Hot rolled Steel Plates, Sheets and Coils
Structural steels
Z Plates

A specially processed steel grade, which takes the requirements of heavy steel construction into consideration. The possibility of lamellar tearing occurring in stiff welded joints has been prevented by improving the perpendicular properties of steel.

Applications
- Frame structures, in which the plates are heavily loaded in the through-thickness direction
- Beams in bridge construction
- Overhead bridge crane structures
- Ship structures
- Machine beds
- Heavily loaded structures such as crushers
- Propeller blade structures
- Oil rig cross frames
- Other offshore structures

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Definition of Z plates, quality classification and dimension range

The properties of the Z plates perpendicular to the plate surface are better than those properties of the corresponding grade of general structural steel. The letter Z refers particularly to the thickness in xyz-coordinates plate width x length x thickness. The through-thickness deformation properties are determined with the tensile test using test pieces that are machined in through-thickness direction of the plate. The result is the perpendicular reduction of area at fracture, that is, the so-called Z value. The figure indicates the reduction of the cross-sectional area of the tensile test piece during tensile test, i.e. perpendicular reduction of area in percents. This calculated Z value set a basis for the quality classification of Z plates, table 1.

Standard ASTM A 770 (1986/2001) deals also with the steel plates having improved through-thickness properties. In this standard, Z plates are defined as plates that have reduction of area value Z ≥ 20%. Z plates with improved through-thickness properties can be delivered in the thickness range of 15 to 100 mm. Z guarantee for thinner plates according to separate agreement. For other dimensions the corresponding dimension range of heavy plates is effective.

Steel grades, product shapes and properties

Z plates can be ordered in any of the steel grades included in the heavy plate production programme. Z plates are used in all parts of the world as structural steels, pressure equipment steels, ship construction steels and offshore steels.

In addition to heavy plates, shop-primed plates and a wide selection of prefabricated plate products are also available. Prefabricated products that are ready for installation can be tailormade, cut, bent and/or bevelled in accordance with customer requirements. The chemical composition, mechanical properties as well as usability in the engineering shop are determined by the steel grade.

Manufacture of Z plates

Z plates are manufactured and tested primarily according to the requirements set in the relevant steel standard or in the Rules of the classification society in question. During the manufacture of the steel, special additional treatment is used to improve the through-thickness properties of the finished plates. If the material standard does not specify requirements for Z plates and the purchaser does not indicate any specific requirements, the standard EN 10164 will be applied.

Occurrence of lamellar tearing in steel structures

Lamellar tearing as a failure type of steel structures is extremely uncommon. When occurring it usually takes the form of cracking parallel to the surface of the plate and in association with a welded joint. The cracks are on different planes and are connected to one another in a step-like form. Most sensitive to this are stiff, fillet and butt welded L and T joints, where large through-thickness stresses may occur. When assessing the possibility of occurrence of lamellar tearing the empirical values for through-thickness reduction of area presented in table 2 can be used.

It must be taken into account that there is no direct correlation between the reduction of area value of steel and the durability of the steel structure. In addition to the material, sensitivity to lamellar tearing is affected also by the type and the design of the steel structure and the implementation of the welding. This means that the minimum reduction of area values given in the standard will not solely guarantee freedom from lamellar tearing. Reduction of area value is, however, a good thumb rule when assessing resistance to lamellar tearing. For critical parts of structure the tensile stress in the through-thickness direction in plates must be reduced, by constructional means and welding techniques, to the level, which will ensure safe use of the structure.

Z plate designation

The designation for plates with improved through-thickness reduction of area properties is the following:
- The designation of the steel grade (according to the material standard, data sheet or other specification)
- The number of the standard defining the Z properties (e.g. EN 10164)
- The designation of the relevant Z quality class (according to table 1).

Example of the designation on drawing and on order

Heavy plates according to EN 10025-3 of the steel grade S355N with Z quality class Z25 according to EN 10164, shall be designated when designing or purchasing in accordance with the following example: EN 10025-3 S355N + EN 10164-Z25.

Z plates that are ordered according to the standard ASTM A 770 (1986/2001) shall be designated by merely the standard name or by the standard plus the symbol ZT.

Material testing and sampling

Z plates are manufactured and tested primarily according to the requirements set in the relevant material standard or in the rules of Classification Society in question. If the standard does not specify requirements for Z
plates and the purchaser does not indicate any specific requirements, standard EN 10164 will be applied. A test unit and the sampling are defined in EN 10164. The through-thickness tensile test and the calculation of the through-thickness reduction of area are defined in the standard EN 10002-1. The test result assessment is based on the sequential method defined in the standard EN 10021.

- **Ultrasonic testing**

  The testing of Z plates always includes ultrasonic testing which is carried out according to the requirements of EN 10160 class S1. It must be noted that the normal ultrasonic technique cannot be used for determining resistance to lamellar tearing.

- **Marking of Z plates**

  Z plates are marked in accordance with the relevant material standard or specification in question, in addition to which is added a Z quality class designation, e.g. S355N + Z25.

### Z quality classes and the corresponding reduction of area values for Z plates according to EN 10164

<table>
<thead>
<tr>
<th>Z quality class</th>
<th>Requirements for reduction of area value (Z values)</th>
<th>Minimum individual value requirement %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality class designation</td>
<td>Minimum average value, requirement for three tests %</td>
<td></td>
</tr>
<tr>
<td>Z15</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Z25</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Z35</td>
<td>35</td>
<td>25</td>
</tr>
</tbody>
</table>

*For plates of thickness less than 15 mm the standard EN 10164 does not require through-thickness tensile tests and these tests are not carried out. However, the same manufacturing process is used for all the Z plates regardless of the thickness.*

### Values for reduction of area in the through-thickness direction

<table>
<thead>
<tr>
<th>Reduction of area in the through-thickness direction %</th>
<th>Probability of occurrence of lamellar tearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z ≥ 35</td>
<td>Extremely unlikely.</td>
</tr>
<tr>
<td>20 ≤ Z &lt; 35</td>
<td>Extremely rare.</td>
</tr>
<tr>
<td>15 ≤ Z &lt; 20</td>
<td>Possible in welded joints highly loaded in the through-thickness direction of the plate.</td>
</tr>
<tr>
<td>10 ≤ Z &lt; 15</td>
<td>Possible in welded joints moderately loaded in the through-thickness direction of the plate.</td>
</tr>
<tr>
<td>Z &lt; 10</td>
<td>Possible in welded joints only lightly loaded in the through-thickness direction of the plate.</td>
</tr>
</tbody>
</table>

### Our Customer Service is happy to give you further information

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