

Armour steel	Steel grade		Material No.	Material Specification
	TKSE-Short name	EN-Short name		
	SECURE 450	-	-	

Heavy plate

Scope

This Material Specification applies to the liquid-quenched and tempered high-strength special steel SECURE 450 with a hardness between 400 - 480 HBW for civil use from 4 up to 20 mm in thickness. This steel is delivered with defined properties of ballistic protection.

Application

The steel may be used at the discretion of the purchaser for purposes of ballistic protection mainly for applications like armoured limousines and valuable transporters.

The entire processing technique is of fundamental importance for the good performance of the products made of this steel. The processor must assure himself that his methods of calculation, designing and working conform with the material to be used, meet the latest requirements of technical progress and are suited to the proposed application.

The selection of the material is up to the purchaser.

Chemical composition (heat analysis, %)

C	Si	Mn	P	S	Cr	Mo	Ni	V
≤ 0.20	≤ 0.5	≤ 1.6	≤ 0.020	≤ 0.005	≤ 1.0	≤ 0.7	≤ 2.25	≤ 0.05

The steel has a fine-grained microstructure. Nitrogen is absorbed to form nitrides.

Delivery condition: quenched and tempered (see paragraph "Heat treatment")

Typical mechanical properties in the state of delivery condition at room temperature (transverse specimens according to ISO 6892-1, method B), Charpy-V-test acc. DIN EN 10045 (transverse specimens).

yield strength R_{eH} ^{*)} MPa	tensile strength R_m MPa	elongation at fracture A %	Impact energy, - 40 °C J
1100	1250 - 1450	8	40

^{*)} If continuous yielding occurs, the yield strength is determined as $R_{p0.2}$

Ballistic properties

For testing the ballistic properties following calibres can be used:

.44 Magnum, 5.56 mm x 45 (SS 92 or SS 109), 7.62 mm x 51 NATO (AP/Smk or Ball).

Other testing conditions can be agreed on customers request.

For use with civil service, e.g. protective buildings or armoured civil vehicles it is useful to follow the testing of bullet resistance to EN 1522 (Bullet resistance, Demands and classification, Windows and doors) or to EN 1063 (Glass in building - Security glazing, Bullet resistant glazing, Classification and test method).

Number of tests

Unless otherwise agreed upon in the order, the tests listed below will be performed during inspections:

Hardness testing will be determined once ever 40 t of a melt. Optional an ultra sonic testing acc. to EN 10160, class S₁ and a bullet resistance testing can be performed.

All test results are documented by inspection certificates following EN 10204-3.1.

Cold forming

Plates of this steel grade can be cold formed at ambient temperature under consideration of their strength. The forming force and the amount of elastic recovery are greater than that of conventional structural steels. Cutting edges must be ground, flash trimmed and smoothly rounded before forming. The minimum bending radius for SECURE 450 should not be less than 4 times that of plate thickness for bending transverse to rolling direction and not less than 6 times plate thickness for bending parallel to rolling direction. The ratio of die opening should be two times that of the bending radius. Cold forming of plates must be performed at low forming speed at room temperature. Preheating is not recommended. It is specifically stated, that the processing of the steel at temperatures above 250 °C is to avoid, because the steel can lose its excellent characteristics at higher temperatures.

Hot forming

Hot forming basically is possible. Such an operation, however, will remove the effect of the original heat treatment. Therefore, after hot forming it is necessary to perform a heat treatment equivalent to that of the state of delivery condition.

Heat treatment

In general the steel obtains its mechanical properties through austenitization followed by conventional quenching and tempering. Direct quenching after hot rolling followed by tempering is considered equivalent to conventional quenching and tempering according to EN 10137-2.

The heat treatment is governed by the chemical composition and the thickness of the material. It is specifically stated, that the processing of the steel at temperatures above 250 °C is to avoid, because the steel can lose its excellent characteristics at higher temperatures. Information on this can be obtained from the manufacturer.

Thermal cutting

Under suitable conditions flame cutting is possible without any difficulty. The processing conditions correspond to unalloyed or alloyed steels. The surface condition of the plates exerts a substantial influence on the flame cutting parameters and the attainable quality of the cut edge. In cases where a higher quality for the flame cut surface is required, then it is recommended to clean the upper and lower sides of the cutting edge. In that case rust, scale and other kinds of dirt must be removed. For work piece temperatures below 5 °C and also if the flame cut edges are to undergo cold forming in the course of further processing it is advisable to preheat the material to about 150 °C before flame cutting.

Welding

If due consideration is given to the general rules for welding, this steel is weldable both manually and automatically. The manual arc welding and the gas shielded arc welding procedures are preferably used. Depending on plate thickness, hydrogen content of the weld metal and heat input the welding may be carried out under preheating. The recommendations of the STAHL-EISEN-Werkstoffblatt 088 respectively EN 1011-2 should be followed. The working temperature should not go beyond 250 °C.

It is specifically stated, that with presently available welding consumables equal strength properties in the weld compared to the base material cannot always be achieved. To prevent cold cracking in the welded joints only welding consumables giving welds with very low hydrogen content should be used. A high cooling rate in the weld region should be avoided. Detailed information is given in our recommendations for welding and our processing brochures.

To ensure, that the steel properties are not impaired to an inadmissible extent by thermal cycles during welding, an upper limit for the heat input has to be fixed. The heat input for welding is governed by the welding process, the plate thickness, the preheating temperature, the form of the welding seam and the requirements imposed on the construction.

General information

Unless otherwise agreed upon in the order, the delivery will be governed by the conditions outlined in EN 10021.

The admissible tolerances are based on EN 10051 for plates cut from hot strip and EN 10029 for four-high mill plates, unless other terms have been agreed upon.

The plates will be supplied with a maximum flatness tolerance of 6 mm/m (smaller flatness tolerances by special agreement). The flatness is determined in acc. to EN 10029, Class S.

For surface quality requirements EN 10163 is applicable.

At the time of ordering it is possible to make further agreements with regard to the testing conditions.

As per special agreement it is possible to supply plates descaled or descaled and primed.

Publisher`s addresses

EN, ISO Standards	Beuth Verlag GmbH, Postfach, D-10772 Berlin
STAHL-EISEN-Werkstoffblätter	Verlag Stahleisen GmbH, Postfach 10 51 64, D-40042 Düsseldorf
Recommendation for thermal cutting of SECURE steels	ThyssenKrupp Steel Europe AG, D-47161 Duisburg
Recommendation for welding of SECURE steels	ThyssenKrupp Steel Europe AG, D-47161 Duisburg
ThyssenKrupp Steel brochure "Ballistic steels. Making life saver."	ThyssenKrupp Steel Europe AG, D-47161 Duisburg