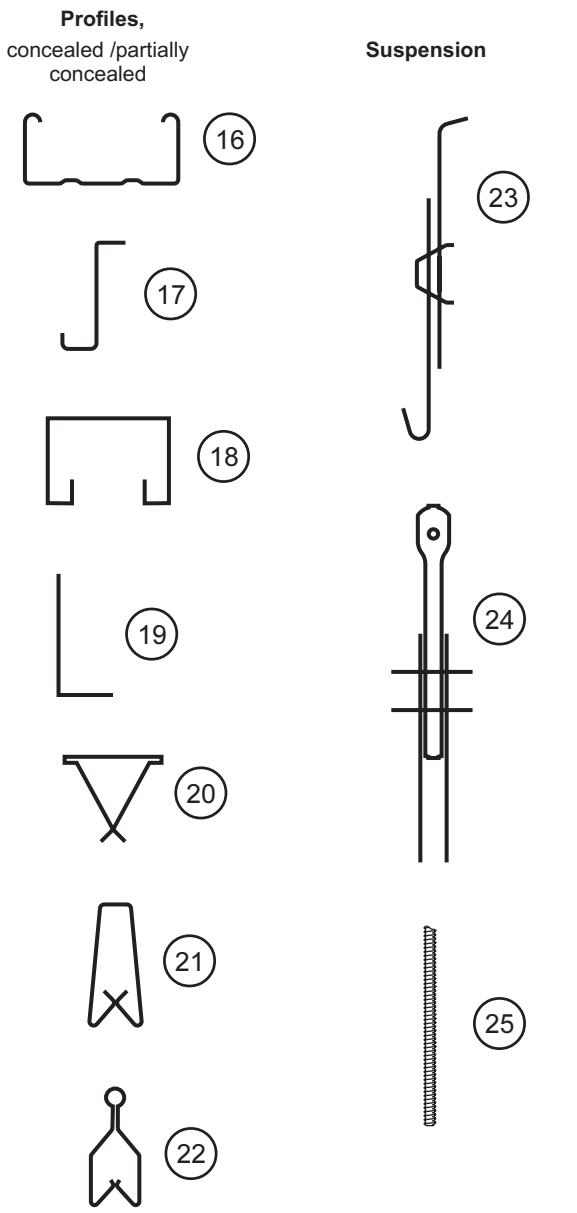
1.1.13 Sub-construction

The parts that support the ceiling membrane are called the sub-construction. It may be available as a complete kit or it may be assembled from elements from various origins. There are three types of sub-constructions.

- **Visible sub-construction**
  A sub-construction the bottom side of which is visible.
- **Concealed sub-construction**
  A sub-construction the bottom side of which is not visible.
- **Partially concealed sub-construction**
  A sub-construction the bottom side of which is partially visible.

Fig. 6 Typical sub-construction elements





1.1.13.1 Top fixing

The fastener that directly connects the suspensions or the sub-construction to the supporting building part.

1.1.13.2 Suspension

The parts of the sub-construction that form the connection to the supporting building part.

1.1.13.3 Connecting components

A fastening component that serves to connect anchoring components, suspensions, the sub-construction and ceiling membranes.

1.1.13.4 Secondary profile

A suspended or directly fastened component of the sub-construction with a direct connection to the supporting building part. Depending on the system, this profile fulfils at the same time the function of primary profile.

1.1.13.5 Primary profile
The part of the sub-construction that directly supports the ceiling membrane. Allowing for the planeness requirements as per Section 3.2, the ceiling membrane is fastened directly to both visible and concealed primary profiles, without the possiblity to adjust the height.

1.1.13.6 Intermediate profile
The part of the sub-construction that is placed between the sub-construction elements to keep them apart and/or to stabilise them.

1.2 Designs

Metal ceilings are divided into the following typical structural designs:
Flat structural systems without visibly positioned main or primary profiles.
- made of metal tiles
- made of metal planks
- made of metal linear components

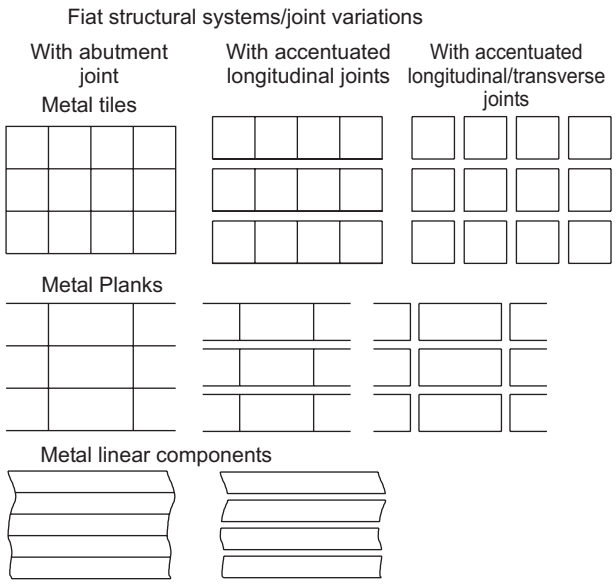
Other elements and constructions

1.2.1 Overview of constructions: Systems without visible secondary or primary profiles

Flat metal ceilings
- made of metal tiles
- made of metal planks
- made of metal linear components

can be formed with abutment joints, accentuated longitudinal joints or with accentuated longitudinal/transverse joints:

Fig. 7 Overview: Typical structural designs without visible main or primary profiles

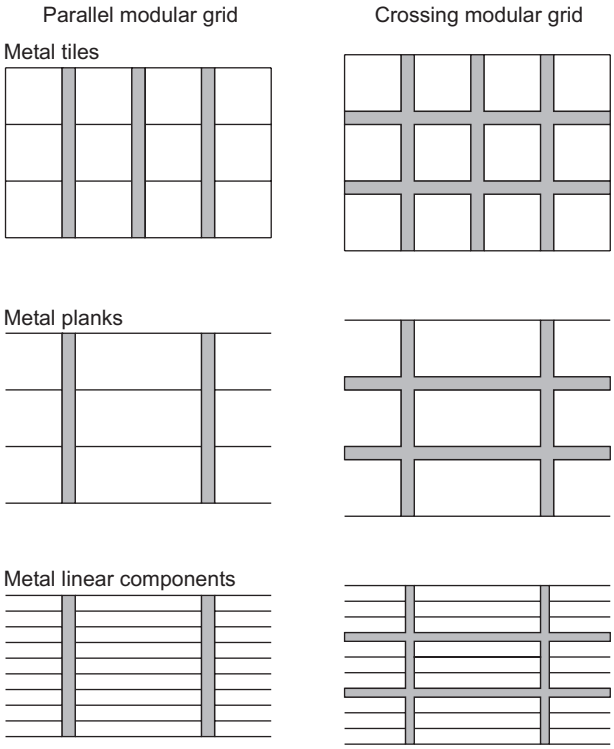


1.2.2 Overview of constructions: Systems with visible secondary or primary profiles

Modular grid systems:
- made of metal tiles
- made of metal planks
- made of metal linear components

can be formed with parallel modular grids, with crossing modular grids or with crossing intersection modular grids.

Fig. 8 Modular grid versions without element joints



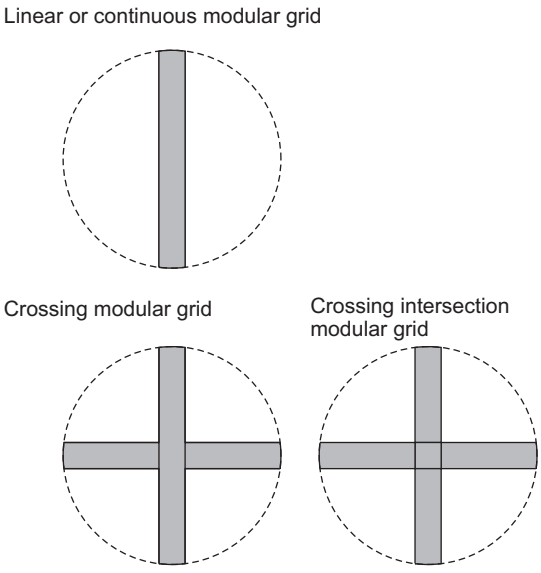
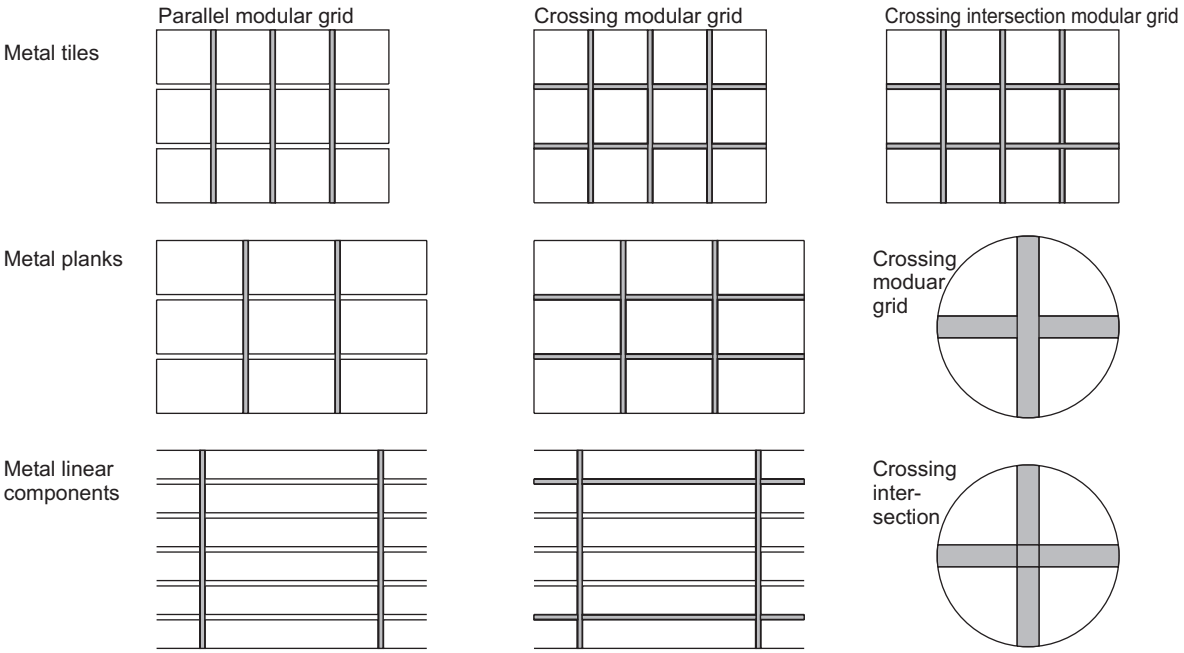


Fig. 9 Versions of modular grids with element joints



1.2.3 Other elements and designs

These ceiling elements are common metal ceiling constructions, but are presently not covered by the TMMC. Application of the TMMC or parts of the TMMC to these constructions must be agreed in individual cases. Examples are shown in the following illustrations.

Fig. 10 Grid systems

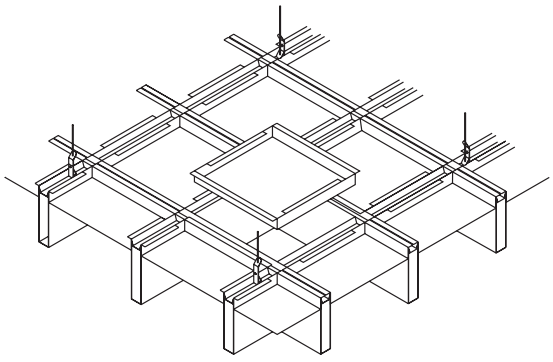


Fig. 11 Baffle systems

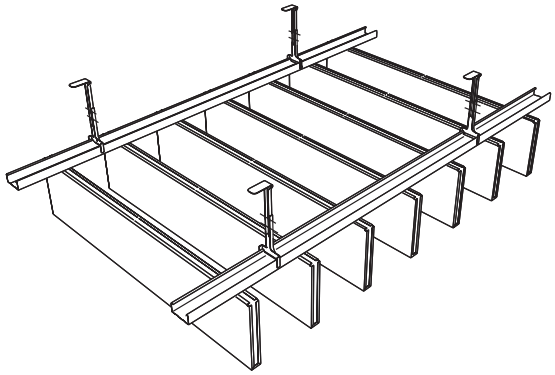


Fig. 12 Thin-gauge grid systems

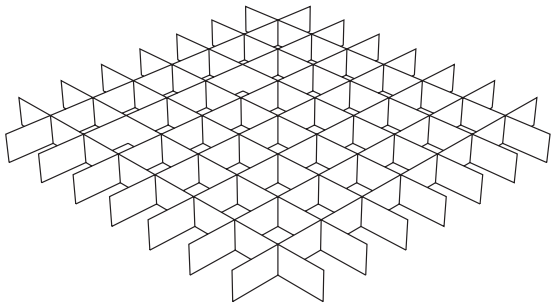


Fig. 13 Cell ceiling systems

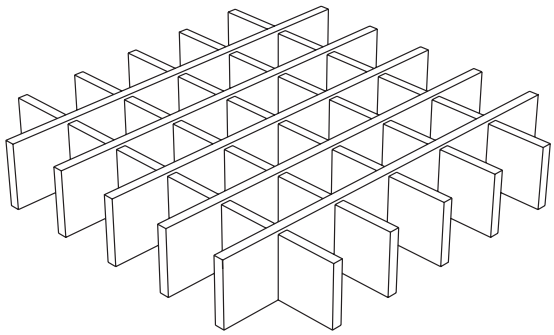


Fig. 14 Screen systems

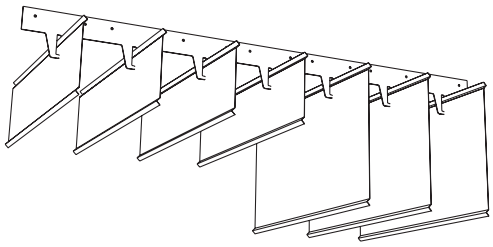


Fig. 15 Curved elements

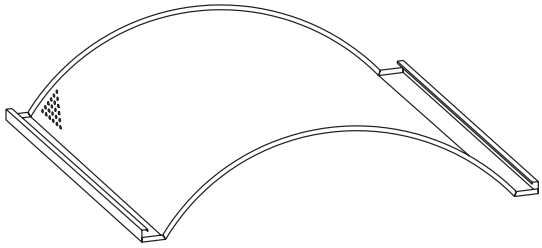


Fig. 16 Stretch-metal ceiling

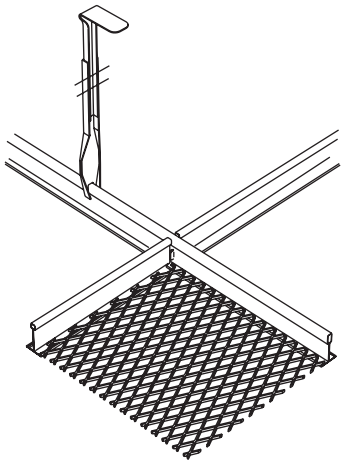


Fig. 17 Corrugated sheet elements

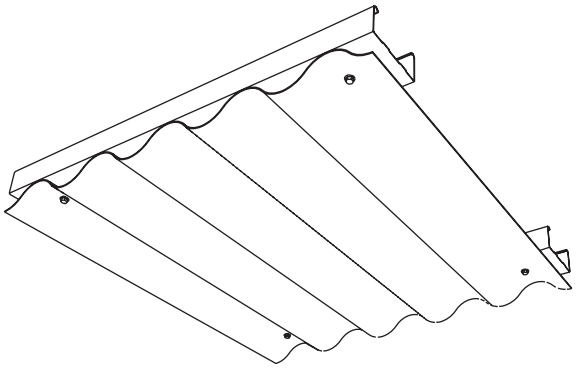


Fig. 18 Accentuated longitudinal joint; Example A (For transverse joint, see Fig. 19, lay-in assembly)

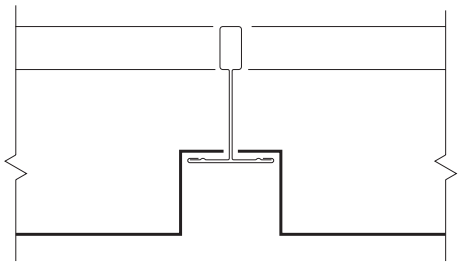


Fig. 19 Accentuated longitudinal/transverse joint; Example B (lay-in assembly)

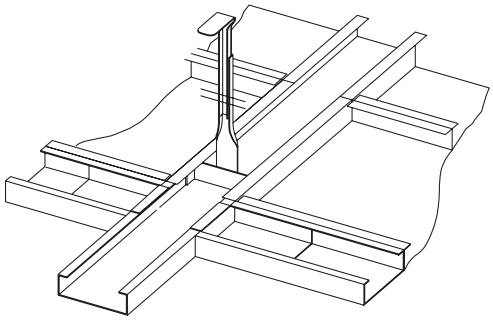


Fig. 20 Accentuated longitudinal/transverse joint; Example C (lay-on assembly)

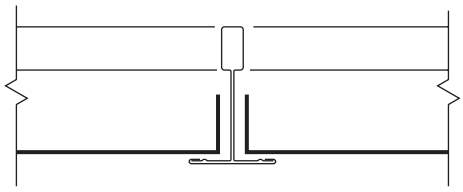
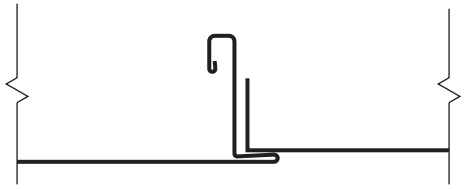


Fig. 21 Accentuated longitudinal/transverse joint; Example D (lay-on assembly)



1.3 Examples: metal tiles, metal planks and metal linear components

1.3.1 Lay-in systems, rebated lay-in systems in visible profiles

Ceiling membranes supported by a visible sub-construction. With an unconcealed visible side or concealed by the bearing-surface area.

1.3.2 Clip-in systems

Ceiling membranes in general with Type R formed edges (see Fig. 4) in conjunction with a concealed sub-construction.

