DIPLAN

Heavy steel plates with improved flatness tolerances over the entire plate dimension

Specification DH-E54-C, edition April 2016[1]

Heavy steel plates according to **DIPLAN** specification are used where narrow flatness tolerances over the entire plate dimension are required. Examples are machined parts: The fabricator aims for a minimum over-size (over-thickness) of the heavy plate. This allows to machine the finished part with minimum machining effort. Other application examples are large sized frames of presses where the fabricator aims for a fabrication without or with a minimum of leveling effort.

Product description

Designation and range of application

DIPLAN specifies very narrow limits of flatness tolerances over the entire plate dimension whereas EN 10029 only gives limits in 1 000 mm and 2 000 mm measuring length. Appendix 1 specifies the measurement of flatness deviations over the entire plate according to DIPLAN specification.

DIPLAN can be agreed for heavy plates with a maximum width of 4 400 mm and a maximum length of 12 000 mm. The thickness range is 50 mm to 300 mm (maximum thickness is 200 mm for high yield strength structural steel in quenched and tempered condition). Dimensional limits depending on the steel grade and the maximum plate weights according to the general delivery program shall be taken into account.
Restricted flatness deviations for plate thickness < 50 mm and plate width > 4 400 mm following this DIPLAN specification may be agreed upon request.

[1] The current version of this specification can be also found on http://www.dillinger.de.

DIPLAN can be agreed for the following steel grades:

Grade description	Standard
Non alloy structural steel (e.g. S235JR+N or S355J2+N)	EN 10025-2
Normalized/normalized rolled weldable fine grained steel (e.g. S355NL or S460N)	EN 10025-3
Thermomechanical rolled weldable fine grained structural steels (e.g. S355ML or S460M)	EN 10025-4
High yield strength structural steel in quenched and tempered condition (e.g. S690QL1 or S960QL)	EN 10025-6
DILLIMAX steel grades according to Dillinger data sheets (e.g. DILLIMAX 690 T or DILLIMAX 965 E)	-

The following table gives the limits of the flatness tolerances both for steel grades according to EN 10025-2 to 4 and for high yield strength structural steel in quenched and tempered condition according to EN 10025-6 or DILLIMAX data sheets.

DIPLAN specification may be agreed upon request as well for other steel grades not listed above.
The limits of flatness tolerances in the following table are valid for the delivery condition ex works. Further processing of the plate as heat treatments like e.g. nitriding may affect the flatness properties. Therefore, DIPLAN flatness tolerances are guaranteed only in the ex-works delivery condition following EN 10029.

DIPLAN flatness tolerances

Grade	Plate thickness t [mm]	Width B [mm]	Flatness with plate length L [mm]	
			L ≤ 6 000	6 000< L ≤12 000
Steel grades according to EN 10025-2, -3, -4	$50 \leq t \leq 300$	≤ 4 400	6[a]	8[a]
High yield strength structural steel in quenched and tempered condition according to EN 10025-6 or DILLIMAX data sheets	$50 \leq t \leq 200$	≤ 4 000		

[a] This maximum value of flatness deviation is valid for the entire plate as described in appendix 1.

In addition to this table the following limits are applied:
Maximum flatness deviation in 1 000 mm measuring length: ≤ 3 mm
Maximum flatness deviation in 2 000 mm measuring length: ≤ 6 mm

In case of wave lengths < 1 000 mm the minimum of the limits in EN 10029, class S (special flatness) and the above values in 1 000 mm measuring length is applied.

The measurement of the flatness deviation is specified in the appendix of this specification. The measurement is either performed with manual devices like a measuring cord or straight edge and a measuring wedge or with automatic laser measuring devices (so called AFC). In any case measurement is performed on a flat measuring table. The maximum flatness deviation is defined as maximum distance from the neutral axis in each measuring line.

Order example

Steel S355J2+N - EN 10025-2 + DH-E54-C, DIPLAN.

