



Aluminium Designer Decking



Material properties, basic values for design

Alloy:

Anticorodal-053 (6060/6063)

For verifications in acc. to DIN 4113:

AlMgSi0,5 F22

Tensile strength $R_m \geq 215 \text{ N/mm}^2$

0,2 proof stress $R_{p0,2} \geq 160 \text{ N/mm}^2$

Brinell hardness $HB \approx 70$

Tension: $\sigma_{\text{perm (H)}} = 95 \text{ N/mm}^2$

Shear: $\tau_{\text{perm (H)}} = 55 \text{ N/mm}^2$

Bearing stress for bolts:

$\sigma_{\text{perm L1(H)}} = 120 \text{ N/mm}^2$

bolts with max. 1 mm clearance

$\sigma_{\text{perm L2(H)}} = 145 \text{ N/mm}^2$

bolts with max. 0,3 mm clearance

Curves with parameter σ_{perm} indicated in the tables on pages 4, 5 and 6 have been based on DIN 4113.

After the changeover to

DIN EN 755-2:

EN AW-6063 T6

Tensile strength $\geq 215 \text{ N/mm}^2$

0,2 proof stress $\geq 170 \text{ N/mm}^2$

Brinell hardness: no longer defined

For verifications in acc. to

Eurocode 9:

The bearing capacity in the case of noncombined loadings is calculated on the basis of the relation

$$E \cdot 1,5 \leq \frac{R}{1,1}$$

(E = effect of actions, R = material resistance)

$$\sigma_{\text{perm}} = \frac{R_{p0,2}}{1,65} = \frac{170(160)}{1,65} = 103(97)$$

This is somewhat more favourable than DIN, but is of no importance for practical design which is generally made on the basis of deflection values.

General properties:

Modulus of elasticity: 70.000 N/mm^2

Mean thermal expansion coefficient:
 $23,5 \cdot 10^{-6} \text{ 1/K}$

Specific mass: $2,7 \text{ g/cm}^3$

Low-temperature performance:
no low-temperature brittleness

Note: The heat generated by welding influences the strength of the material. In this case for permissible stresses refer to DIN 4113/2 or EC 9.



Decking - Load bearing capacity and verifications

The simple theory of beams is used for the verification of designer planks subject to **distributed loads** owing to the preferred supporting direction parallel to the ribs. The necessary calculation formulae can be found in any technical textbook. For calculations of deflection, the modulus of elasticity E for aluminium of $7 \cdot 10^6 \text{ N/cm}^2$ ($70\,000 \text{ N/mm}^2$) shall be used; for geometric values taking into account the full deduction of perforations refer to the table on page 3.

The section modulus (W_{net} !) specified without parentheses can be used directly for stress verification. The moment of inertia (I_{net}) is conservative for calculations of deflections. The effective moment of inertia is somewhat higher and ranges between the value of the milled (net) and the value of the unmilled cross section.

With **point loads** the deflection calculation is no longer as simple as for distributed loads. In this case, the lateral rigidity has a noticeable effect on the bearing width. This is only about 20 cm for a span of 1 m, rises to about 40 cm for 2 m span and to about 45 cm for 3 m span. – These figures refer to a one-man load (80 kg), single-span and coupled planks. – The supporting behaviour is non-linear owing to various supporting mechanisms acting in the lateral direction, i.e. dependent on loading and support conditions. A simple representation of the supporting width or an effective moment of inertia are, therefore, not possible. The following diagrams show the bending under one-man load as a function of the span and at various loadings. A linear extrapolation to higher loads is permissible.

Approximate stress values can be calculated from deflection measurements. A more accurate calculation is normally not required, since the designer planks have high load bearing capacity and are normally only dimensioned according to the deflection allowed.

Permissible deflections

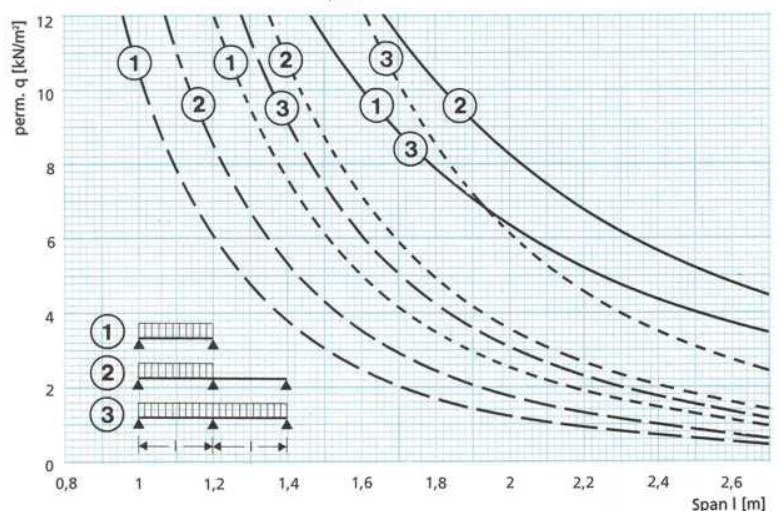
Coverings suitable for walking on should not deflect more than 5 mm under one-man load for psychological reasons (subjective feeling of safety). For areas rarely trodden, this figure can be raised to 8 mm. In special cases, e.g. inspection ways, scaffolding and the like, which are only used by service personnel, larger values are permissible. For distributed loads the

permissible deflection is determined according to regulations, e.g. $l/400$. In general, $l/200$ should not be exceeded.