Fig. 22 Clip-in design

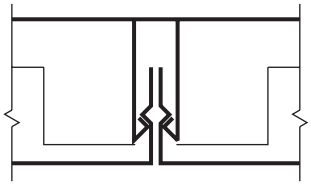


Fig. 23 Modular grid A

Fig. 24 Modular grid B

1.3.3 Hook-on systems

A construction that is fastened to a concealed sub-construction.

Fig. 25 Abutment joint

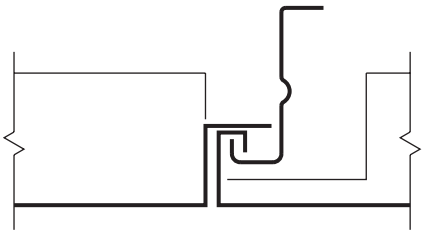


Fig. 26 Accentuated joint

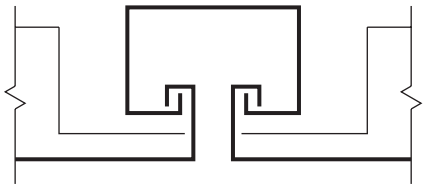
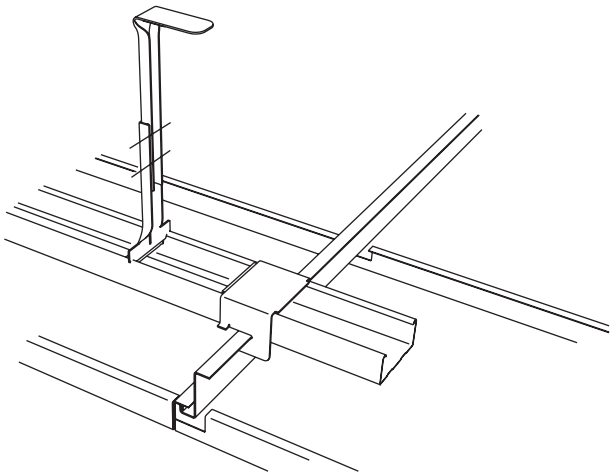


Fig. 27 Illustration of the construction

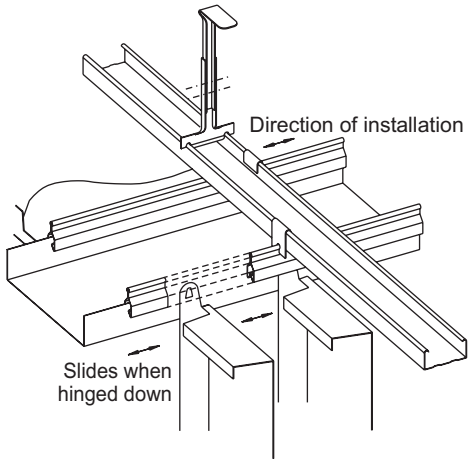


1.3.4 Examples: Swing-down systems

This function is found in systems made of metal tiles and metal planks.

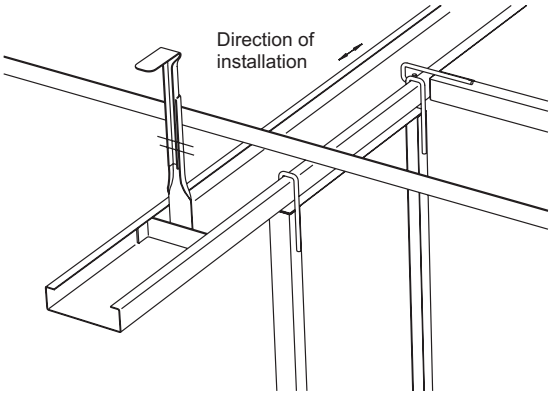
The ceiling membrane is connected to an invisible or visible sub-construction. Individual or all of the ceiling elements swing down out of the ceiling along either the longitudinal or the transverse axis of the element. The visible side of the ceiling membrane remains completely visible.

Fig. 28 As a clip-in system



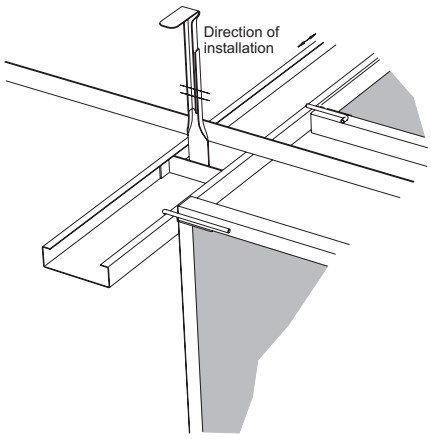
Direction of swing-down along the direction of installation

Fig. 29 As a rebated lay-in system



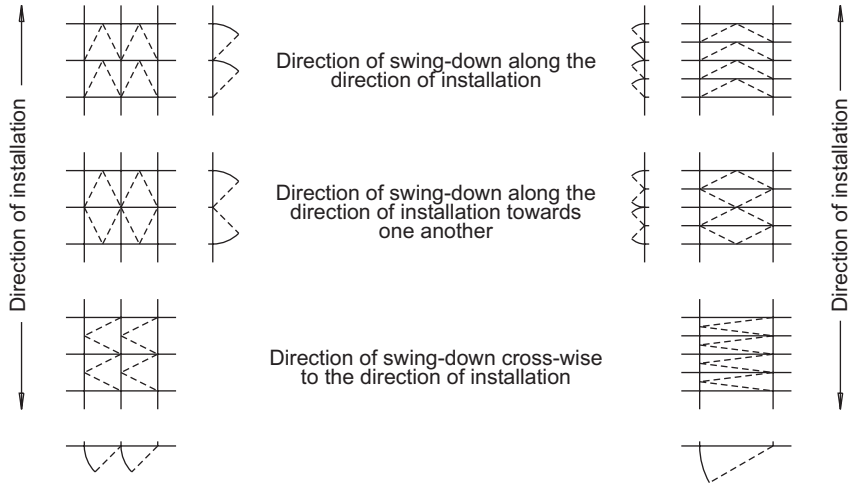
Direction of swing-down cross-wise to the direction of installation

Fig. 30 With suspension locking elements



Direction of swing-down along the direction of installation

Fig. 31 Illustration of swing-down directions



1.3.5 Free spanning systems

Fig. 32 Illustration of ceiling spanned without supports

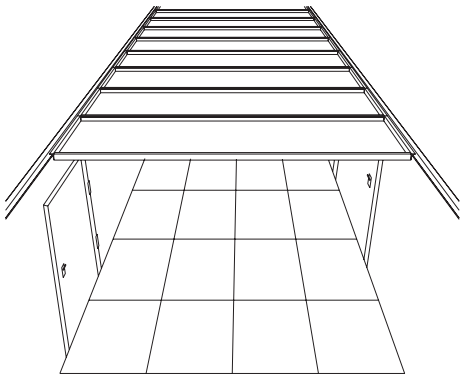


Fig. 33 Perimeter connection A

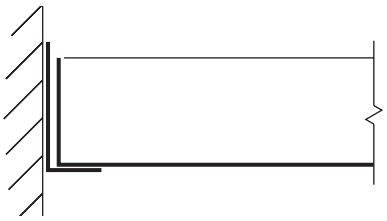


Fig. 34 Perimeter connection B

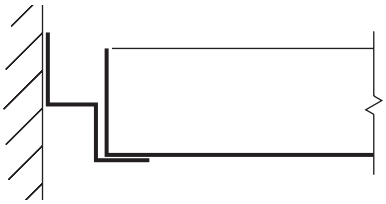


Fig. 35 Perimeter connection C

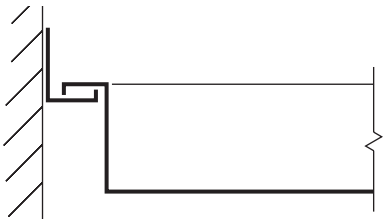


Fig. 36 Perimeter connection D

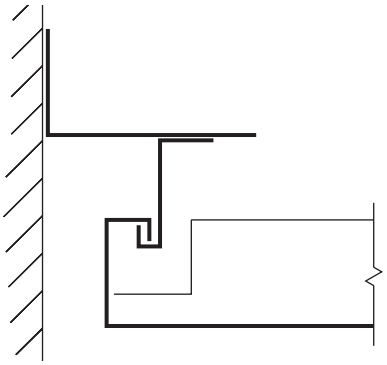


Fig. 37 Perimeter connection E

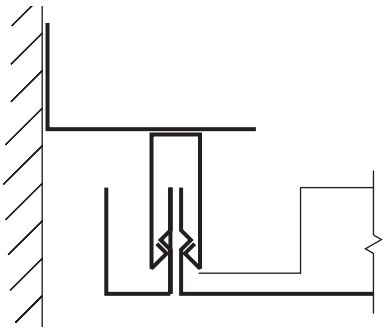
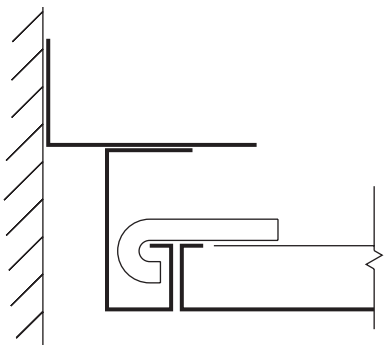


Fig. 38 Perimeter connection F



1.3.6 Metal linear components

Fig. 39 Open joints

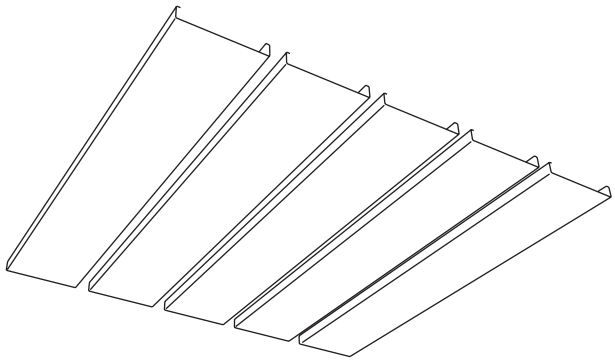


Fig. 40 Abutment joint

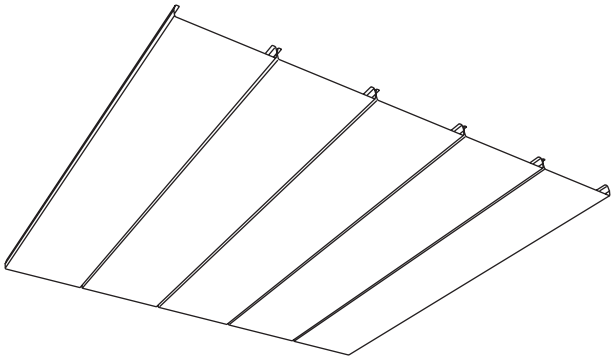


Fig. 41 Covered joint

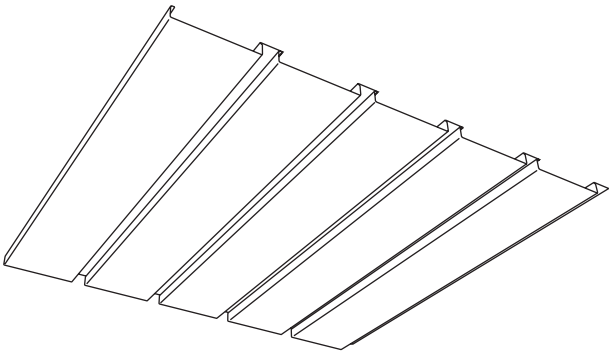
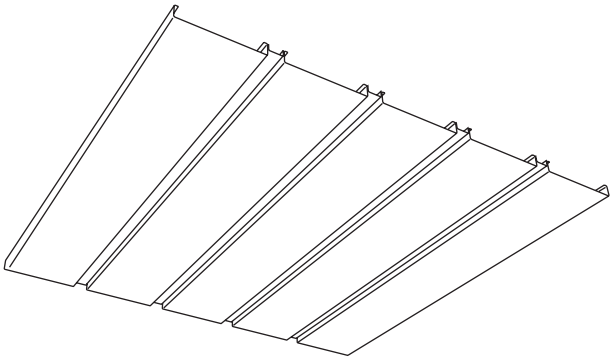


Fig. 42 With infill profiles



1.3.7 Perimeter connections

All the perimeter connections shown in Fig. 6 are basically possible.
In addition, there are also manufacturer-specific constructions.

Fig. 43 Shaped versions

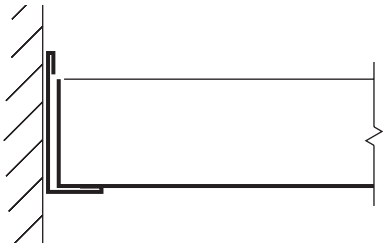


Fig. 44 Shaped versions

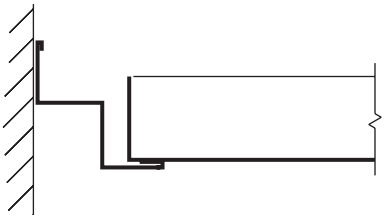


Fig. 45 For cut panels

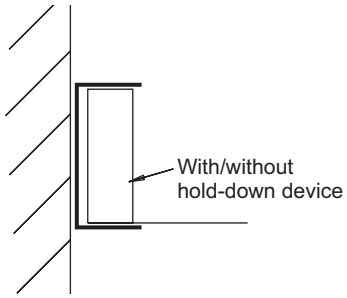


Fig. 46 For cut panels

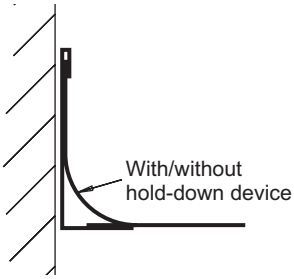
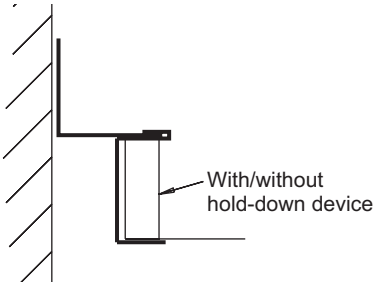


Fig. 47 For cut panels



2 Range of application

The regulations of the TMMC are agreements under private law and define the quality of metal ceilings that come under the range of application.

2.1 Areas of use and main components

Metal ceilings are made up of the following main components:

- Ceiling membranes
- Sub-construction elements
- Fasteners
- Supplementary elements, such as light fittings, ventilation fittings, etc.

The TMMC applies to metal ceilings that are not exposed to any external weather effects, such as in:

- Office and administration areas
- Airports, schools and hospitals
- Salesrooms and shopping arcades and assembly places
- Workshops and workrooms with production operations
- Residential and hotel areas

The application extends to:

- Industrially produced, visible metal ceilings for use in the interior of buildings without any special requirements
- Squared metal tiles and metal planks made of steel sheet with liners up to 400 g/m²
- Metal linear components made of aluminium with liners up to 400 g/m² and coverings up to 1.5 kg/m²
- For special-purpose applications or constructions (see 2.6), as, for example, is the case at indoor pools, gymnasiums, in outdoor areas or for special-purpose ceilings as defined by the TMMC, additional requirements shall be taken into account which go beyond the specifications in the TMMC and shall be agreed on separately.

The TMMC deals with the following essential properties.

1) Mechanical safety
2) Tolerances for dimensions
3) Surfaces
4) Reaction to fire of the materials
5) Resistance to fire of the constructions
6) Regulated substances
7) Electrical safety
8) Reduction of airborne-sound
9) Sound absorption
10) Heat and moisture
11) Transport and storage
12) Installation

When used as intended, metal ceilings are exposed to permanent loading, and so the building components used have to display certain indispensable prerequisites. These properties and prerequisites are explained in the following.

The building designer has to give notification in advance of any special conditions of use, especially effects relevant to safety going beyond the TMMC.

The construction and execution of a metal ceiling have to be designed for such in individual cases. The building designer has to specify any requirements for the application of special safety measures.

If metal ceilings are used which the TMMC does not apply to, the manufacturer shall be entitled to agree application of the TMMC or parts of the TMMC in individual cases.

2.2 Materials

Metal ceiling components as defined by the TMMC are essentially made up of:

- Metallic materials
- Insulating materials
- Combinations of these materials

The properties of the components are connected with properties of the materials used. These have to meet the requirements for the intended use.

The primary components of metal ceilings do not consist of organic materials, so that fluctuations in dimensions and properties resulting from changes in temperature and/or humidity are comparatively low. Changes due to the climate, however, such as the results of heating, may be natural physical behaviour and be in accordance with the latest developments in the technology.

On account of the scope of this document and because there are different regulations in part for the materials used, not all of the materials listed in the following are dealt with in the TMMC.The materials used are:

2.2.1 Ceiling membranes

Steel

- Steel sheet as per EN 10327 or EN 10152, at least the quality DX 51 D or DC 01, galvanised
  - With powder coating
  - With special surfaces, such as non-woven fabrics, foils and coatings
- Steel sheet, coil-coated as per EN 10169 Parts 1 and 3, galvanised at least with quality DX 51 D as per EN 10327 or DC 01 as per EN 10152

Aluminium

- Alloy as per EN 5733-3
- Mechanical properties as per EN1396
- With powder coating
- Wet painted
- Aluminium sheet, anodised (coil anodised, individually anodised)

- With special surfaces, such as non-woven fabrics, foils and coatings
- Aluminium sheet, coil coated as per EN 1396

2.2.2 Sub-construction

Steel

- Steel sheet as per EN 10327 or EN 10152, at least quality DX 51 D, galvanised as per EN 13327 or DC 01, galvanised as per 10152; if necessary:
  - With powder coating
  - Wet painted
- Steel sheet, galvanised, coil coated as per EN 10169, Parts 1 and 3, at least quality DX 51 D, galvanised as per EN 13327 or DC 01, galvanised as per EN 10152

Aluminium

- Alloys as per EN 573-3 and/or EN 485-5
- Mechanical properties as per EN 1396
- Aluminium sheet coil coated as per EN 1396
- With powder coating
- Wet painted
- Aluminium sheet, anodised (band anodised, individually anodised)

2.2.3 Other materials for membranes and sub-construction

- High-grade steel
- Copper

Note

Metal ceilings made of “other materials” do not come within the scope of the TMMC. Application of the TMMC or of parts of the TMMC must be agreed in individual cases.

