WELDING OF HIGH STRENGTH MATERIALS USED IN THE MANUFACTURE OF SPECIAL EQUIPMENT

Eva BREZOVÁ[1*] - Harold MÄSIAR[2] - Pavol RADIČ[3]

[1] *Ing. Eva Brezová, Alexander Dubček University of Trenčín, Faculty of Special Technology, Pri Parku 19, 91106 Trenčín, Slovakia*

[2] *doc. Ing. Harold Mäsiar, Alexander Dubček University of Trenčín, Faculty of Special Technology, Pri Parku 19, 91106 Trenčín, Slovakia*

[3] *Ing. Pavol Radič,' VUZ PI-SR, Račianska 71,832 59 Bratislava 3*

**Corresponding author E-mail address: eva.brezova@tnuni.sk*

Abstract

The paper brings closer knowledge in area of welding of high strength materials such as HARDOX, WELDOX, ARMOX, QSTE often used in the production of special equipment. It describes features of some selected sheet metals, their weld ability, preheat temperature and interpass temperature, a choice of additional material. WELDOX Design steel plates and HARDOX wear resistant plates combine extreme durability with exceptionally good weld ability. All conventional welding methods can be used for welding of these steels with any other wieldable steels**.**

Keywords: welding, steels, high-strength materials, HARDOX, WELDOX, ARMOX, QSTE

1 High-strength materials HARDOX,WELDOX, ARMOX, QSTE

2 ARMOX

General welding information SSAB Oxelüsund AB, Sweden, produces armour plate with a lean chemical composition which simplices welding. ARMOX plates should be welded with a consumable which produces low hydrogen content in the weld metal. Good results require that hydrogen, which can induce cold cracking, is kept away from the weld area. ARMOX plates can be welded by either manual metal-arcor gas metal-arc. All ARMOX grades can be welded to other weldable steel. ARMOX plates have been developed to have as low a carbon equivalent as possible without loss in hardness, strength and ballistic properties.Typical carbon equivalents are shown in the table below.
Edge preparation a good at between the work pieces is essential to minimize stresses and thereby the risk of cracking. All types of impurities on and near the edges, such as mill scale, rust, oil, paint and moisture, should be removed before welding.

Steel grade	Thickness range	Carbon equivalent CEV (IIW)[1]
ARMOX 370 T	3 - 150 mm	0.67- 0.75[2]
ARMOX 440 T	4 - 30 mm	0.68 -0.72
ARMOX 500 T	3 - 150 mm	0.67- 0.75[2]
ARMOX 560 T	5 - 100 mm	0.79- 0.85[2]
ARMOX 600 T	5 - 100 mm	0.85[2]

Tack welding

During tack welding the cooling rate is more rapid which increases the risk of cold cracking. In areas of high restraint the minimum length of each tack weld should be 50 mm to prevent this.

Working temperature and heat input

If ferritic consumables are used preheating is necessary and the plate should be welded at a working temperature of 75-200°C, dependent on plate thickness and restraint conditions.The temperature should be maintained throughout the entire weld operation, tack welding and root passes included.
ARMOX plates have been developed to have as low a carbon equivalent as possible without loss in hardness, strength and ballistic properties.Typical carbon equivalents are shown in the table below.

Edge preparation

A good at between the work pieces is essential to minimize stresses and thereby the risk of cracking. All types of impurities on and near the edges, such as mill scale, rust, oil, paint and moisture, should be removed before welding.
If **austenitic** consumables are used, the plate should be welded at least at room temperature (18-25°C), but when welding in plate thicknesses in excess of 30 mm in conjunction with high levels of restraint preheatingn to 100 - 150°C is recommended.
Do not preheat ARMOX plates above 200°C.