General note

DIPLAN only specifies additional flatness requirements. All other requirements are according to the specifications e.g. in EN 10025 or the specified DILLIMAX data sheets.
If particular requirements are demanded and not covered in this specification, please contact us with the specifications for our review and agreement prior to ordering. The information in this specification is a product description. This specification is updated at occasion demands. The latest version is available from the mill or as download at www.dillinger.de.

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Appendix 1 to DIPLAN specification

EN 10029 specifies flatness tolerances in measuring lengths of 1 000 mm and 2 000 mm. Flatness measurement is performed on a flat measuring table with a straight edge and if necessary with distance blocks. The distance between the straight edge and the plate surface is measured with a wedge (see Figure 1).

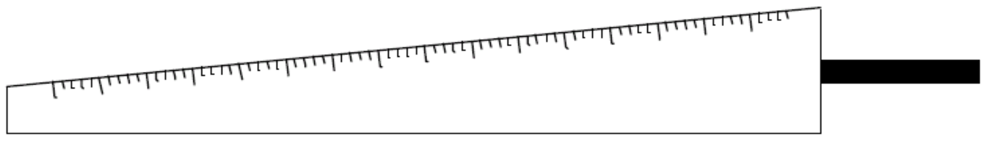
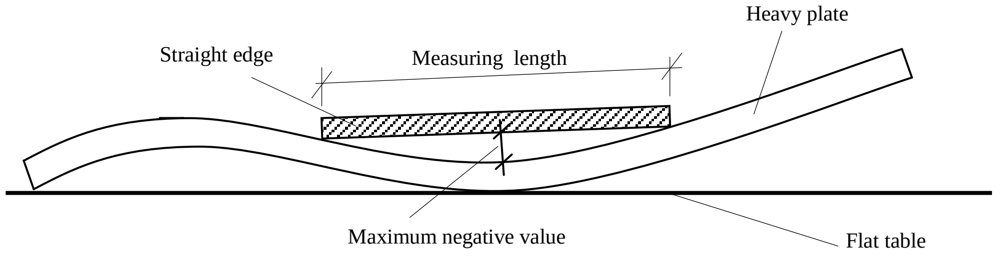
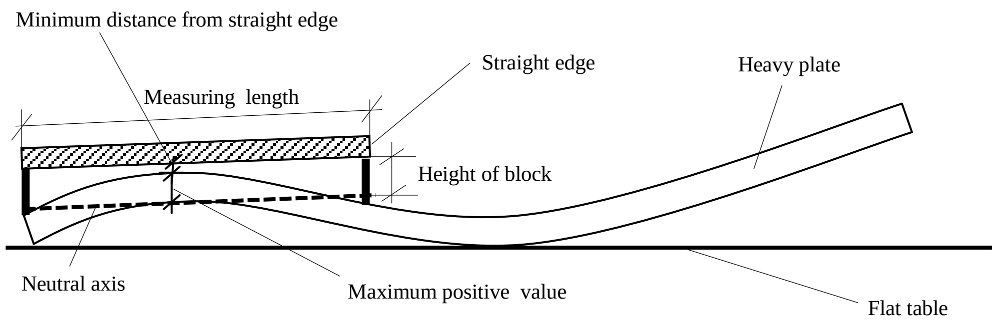


Figure 1: Measuring wedge for distance measuring

Figure 2 illustrates the flatness measurement according to EN 10029 in measuring lengths of 1 000 mm or 2 000 mm. The illustrated example shows a plate with both convex (bellied) and concave (hollow) curves. The flatness deviation is defined as the maximum distance in case of a hollow curve or as minimum distance between the plate and the straight edge subtracted from the height of the distance block in case of a bellied curve respectively. EN 10029 does not define flatness tolerances in longer measuring lengths over the entire plate.