2.2.4 Fittings

Built-in fittings and accessory parts, such as lights, ventilation fittings, etc, are not explained in detail here and have to be engineered to fit the ceiling system by the building designer. This applies in particular to mechanical resistance, fastening, colour, equipment, construction and usage, such as inspection capability.

2.2.5 Liners and coverings

Liners and coverings used in conjunction with metal ceilings are:

- Liners in the ceiling membrane made of mineral wool and foamed materials
- Non-woven fabric inserted or glued in the ceiling membrane

These are regulated in respective product standards and/or national regulations and are not explained here in detail.

Insulating materials can influence the behaviour of metal ceilings and have to be engineered to fit the ceiling system.

If liners are used with a weight per unit area greater than 400 g/m², such as plasterboard panels, such ceilings are considered as special-purpose ceilings and any application of the TMMC or parts of the TMMC must be agreed in individual cases.

With metal linear component ceilings, any coverings on the carriers are permitted up to 1.5 kg/m², otherwise these have to be agreed on separately.

2.3 Material quality

The materials have to comply with the respective national statutory and other relevant regulations and rules. This applies both to manufacturer and installation.

2.4 Exposure conditions

Metal ceilings as per the TMMC are designed for use in the interior of buildings without any special requirements. The materials are designed for use under normal climatic conditions for room air without any corrosive pollution. The exposure conditions in accordance with 5.4.1, Table 3, Categories A and B shall apply. Any differing climatic conditions shall constitute special-purpose usage and must be agreed separately. Brief deviations are allowed during the installation.

Metal ceilings are basically resistant to cold. Also being good heat conductors, they are suited as heat exchange surfaces (chilled ceilings). For big differences in temperature, one must allow for the differences in thermal expansion there might be between the metal ceiling and the supporting sub-construction. Constant temperatures of higher than 50° C should be avoided with painted metal ceilings, as, depending on the colour used, the colour might change. Special attention should be given to this when installing lights, because if unsuitable lights are used, overheating can develop.

The building designer should take suitable measures to prevent the formation of condensation.

2.5 Special exposure conditions

If, for example, the climatic conditions to be expected differ from normal climatic conditions, special measures must be taken or arranged.If special exposure is to be expected, such as through corrosive liquids, gases or radiation, or if there are requirements upon the mechanical resistance beyond Category 3, the building designer must specify such requirements.

Then suitable measures to guarantee the safety and durability of the metal ceiling must be agreed on separately.

2.6 Special-purpose ceilings and special-purpose functions

Metal ceilings with special-purpose functions as defined in the TMMC are constructions which assume additional functions, through special surface-mounted fittings or constructions, for example, or which display special characteristics, such as:

- Ceiling heating and cooling systems
- Ceilings with requirements for fire resistance
- Ceilings with requirements for longitudinal sound reduction
- Ceilings with heavy liners and coverings
- Ceilings with special-purpose swing-down mechanisms
- “Outsized” ceiling panels
- Stretch-metal ceilings
- Baffle ceilings and structural module ceilings
- Clean room ceilings and ceilings with special requirements for hygiene and tightness
- Ceilings that are impact-resistant to balls thrown
- Ceilings for outdoor use
- Ceilings for use with high humidity exposure
- Earthquake-proof and shock-resistant ceilings
- Ceilings for chemical exposure
- Illuminated ceilings
- Metal tiles ceilings and planks ceilings made of aluminium
- Ceilings with special shapes, such as arches, trapeziums, etc
- Ceilings with special requirements for inspection capability
- All the ceilings cited in 1.2.3

Such ceilings do not come within the scope of the TMMC.
Application of the TMMC or of parts of the TMMC may, however, be agreed in individual cases.

3 Requirements for safety and mechanical resistance

3.1 General

The supporting elements (sub-construction, suspensions and their fasteners) have to safely transfer the loading by the metal ceiling onto the supporting building parts.
The fastening must be designed such that any failure or breakdown of a supporting element for the metal ceiling cannot result in a runaway crash.
The number of anchoring elements should be dimensioned such that the permissible load-bearing capacity of the anchors is not exceeded[1].

Structural connections should be selected or designed such that tolerances usual in buildings can be taken up without having any negative effect on safety. The on-site conditions, such as façade movements, instances of building expansion and expansion joints should also be taken into account and specified by the building designer.
The sub-construction has to be engineered to fit the ceiling membrane and have sufficient longitudinal and transverse stability.Only sub-construction elements approved by the manufacturer may be used.
Any built-in fittings or loads have to be separately suspended or accommodated. The application of any additional loads, fasteners and recesses, cables (sprinklers, built-in lights, speakers, vents, etc) on the ceiling has to be specified by the building designer and taken into account by the installation company responsible. Perimeter connections must be made according to the manufacturer’s regulations.

The sub-construction and ceiling membrane shall be separately prescribed for special applications, such as in kitchen areas, in outdoor areas (pressure forces and suction forces) for damp rooms and clean rooms as well as for rooms with special requirements for safety in case of fire, acoustics, resistance to balls thrown and similar special-purpose areas (see also Section 2.6).

If lightweight partitions are fastened to the metal ceilings, the forces resulting from the partitions have to be taken up by suitable constructions. Without special measures, metal ceilings as per the TMMC are not designed to take up the fixing of lightweight partitions.

To fix partitions to metal ceilings, the building designer shall provide specifications regarding both the design (mechanical resistance, acoustics, safety in case of fire, etc) and the loads to be assumed.

3.2 Profiles for sub-constructions

Unless the dimensions, type and quality of the material make it possible to calculate the certainty of the supporting capacity and the deflection according to technical building regulations, the manufacturer has to prove the certainty of the supporting capacity of the sub-construction in accordance with Section 6.

If a building component that has been tested once is used in a configuration that differs from the test, the manufacturer has to prove by calculation the load permitted, using the test data if necessary.

1) Note
If DIN 18168 is applicable nationally, at least one anchor per 1.5 m² of ceiling area should be positioned. The number of anchors selected may be fewer in these cases if a certificate is submitted according to technical building regulations, such as according to Eurocode 3 (European) or nationally (DIN 18168, Part 2, Point 1 and/or DIN 18800).

Constructions that are for direct (without connecting members adjustable in height) fixing of a ceiling membrane, (such as panel carriers, T-sections, profiles for modular grids, etc) have to comply with Deflection Category 1 of Table 1.
All other sub-construction profiles have to comply with Deflection Category 3.
The deflection of the sub-construction for Category 3 should be specified by the installation company. The loading values permitted (tensile strength, maximum allowable momentum, etc) shall not be exceeded.

The requirements for the planeness of the ceiling membrane remain unaffected, i.e. the planeness of the ceiling membrane must be complied with irrespective of the deflection by the sub-construction, and is regulated in Point 4. Any national regulations going beyond this must be complied with.

Table 1
Deflection categories of profiles for sub-constructions

Category	Maximum Deflection
Category 1	L /500, but not more than 4.0 mm
Category 2	L/300
Category 3	No limit

*) L is the span, which usually is the distance between the suspension elements and/or the bearing points.

The use of a certain deflection category is not prescribed in EN 13964. If national standards apply, such as DIN 18168, Deflection Category 1 is prescribed.

3.2.1 Sub-constructions made of steel

Steel of the at least the quality DX 51 D or DC 01 shall be used for sub-constructions made of galvanised coil or steel sheet as per EN 10327 or EN 10152.
If other steels are used, they have to meet one of the standards EN 10169, Parts 1 and 3, EN 10214 or EN 10215.
EN 10143 applies to the tolerance for thickness.
For further specifications, refer also to Section 5.4.1.

3.2.2 Sub-constructions made of aluminium

For sub-constructions made of aluminium alloys, the alloys have to fulfil EN 573-3 and EN 485-5, the 0.2% elastic limit has to be at least 160 N/mm². For further specifications, refer also to Section 5.4.1.

3.2.3 Sub-constructions made of wood

Wooden sub-construction for fastening metal ceilings are not regulated here and should be classified as special-purpose constructions according to Section 2.6.

3.3 Suspensions and connecting components

3.3.1 Suspensions and connecting components made of metal

The permissible load-bearing capacity of suspensions in connection with the sub-construction and of connecting components between profiles for the sub-construction shall be checked including the fasteners in accordance with Section 6 unless, the dimensions, type and quality of the material make it possible to determine the load-bearing capacity and deflection by mathematic calculation.
The fasteners shall be engineered to fit the profiles for the sub-construction with regard to load-bearing capacity and function.

3.3.2 Suspensions made of wood

Wooden suspensions for fastening metal ceilings are not regulated here and should be classified as special-purpose constructions according to Section 2.6.

3.4 Anchors and fasteners

3.4.1 General

The number of anchoring elements shall be dimensioned such that neither the permissible load-bearing capacity of the anchoring elements nor the permissible deformation of the sub-construction are exceeded. Follow the instructions by manufacturers of system or of individual components. The load-bearing capacity of the anchoring elements and of the construction parts have to be sufficient with regard to the loads to be applied.
The design (selection) of the anchoring elements is the responsibility of the installation company.

3.4.2 Design of fasteners

If the anchors are to be used in a solid construction part, for the anchoring elements selected the suitability shall be verified by a European Technical Approval (ETA) as per ETAG 001. In such case, the design of the anchoring elements has to comply with the ETA. When the ceiling is considered as a whole, the load arising from the suspension and the building components connected must not exceed the admissible load specified in the ETA for the anchoring element selected. The admissible displacement of the anchoring is specified in the ETA.

This must be taken into account if any displacement is possible of suspensions and connecting components. In addition to ETA-approved anchoring elements, anchoring elements with national approval may also be used.

If it is necessary to meet fire protection requirements, the manufacturer shall be consulted. Certified information on the load-bearing capacity shall be taken from the tests according to the standard tempera-

ture-time curve as per ISO 2841 and/or EN 13501-2 for anchors that are suited for suspended ceilings.
Alternatively, the information in the test certificates from the ceiling fire rating tests applies.
The installation shall be carried out strictly according to not only the instructions by the manufacturer of the anchoring elements selected but also the provisions of the certificates.

3.5 Ceiling membranes

The ceiling membranes shall be designed and installed such that when used as directed, their falling will be ruled out.When carrying out inspection work, comply with the TMMC' specifications, the manufacturer's instructions as well as the product-specific instructions for installation and use.
If metal ceilings are used that are in keeping with the regulations according to Section 2.6, the safety of the ceiling membrane against crashing shall be certified by the installation company separately.
For further specifications on materials, refer also to Section 5.4.1.

3.6 System conformity

The sub-construction and the ceiling membrane have to fit to one another.
Only structural elements approved by the manufacturer shall be used. The responsibility for proving equivalence when structural elements from different manufacturers are used shall be incumbent upon the installing company.

3.7 Additional requirements

All of the special-purpose constructions listed in 2.6 require suitable additional measures, which are not fulfilled in normal cases by suspended ceilings in accordance with TMMC. These additional measures shall be agreed on separately.

3.7.1 Wind load resistance

Wind loading can even occur in interior rooms, i.e. when windows and doors are open.
When allowing for such wind loading, one must assume that wind speeds may experience a varying degree of amplification locally due to the shape of the grounds, building or street fronts, vacant property, street indentations, the shape and height of the building, etc. To prevent damage, it is therefore pointed out that it is usual to close the windows during bad weather conditions, because these amplifications cannot presently be precisely calculated.
Consequently, pressure forces and suction forces cannot be assumed in a wholesale fashion. The wind loading must be determined and specified by the building designer in accordance with Sections 5.2 and 10.2 of ENV 1991-2-4. Due to their usually open structure and the resulting possibility for pressure compensation, metal ceilings generally display comparatively favourable behaviour.
If no information is provided in this regard, metal ceilings according to the TMMC are designed for pressure forces and suction forces of 40 N/m².If greater pressures are to be applied, additional measures are usually necessary and shall be arranged seperately.
With the wind loading assumed above or with a wind loading specified in an individual case, constructions in accordance with TMMC must not, when used as directed, result in either the ceiling falling or in any suspensions or fasteners detaching.

3.7.2 Impact resistance

When suspended ceilings have to resist the effects of impacts (such as by balls in gymnasiums), the building designer shall identify and cite the type of such effects.
Ceilings as per the TMMC are not impact-resistant in accordance with EN 13964.
If such requirements are to be met, additional measures have to be agreed on separately.

3.7.3 Seismic resistance

When suspended ceilings have to resist seismic effects, the building designer has to identify and cite the type of such effects.
If such requirements are to be met, additional measures have to be agreed on separately.

3.7.4 Load-bearing capacity of the ceiling membrane

Sub-constructions as per the TMMC are not designed to assume additional loading.
If such additional loading is to be applied, such as through the installation of light fixtures, etc, then Section 3.1 as well as the manufacturer's instructions shall be complied with.

3.7.5 Electrical safety

Electrical installations (electrical cables and systems) that are installed in or over suspended ceilings have to meet the requirements according to CENELEC HD 384 or country-specific regulations.
Electrical cables shall be supported such that no damage occurs to the cables, their insulation or their connections, either by stress or by the type of fastening.

4 Dimensional tolerances
4.1 Metal tiles and metal planks
4.1.1 Tolerances
4.1.1.1 Dimensions of elements
Note:
These tolerances only apply to unperforated panels and panels with edges without perforation. If the perforation is run beyond the edging, the tolerances have to be determined separately.

For element length:
(based on the longer side)
+0 -0.4 mm/m
For length under 1.0 m:
+0 -0.5 mm
For element width:
+0 -0.4 mm

4.1.1.2 Deflection
In the centre of the long the edge (A1 and A2); in the centre of the visible surface (B).
Specifications for perforated panels, 4 mm maximum diameter of the holes, maximum open cross-sectional area of 25%. Additional liners/ inserts may increase the deflection. Offsets in height between individual panels are allowed as long as the panels do not exceed the deflection tolerances allowed.

Fig. 48 Deflection of metal ceilings

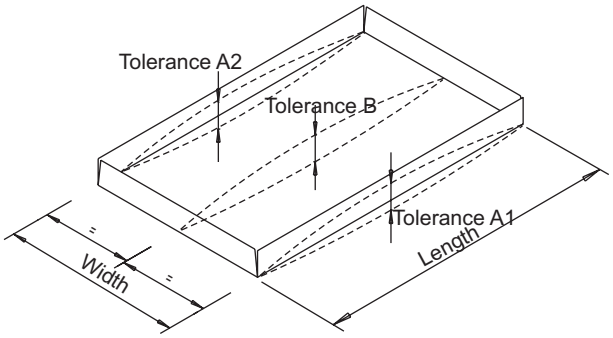


Table 2

l = length in mm	0 < l ≤ 1000		1000 < l ≤ 2000		2000 < l ≤ 3000	
b = width in mm	A1/A2	B	A1/A2	B	A1/A2	B
0 ≤ b ≤ 400	- 0.5 + 0.5	- 0.2 + 3.0	- 0.5 + 1.5	- 0.2 + 4.0	- 0.5 + 3.0	- 0.2 + 6.0
400 < b ≤ 500	- 0.5 + 0.5	0 + 4.0	- 0.5 + 1.5	0 + 5.0	- 0.5 + 3.5	0 + 7.0
500 < b ≤ 625	- 0.5 + 0.5	0 + 6.0	- 0.5 + 1.5	0 + 7.0	- 0.5 + 4.0	0 + 9.0
625 < b ≤ 1250	- 0.5 + 0.5	0 + 10.0	- 0.5 + 1.5	0 + 13.0	to be agreed on	

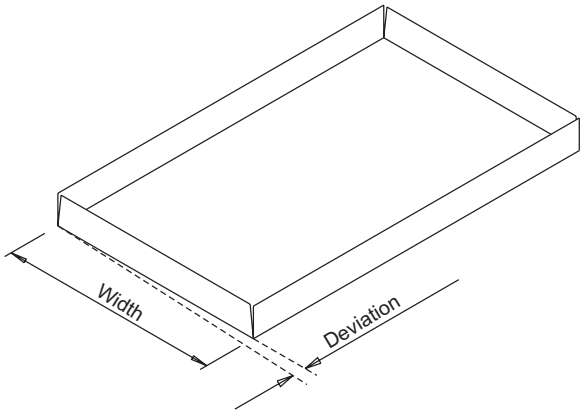
(Negative figures indicate arching upwards)

For lengths of 1000 mm and upward, A1 and A2 may differ from the figure specified in table 2 by a maximum of 50%. Constrictions in the centre of the metal ceiling panel depend on the tolerances between A and B and may change the straightness of the edges.

4.1.1.3 Angularity
The angularity of the long edge, based on the short edge.Widths up to 625 mm:
±0.5 mm

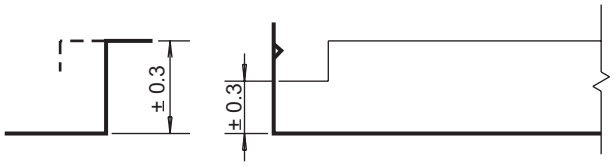
Widths of 625 mm to 1250 mm:
±0.6 mm

Fig. 49 Angularity



4.1.1.4 Height of the thin-gauge membrane component
From the bottom of the edge to the top of the edge, depending on the design, measured on the element:
±0.3 mm.

Fig. 50 Examples of edging



The deviations from 90º by the vertical edge are caused by production and system. Tolerance specifications for cut-outs in the edges (levelling point) only apply to clip-in designs.