Recommended working temperatures for welding with ferritic consumables

Steel grade	Heat input Q [kJ /mm] **	combined plate thickness t1+ t 2+ t3 [mm] 20	30	40	50	60	70
ARMOX 440 T	1	100°C	125°C	150°C	175°C	200°C	200°C
	2	50°C	75°C	100°C	125°C	150°C	175°C
ARMOX 370 T/ 500 T	1	125°C	150°C	175°C	200°C	200°C	200°C
	2	75°C	100°C	125°C	150°C	175°C	200°C
ARMOX 560 T/ 600 T *	1	125°C	150°C	175°C	Use austenitic cons		
	2	125°C	150°C	175°C	Preheat 100 - 150°C		

*ARMOX 560Tand ARMOX 600Tare recommended to be welded with austenitic consumables.

Welding recommendations for ARMOX plate (cont.)

Selection of consumables

Consumables should be selected on the basis of strength and toughness requirements in the welded joint as well as on the prevailing restraint conditions. In order to achieve an optimum combination of strength and toughness in the welded joint, select a consumable with as lowest strength as possible, but which still ful¢ls the strength requirements for the joint. Overmatching should be avoided. Designers should attempt to position the welds in low stress areas. In most cases, undermatching consumables can then be used.The main advantages of a low-strength instead of a high-strength consumable are an increase in plastic deformation capacity (ductility), a reduced susceptibility to cracking and better toughness in the weld joint. Basic consumables are most suitable for ARMOX plate.

Handling of consumables

Select the weld process and consumables which produce the lowest possible level of hydrogen in the weld metal. Covered electrodes should be thoroughly dried to ensure that the hydrogen content does not exceed 5 ml per 100 g weld metal (the Hg method according to iso 3690).

Consumables should be stored to ensure that moisture absorption is prevented. Always keep opened packages of electrodes dry and warm (at least125°C).
Do not return unconsumed electrodes to dry cabinets if there is the slightest risk that they may have absorbed moisture. (Harmful absorption can take place in 30 to 60 minutes).
If there is any risk that moisture has been absorbed, the consumable must be discarded or ask the manufacturer for advice on redrying. Precautions that apply to covered electrodes also apply in the main to granular £ux, and £uxcored wires.

3 HARDOX

HARDOX is a trade name of SSAB (equivalents are available from other manufacturers).

It is wear plate, designed to last longer than standard mild steel. There are various hardness levels with 400 and 500 being the most common. It is relatively lean in alloy content and as such is not that prone to cracking especially if a few rules are followed. HARDOX is weldable using 7018 electrodes or standard mild steel MIG wire (SG2) but will need preheat for thick sections.

HARDOX 400 is the most popular of the HARDOX abrasion-resistant steel products. Thanks to its high toughness and problem-free weldability, it is often used as abrasion-resistant and structural steel at the same time.

HARDOX 400- 40mm combined thickness will need 75°C preheat whilst HARDOX 500 20mm combined thickness will need 100°C. Thicker sections will need higher preheat, and in both grades the interpass temp should be kept to 150 - 175°C.
If preheating is a problem it is possible to weld without preheat using a 309L type electrode or wire, but remember stainless cannot be burned with standard oxy-acetylene. Some of the digger bucket repairers once warned me of this problem which gives them headaches on subsequent repairs.

Another consideration is that the weld will be softer than the plate. If this is a potential problem the weld can be capped using a hard facing electrode or wire. A single pass with a 600 hardness consumable should match or exceed the hardness of the plate. 2 passes will exceed.
These hardness numbers are Vickers, there is also Brinell and Rockwell hardness scales. Basically all are tests that measure the indentation made by a standard shaped object (either a pyramid or a ball) under a standard load.

HARDOX 450 was originally developed for truck beds. It offer greater hardness (and hence abrasion resistance) while maintaining high impact strength and very good weldability. It is increasingly used also in other applications, in which previously used was the HARDOX 400 material.

HARDOX 500 is used mainly in applications requiring very long life in abrasion-resistant conditions, or in applications in very hard rocks or minerals.

HARDOX 600 offers extreme hardness with high impact strength, and competes with such materials as cast steel, cast manganese steel and ceramics, offering better availability and machinability as these materials.
For HARDOX 600 steels, the final values of mechanical properties and the available thickness range will be defined gradually
HARDOX steels have mill certificates guaranteeing ranges of hardness and chemical composition. The values of impact strength KV and carbon equivalent Ce shown above are typical values.