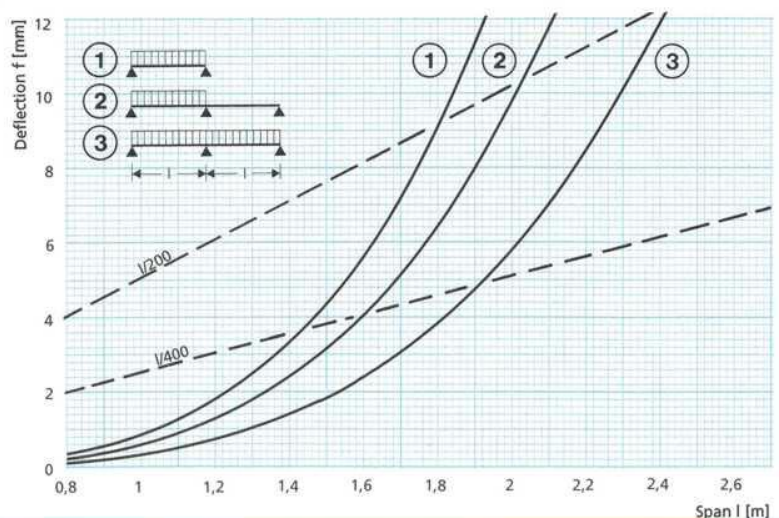
Distributed loads

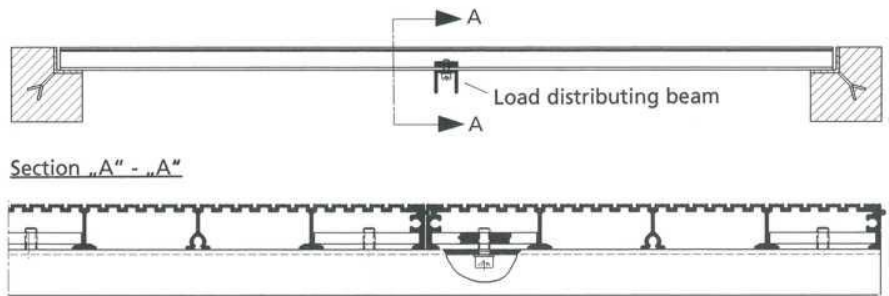
Permissible loads for planks under uniformly distributed load at various supporting conditions in function of the span. The permissible loads are determined on the basis of the "net geometric values" for different conditions.

- — — — — Deflection $f = l/400$
- - - - - Deflection $f = l/200$
- Stress $\sigma = 9,5 \text{ kN/cm}^2$ ($\triangleq \sigma_{\text{perm}}$ in DIN 4113)



Deflection of planks under a distributed load of $3,5 \text{ kN/m}^2$ (350 kg/m^2) in function of the span and at different supporting conditions (calculated on the basis "net geometric values").





Concentrated loads

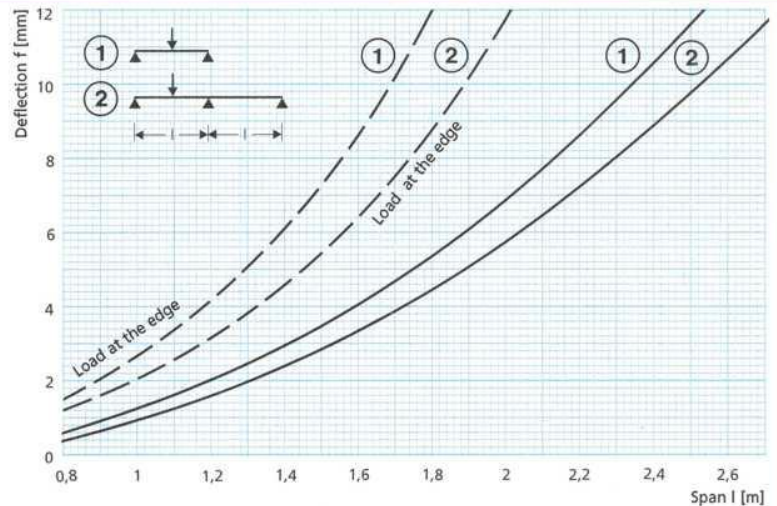
Single plank

Deflection f of a single plank under one-man load (80 kg) as function of the span at various supporting conditions.