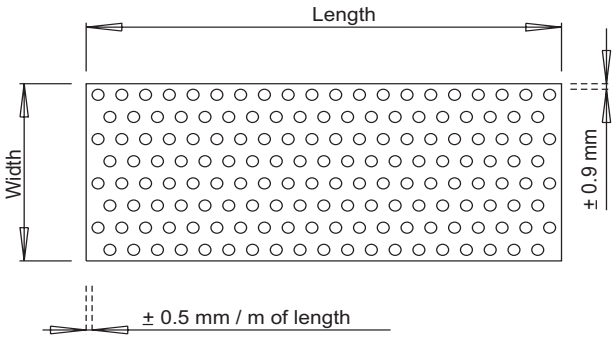
4.1.2 Perforation and liners
Selection of the visible perforation pattern depends on architectural and acoustic requirements. The designation of the various perforation patterns should be taken from the manufacturer's specifications. The edge being unperforated depends on the perforation pattern used and may be different on the long and short sides. With different panel lengths the unperforated edge may vary in width on the end sides. When the open cross-sectional area is determined, only the perforated areas are calculated in, unperforated areas such as the edges are not considered.

The specification of the diameter of the holes is without any surface coating. The open cross-sectional area may change depending on the type of surface treatment. Acoustic inserts are allowed up to a weight per unit area of 400 g/m² without effects on the deflection.
Dark non-woven fabrics are usually installed.
If light-coloured non-woven fabrics are used, especially white ones, different shades may occur.

4.1.2.1 Perforation deviation

Deviation by the unperforated edge on the long sides: ±0.9 mm
Deviation from the unperforated edge on the short sides: ±0.5 mm/m of element length
for lengths under 1.0 m: ±0.5 mm

Fig. 51 Perforation



4.2 Metal linear component ceilings

Principle of the assembly

Fig. 52 Linear component (cross-section)

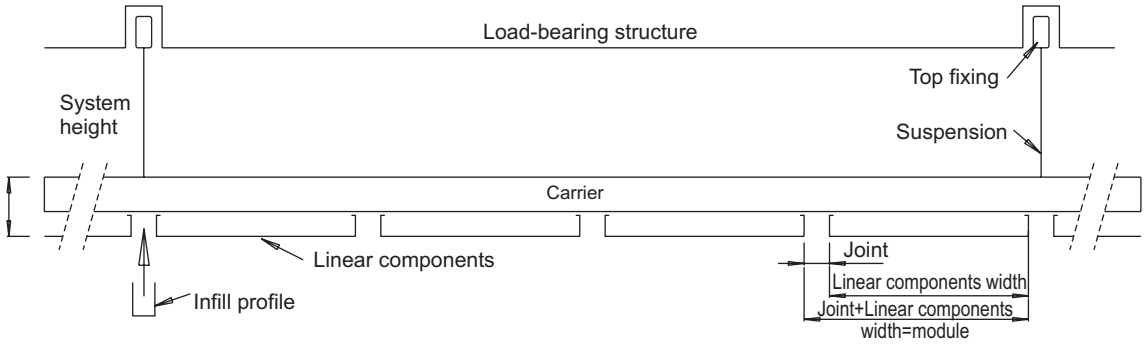
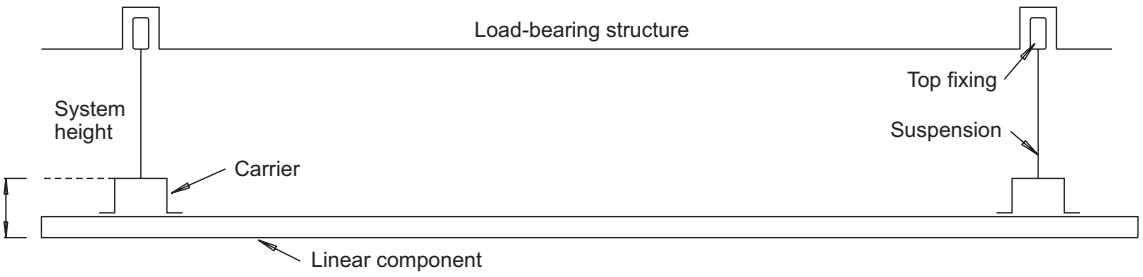


Fig. 53 Linear component (longitudinal section)



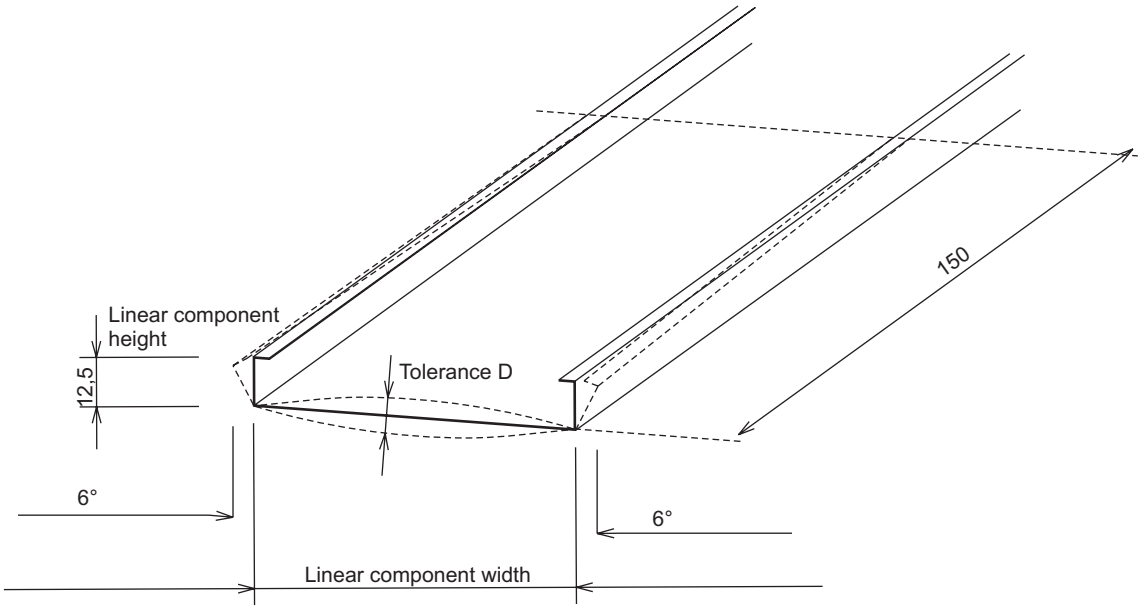
4.2.1 Tolerances for the linear components

4.2.1.1 Dimensions of the linear components

Panel height: ± 0,30 mm
Panel length: 850 - 3000 mm ±1,00 mm
> 3000 - 6000 mm ±1,50 mm
Panel width : ± 0,50 mm

Due to material properties as well as production, additional dimensional deviations occur on the panel ends because of spring-back as shown in Fig. 54 and Fig. 67.
The spring-back amounts to a max. of 6° per side or 0.1 x the height of the metal linear component (equalling 1.25 mm for a metal linear component height of 12.5 mm). Inserts are allowed up to 400 g/m². Coverings are allowed up to 1.5 kg/m²

Fig. 54 Width/height

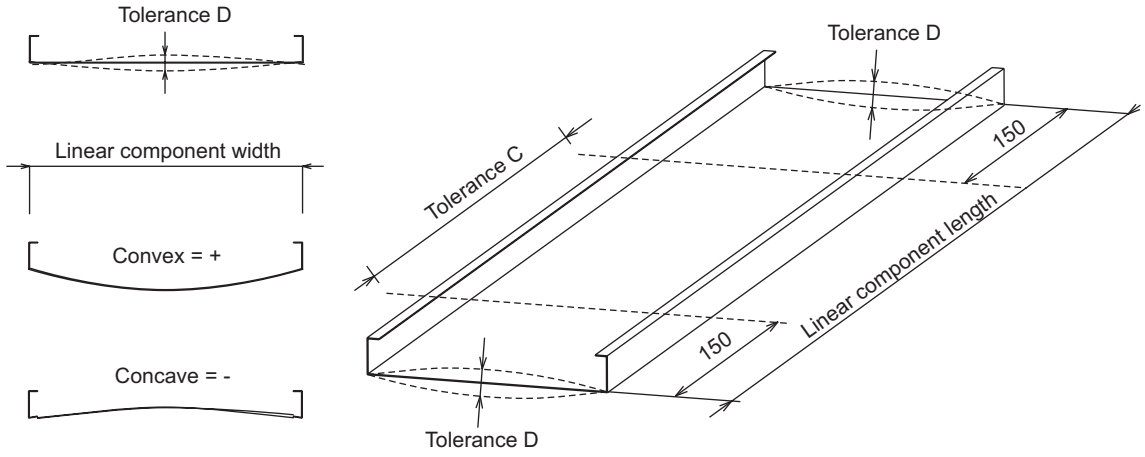


Height of metal linear component	12,5	15,5	24,5	28,5	38,5
Spring-back per edge	1,25	1,55	2,45	2,85	3,85

4.2.1.2 Surface planeness

Note:
Special requirements upon the linear component planeness for the perimeter trim connection shall be specified by the building designer.

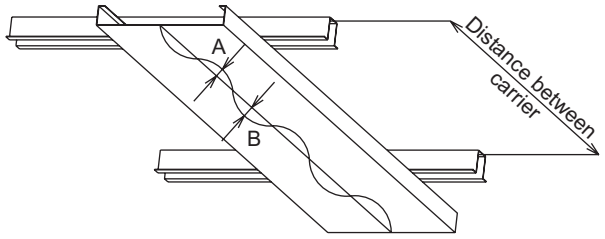
Fig. 55 Surface planeness



Linear component width			
0 - 100	**101 - 200**	**201 - 300**	**301 - 400**
C	**C**	**C**	**C**
-0.50	-0.75	-1.00	-1.25
+1.00	+1.50	+2.00	+2.20
D	**D**	**D**	**D**
-1.00	-2.00	-3.00	-3.50
+1.00	+1.50	+2.00	+2.20

4.2.1.3 Waves

Fig. 56



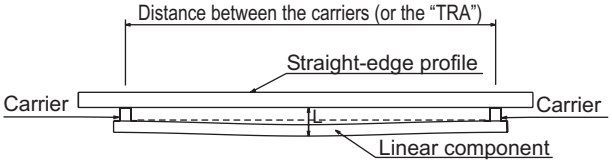
Due to material properties as well as production, waves may develop in the visible surface of the linear component.

Waves			
Width of linear component			
0 - 200		201 - 400	
A	B	A	B
-0.25	+0.25	-0.40	+0.40

4.2.2 Linear component deflection between two carriers

The deflection of the metal linear component between two carriers/points of support amounts to 1/500 x distance between the carriers (or the "*TRA*"), measured in the centre between two carriers or points of support.

Fig. 57 Deflection



4.2.3 Special lighting conditions

Deviations in the planeness and waves due to material properties or production may become visible under special lighting conditions, even though the tolerances above are complied with.

4.2.4 Camber

Deviation is a maximum of 1/1667 x panel length, measured in the centre of the panel length (equalling 0.6 mm to 1.0 m).

4.2.5 Perforation

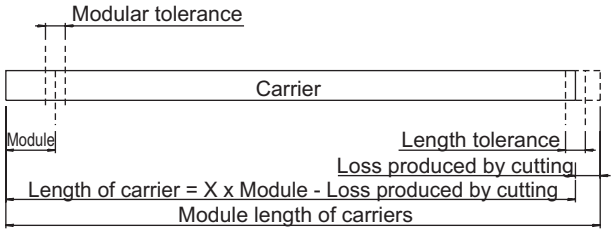
The metal linear components are perforated over the ends. Therefore differently cut perforation holes at the linear component ends can occur.

4.2.6 System height of the metal linear ceiling system

The system height cited by the manufacturer has a system height tolerance of ±1 mm.

4.2.7 Tolerances for the carriers

Fig. 58 Modular length of carrier



4.2.7.1 Module tolerance for the carrier

A tolerance of ±5/100 mm per module applies to the carrier module.

4.2.7.2 Length tolerance

The length of the carrier is a multiple of the carrier - module.

The length of the carriers results from the number of carrier- modules, including module tolerances, minus a length difference (loss produced by cutting) to be cited by the manufacturer.

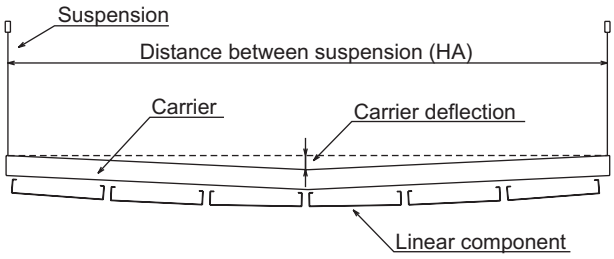
Productionwise, each carrier begins and ends in the joint of the punching-module.

The module dimensions are guaranteed even over several carriers by utilising carrier connecting components or manufacturer 's installation instructions.

4.2.7.3 Deflection of the carriers between two suspension points

The deflection of the carriers between two suspension points amounts to 1/500 x the distance between suspensions (HA), measured in the centre between two suspension points.

Fig. 59 Carrier deflection



5 Requirements for surfaces and exposure

5.1 General

For the requirements described further on (see Point 6), a distinction must be made between coil coating and individual coating, because these manufacturing processes for the finishing are technologically fundamentally different.
Whereas with linear component ceilings as per the TMMC, the finishing on aluminium coils is always applied prior to the shaping and perforation, the surface of metal tile and metal planks may also be coated after their production has been finished, such as by wet painting or by powder coating.

Surface coating for metal planks and metal tiles:
- Powder coating on steel sheet
- Wet painting on steel sheet
- Coil coating on steel sheet
- Coatings on aluminium sheet[1)]
- Coil anodised aluminium[1)]
- Individually anodised aluminium[1)]
- Special-purpose coatings, such as foils, fibrous webs, etc[1)]

Surface coating for metal linear components:
- Coil coating on aluminium sheet or steel sheet
- Wet painting on steel sheet[1)]
- Special-purpose coatings, such as foils[1)]

1) TMMC application must be agreed on separately

As long as no other agreements have been made, the specific requirements listed in the following apply to the surfaces listed above, irrespective of the method of production selected.
When assessing tolerances for colours and gloss rates, a distinction must be made as to whether finishing subject to assessment:
- Are being used in one and the same room
- Are being used in direct combination with other installations painted the same colour
- Are being used in rooms that are independent of one another
- Are produced and assembled in continuous batches

The specifications made in the TMMC apply to cases in which direct abutment takes place; greater deviations are allowed in situations that are spatially independent of one another.
Deviations occurring in places and which, due to their being locally restricted and insignificant and are not visible to the normal human eye at distances greater than 1.5 m, are negligible.

If the direction of installation influences the visual quality, this must be sufficiently labelled by the manufacturer and taken into account during installation and inspections.

The following specifications apply to visible sides. Visible sides are all surfaces visible from beneath, but not including the edging. Any specifications differing from this should be stipulated to the manufacturer.

The thickness of the coating depends on the various methods of production. A minimum coating thickness is not prescribed. Even covering of the base material as well as compliance with the specifications for the surface and tolerances must be guaranteed, irrespective of the thickness of the coating. Requirements upon light reflection are not regulated in the TMMC.

If such is agreed on separately, one must take into account the influence of the perforation and/or of any inlays on the reflection coefficient.
In cases of colour matching between different manufacturers of, for example, built-in fittings, providing samples is required at least in DIN A5 (unperforated).

It is not sufficient to only indicate the colour according to, for example, RAL, NCS, etc. Deviations from such colours for which samples have been supplied should be treated analogously to 5.2 and 5.3.
If binding colour samples are agreed on, it is advisable to keep (until the inspection for acceptance of the construction work) colour return-reference samples, at least for each batch of the main colours.
In cases of subsequent deliveries after long periods of time, greater deviations in surfaces have to be accepted than according to 5.2 and 5.3. The same applies when subsequent delivery of the same colour is not possible due to changed technical conditions (such as new environmental protection laws).

5.2 Requirement upon the surface for coil-coated materials

5.2.1 Colour / colour deviation

The deviation permitted results according to EN 1396. This standard is based on coil-coated, unperforated sheeting made of aluminium. Requirements for coil-coated steel sheet result from EN 10169, Parts 1 and 3.

5.2.2 Mechanical properties / resistance

The resistance of the painted surface of coil-coated aluminium sheet meets the standard EN 1396, Table C1, Category 2a. That of coil-coated steel sheet meets EN 10169, Parts 1 and 3, Category CPI 2.
The mechanical properties of painted surfaces meet the specifications of EN 13523 and/or ECCA T1 to T23.

5.2.3 Class of exposure

Coil-coated metal sheets meet the requirement for use in the interior of buildings according to the exposure conditions. See 2.4.

5.3 Requirement upon the surface for powder-coated and wet-painted materials

5.3.1 Deviations from gloss rate

The tolerance specifications apply to measurements according to ISO 2813 and are prescribed as follows:

Matt gloss	
(0 < 30 E)	±4 E deviation
Medium gloss	
(30 < 70 E)	±5 E deviation
High gloss	
(70 d" 100 E)	±6 E deviation

The incidence angle is 60°. For gloss rates below 20 E, an 85° measuring head should be used..

5.3.2 Colour / colour deviation

A distinction should be made here between white colours and non-white colours.

5.3.2.1 White colours

With the white colours primarily used, the ΔE-difference according to the CIE-Lab method as per ISO 7724-2 and ISO 7724-3 must not be greater than 1.0 per production batch. A greater tolerance than ΔE = 1.0 is possible when different deliveries from one manufacturer are added or in combination with products from a different manufacturer (such as light fittings).

5.3.2.2 Non-white colours

For non-white colours, the ΔE-distances according to the CIE-Lab method as per ISO 7724-2 and ISO 7724-3 may also be above 1.0, colour differences being more difficult to recognise visually in such cases. If nothing special is prescribed, ΔE = 1.5 applies. Tolerances for metallic paintwork have to be agreed on separately.

5.3.3 Mechanical properties / resistance

The painted surfaces comply with normal usage as per EN 13964, Table 7, Categories A and B.

5.4 Corrosion-protection requirements

5.4.1 Corrosion

The usage categories are regulated according to Table 3.