Important parameters in welding

The extreme performance of Hardox is combined with exceptional weldability. Any conventional welding method can be used for welding these steels to any type of weldable steel. This information is aimed at simplifying, improving and boosting the efficiency of the welding process. It offers good advice on preheat and interpass temperatures, heat input, welding consumables, shielding gas and a great deal more. We want every user to take advantage of the full benefits of the unique properties of HARDOX.

Heat input

Welding with the recommended heat input results in good mechanical properties in the heat affected zone (HAZ).

The heat supplied by the welding process affects the mechanical properties of the welded joint. This is described by the heat input (Q) that can be calculated using this formula.
Different methods of welding have varying thermal efficiency (k). In the table you find approximate values of this property.

Welding consumables

Unalloyed, low-alloyed and stainless steel consumables can be used for the welding. HARDOX should be welded with low strength consumables as shown in the figure below.

Weld sequences and gap size

To avoid hydrogen cracks in the welded joint the starting and stopping sequences should not be located in a corner. If possible, the starting and stopping procedures should be at least 5–10 cm from a corner. Also, the gap in the weld joint should be a maximum of 3 mm.

Welding on the HARDOX primer

Welding can be carried out directly on the excellent primer, due to its low zinc content. The primer can easily be brushed or ground away in the area around the joint. Removing the primer prior to welding can be beneficial, as it can minimize the porosity in the weld and can facilitate welding in positions other than the horizontal.
If the primer is left on the weld preparation, the porosity of the weld metal will be slightly increased. The MAG welding process with flux cored wire and the MMA welding process offer the lowest porosity. As in all welding operations good ventilation must be maintained, then the primer will not have a harmful effect on the welder and his surroundings.

Post weld heat treatment

HARDOX HiTuf can be stress relieved by post weld heat treatment, although this is seldom necessary. This method should not be used for stress relieving on other grades, since this may impair the mechanical properties.

4 WELDOX

When using WELDOX, you are using the best extra-high strength structural steel in the world. WELDOX is highly-rated for its flatness, surface finish, thickness tolerances and low inner stress and recognized to have the highest and most even quality in the market.
WELDOX belongs to a new generation of extra-high strength structural steels that make machining easy. Because of WELDOX's high purity, a chemical composition similar to ordinary steel, even mechanical characteristics and evenly-distributed stress, you can weld, bend, cut and mill the plate as you would with ordinary steel.
WELDOX can:

- Increase profitability. You will require lesser amounts of steel to maintain the same strength of design, thereby lowering material costs.
- Cut production costs. Bending instead of welding, for example, will save expensive welding hours.
- Increase satisfaction. Offer lighter and safer products with increased functionality.

WELDOX, RQT and S690 are the same steels and are usually known by the trade name WELDOX. They are very high strength steels but have lean compositions (low alloy). Their strength is achieved by thermo-mechanical means: rolling and quenching and tempering (RQT).
These days they find use in all sorts of fabrications from battery powered vehicles to skips, in fact anywhere where their increased strength can be used to lighten the fabrication. If the strength is higher you need less thickness to provide the same overall strength. Thinner equals lighter and alighter skip can hold more rubbish but maintain the same overall weight.
These steels provide little problems in welding providing the correct consumables are used in the correct procedure.
As far as consumables are concerned you need an E10018-G or a 11018-G electrode or an ER100S-G or ER110S-G wire.
The procedure is reliant on the correct preheat for the thickness of plate involved. Preheats increase with thickness. Over 30mm you need 75°C and over 70mm thick its 100°C. These thicknesses are combined so if its 20mm to 20mm its 40mm combined. These preheats assume a heat input of 1.7kJ/mm which is common with

electrodes but more difficult with MIG (the tendency in MIG is for lower heat input so higher preheats are required).
Heat Input is a number that relates to the energy applied to the weld. It is Volts x Amps x Time / Length.Given that a process such as MIG will weld faster than MMA, the time taken for a unit length will be shorter so the divider will be greater and thus the heat input will be lower (even though the amps might be higher). Think of it like waving a gas flame across the weld. Do it slowly and it will get the plate hotter than wafting it across very quickly. The greater the Heat Input the more heat in the weld.