The curves are the results of tests with one person. In the case of "load at the edge" the person stood facing outwards on the edge of the plank with the full weight on the ball of the foot. The following span limits l_{lim} were determined for a point load of 150 kg in the case of "load at the edge" on the basis of permissible stress values ($\sigma = 95 \text{ N/mm}^2$):

single-span: $l_{lim} = 1,38 \text{ m}$
two-span: $l_{lim} = 1,50 \text{ m}$

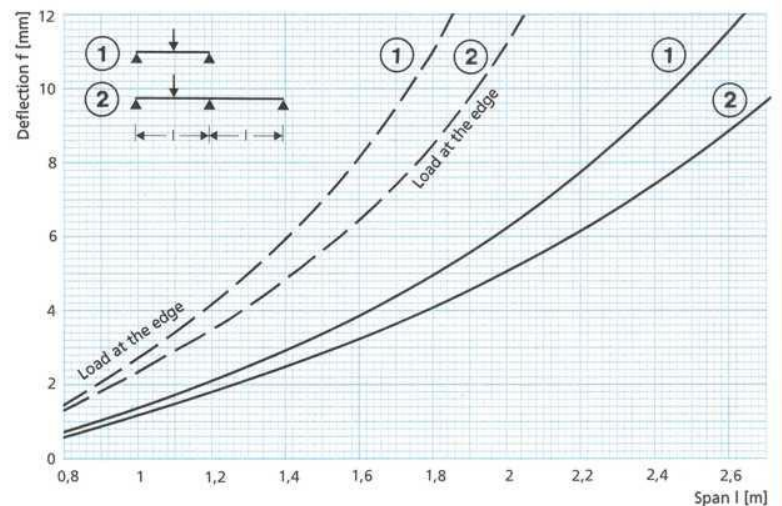
(Calculated from deflection measurements.)



Coupled planks

Deflection f of coupled planks under one-man load (80 kg) as function of span and at various supporting conditions.

The curves are the results of tests with one person. The planks were connected with one coupling each per span. For small spans couplings can be waived unless there is no "spring effect" (approx. $f_{edge} \leq 2 \text{ mm}$). The diagram also shows the deflections under "load at the edge" (see definition above).

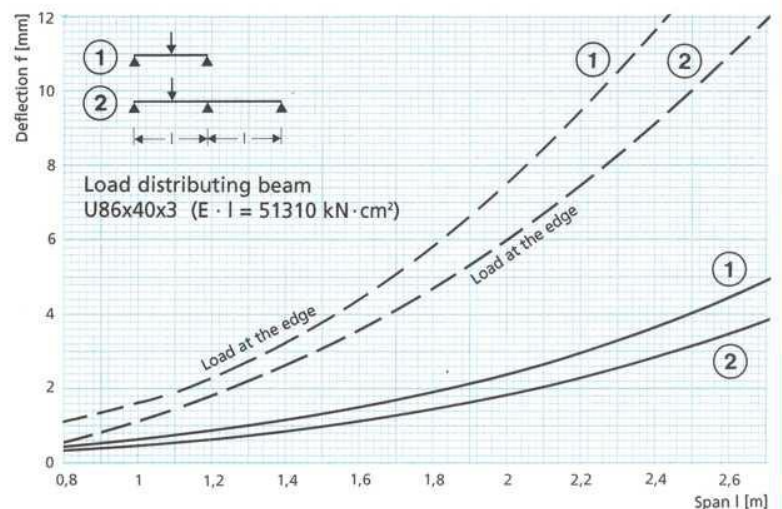


Coupled planks with load distributing beam

While in the case of distributed loads greater deflections are permissible, they have a considerable influence on the subjective feeling of motion with regard to the load bearing capacity, e.g. for pedestrians. By the simple and inexpensive method of fitting load distributing beams, the point load is spread over several sections, and the surface feels more rigid to the user. The load distributing beam must not be supported at the ends. The load bearing capacity under distributed load does not change when fitting a distributing beam.

The illustration opposite shows the deflection of planks under one-man load (80 kg) in function of the span and at various supporting conditions.

The curves are the results of tests with one person. The diagram also depicts the deflection under "load at the edge" (see definition above). The load distributing beams are installed in the centre of the field (see drawing above).



A comparison between the two diagrams above shows an average rise in rigidity when using a distributing beam as follows:

2,6 for load in the centre of an area and
1,9 for load at the edge.

Steps – Load bearing capacity and verifications

For loads according to DIN 1055/3, the following span limits l_{lim} are given by the permissible stress values ($\sigma = 95 \text{ N/mm}^2$): Usually the span limit cannot be used for the design of stairs (rigidity of the step). The indication of these values is to show the engineer when more accurate calculations are required.

Die No. 40822	distributed load	5 kN/m ² (500 kg/m ²)	$l_{lim} > 250 \text{ cm}$	
	point load*	1,5 kN (150 kg)	$l_{lim} > 250 \text{ cm}$	
	point load*	2,0 kN (200 kg)	$l_{lim} = 208 \text{ cm}$	→
Die No. 40823	distributed load	5 kN/m ² (500 kg/m ²)	$l_{lim} > 250 \text{ cm}$	
	point load*	1,5 kN (150 kg)	$l_{lim} > 250 \text{ cm}$	
	point load*	2,0 kN (200 kg)	$l_{lim} = 200 \text{ cm}$	→
Die No. 38130	distributed load	5 kN/m ² (500 kg/m ²)	$l_{lim} = 235 \text{ cm}$	
	point load*	1,5 kN (150 kg)	$l_{lim} = 171 \text{ cm}$	→
	point load*	2,0 kN (200 kg)	$l_{lim} = 128 \text{ cm}$	→
	point load at centre	2,0 kN (200 kg)	$l_{lim} = 207 \text{ cm}$	→