Table 3: Exposure Categories

Category	Conditions of Use
A	Components of buildings that are generally exposed to varying relative humidity of up to 70% and varying temperature of up to 25° C, but without corrosive pollution
B	Components of buildings that are frequently exposed to varying relative humidity of up to 90% and varying temperature of up to 30° C, but without corrosive pollution

The level of corrosion protection for metal ceilings according to the TMMC only meets environmental conditions as per Table 3, Categories A and B, as they are found in enclosed spaces, such as in housing units (including kitchens and baths), offices, schools, hospitals and sales premises.The following detailed requirements are placed upon this corrosion protection:

Table 4
Corrosion protection categories of the metal components of sub-constructions and ceiling membranes

Category according to Table 3	Sub-construction profiles, suspensions a), fasteners and ceiling membranes	
	components made of steel	Components made of aluminium
A	Products made from continuously hot-dip galvanised coil and sheet, Z100, ZA095 or AZ100 as per EN 10327 b) c) Products made from electrolytically galvanised, cold-rolled flat rolled steel, ZE25/25 as per EN 10152c) Organically coil-coated flat rolled steel made of steel of corrosion protection category (interior areas) CPI2 for the side used, as per EN 10169, Parts 1 and 3 f) (such as coating system ZE15/15-HDP25-2T-CPI2)	No additional corrosion protection required
B	Products from continuously hot-dip galvanised coil and sheet, Z100, ZA095 or AZ100 as per EN 10327 b) c) Products made from continuously electrolytically galvanised, cold-rolled flat rolled steel as per EN 10152, with or without additional organic coating d) as follows c): ZE25/25 + 40 µm per side e), ZE50/50 + 20 µm per side e) or ZE100/100 without organic coating Continuously organically coated (coil-coated) products in the corrosion protection category (interior areas) CPI2 for the side used as per EN 10169, Parts 1 and 3 f) (such as coating system ZE15/15-HDP25-2T-CPI2)	No additional corrosion protection required or coil-coating as per EN 1396, Corrosion Index 2a

a) If round steel wire is used as a suspension or part or a suspension, it has to meet the requirements according to ISO 7989 (zinc coating for round steel wire).
b) prEN 10327 replaces EN 10142 (Z), EN 10214 (ZA) and EN 10215 (AZ).
c) A similar corrosion protection is allowed it if results in similar protection.
d) Post painting of parts with a zinc-compatible organic coating as per EN ISO 12944-3 or an equivalent coil coating in accordance with EN 10169, Parts 1 and 3.
e) This only applies to ceiling membrane components.
f) This only applies to capping material for sub-construction components.

Note:If according to national standards, DIN 18168 applies, the corrosion protection cited there shall be carried out.

5.4.1.1 Alternative methods of corrosion protection

All methods of corrosion protection are permitted if they meet the requirements cited above in their protective effect. The effectiveness of alternative methods of protection shall be proven.

5.4.1.2 Special-purpose corrosion-protection requirements

For special areas of use indoors, the relevant standards have to be complied with and special measures agreed on. See Section 2.6.

5.4.1.3 Exemptions to corrosion protection

Standardised components, such as bolts, nuts, split washers, serrated lock washers, metal-plate spring-action locknuts, toothed lock washers, etc, have to have a corrosion-protection coating usual for such mass-produced parts (galvanised, chemically blacked, etc), e.g. as per ISO 7989. No separate requirements are prescribed for ceilings according to the TMMC.

5.4.2 Contact corrosion

Contact between different materials must be prevented if corrosion could develop.

Any special requirements going beyond this, such as per EN ISO 12944-3 have to be agreed on separately.

6 Test methods

6.1 General testing conditions

Unless described otherwise, the test methods described in the TMMC are carried out directly at the manufacturer's after production or in test laboratories.
This enables accuracy and reproducibility of the test results.
Binding measurements shall be carried out under defined conditions in the test laboratory, using suitable, calibrated measuring instruments. Alternatively, measurements may be carried out at the construction site in order to provide some orientation if sufficiently reproducible conditions can be created. If measurement results on site are influenced by the sub-construction, such influence shall be determined and taken into account.

6.2 Test methods for mechanical resistance

6.2.1 General

This method of testing shall be used on metal sub-constructions, suspensions and connecting components whose load-bearing capacity cannot be proven according to static dimensioning rules (technical building regulations). The safety factor is 2.5.
If national standards apply, such as DIN 18168, the relevant safety factors apply.
Those national standards contain further information about carrying out tests and determining the permissible load-bearing capacity.
The test pieces have to be tested for all features characteristic of the construction site. The test results are used to determine and/or calculate the deflection of primary profiles as well as the loading permitted for the components and/or constructions tested and they include various types of loading, spans and components.
If there is a sub-construction, a bending test shall be carried out.
The planeness tolerances for the ceiling membrane must be complied with, irrespective of the bending and/or displacement of the sub-construction.In special cases it might be necessary, irrespective of the testing of individual components for the sub-construction, to test complete systems in order to examine visible properties, such as planeness, installation accuracy and general appearance.
The ceiling membranes themselves do not require testing as long as they do not assume any additional loading, with the exception of that cited in 2.1.

6.2.2. Sub-constructions made of metal

6.2.2.1 General

The sub-construction profiles supporting the ceiling membranes and possibly additional loads, and which carry the load onto supporting building parts shall be tested if the load-bearing capacity cannot be determined by calculation.
The load-bearing capacity of the metal sub-construction profiles is determined by bending tests at various spans and loadings. The specifications according to 3.2 must be complied with for the permissible load-bearing capacity.
The bending test supplies characteristic information for the sub-construction profiles with regard to:
Tensile bending strength EI [N mm²]
Permissible bending moment M [N m]

6.2.2.2 Testing procedure, assessment and test report

How the testing is carried out, the assessment of the testing and the drawing up of the test report are all regulated in Sect. 5 of EN 13964.

6.2.3 Suspensions and fasteners made of metal

6.2.3.1 General

The testing of the suspension shall include all the elements except for the anchors (such as plugs). Anchors to supporting building elements have to be engineered to fit the suspension.
Suspensions and connecting components are loaded to their breaking point. The minimum load-bearing capacity is 0.15 kN.

6.2.3.2 Testing procedure, assessment and test reports

How the testing is carried out, its assessment and the drawing up of the test report are all regulated in Sect. 5 of EN 13964.

6.2.4 Dynamic testing

This testing shall be carried out if wind loading occurs in the indoor area, if the loads cited in 3.7.1 are exceeded or if national regulations require it. The details are regulated in Sect. 5.3.3 of EN 13964.

6.2.5 Monitoring of the material properties and dimensions

The manufacturer shall assure that the values measured during the monitoring of the manufacture comply with the values specified in the test report.

6.3 Test method for dimensional accuracy and deflection of ceiling membranes

The following methods for testing the dimensional accuracy and deflection of metal ceilings and their constructions can be used for laboratory tests and test at the construction site when they are already installed, provided general conditions are met, such as sufficiently even bearing surfaces and suitable linear straight-edge profiles.

In doing so, one must take into account the fact that influences by the construction and installation can have an influence on the test result. The values found at a construction site can therefore only provide indications for testing at the factory or laboratory.
Individual one-offs due to unique errors shall not be taken into account.

Factory or laboratory tests are decisive in determining whether products have been delivered within the limits of the tolerances agreed on.

Factory or laboratory tests eliminate constructional influences by providing as far as required a construction that is levelled, aligned in right-angled fashion and stress-free, into which the products to be tested are installed.

The respective structure of the construction should be inspected for right-angle squareness and levelness prior to the start of the testing, using precision tools.

ISO 3599, ISO 6909 & ISO 8512-2 apply with regard to the units, testing equipment and terminology.
Calliper gauges, depth gauges, dial gauges, rulers and measuring tables (such as proof planes) have to comply with these standards.
Alternatively, measuring instruments, such as testing frames with electronic sensors, etc, can be used if their accuracy is sufficient and proven and monitored accordingly (such as with block gauges). Such devices shall have surface planeness at least in accordance with Fig. 61.

Lengths greater than 2 m may be recorded using a tape measure, a meter stick or suitable measuring equipment, such as with electronic gauging sensors.

If tape measures are used, they have to be produced and inspected at least for Accuracy Rating 2 according to the European Weights and Measures Regulations for tape measures up to 10 m in length.

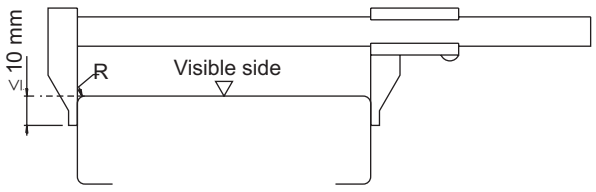
For binding determination of dimensions with tape measures, a tape measure deposited by the factory is decisive, because substantial tolerances are permitted for tape measures with Accuracy Rating 2.

6.3.1 Test method for dimensional accuracy and deflection of metal planks and metal tiles

6.3.1.1 Testing dimensions of the elements

This testing can be carried out on a level surface or with panels supported only at the corners.

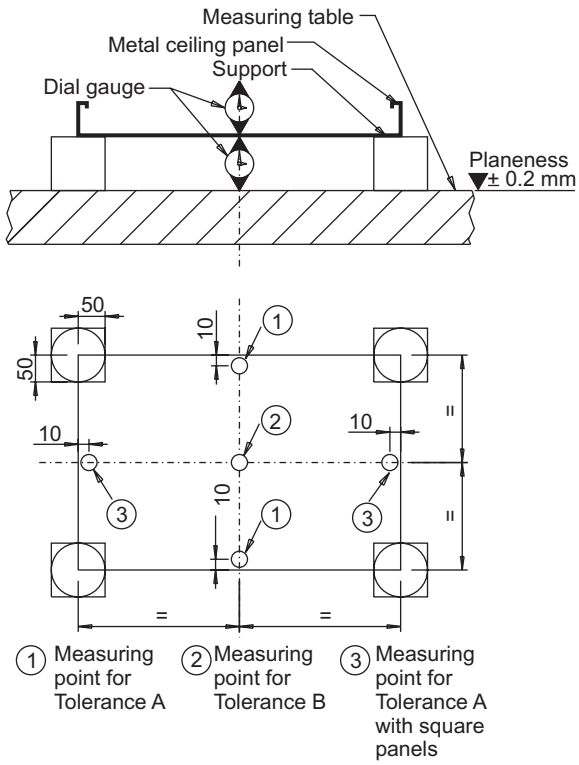
Fig. 60 Example of measurement with a slide gauge



6.3.1.2 Testing of deflection

This testing requires a sufficiently level surface, such as a proof plane or another suitable device that allows planeness of at least +/- 0.2 mm. When recording the deflection, be sure not to deform the ceiling membranes while measuring them, especially in the centre of panel surface. For testing at a construction site to provide orientation, testing set-ups analogous to Fig. 71 can also be used.

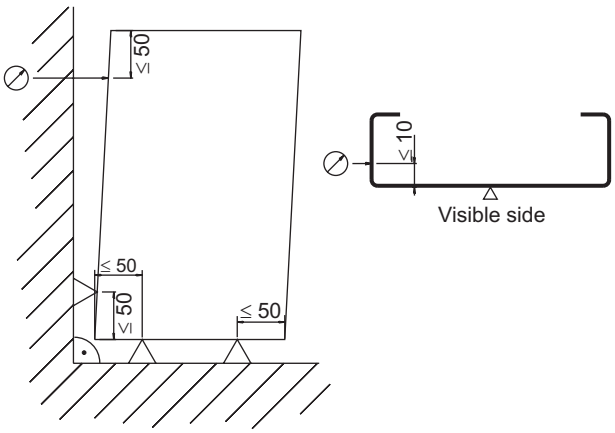
Fig. 61



6.3.1.3 Testing of angularity

This testing can be carried out on a level surface or with panels supported only at the corners. When carrying out the test, be sure precise three-point contact is provided.

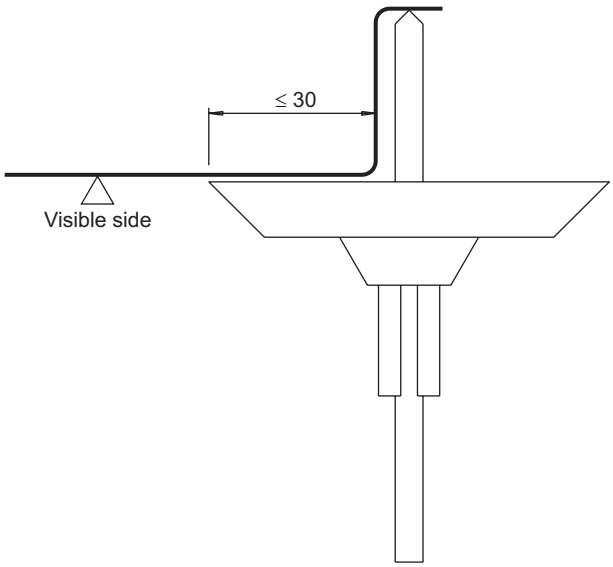
Fig. 62 Example of measuring angularity



6.3.1.4 Testing of height of metal planks and metal tiles

Other dimensions, such as of cut-outs, additional edging, etc, should be recorded correspondingly. Datum planes should be specified in individual cases if required; otherwise the manufacturer's specifications apply.

Fig. 63



6.3.2 Testing of dimensional accuracy and deflection for metal linear components

6.3.2.1 Linear component length

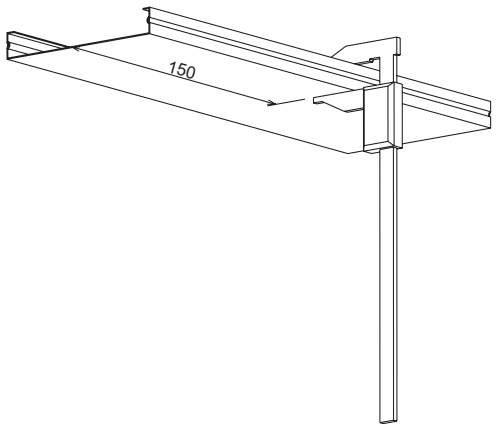
Use a tape measure to determine the linear measurement and/or deviation in dimension.

6.3.2.2 Panel height

To test the panel height, use a steel calliper gauge or a digital calliper gauge with accuracy of +/- 0.02 mm.

When testing the panel height, be sure to do so at least 150 mm away from the end of the panel.

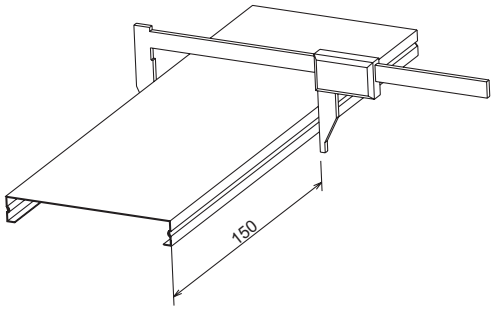
Fig. 64



6.3.2.3 Linear component width

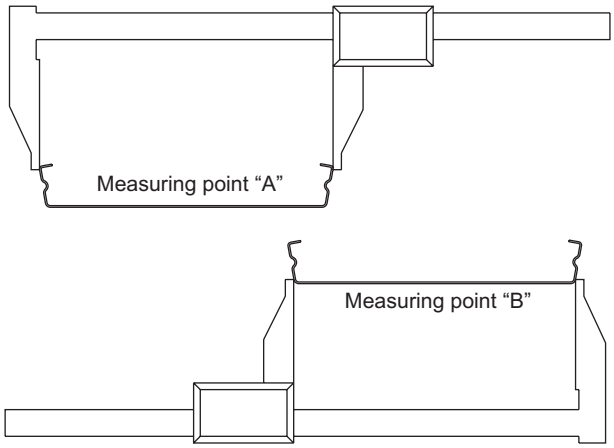
Carry out this measurement following the same procedure as for the panel height.

Fig. 65



The dimensions for spring-back at the panel ends is determined by two measurements.

Fig. 66



Measurement 1 is taken over the widest place in the panel width at the end of the panel.
Measurement 2 is taken over the visible surface of the panels, but 150 mm away from the end of the panel.The deviation is (Measurement A – Measurement B) / 2

The measurement of the angle can be carried out using a high-accuracy all-purpose protractor or a digital protractor.

Fig. 67

6.3.2.4 Surface planeness and waves

The dimensions for planeness and waves are tested with the aid of an H-ruler and a high-accuracy digital depth gauge.

Fig. 68 (Concave)

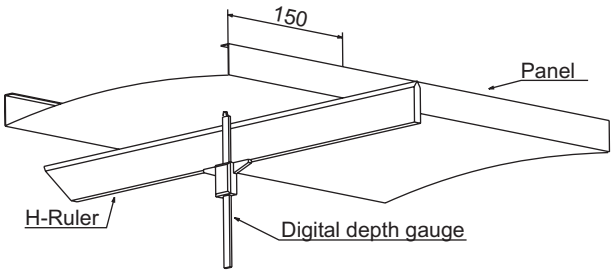
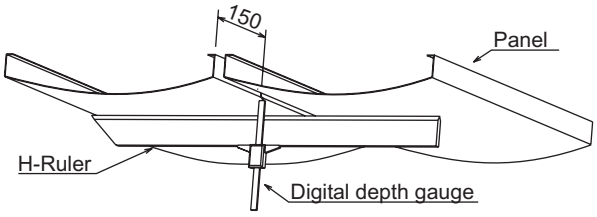


Bild 69 (Convex)

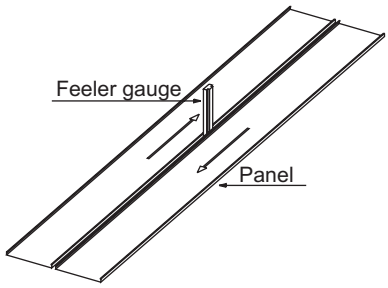


Digital depth gauge. Be sure to measure the planeness for Tolerance D at the end of the panel, Tolerance C shall not be measured less than 150 mm away from the end of the panel.

6.3.2.5 Camber

The camber of panels is tested on a completely level surface. Two panels are laid along the entire length next to one another, one of the panels being turned by 180 degrees. Using a feeler gauge, measure the distance between the panels in the centre of the panel length.