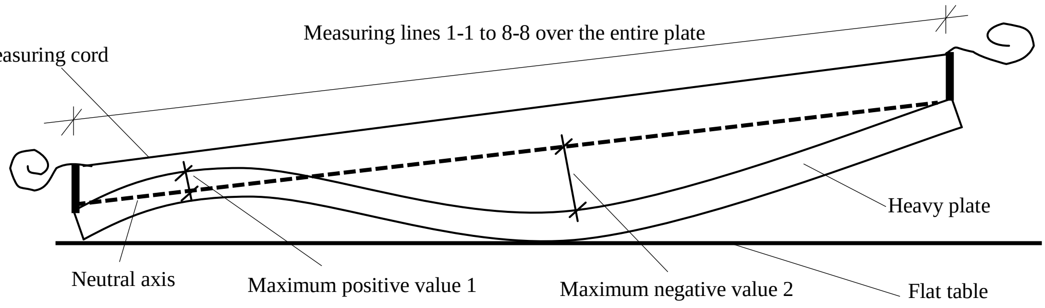
Maximum negative value (wave trough, hollow)
= Maximum distance between plate and straight edge



Maximum positive value (wave crest, bellied)
= Height of block - Minimum distance between heavy plate and straight edge

Figure 2: Flatness measurement according to EN 10029 in 1 000 mm and 2 000 mm measuring length (schematic sketch)

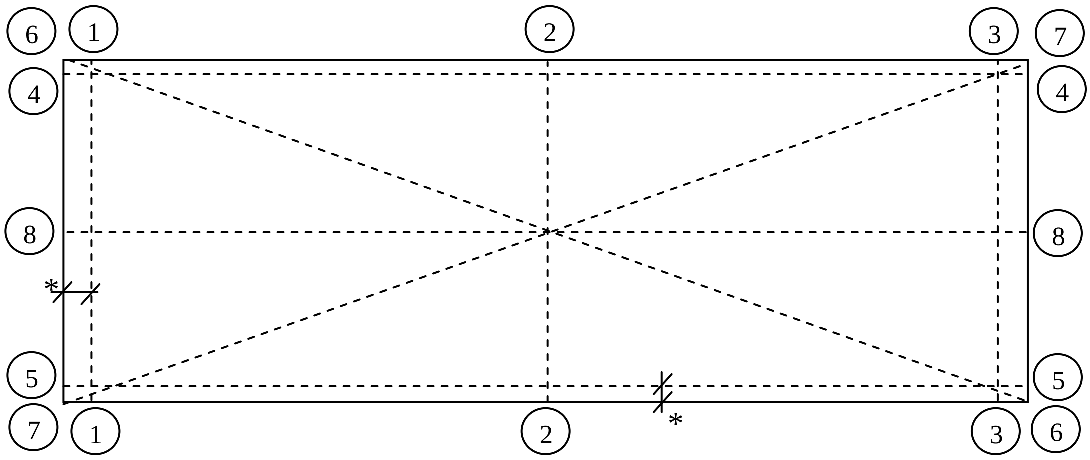
Figure 3 illustrates the DIPLAN measurement over the entire plate which is not specified in EN 10029.



Maximum DIPLAN value
= Maximum of value 1 and 2 = Max {I value 1 I; I value 2 I}

Figure 3: DIPLAN flatness measurement over the entire plate (schematic sketch)

DIPLAN specifies the maximum flatness deviation as maximum distance from the neutral axis: This is the maximum of the maximum negative value measured in a wave trough (hollow concave curve) and the maximum positive value measured in a wave crest (bellied convex curve). Measurement is performed in 8 measuring lines 1-1 to 8-8 over the entire plate. Figure 4 plots the pattern of the 8 measuring lines over the plate is plotted in figure 4. The maximum flatness deviation in each of the 8 measuring lines is documented. These measuring results may contain effects of an inhomogeneous plate thickness.



* Distance from edges as to EN 10029 for special flatness tolerances

Figure 4: DIPLAN pattern of measuring lines 1-1 to 8-8

Informational appendix: Over-thickness for machining process

Machining is a complex process requiring specialist expertise. Only this experience and the above flatness specifications allow to create appropriate specifications for the heavy plates for specific machined parts. Therefore, the following remarks are purely informational and maybe helpful for the specification making process.

If a coplanar machined part shall be fabricated an over-thickness may be specified to compensate for possible flatness deviations and thickness inhomogeneity over the plate. DIPLAN helps to reduce this over-thickness. Figure 5 illustrates the machining of a plate with both convex (bellied) and concave (hollow) curves. Worst case is if wave crests (bellied) and wave troughs (hollow) have exactly same height. In that case the following over-thickness may be necessary: Finished thickness plus 2 times the flatness tolerance in table of DIPLAN flatness tolerances.