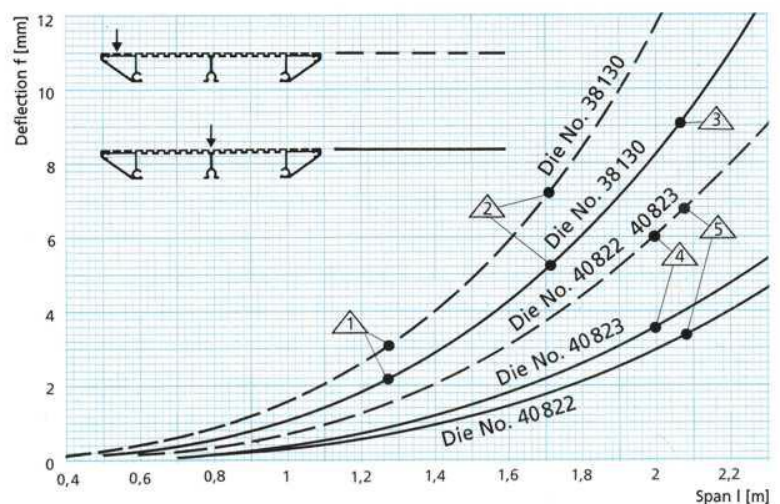


In general steps have to be chosen in function of their rigidity. The rule is that deflections under one-man load of 5 mm should not be exceeded (subjective feeling of motion). Provided the steps are suitably connected to each other, the permissible point loads can, at least, be doubled.

Since the steps have to a large extent linear σ -f characteristics (also in the case of "load at the edge"), the permissible span or span limits can be deducted from the figures above.

* Calculated from deflection measurement in the case "load at the edge"

Deflection f of a step under one-man load (80 kg) in function of span. The group of curves differ in the position of load application: load on the front edge (nose) or load in the centre (see diagram).



Fixing of the planks



Place clamping jaws of fixing wedge or of coupling over two adjoining edge feet. Tighten firmly bolt of coupling, only slightly tighten bolt of fixing wedge.

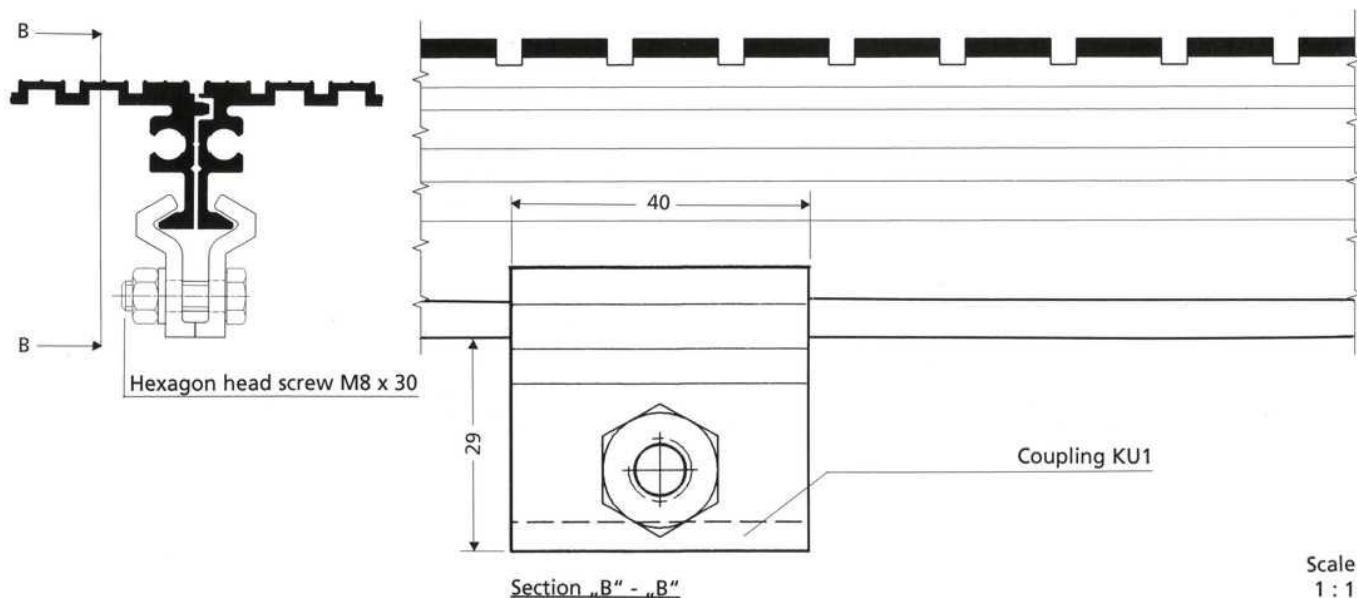
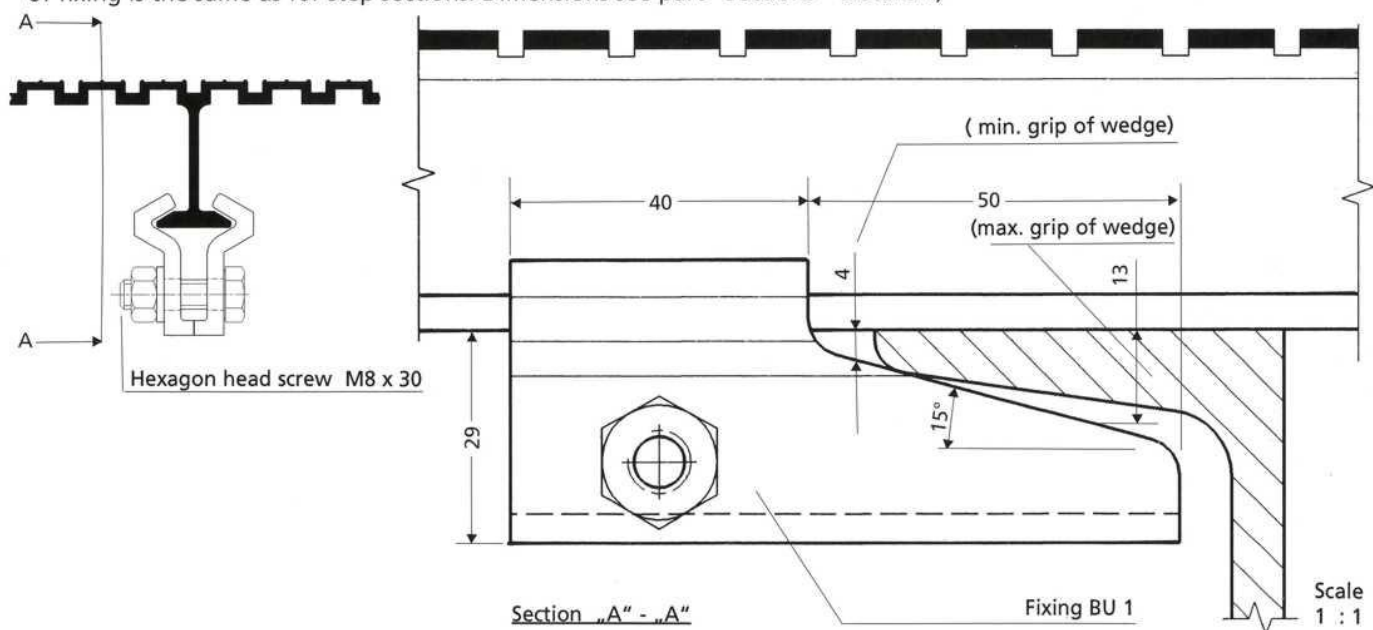