Fig. 70

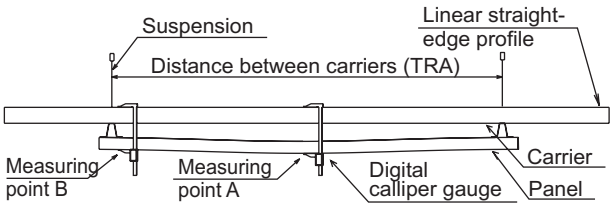


The measured value for the camber is (value measured by the feeler gauge) / 2

6.3.2.6 Linear component deflection between two carriers

This measurement is carried out using a linear straight-edge profile and a high-accuracy calliper gauge.
One must first check at the construction site as to whether the manufacturer’s installation guidelines have been complied with in regard to the maximum distance between carriers.

Fig. 71



The mean distance between carriers shall be selected as Measuring Point A.

The centre of the cross-section of the carrier shall be selected as Measuring Point B.

The degree of deflection = Measuring Point A - Measuring Point B

6.3.2.7 Carrier module tolerance

The module tolerance is measured over the entire factory-made length of the carrier. Suitable measuring instruments shall be used (such as a tape measure with Accuracy Rating 2).

The desired length of the carrier is produced by the following formula:

Number of modules x module [mm] - loss produced by cutting

Example 1: 40 x 100 mm – 5 mm = 3.995 mm
Example 2: 80 x 50 mm – 5 mm = 3.995 mm

The loss produced by cutting shall be specified by the manufacturer.

The maximum deviation in length from the module tolerance is calculated as follows:

Number of modules x module tolerance (max.)

Example 1 $40 \times \frac{5}{100}$ mm = +/- 2 mm

Example 2 $80 \times \frac{5}{100}$ mm = +/- 4 mm

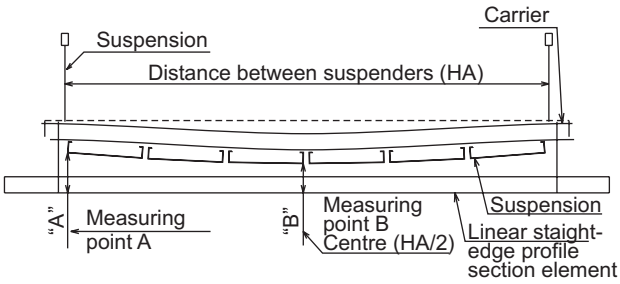
The dimensional accuracy is met when for several carriers measured, the actual length is not greater than the desired length plus or minus the maximum deviation in length.

6.3.2.8 Deflection of carriers

The measurement of the deflection of the carriers between two suspension points is carried out using a linear straight-edge profile fixed next to the suspension and a high-accuracy calliper gauge.

One must first check at the construction site whether the manufacturer's installation guidelines have been complied with in regard to the maximum distance between suspensions.

Fig. 72



The suspension position shall be selected as Measuring Point A.

The mean distance between suspensions shall be selected as Measuring Point B.

Measure the distance between the linear straight-edge profile and the visible surface of the panel.

The degree of the carrier deflection
= Measurement A – Measurement B

6.4 Test methods for surfaces and exposure

6.4.1. Testing conditions

These tests are carried out in a laboratory with climatic conditions according to EN 23270, i.e. a temperature of 23 ±2° C and relative humidity of 50 ± 5%.
The test piece shall have an unperforated surface the minimum area of which meets the requirements of the respective test standard.
If appropriate surface areas are not available, a visual assessment shall be carried out in accordance with ECCA-T22 (1995).

6.4.2 Measuring the desired thickness of coatings

If desired thicknesses of coatings have been prescribed by individual agreement for metal ceilings, the measurement shall be carried out according to ISO 2360.

6.4.3 Measuring the gloss rate

The measurement of the gloss rate shall be carried out according to ISO 2813.

6.4.4 Measuring colour deviations

This measurement shall be carried out according to the CIE-Lab Method as per ISO 7724-2 and ISO 7724-3.

6.4.5 Mechanical resistance

With coil-coated metal ceilings the measurement of mechanical resistance and of the resistance of surfaces shall be carried out according to EN 1396 and/or EN 10169, Parts 1 and 3 and/or EN 13523 and/or ECCA T1 to T23.

For all other types of coatings, the measuring conditions shall be defined in individual cases. In the absence of such specifications, the regulations specified by the manufacturer apply.

6.4.6 Test method for corrosion protection

The test methods for corrosion protection are regulated in EN 12944-3.

7 Safety in case of fire

Requirements for safety in case of fire (reaction to fire and resistance to fire) can result both from statutory regulations and from agreements under private law (such as insurance policies).
Metal ceilings in accordance with the TMMC are especially well suited for complying with requirements upon, for example, non-combustibility. Building designers have to specify the concrete requirements, such as in conjunction with inserts, coverings, surfaces, etc.
Unless expressly regulated otherwise, specifications cited by manufacturers apply to materials and components according to the certificates cited in the manufacturer's specifications.
To be transferred to the situation at a construction site, these shall be assessed by the building designer.

7.1 Fire resistance

If requirements are placed upon the fire resistance of a metal ceiling, then these shall be assessed according to the national regulations.
The suspended ceiling to be tested shall be representative of the entire ceiling system (suspensions, sub-construction, ceiling membranes, connections & built-in fittings) for which the fire resistance rating is required.

7.2 Reaction to fire

If requirements are placed upon the reaction to fire rating of a metal ceiling, then these shall be assessed according to the national regulations.

8 Acoustics

Requirements for acoustics (reduction of airborne sound and impact sound, sound absorption) may result from statutory regulations or from agreements under private law.Metal ceilings in accordance with the TMMC are basically suited to comply with such requirements. The building designer shall specify these requirements separately.

Unless expressly regulated otherwise, specifications relevant to acoustics cited by manufacturers are based on laboratory results.

8.1 Sound absorption

The degree of sound absorption required and the arrangement of the sound-absorbing surfaces depend on a number of factors.
These factors include the type of use for the room, the type of sounds produced, the necessity to control reverberation and the reflection properties of the peripheral surfaces.

The reverberation time required as well as the type, amount and arrangement of the materials effecting the acoustics shall be determined and calculated by the building designer.

For suspended ceilings with requirements for sound-absorbing properties, the manufacturer determines the sound absorption coefficient by testing according to EN 20354.
The sound absorption coefficient has to be indicated at least in octaves and converted to a rated sound absorption coefficient $alpha_w$ as a single-figure value according to EN ISO 11654 and cited indicating the form indicators if necessary.
It is allowed to specify the sound absorption rating according to EN ISO 11654 as well as a conversion to parameters in accordance with ASTM-specifications.

8.2 Transferability / Tolerances for laboratory testing

To be transferred to a situation at a construction site, results of laboratory tests require an acoustic assessment, such as deduction of corrective degrees and inclusion in the calculation of building components that are involved or in the surroundings (flanking parts), etc.
This assessment shall be carried out by the building designer.The values at a construction site may deviate from laboratory results due to different installation conditions/ flanking components as well as production tolerances. For absorption specifications, the tolerance zone for production processes shall be fixed at ± 10 % for absorbent and ± 20 % for slightly absorbent/reflecting material.
This tolerance zone shall be assumed as +1 dB to -4 dB for constructions insulated against horizontal sound transmission and +1 dB to -2 dB for acoustics specifications. For special applications / acoustic requirements, further related examinations, calculations and laboratory tests as well as inspections on site might be necessary.
The results of acoustic laboratory tests may, under the following conditions, be extended to other ceilings of a similar design without new tests being required:

- It has to be verified that every change will result in an improvement in the acoustic performance (such as an increase in the thickness of its ceiling membranes, its density or of its dynamic stiffness).
- In case of doubt, the improved property has to be verified by a recognised testing authority.

- Changes in the surface are allowed under the conditions specified above.
- Building components and ceiling membranes from a supplier may be replaced by building components and ceiling membranes from another supplier if they have identical or improved acoustic properties.

8.3 Noise emission

Due to thermal or mechanical loading (compression and suction) metal ceilings may in exceptional circumstances emit noises.
If such emissions are to be ruled out, this shall be agreed on separately.

9 Heat, Cold and Moisture

9.1 Thermal insulation

Metal ceilings are suited for meeting such requirements with the aid of additional measures. These requirements shall be specified and agreed on separately by the building designer.

9.2 Condensation

If there is a danger of condensation forming in the insulation under a cold cavity, this shall be prevented either by installing a vapour barrier on the warm side of the insulation or by sufficient ventilation or by a combination of the two measures.

10 Hygiene, health and environment

According to the latest findings, there is no emission of any contamination or regulated substances or pollution by particles that are hazardous to health from metal ceiling constructions, which are a threat to the health of people inside or outside the buildings.
Special instances of exposure (such as fire) are not included here.

10.1 Emission of regulated substances

All the substances contained (such as solvents, mineral fibres and adhesives) shall comply with the regulations of the respective country. Metal ceilings contain no asbestos.

10.2 Metal ceilings with special hygienic requirements

Due to their nature and ease of cleaning, metal ceilings in accordance with the TMMC definitely meet hygienic requirements. When there are special requirements for sterility, dust-tightness, airtightness, etc, these shall be prescribed separately.

10.3 Environmental protection and disposal

Due to their material properties and the possibility to dismantle their constructions, metal materials can immediately be supplied directly to a recycling system that is separated according to raw materials.

11 Quality certification

TAIM membership entitles one to label with the TAIM logo ones products produced according to TAIM specifications. Such labelling is prohibited for those who are not members of TAIM.

12 Transport and storage

Transport and storage are carried out according to manufacturer's instructions.

13 Care, Maintenance and use

13.1 Service life requirements

Metal ceilings in accordance with TMMC are low-maintenance, easy to care for and durable. They have to retain their properties providing their fitness for use when they are exposed to the conditions intended, are serviced according to the manufacturer's recommendations and are not adversely treated during their useful life.
The specifications for the guarantee, especially for time limits, apply irrespective of this.

The following instructions regarding durability and maintenance shall be followed:

- The instructions listed in 13.2 apply with regard to cleaning recommendations. Any instructions differing from these must be cited by the manufacturer.
- Metal ceilings are low-maintenance, but from time to time it is advisable to check for:
  - Any changes, new built-in fittings, such as lighting units, etc
  - Any lowering in sections
  - Any deformation

If there turn out to be any changes, these shall be investigated and acted upon if necessary. One must always rule out the possibility that any parts of the ceiling are detaching, it being possible for them to fall.

These minimum requirements must be complied with so that the ceiling is able to comply with the properties required for the duration of its useful life.

13.2 Care and cleaning

Cleaning recommendations for metal ceiling panels with abrasion-proof surfaces:

The possibility in surfaces varies widely, ranging from normal white in colour to metallic colours, fluorescent colours and anodised surfaces. All colours may require a cleaning system of their own, the cleaning recommendation given here are applicable for all common systems.

To rule out any damage, however, it is always necessary to ask the manufacturer. Possible cleaning methods:

- Using only clear water, with a small amount of neutral or slightly alkaline washing agent if necessary.
- Soft, non-abrasive cloths or rags will also produce a mechanical cleaning effect.
- Do not use steam jet devices or high-pressure cleaners.
- Do not use any scratching or abrasive agents.
- Only use soft cloths or industrial cotton wool for cleaning.
  Refrain from hard rubbing.
- Do not use any acidic or very alkaline cleaning or wetting agents.
- Do not use any organic solvents that contain esters, ketones, alcohols, aromatic compounds, glycol ether, halogenate hydrocarbons or the like.
- Do not use any cleaning agent the composition of which you do not know.
- Greasy, oily and sooty substances can be removed with gasoline hydrocarbons not containing any aromatic compounds. It is absolutely necessary to carry out preliminary testing on non-visible spots.
- Residues of glues, silicon gum or adhesive tape can also be removed in this manner. It is important to remove such immediately. It is absolutely necessary to carry out preliminary testing on non-visible spots.

14 Installation Instructions

14.1 General

Qualified employees with the relevant experience shall carry out installation and handling of metal ceilings. Thin-gauged materials have to be handled with the necessary care to avoid injuries and damage. Protective gloves shall always be worn during handling of the membrane components.
The installation company shall appoint a construction site manager in charge of the building trade, who carries through and monitors the installation according to the rules relevant to the technology.
The installation company has the obligation and the full responsibility for providing sufficient safety and system conformity such that any components falling during or after the installation is ruled out.

The manufacturer's regulations shall be complied with.
The installation company shall rule out any dangers of damage to property and especially of dangers to life and limb for individuals in the room during and after the installation.

The static circumstances specified by the building designer, such as façade movements, expansion by the building and expansion joints, shall be taken into account.

14.2 Installation instructions

14.2.1 Requirements upon suspended ceilings elements

Only structural elements approved by the manufacturer shall be used.
The sub-construction shall be engineered to fit the metal ceiling system and have sufficient longitudinal and transverse stability.

14.2.2 Planeness tolerance

The planeness deviation for the installation of visible sub-constructions, ceiling membrane materials and perimeter trims is ± 2 mm per meter of length, this, however, amounting to a maximum of 5 mm over a distance of 5 metres when measured horizontally in every direction from any suspension point.
Instances of deflection permitted in the ceiling membranes are not included in the tolerances for planeness and shall be taken into account separately. See also 4.1.1.2.

14.2.3 Installation sequence

To ensure planeness of the installation, first fix the perimeter trims to the bordering building parts such that they are level and even according to the suspension height desired. If the perimeter connection is open, the levelness shall be ensured by suitable measuring points.

14.2.4 Alignment

The visible sub-constructions and carriers running in parallel shall be aligned such that the modules are in precise alignment with one another (using a laser or alignment string). Make sure the modules are aligned behind carrier abutments.

14.2.5 Absence of twisting

The suspension of the carriers shall result in stress-free and level conditions whilst at the same time being tight.

14.2.6 Alignment of the sub-construction

Metal ceilings and their elements, which are usually very long, make it necessary to install and align the sub-construction (carriers) very carefully. This applies in particular to metal linear components, because transverse bracing (a supporting grid construction) is not customary.

14.2.7 Built-in fittings, surface-mounted fittings and attachments

The entire responsibility for built-in fittings, surface-mounted fittings and attachments is incumbent on the building designer, including in particular the selection of types/positions/selections as well as fundamental system conformity.
The integration of built-in fittings, surface-mounted fittings and attachments shall be carried out following the specific guidelines by both the ceiling manufacturer and the manufacturer of the built-in/surface-mounted fittings and attachments. All instances of work in this connection are additional measures and shall be agreed on separately.
The connection of, for example, electric components shall be clarified in the individual case according to the manufacturers' specifications.

14.3 Surfaces

14.3.1 Batch dependency

To prevent deviations in colour and gloss rate between different batches, for large-surface installations, the entire material for the area to be covered should be produced in one delivery.
If this is not possible the manufacturer has to identify the different batches so that during installation a mix-up shall not occur.

14.3.2 Directional dependency

The manufacturing process for metal ceilings is usually directionally bound, this being so all the way from the rolling/edging techniques to the painting.
When this constitutes an influence on their installation, the manufacturer shall specify such. To prevent visual deviations, metal planks, metal tiles and metal linear components shall always be installed in a directionally bound fashion. The direction for installation is determined either by labelling on the metal ceilings / linear components or by instructions on the packaging by the manufacturer.

14.4 Special characteristics for metal linear components

14.4.1 Surface planeness at the edges

Due to production processes for thin-gauged metal linear components, deviations in surface planeness may occur when cutting to size is carried out either at the factory or by customers for fitting the panels on the perimeter trims, this is unavoidable due to production and manufacturing processes and is state-of-the-art. When carrying out invitations to bid, clients shall allow for any special requirements upon panel surface planeness for the connection to the perimeter trim bearing surface.

14.4.2 Linear component longitudinal joints

Abutments of perforated metal linear components (without right-angle edging) shall be provided with black longitudinal splices. Slight visual detraction in the visual planeness of the ceiling at linear component abutments is technically unavoidable, because perforated metal linear components are not provided with an unperforated edge on the ends.

14.4.3 Squareness, thermal expansion, additional loading and special-purpose areas

One shall assure the metal linear components are absolutely square in relation to the carriers at any point where the elements connect with each other. When using suspended ceiling components, including the ceiling membranes, be sure to take into account the thermal expansion and contraction of aluminium. It equals 0.024 mm per meter of section length for a temperature difference of 1° C. Suspended ceiling components made of aluminium are manufactured at an ambient temperature of +18° C. Deviations in length due to thermal expansion/ contraction are not taken into account for the quality standard's length tolerances.
Additional built-in fittings and loads shall be suspended separately. Any fastening there might be on the ceiling system shall be arranged in advance with the manufacturer. Built-in fittings for chilled ceilings and fire-resistant ceilings in particular shall be carried out by qualified specialists, who have the relevant knowledge concerning these systems and the properties they require.
The sub-construction and panel quality as well as their installation shall be separately prescribed for special applications, such as in kitchen areas, in outdoor areas, for damp rooms and clean rooms as well as for rooms with special requirements for safety in case of fire, acoustics, resistance to balls thrown.

The manufacturer's regulations shall be complied with.

One must be absolutely sure to follow the manufacturer's transport regulations as well as the instructions for proper stacking and dry storage.

The manufacturer's regulations shall be complied with for care and maintenance.