Welding WELDOX

WELDOX has been developed to provide excellent weldability, combined with high strength and toughness. The ore-based metallurgy and advanced processing in the steel shop ensures very low contents of residual elements in the steel. WELDOX high strength steels have excellent bendability and machinability properties. Due to the high strength of the steel, the end products can be strong but lightweight, which allows for substantial reductions in the cost of materials, welding and transport. Good flatness and fine surface quality are also distinguishing features of WELDOX plate.
WELDOX high strength steel is produced in thicknesses ranging from 4 to 130 mm, and with guaranteed yield strengths between 700 MPa and up to 1300 MPa. The flexible production system enables us to deliver plate with tailored properties to suit the customer's requirements. We can supply plate in thermomechanically rolled or quenched and tempered condition. In addition, most WELDOX steels can be supplied with guaranteed impact toughness at temperatures down to –60°C.
Preheat and interpass temperatures - The right preheats and interpass temperature is important in order to avoid hydrogen cracking.
WELDOX are high-strength structural steels with yield strength ranging from 420 to 1100 MPa. Their principle lies in achieving the given degree of strength while maintaining the best possible weldability. The result is for example WELDOX 700 with yield strength 700 MPa, which at 20 mm thickness has identical weldability as steel 11523.

Table 1 Mechanical properties and carbon equivalent

Quality	Thickness [mm]	Reh [MPa]	Rm [MPa]	Impact energy KV [J] at -40°C
WELDOX 355	8 - 16	355	450 - 610	40J
	(16) - 25	345	450 - 610	
WELDOX 420	8 - 16	420	520 - 660	27J
	(16) - 40	400	520 - 660	
	(40) - 63	390	500 - 660	
	(63) - 80	380	480 - 640	
WELDOX 460	8 - 16	460	540 - 720	27J
	(16) - 40	440	510 - 720	
	(40) - 63	430	530 - 710	
	(63) - 80	420	510 - 690	
WELDOX 500	8 -16	500	570 - 720	40J
	(16) - 40	480	570 - 720	
	(40) - 80	460	550 - 720	
WELDOX 700	5 - 50	700	780 - 930	27J
	(50) - 100	650	780 - 930	
	100 - 130	630	710 - 900	
WELDOX 900	4 - 50	900	940 - 1100	27J
	(50) - 80	830	880 - 1100	
WELDOX 960	4 - 50	960	980 - 1150	27J
WELDOX 1100	4 - 25	1100	1250 - 1550	27J
WELDOX 1300	4 - 10	1300	1400 - 1700	27J

WELDOX 700

General Product Description
WELDOX 700 is a general structural steel with minimum yield strength of 650 - 700 MPa depending on thickness. WELDOX 700 meets the requirements of EN 10025 for the corresponding grades and thicknesses. Typical applications are demanding loadbearing structures.

Available dimensions

WELDOX 700 E is available in plate thicknesses of 4 – 160 mm and WELDOX 700 F is available in plate thicknesses of 4 - 130 mm. Both grades are available in widths up to 3350 mm and lengths up to 14630 mm. For thicknesses over 100 mm preferred width is 1650 mm with untrimmed edge. More detailed information on dimensions is provided in the dimension program at www.ssab.com.

WELDOX 900

WELDOX 960

WELDOX 900 as a material has contributed towards the revolution in the development of travelling cranes. By utilising the strength of these steels, the maximum load capacity of these cranes increased eight-fold without increasin**g** their weight.
WELDOX 960 is in the largest models used for all load-bearing structures - the boom, the rotating mechanism, the undercarriage and the stabilising supports.
Each kilogram of weight saved reduces the dead weight and increases the crane's load capacity. Booms are manufactured according to stringent requirements on bendability, planeness and quality of the surface, which are exactly the properties which the WELDOX steels offer.

WELDOX 1100

It used to take a crew of sixty 10 hours to assemble a mobile bridge of a maximum span 30 m in the past. Meeting today's requirements, Karlskronavarvet AB has developed and built a very modern mobile bridge using the best steel available on the market - WELDOX 1100. It takes a crew of seven workers about 75 minutes to assemble the FB48 bridge. The span of the bridge is 46 metres without additional supports.