Drive fixing wedge beneath the support projection using a hammer.



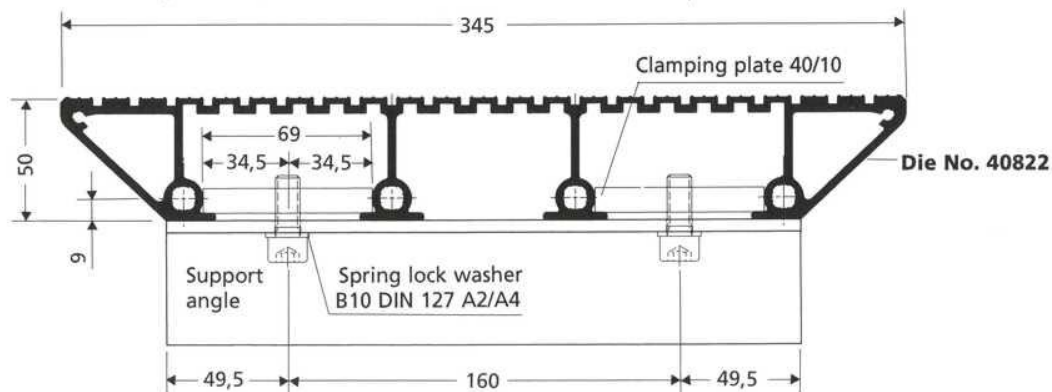
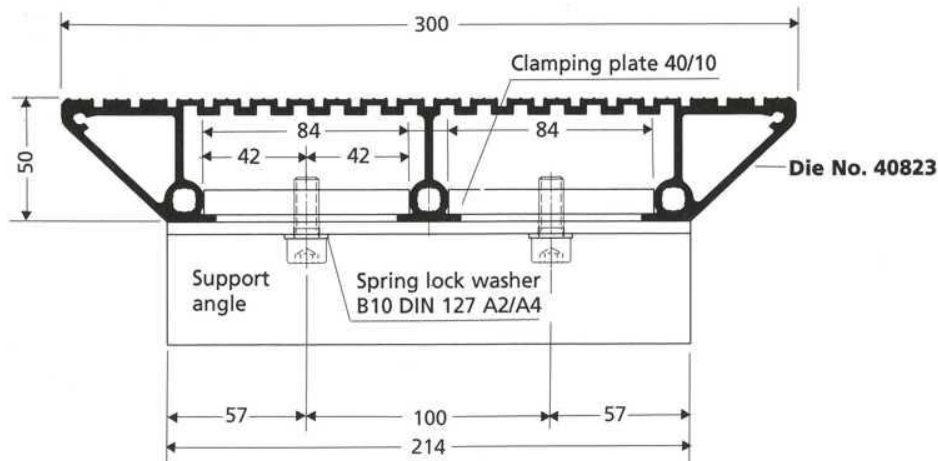
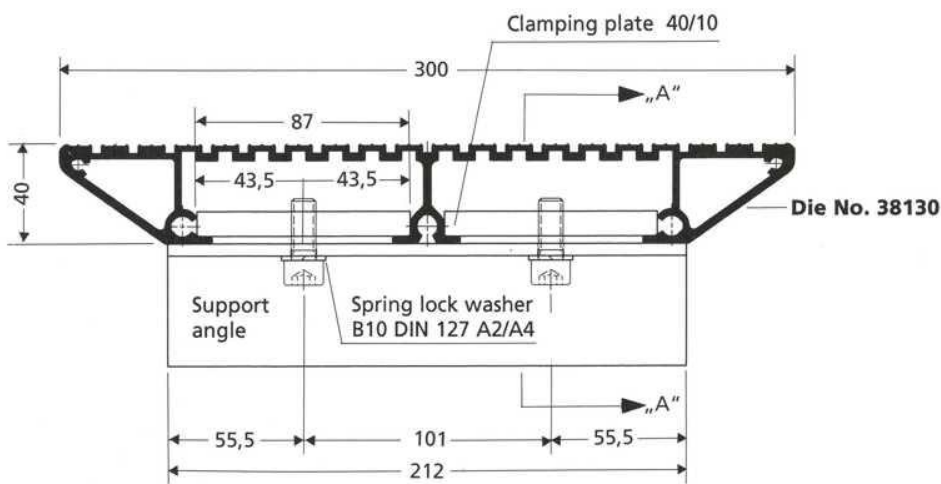
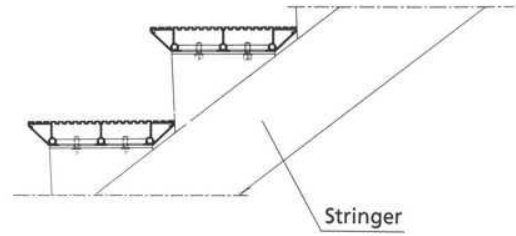
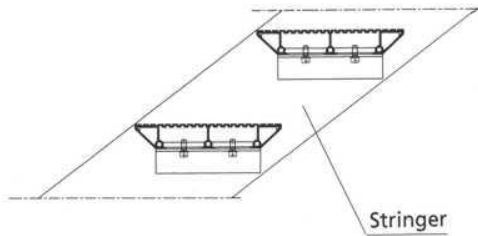
Then firmly tighten clamping wedge bolt to prevent loosening during vibration.