Appendix 1:
List of Standards and Guidelines

EN 1395
Aluminium and aluminium allows / Coil-coated sheet metals and coils for general applications / Specifications

EN 1602
Thermal insulating materials for the building trade / Determining the apparent density

V ENV 1991-2-4
Eurocode 1: Fundamentals of planning of supporting structures and actions upon supporting structures / Parts 2-4: Actions upon supporting structures; wind loads

EN 10327
Continuously hot-dip galvanised coil and sheet metal made of soft steels for cold forming / Technical terms and conditions of delivery

EN 10143
Continuously hot-dip finished sheet metal and coil made of steel; dimensional variations and form tolerances

EN 10152
Electrolytically galvanised, cold-rolled flat rolled steel / Technical terms and conditions of delivery

EN 10214
Continuously hot-dip finished coil and sheet metal made of steel with zinc-aluminium coatings (ZA) / Technical terms and conditions of delivery

EN 10215
Continuously hot-dip finished coil and sheet metal made of steel with aluminium-zinc coatings (AZ) / Technical terms and conditions of delivery

EN 13501-1
Classification of building products and structural designs to their behaviour in fire – Part 1: Classification with the results from the tests on the behaviour in fire by building products

EN 13501-2
Classification of building products and structural designs to their behaviour in fire – Part 1: Classification with the results from the tests of fire resistance (with the exception of products for ventilation systems)

ISO 7724-3
Paints and coating materials; chromatometry; Part 3 Calculating variations in colour

ISO 2813
Paints and coating materials / Determining the reflectometer values of coatings (except for metallic coatings) under 20°, 60° and 85°

ISO 6707-1
Building and structural engineering; vocabulary; Part 1: General terminology

EN 13523-0
Coil-coated metals / Test methods / Part 0: General introduction and list of test methods

EN 13523-1
Coil-coated metals / Test methods / Part 1: Thickness of coating; German version EN 13523-1:2001

EN 13523-2
Coil-coated metals / Test methods / Part 2: Gloss

EN 13523-3
Coil-coated metals / Test methods / Part 3: Variation in colour; colourimetric comparison

EN 13523-4
Coil-coated metals / Test methods / Part 4: Pencil hardness

EN 13523-5
Coil-coated metals / Test methods / Part 5: Resistance to fast deformation (impact test)

EN 13523-6
Coil-coated metals / Test methods / Part 6: Adherence after being dented (indentation test)

EN 13523-7
Coil-coated metals / Test methods / Part 7: Resistance to cracking when bent (T-bend test)

EN 13523-8
Coil-coated metals / Test methods / Part 8: Resistance to salt spray

EN 13523-9
Coil-coated metals / Test methods / Part 9: Resistance to immersion in water

EN 13523-15
Coil-coated metals / Test methods / Part 15: Metamerism

EN 13523-18
Coil-coated metals / Test methods / Part 18: Resistance to spotting

EN 13523-22
Coil-coated metals / Test methods / Part 22: Variation in colour; visual comparison

EN 13964
Suspended ceilings / Requirements and test methods

APPENDIX 1

EN ISO 12944-3
Issued July 2003; English version
Coating materials / Corrosion protection of steel structures by means of coating systems / Part 3: Basic rules on designing (ISO 12944-3: 1998)

EN 573-3
Aluminium and aluminium alloys / Chemical composition and form of semi-finished products / Part 3: Chemical composition

ISO 7989
Zinc coatings for steel wire

EN 10169-1
Continuously organically coated (coil-coated) flat rolled steel products / Part 1: General information, definitions, materials, limit deviations & test methods

EN 10169-3
Continuously organically coated (coil-coated) flat rolled steel products / Part 3: Products for use in building interiors

EN 23270
Paints and coating materials and their raw materials / Temperatures and humidity levels for conditioning and testing (ISO 3270: 1984)

ISO 2360
Non-conductive coatings on non-magnetic base metals; measuring the thickness of coatings; the eddy current method

EN ISO 11654
Acoustics / Sound absorbers for use in buildings / Assessing sound absorption (ISO 11654: 1997)

ISO 8512-2
Proof planes; Part 2: Hard rock

ISO 3599
Calliper gauges with vernier gradation to 0.1 and 0.05 mm

ISO 6906
Calliper gauges with vernier gradation to 0.02 mm

DIN 18168-1
Lightweight ceiling cladding and suspended ceilings; requirements for their execution

DIN 18168-2
Lightweight ceiling cladding and suspended ceilings; certification of load-bearing capacity of suspended ceilings and suspensions made of metal

ISO 7989
Zinc coatings for steel wire

EN 10327
Continuously hot-dip finished sheet metal and coil made of soft steels for cold forming / Technical terms and conditions of delivery

EN 10142
Continuously hot-dip galvanised sheet metal and coil made of soft steels for cold forming / Technical terms and conditions of delivery

EN 10214
Continuously hot-dip finished coil and sheet metal made of steel with zinc-aluminium coatings (ZA) / Technical terms and conditions of delivery

EN 10215
Continuously hot-dip finished coil and sheet metal made of steel with aluminium-zinc coatings (AZ) / Technical terms and conditions of delivery

EN ISO 12944-3
Coating materials / Corrosion protection of steel structures by means of coating systems / Part 3: Basic rules on designing (ISO 12944-3: 1998)

ISO 2813
Paints and coating materials / Determining the reflectometer value of coatings (except for metallic coatings) under 20°, 60° and 85°

ISO 7724-2
Paints and coating materials; chromatometry; Part 2: Determining colorimetric measures

ISO 7724-2
Paints and coating materials; chromatometry; Part 3: Determining variations in colour

APPENDIX 2

Appendix 2:
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APPENDIX 2

Appendix 3:
Quality Standards for Metal Ceilings, Abridged Version

The following abridged version of the quality standard with integrated cross-references to the TMMC takes up the most important contents of the TMMC, though without guaranteeing completeness.

A summary of all the product features of metal ceilings along with inspection criteria should be taken in detail from the various sections of the TMMC.

Note also that these quality guidelines as well as the TMMC do not apply to the ceilings listed in 2.6.

Application of these quality guidelines as well as the TMMC or parts of it may be agreed on for these ceilings in individual cases.

The TMMC with the quality guidelines integrated in it contains relevant references to specifications from other publications in the form of ISO- or European standards or drafts of standards.

Due to its international character, no references are usually made to national regulations, such as DIN- or VDI-Standards, British Standards or US Standards. National regulations, however, must be followed, irrespective of the user.

Normative references are cited at the respective places in the text, the publication being listed in the appendix. In cases of dated references, subsequent amendments or revisions of such publications only need be followed if they have been incorporated through amendments or revisions of the TMMC.

In cases of undated references, the issue of the publication cited is effective (including any amendments) at the time when this Technical Manual goes to press.

To follow this are:
- Quality standard for metal tiles and metal planks; standing: August 2003
- Instructions for installation and handling; standing: August 2003
- Quality standard for metal linear components; standing: August 2003

TAIM Quality Standard for Metal Ceilings: Abridged version

Technical Association of Industrial Metal Ceiling Manufacturers (TAIM) e.V., P.O. Box 1842, D-64608 Bensheim, Germany, www.taim.info

Refer to the TMMC (Technical Manual on Metal Ceilings) for further information

Quality standard for metal tiles and metal planks

1. Objectives

With the edition of this standard TAIM pursues the objective of redefining the technological developments and unifying the quality standard (thus defining the liability of the individual members of TAIM).

2. Applicability

The standard applies to industrially manufactured, visible rectangular ceiling elements made of steel sheet without inserts.

3. Material

Galvanized steel sheet according to respective DIN standard. Zinc coating min. 2.5 µm per side.

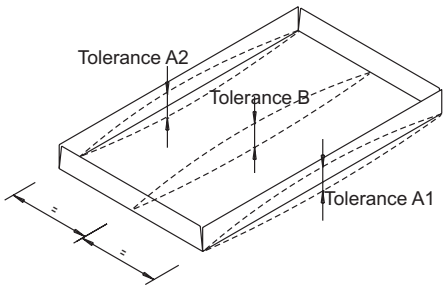
4. Tolerances

4.1 Panel dimensions

for length (longer edge)	+ 0 - 0.4 mm/m
for length smaller than 1.0 m	+ 0 - 0.5 mm
for width	+ 0 - 0.4 mm

4.2 Deflection

At centre of long edge (A), at centre of panel face (B). Specifications for perforated panels, hole diameter max. 4 mm, free cross section max. 25 %. Additional inserts can increase the deflection. A1 and A2 may deviate by not more than 50% from the value indicated in the table.

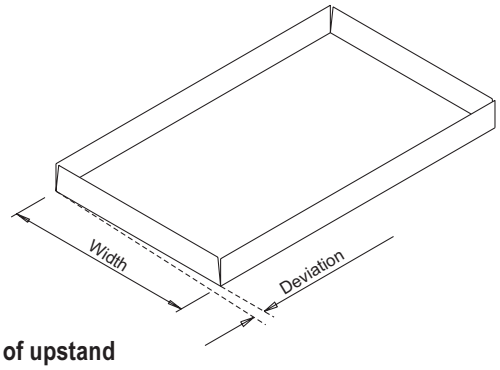


l = length in mm	0 < l ≤ 1000		1000 < l ≤ 2000		2000 < l ≤ 3000	
b = width in mm	A1/A2	B	A1/A2	B	A1/A2	B
0 ≤ b ≤ 400	- 0,5 + 0,5	- 0,2 + 3,0	- 0,5 + 1,5	- 0,2 + 4,0	- 0,5 + 3,0	- 0,2 + 6,0
400 < b ≤ 500	- 0,5 + 0,5	0 + 4,0	- 0,5 + 1,5	0 + 5,0	- 0,5 + 3,5	0 + 7,0
500 < b ≤ 625	- 0,5 + 0,5	0 + 6,0	- 0,5 + 1,5	0 + 7,0	- 0,5 + 4,0	0 + 9,0
625 < b ≤ 1250	- 0,5 + 0,5	0 + 10,0	- 0,5 + 1,5	0 + 13,0	to be agreed	

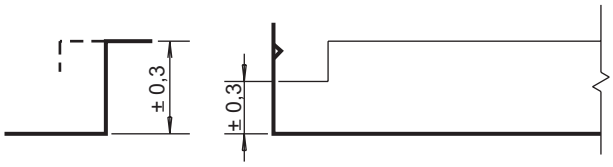
Constrictions at the centre of the panel depend on tolerances between A and B and can affect the straightness of the edge. Negative values mean upwards buckling.

TAIM
Technical Association of Industrial Metal Ceiling Manufacturers (TAIM) e.V.

4.3 Angularity
of the long edge in relation to the short
widths up to 625 mm ± 0.5 mm
widths from 625 mm to 1250 mm ± 0.6 mm



4.4 Height of upstand
± 0.3 mm to support or upstand depending on design measured on the panel

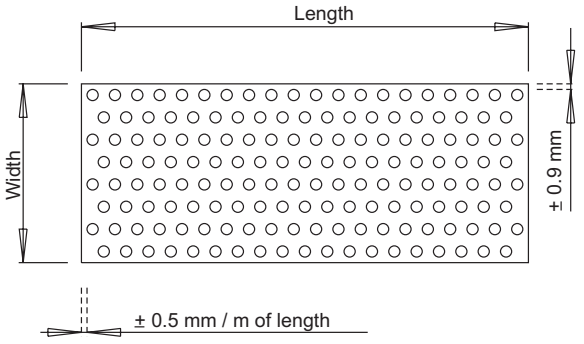


Deviations from 90° angle of the vertical upstand are immanent to production process and system-inherent. Indication of tolerance is not necessary. Indication of tolerance for the recess is only valid for clip-in constructions.

4.5 Perforation
Choice of visible perforation pattern depends on architectural and acoustical requirements. See specifications of the manufacturer for designations of the various patterns. The unperforated border depends on the perforation pattern and may be different at the long and short edge. Indication of the perforation diameter applies only to material without surface coating. When determining the free sectional area the unperforated areas are not considered.

4.5.1 Deviation in width
of unperforated border on long edges ± 0.9 mm

4.5.2 Deviation in length
from unperforated border on
short edges ± 0.5 mm/m length of element
for lengths ≤ 1.0 m ± 0.5 mm



5. Surface finishes

5.1 Measurement of colour differences
Any computerized measuring device operating according to the Cielab method may be used. ISO 7724-2 and ISO 7724-3 must be complied with.

5.2 Binding colour samples
The samples must meet the following criteria:
- min. size DIN-A5
- unperforated
- coating thickness according to respective production process.
It is advisable to keep samples of the main colours of each batch.

5.3 Desired coating thickness
It must be ensured that base material is uniformly covered. The coating thickness depends on the manufacturing process used.

5.4 Gloss rate
Measuring method according to ISO 2813. Normally, the angle of incidence is 60°.

Tolerances:

dull-bright	0 < 30 (E)	± 4 deviation E
semi-matt	30 < 70 (E)	± 5 deviation E
high gloss	70 ≤ 100 (E)	± 6 deviation E

Greater gloss differences must be accepted in case of additional deliveries after extended periods of time.

The same applies if, by change of technical conditions (e. g. new environmental laws), a finish cannot be matched.

5.5 Allowable tolerances in shade of colour
5.5.1
For whites mainly used, the difference in ΔE value may not exceed 1.0 within one delivery. On materials out of several deliveries this value may add up to tolerances greater than ΔE = 1.0.

Greater colour differences must be accepted in case of additional deliveries after extended periods of time.

The same applies if, by change of technical conditions (e. g. new environmental laws), a finish cannot be matched.

5.5.2
For non-white colours the ΔE differences may be greater than 1.0; here colour differences are harder to visually ascertain. Tolerances are to be agreed upon from case to case.

5.5.3
Criteria quoted above for whites and non-white colours also apply to colour differences of deliveries and samples mutually declared binding.

5.5.4
These provisions do not apply for deliveries of other supplier or other construction units.

5.6 Mechanical properties / resistance
Basically varnish coatings are according to EN 13964 Table 7 Class A and B. Special requirements exceeding the above criteria must be agreed upon separately. The maximum additional load is up to 400 g/m².

TAIM Quality Standard for Metal Ceilings: Abridged version

Technical Association of Industrial Metal Ceiling Manufacturers (TAIM) e.V., P.O. Box 1842, D-64608 Bensheim, Germany, www.taim.info

Refer to the TMMC (Technical Manual on Metal Ceilings) for further information

Instructions for installation and application

1. General

Metal ceilings must be installed by qualified installers in possession of the required knowledge and expertise. The ceiling contractor shall appoint a responsible foreman who will ensure installation according to current standard construction methods.

The ceiling contractor has the duty and the responsibility of ensuring proper safety, so that during and after completion of the work of installation the hung ceiling cannot fall down.

The instructions for installation and application of the manufacturer must be obeyed. The ceiling contractor must ensure that there will be no danger of damage to property or injury to people who are in the room during and after installation of the metal ceiling. In cases of doubt the manufacturer must be consulted.

2. Static

Connections to the construction are to be chosen or designed in such a way that standard tolerances may be allowed for. Allowance must be given to static considerations such as façade movement, building expansion and contraction and expansion joints.

The regulations according to EN 13964 and regulations in the country of use, e.g. DIN 18168 Part 1 and Part 2, are to be applied or a static check undertaken or a tested construction used.

3. Sub-construction

3.1 Planks- Tiles- Linear panels

3.1.1

Only construction parts approved by the manufacturer may be used. The sub-construction/ carrier must suit the system of panels installed and possess sufficient longitudinal and lateral stability.

3.1.2

For the installation of the sub-construction and the ceiling panels and edge-trim profiles the allowed tolerance in the levelling is ± 2 mm per 1.0 m length, with a maximum of 5 mm measured horizontally over 5.0 meter distance in any direction from a suspension point. Allowed bendings of the insert material are not included in the flatnaess tolerances and must additionally be observed.

3.1.3

To ensure the proper level of the ceiling during installation, first the edge-trim profiles must be fixed at the required level to the adjacent construction. In case of a floating installation the level of the ceiling must be ensured by measuring from proper datum points.

3.1.4

The linear alignment of panels, together with any elements and panel carriers, have to be exactly aligned (either by laser or mason's string) on module. Special attention must be paid to the alignment of the modules when joining the carriers.

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3.1.5
The suspension of the carriers must provide stress-free and level conditions whilst at the same time being tight.

3.1.6
Metal Ceilings in general and long linear panels in particular necessitate precise installation and alignment of the sub-construction and carriers. It especially applies to linear ceilings where lateral connections between the carriers (secondary grid) are not customary.

4. Panels

4.1 Planks- Tiles- Linear panels

4.1.1
To avoid deviations in colour and gloss-level between different production runs of the painted material, it is advised that projects requiring larger quantities should be manufactured and supplied in one batch.

4.1.2
The production process of metal ceilings from roll-forming/ press-breaking to coating is generally “direction bound”. To avoid optical colour deviations it is necessary to install all planks, tiles or linear panels in the same direction. The installation direction is determined either by markings on the ceiling elements or by an instruction on the packing by the ceiling manufacturer.

4.2 Linear panels

4.2.1
Due to the manufacturing process of thin-walled linear panels it is possible that deviations in the plane of the panel occur at the point where the panel lies on the edge-trim profile. These deviations can occur when cutting the panels in the factory as well as on site cutting, are imminent to the production- and manufacturing process, are unavoidable and current technology. The deviations can be reduced by the use of hold down clips. Any special demands on the planeness of the panels must be specified beforehand.

4.2.2
Joints in perforated panels (without closed panel ends) must be made with black panel splices. A slight optical detrimental effect in the continuity of the perforated panels is unavoidable for technical reasons: perforated linear panels can not be executed with a blind border at the panel ends.

4.2.3
Resulting from the chosen direction of the panels in the linear ceiling the absolute squareness of the angle between linear panel and carrier must at any point be taken care of.

5. (Thermal) expansion of the sub-construction and ceiling panels

The installation of construction profiles, including the ceiling panels, has to allow for the thermal expansion and contraction of aluminium. The expansion co-efficient of aluminium is 0.024mm per 1.0 m profile-length for each 1°C temperature difference.

Ceiling elements from aluminium are normally produced at an ambient temperature of ca. +18°C. The tolerances in length as indicated in the Quality Standard for Metal Linear Panels do not take into account the thermal expansion and contraction of the elements.

6. Fixtures

Additional fixtures and loads must be suspended separately. Any fixings to the ceiling system must be agreed upon with the ceiling manufacturer beforehand. Fixtures, in particular for chilled or fire resistant ceilings must be installed by qualified installers with proper experience in- and knowledge of the systems and any special requirements.