WELDOX steels are also available in versions marked D, F (e.g. WELDOX 700 D), where D means a guaranteed value of impact strength KV at -20°C, E means a guaranteed value of impact strength KV at -40°C and F at -60°C. It corresponds to EN 10137 coding Q or QL1 (e.g. S 690 QL).

5 QSTE

QSTE... HOT-ROLLED SHEET STEEL

QSTE..is identification of hot-rolled sheet steel.
QSTE.. high strenght steels are low-alloy cold forming steels intended for the enginnering and automotive industries. The entire range extends from QSTE.. cold-forming steels to wear-resistant or corrosion resistant steels, as well as ballistic protection sheet steel and electrical sheet steel.

This brochure describes the range and characteristics of QSTE... hot-rolled sheet steel. It is a general overview to assist in the selection of the right QSTE... steel for your particular product.

High strenght steels

QSTE... is identification of hot-rolled products and is available as high strenght and extra-high strenght cold-forming steels.
QSTE.. High strenght cold-forming steels are modern structural steels. QSTE... steels have been used for many years in the engineering industry and have been under continual development.

QSTE... is a range of high strenght cold-forming steels distinguished by high strenght, excellent formability and good weldability, which makes them suitable for a wide range of applications.
Materials marked QSTE.. plus a numeric code identifying intermediate yield, correspond to materials S ... MC. (e.g. QSTE 690 TM = S 650 MC = DOMEX 650 MC = RAEX OPTIM 650 MC = PAS 650 MC according to the EN standard.)

QSTE...

All QSTE... high strenght cold-forming steels are produced in modern plants under strict process control.
The steels are micro-alloyed with niobium, titanium and vanadium, which enables low carbon and manganese contents to be maintained. The steels are produced by metallurgical processes that ensure very high purity of the steels, and they are then finished in a carefully controlled thermomechanical rolling process that ensures consistend properties:

QSTE... high strenght cold-forming steels are characterised by:

- Excellend formability in relation to their high strenght.
- Good weldability due to their low contents of alloying elements.
- Good impact strenght at low temperatues, which should be specified at the time or ordering.
- Suitable for laser cutting.
- Suitable for hot-dip galvanising due to their appropriately formulated chemical composition. The order should specify that the steel will be hot-dip galvanised

QSTE... steels are available in the strenght levels shown in the figure below.

Steel grades and mechanical properties

QSTE.. high strenght steels are modern low-alloy structural steels for cold forming. QSTE.. is available in nine steel grades, with grade designations corresponding to the minimum yield strenght in the direction of rolling, ranging from 315 N/mm2. QSTE meets the requirements of the EN 10149-2 standard, and is also guaranteed to allow for thigher minimum bending radii.
QSTE... has a high yield strenght*tensile strenght relationship. The steel has high internal purity and can be bent both along and across the direction of rolling, with the minimum radii shown in the table. The mechanical propertis in the table are guaranteed in the directions of rolling.

Impact strenght

QSTE.. Cold-forming steels have high impact strehgnt. The test temperatues and the energy levels that can be guaranteed are shown in the table.

Table 2 Mechanical properties

Mechanical properties							
Grade	Min. yield strength	Tensile strength	Min. total elongation [%]		Smallest recommended bending radius bending angles ≤ 90°		
	R_{eh} (N/mm²) min.	R_m (N/mm²) min.	A_{80} t < 3	A_5 t ≥ 3	min. t ≤ 3	min. 3 < t < 6	min. t > 6
S355MC	355	430 - 550	19	23	0,25 x t	0,5 x t	1,0 x t
QStE 380 TM	380	450 - 590	18	22	0,25 x t	0,5 x t	1,0 x t
S420MC	420	480 - 620	16	19	0,5 x t	1,0 x t	1,5 x t
S460MC	460	520 - 670	14	17	0,5 x t	1,0 x t	1,5 x t
QStE 500 TM(S500MC)	500	550 - 700	12	14	1,0 x t	1,5 x t	2,0 x t
QStE 550 TM(S550MC)	550	600 - 760	12	14	1,0 x t	1,5 x t	2,0 x t
QStE 690 TM(S650MC)	650[1]	700 - 880	10	12	1,5 x t	2,0 x t	2,5 x t
S700MC	700[1]	750 - 950	10	12	1,5 x t	2,0 x t	2,5 x t