As an alternative to the fixing wedges (BU1), the planks can also be fixed by means of inserted clamping plates (the principle of fixing is the same as for step sections. Dimensions see part "Sections - Details".)

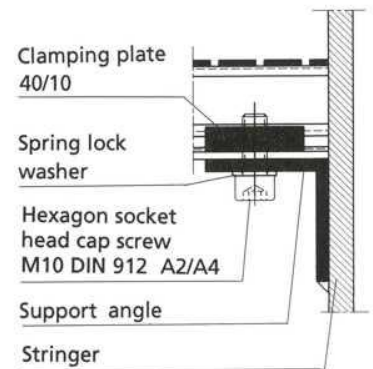


Fixing of steps

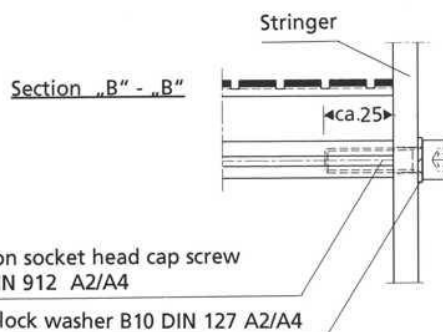
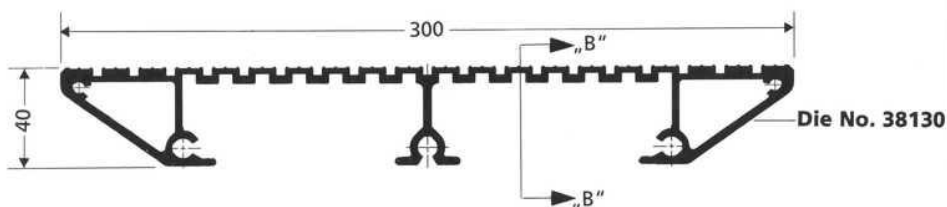
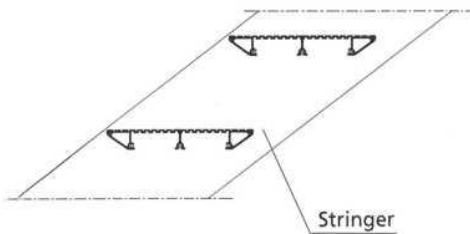
Fixing on support structures



Section „A” - „A”