Normally, only a considerably smaller over-thickness is necessary because wave crests (bellied) and wave troughs (hollow) do not have same height. Calculating an over-thickness, the thickness tolerance class shall be considered. For constructional steel as to EN 10025 class A according to EN 10029 for the thickness tolerance is applied if nothing else is specified (A means: the thickness may be lower than the nominal thickness).

Usually, fabricators may add an extra over-thickness as buffer for the machining process. This buffer is depending on the fabricator’s experience. Especially for high yield strength steel grades such a buffer may be necessary because there may be deformations during the machining process depending on the applied machining parameters. Dillinger optimizes the production process regarding low internal stresses. This reduces the deformations to a minimum.

Example: Coplanar machined component made of S355J2+N

Finished dimensions: 250 mm x 2 000 mm x 6 000 mm

t_{plate} = 250 mm + 2 x 6 mm (see table DIPLAN flatness tolerances) (+ buffer) = 262 mm (+ buffer)

Thickness tolerance class C (lower value of the tolerance band equal to nominal thickness)

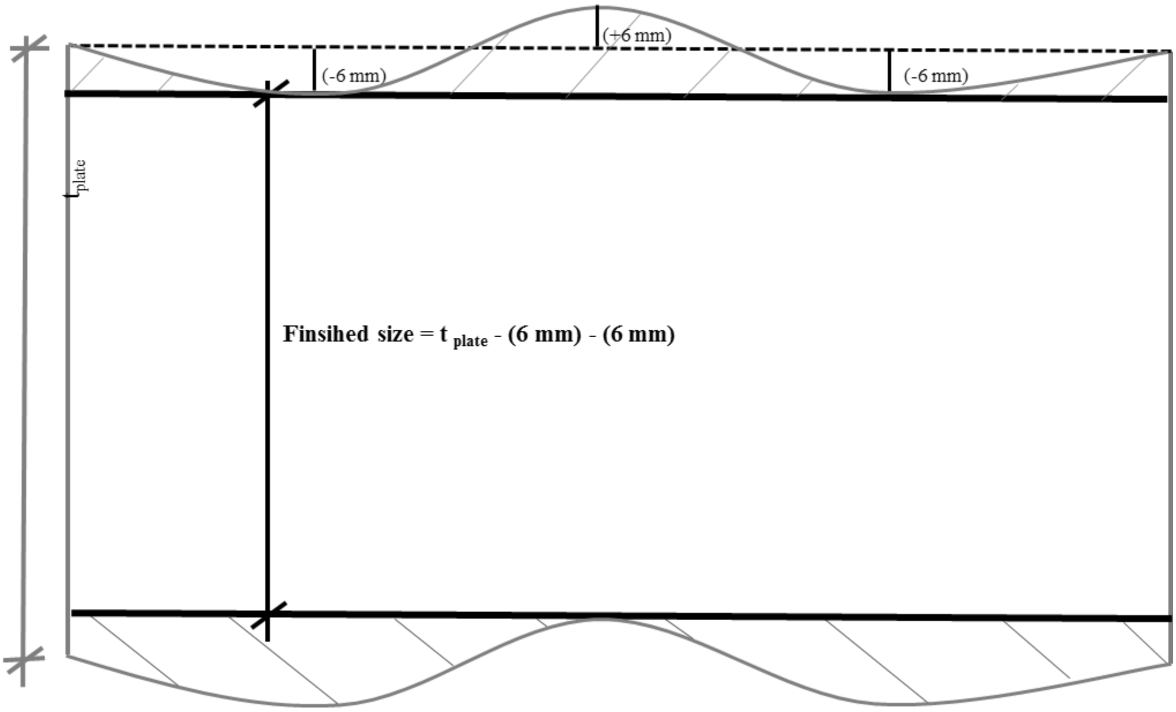


Figure 5: Scheme of the machining process