Table 3 Chemical composition

Chemical composition in percent by weight [%] (Heat analysis)									
Grade	C	Si	Mn	P	S	Altotal	Mo	Ti	B
	max.	max.	max.	max.	max.	min.	max.	max.	max.
S355MC	0,12	0,5	1,5	0,025	0,02	0,015	-	0,15	-
QStE 380 TM	0,12	0,5	1,5	0,025	0,01	0,015	-	-	-
S420MC	0,12	0,5	1,6	0,025	0,015	0,015	-	0,15	-
S460MC	0,12	0,5	1,6	0,025	0,015	0,015	-	0,15	-
QStE 500 TM (S500MC)	0,12	0,5	1,7	0,025	0,015	0,015	-	0,15	-
QStE 550 TM (S550MC)	0,12	0,5	1,8	0,025	0,015	0,015	-	0,15	-
QStE 690 TM (S650MC)	0,12	0,6	2	0,025	0,015	0,015	0,5	0,22	0,005
S700MC	0,12	0,6	2,1	0,025	0,015	0,015	0,5	0,22	0,005

Product temperature during welding

When welding abrasion-resistant structural steel, it is important to minimise the risk of cracks developing in cold state (sometimes called hydrogen cracks and delayed cracks). The main cause of these cracks developing is the presence of hydrogen and a development of tension in the weld. The risk of cracks developing can be minimised by the following procedure:

- preheating the material before welding
- thorough cleaning and drying of all gaps
- minimising shrinkage tension. This can be achieved by accurate positioning of the product and suitably planned welding procedure
- selecting filler material with low hydrogen content

6 Preheating

Preheating is extremely important when tack welding and root-welding. The higher the temperature is during and after the welding, the easier it is for hydrogen to escape.

The need to apply preheating increases with the material thickness (see the table below) , in order to compensate the thicker material's quicker cooling and also because thicker material has higher CE value than a thinner one.

When the ambient temperature is high or when the temperature is below +5°C, the values shown in the table should be increased by 25°C. And the temperature should be similarly increased when the material being welded is rigidly fixed.

When welding different types of steel, or when using electrodes with higher carbon equivalent CE than the carbon equivalent of the material being welded, the required preheating is determined according to the steel (or electrode) with higher carbon equivalent.

Table 4 Preheating temperatures and temperature interpass

	Recommended preheating temperatures for different combined (cumulative) material thickness [mm]										Recommended temperature interpass
$t_1+ t_2+ t_3=$	30	40	50	60	70	80	90	100	110	120	130	[°C]
S355 (SS2132)									75 °C			225-250
WELDOX 355												225-250
WELDOX 420/460									75 °C			225-250
WELDOX 500									75 °C			200-225
WELDOX 700			75 °C					100 °C		150 °C		200-225
WELDOX 900*	75		100 °C							150 °C		150-175
WELDOX 960*			100 °C							150 °C		150-175
WELDOX 1100*					150 °C				175 °C			150-175
HARDOX 400			75 °C			100 °C			175 °C			150-175
HARDOX 500	100	125	150 °C			175 °C						150-175

*) The preheating temperature is determined according to the filler material, provided the carbon equivalent of this material is higher that the carbon equivalent of the steel.