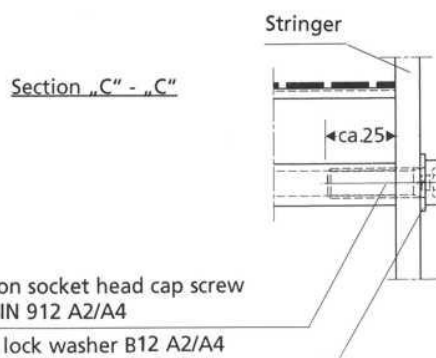
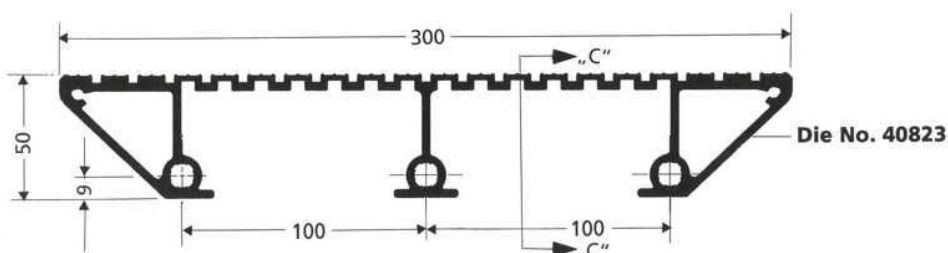


Fixing by bolts into screw ports



Hexagon socket head cap screw
M10 DIN 912 A2/A4

Spring lock washer B10 DIN 127 A2/A4



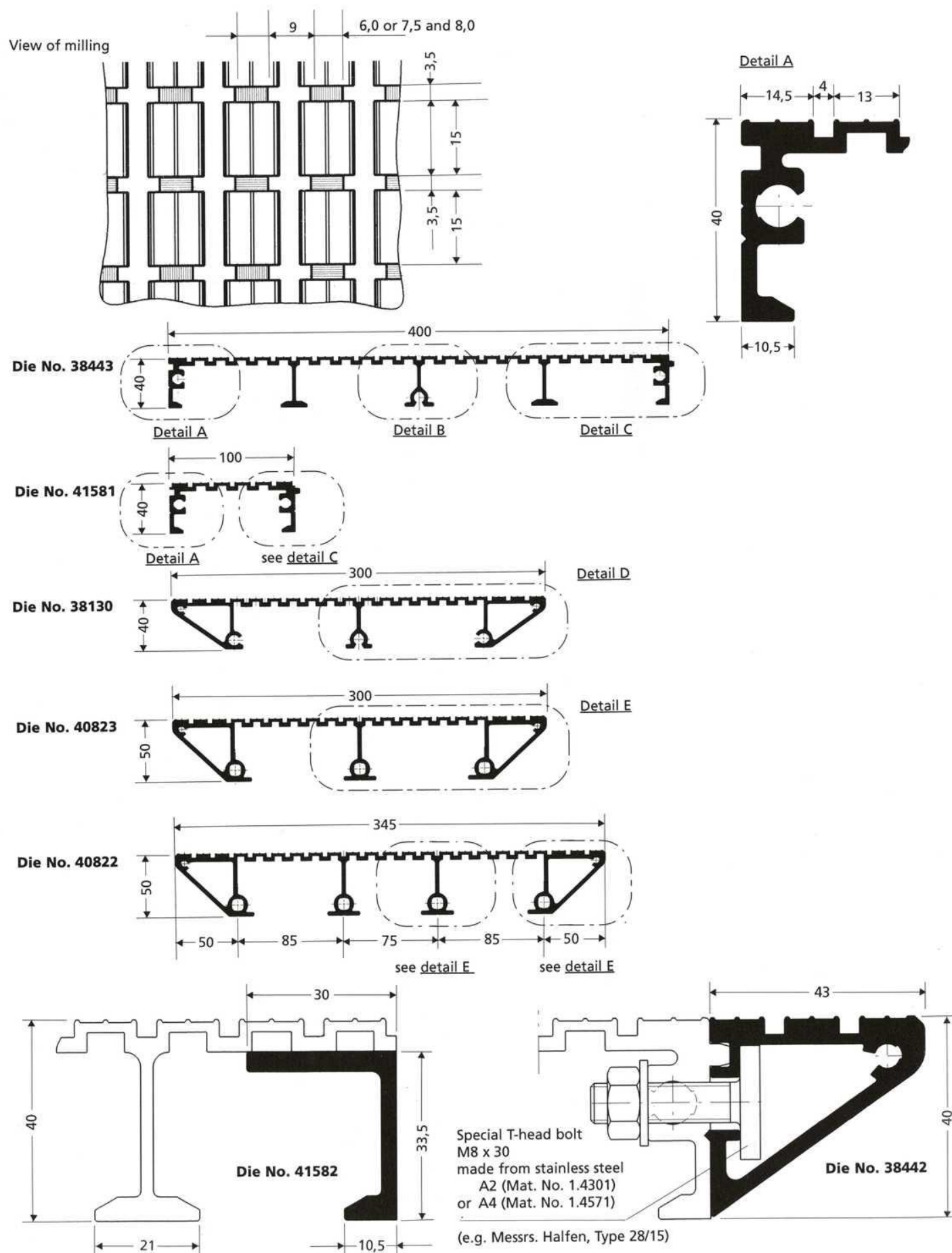
Hexagon socket head cap screw
M12 DIN 912 A2/A4