7. Non-standard applications

For non-standard applications, i.e. kitchens, exterior ceilings, high-humidity level rooms and clean room ceilings as well as applications with demands for fire resistance, acoustic performance and sporthall ceilings both the sub-construction and the quality of the ceiling panels must be agreed upon separately. The instructions for installation and application of the manufacturer must be complied with.

8. Instructions for transportation and storage

The transportation instructions of the manufacturer and the details concerning correct stacking and dry storage must be obeyed.

9. Care and maintenance

Works of care and maintenance must be in accordance with the manufacturer ’s instructions.

TAIM Quality Standard for Metal Ceilings: Abridged version

Technical Association of Industrial Metal Ceiling Manufacturers (TAIM) e.V., P.O. Box 1842, D-64608 Bensheim, Germany, www.taim.info

Refer to the TMMC (Technical Manual on Metal Ceilings) for further information

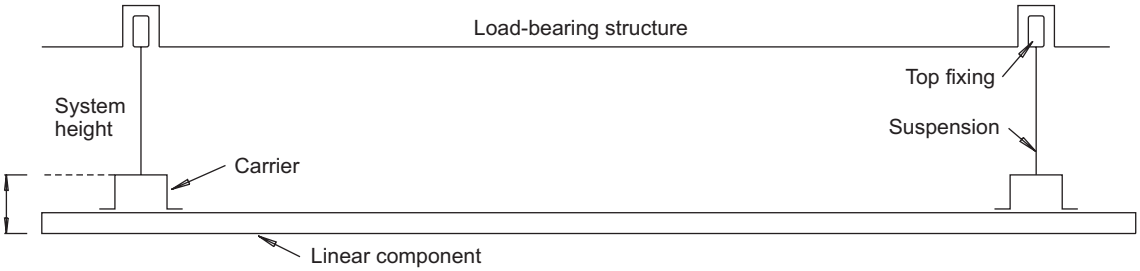
Quality standard for metal linear components

1. Objectives

With the edition of this standard TAIM pursues the objective of redefining the technological developments of metal linear panels and unifying the quality standard (thus defining the liability of the individual members of TAIM).

2. Applicability

The standard applies to industrially manufactured metal -linear panels for interior use in standard applications. In case of special demands on performance, f.i. application in swimming pools-sport halls and exterior usage, additional relevant standards have to be taken into consideration.



Picture 1

2.1 Product definition:

Ceiling components of relatively narrow width with a length that is a multiple of the width.
Width max. 400 mm.

a) the linear panels attach with their sides to the carriers. In general the angel between linear panel and carrier is 90°.
b) the sides of the linear panels can be executed in many different shapes.
c) at both ends the linear panels are open.
d) the joint between the sides of the panels can have a width of 0 - X mm.
e) the modular dimension is panel width + joint.
f) the open joints between the linear panel sides may be closed with a join profile.

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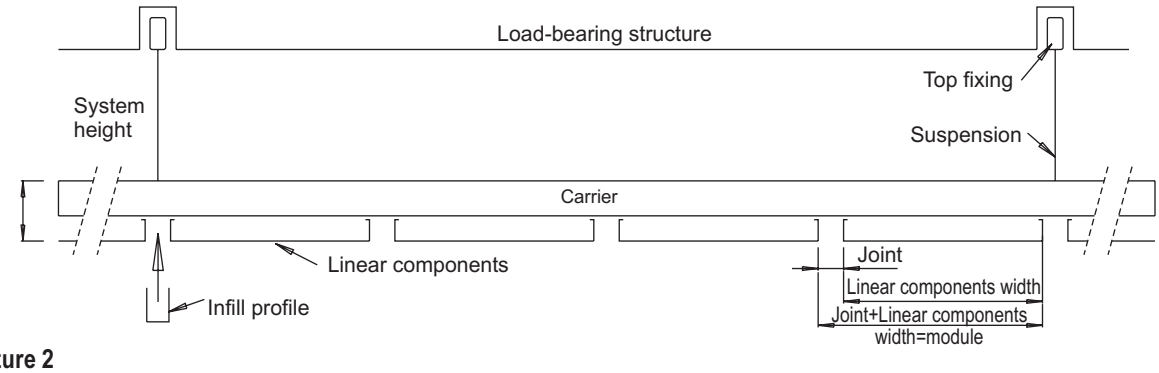


Picture 2

2.2 Construction parts: suspension, carriers and hangers
The sub-construction has to fit the linear panels. It is only allowed to use construction parts which are approved by the manufacturer.

2.3 Acoustic pads
with a maximum dead weight of 1.5 kg/m² are to be carried by the ceiling system.
Additional loads have to be calculated and approved by the manufacturer.
Inserts are permissible up to 400 g/m².

3. Material: Panels

Aluminium according to EN 1396.

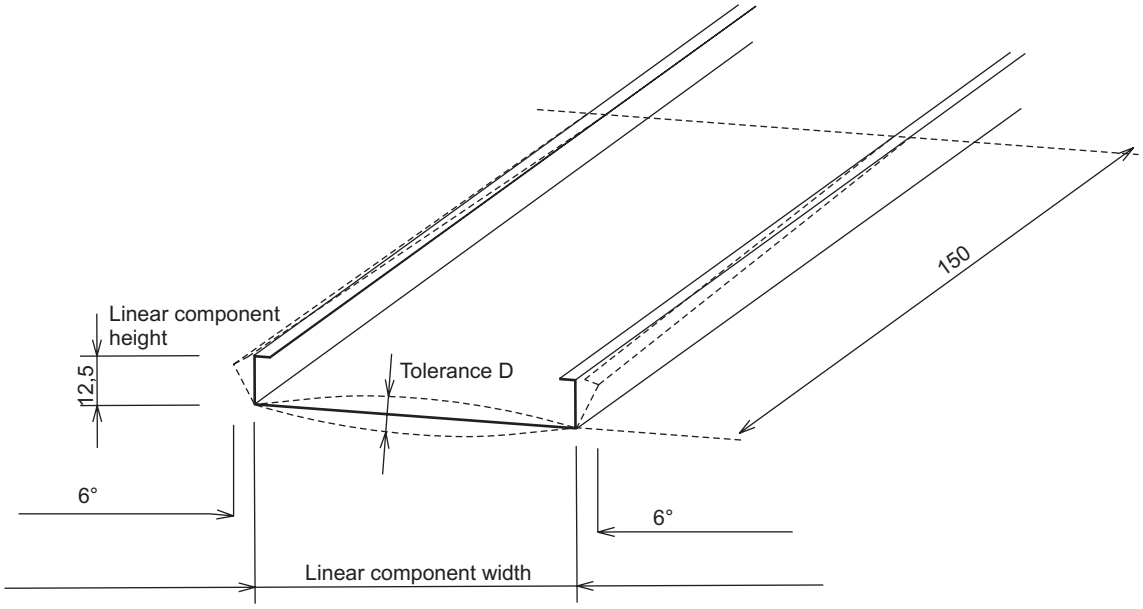
4. Tolerances of the Linear Panels

4.1 Dimensions

Panel height:	± 0,30 mm
Panel length:	850 – 3000 mm ± 1,00 mm
	3000 – 6000 mm ± 1,50 mm
Panel width:	± 0,50 mm

Due to material- and production properties additional dimensional tolerances occur because of spring back at the panel ends (see pictures 3 and 4). The spring back is up to a maximum of 6° on each side or 0,1 x metal panel height (corresponding to 1,25 mm with a metal panel height of 12,5 mm).

Metal panel height	12,5	15,5	24,5	28,5	38,5
Spring back per edge	1,25	1,55	2,45	2,85	3,85

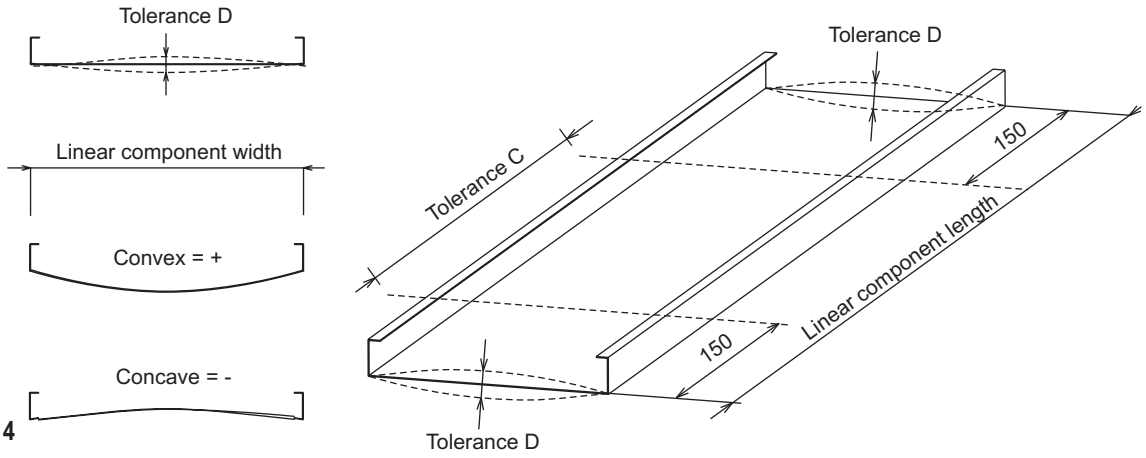


Picture 3

4.2 Plane and Ripples

4.2.1 Plane

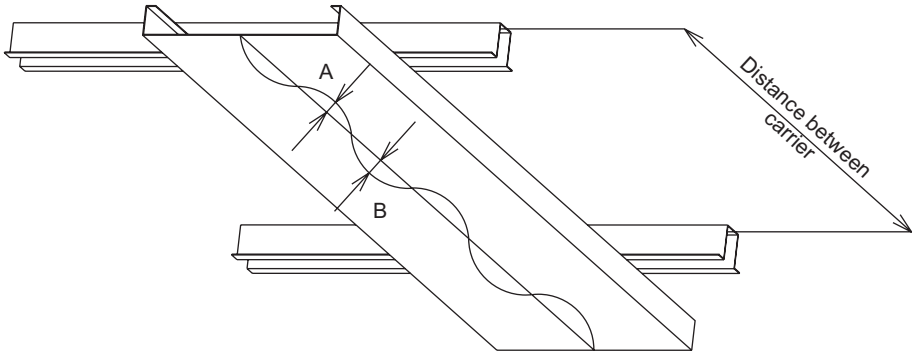
Linear panel width			
0 - 100	**101 - 200**	**201 - 300**	**301 - 400**
C	**C**	**C**	**C**
-0.50	-0.75	-1.00	-1.25
+1.00	+1.50	+2.00	+2.20
D	**D**	**D**	**D**
-1.00	-2.00	-3.00	-3.50
+1.00	+1.50	+2.00	+2.20



Picture 4

4.2.2 Ripples

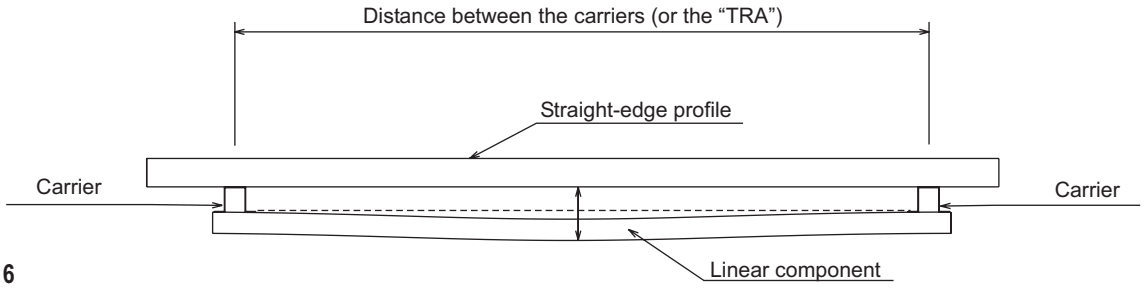
Ripples			
Linear panel width			
0 - 200		**201 - 400**	
A	**B**	**A**	**B**
-0.25	+0.25	-0.40	+0.40



Picture 5

4.2.3 Deflection between two carriers

The deflection of the panel between two carriers/ points of support is 1/500 x carriers distance (TRA), measured in the middle between two carriers/ points of support.



Picture 6

4.2.4 Special lighting conditions

Under special lighting conditions it is possible that material- and production specific deviations are visible even when above tolerances are kept.

4.3 Camber

Deviation is maximal 1/1667 x panel length, measured in the middle of the length of the panel (equals 0.6 mm over 1.0 m).

4.4 Perforation

The panels are perforated over the panel ends. Therefore differently cut perforation holes at the panel ends can occur.

4.5 System height of the linear panel system

The height of the linear panel system as defined by the manufacturer has a tolerance of ± 1mm (see picture 1 and picture 2).

5. Sub-construction

5.1 Carriers

The carrier should take up the panels in a modular way (see picture 2).
The shape of the carriers is manufacturer specific. The panels are fixed to the carriers either by clamping- or by hanging on the prongs.
Longitudinal connections of the carriers are realised by manufacturer-approved elements (modular carrier splices) or by way of a manufacturer-approved installation method.

5.2 Carrier distance/ panel span

Due to the often long length of the linear panels the:
a) carrier distances (panel spans)
b) distances between the suspension points over the length of the carriers (carrier spans)

should comply with manufacturers recommendations.

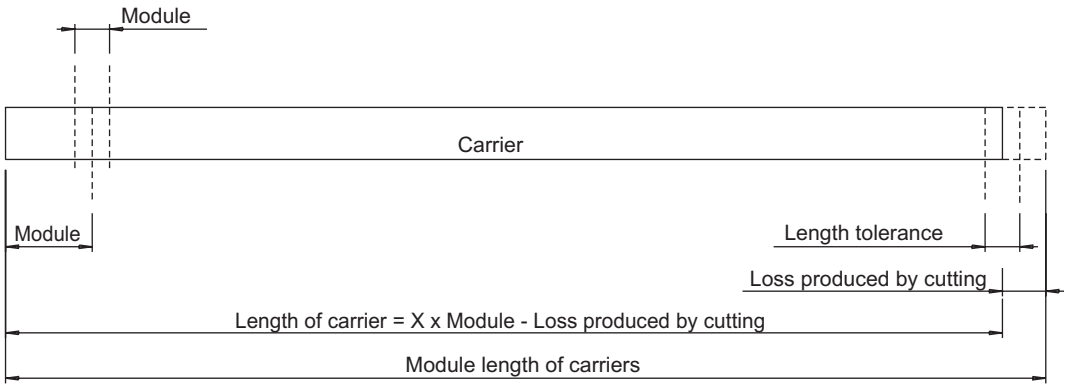
Lateral connections between the carriers are possible, however with linear ceilings not customary.

5.3 Material: Carriers

Material for the carriers can be aluminium according to EN 1396 or pre-coated steel strip according to EN 10169 part 1.

Carriers from pre-coated steel strip shall fulfil the requirements of 6.2

5.4 Tolerances of the carriers



Picture 7

5.4.1 Tolerance of the carrier module

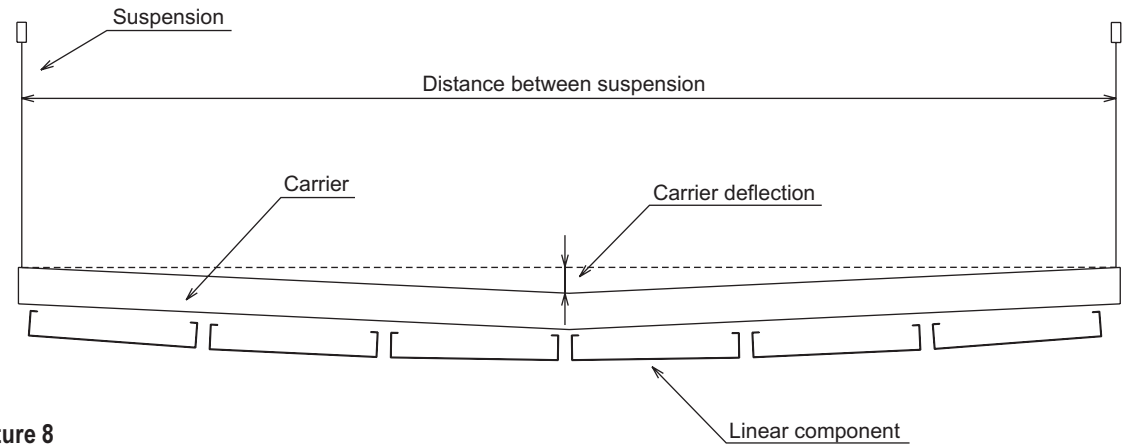
The tolerance of the carrier module is ± 5/100 of the linear panel module.

5.4.2 Tolerance of the carrier length

The length of the carrier is a multiple of the carrier module. The total length of the carrier follows from the number of carrier modules including the module-tolerance, minus a cutting tolerance which is determined by the manufacturer (see picture 6).

Production wise each carrier starts and ends in the joint of the punching-module.

Carrier splices or manufacturer 's installation instructions ensure the modular dimensions over the length of more carriers.



Picture 8

5.4.3 Deflection of the carriers between two suspension points

The deflection of the carriers between two suspension points is 1/ 500 x suspension distance (HA), measured in the middle between two suspension points.

6. Surface finishes

Measurement of colour differences
According to EN 1396

Coating thickness
According to EN 1396

Gloss
According to EN 1396

Allowable deviations in shade of colour
According to EN 1396

6.1 Mechanical properties/ resistance

Basically the paint finish is in compliance with EN 1396, Table C1, Category 2a.

6.2 Classes of exposure

The linear panels made from aluminium fulfil the requirements for normal use in normal climatic conditions in the interior of buildings, generally exposed to varying relative humidity up to 70% and varying temperature from +7° C up to +30° C but without corrosive pollutants.
In situations likely to produce corrosion contact between dissimilar materials shall be avoided.
Special requirements exceeding the above criteria must be agreed upon separately.

7. Installation

EN 13964 as well as regulations in the country of use, e.g. DIN 18168 Part 1 and Part 2, are mandatory.
The instructions for installation and applications as published by TAIM e.V. as well as the installation instructions of the manufacturer apply.

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