The recommended product temperatures are based on the assumption that: -the hydrogen content is lower than 5 ml per 100 g of the metal being welded, - the heat input is roughly 1.7 kJ/mm

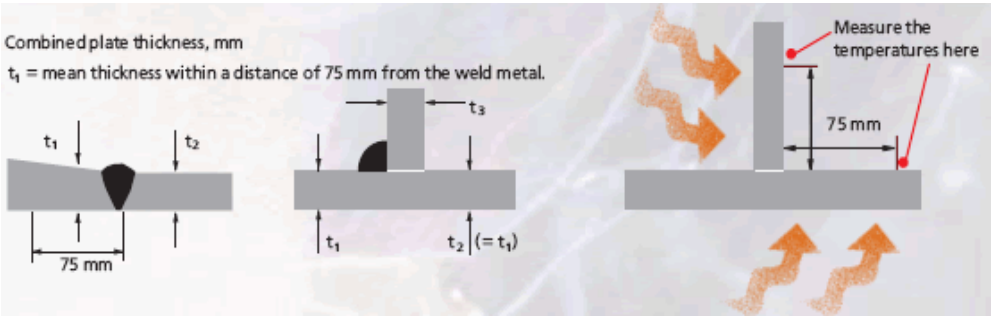

Fig.1 Measure temperatures here

Combined (cumulative) material thickness [mm]
T1 = median thickness at a 75 mm distance from the welded joint

Post-heating

When the weld is heated immediately after being made, it will be easier for hydrogen to escape from the steel. The post-heating temperature should be the same as the preheating temperature.
The heating time should not be less than 5 minutes per millimetre of material thickness, but not less than one hour.

Post-treatment

Annealing to reduce tension

Annealing to reduce tension is done in order to reduce residual tension after welding.
WELDOX may be annealed to reduce tension only if such procedure is required by the construction regulations.

HARDOX and WELDOX 1100 may not be annealed to reduce tension!

Measures to increase the fatigue strength

Fatigue strength of welds can be increased by various post-treatments. This will lead to smoother transition between the weld and the steel and reduce the concentration of tension. For further details refer to the *Handbook on welding of Oxelösund steels.*

When welding HARDOX and WELDOX materials, we recommend to abide by the heat input limits shown below. The heat input lower than values shown will guarantee achieving a satisfactory combination of toughness and strength, and a sufficient hardness of the heat effect zone (HEZ)

Recommended strength when welding HARDOX and WELDOX steel	
WELDOX 355/420	Greater strength than the base material
WELDOX 460/500	Greater or equal strength than the base material
WELDOX 700	Equal or lower strength than the base material
WELDOX 900/960	Lower strength than the base material
WELDOX 1100	Lower strength than the base material
HARDOX 400/500	Lower strength than the base material

Fig.2 When making corner welds, we recommend using a material of lower yield strength.

Using soft electrodes for welding HARDOX steel

HARDOX should be welded with soft electrodes. A soft electrode is a filler material with yield strength less than 500 MPa. These electrodes reduce the level of residual tension in the weld and hence the tendency of the material to develop cracks in cold state.
Provided the weld is situated in a place where it is subjected to considerable wear and tear, it is possible to use hard electrodes.

HARDOX can be successfully welded using austenitic stainless steel filler materials when:

- the welded components are rigidly clamped
- the product cannot be preheated
- the material is thicker than 60 mm

7 Conclusions

Specialize in the armor plates ARMOX, wear resistant plates HARDOX and high-strength structural WELDOX plates. ARMOX armored plates are used for military purposes and today it is also used for civilian purposes.

High-strength steel faces a great perspective. Their consumption is growing worldwide faster than consumption classically ch steel.

Finally, it should be noted that the energy consumed quantity, amount of the resultant him dioxide and other impurities are to produce 1 kg of high-strength steel in substantially the same as the classic production of 1 kg of steel. One kilogram of classic steel can be replaced with, for example, half a kilogram of high-strength steel.

Interesting reasons for the use of high-strength steel is weldability. In some cases, owing to the thickness of sheet steel type must already 11 523 preheated, can be equivalent to the thickness of the steel WELDOX 420 to WELDOX 700 welding without preheating. This can have significant if welding takes place in the field and preheat can be technically difficult. Currently, the predominant high-strength steels therefore, applications need to reduce the weight of reasons other than saving material costs. The first is that there is a weight restriction product in terms of its handling, transport, legislative provisions and The second reason is that by reducing the weight of a great increase in capacity (tonnage) devices. Also the economic criterion can justify the use of these steels.

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