Spring lock washer B12 A2/A4

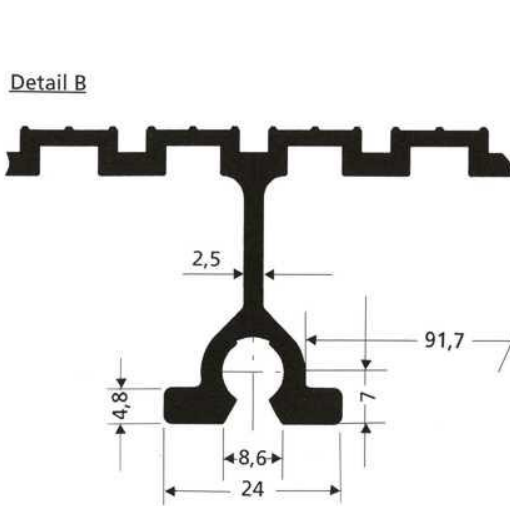


The connections shown on this page (normal machine bolts into taped screw ports) also prove themselves under a repeated loading. Tests made with a load of 1 kN (100 kg) applied in the middle of the front edge of the step (stringer made of AlMgSi1 F31 with a web thickness of 5 mm) and a span of 1,5 m (die No. 38130) or 1,85 m (die No. 40823) have shown that connections were still firm even after 200.000 load cycles ($R = 0,1$).

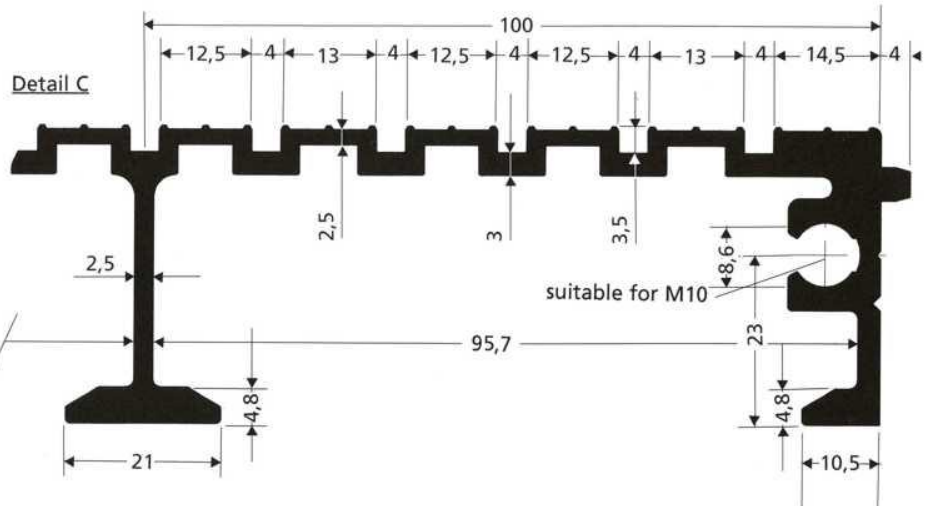
Sections – Details scale 1:1



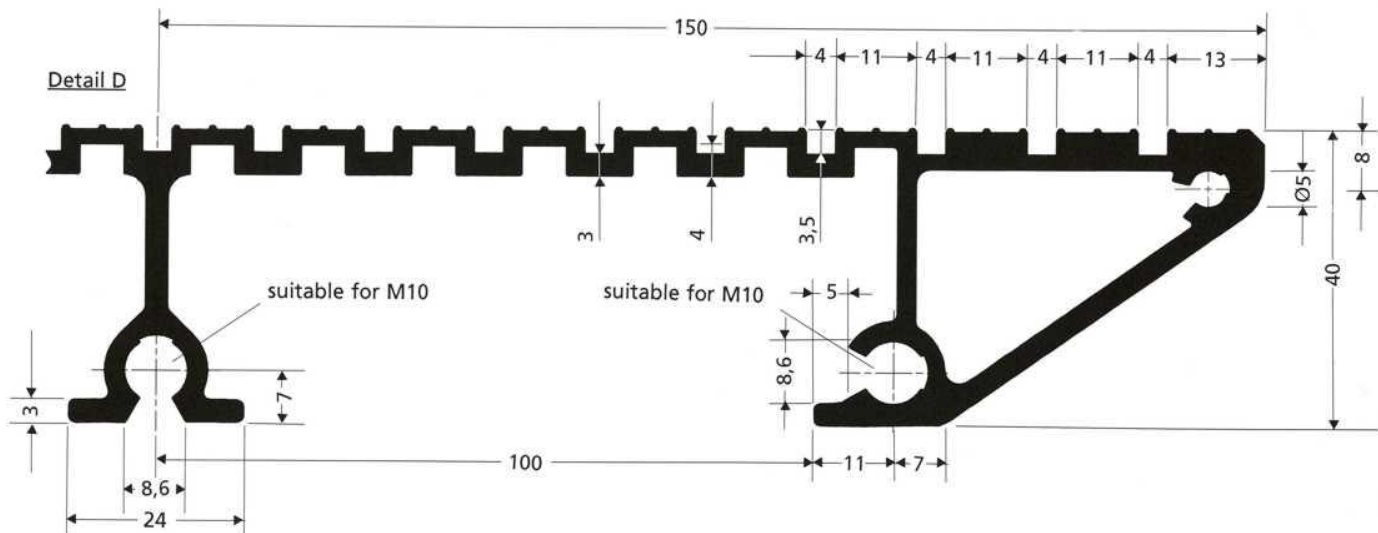
Detail B



Detail C



Detail D



Detail E

