HARDOX®
TechSupport

Information from SSAB Oxelösund. **#29**

Welding of cutting edge to bucket and adapters to cutting edge

Welding of teeth adapters to the cutting edge is a critical welding operation under the bucket manufacturing process. The risk for hydrogen cracking in the welded area is evident due to the heavy gauges and hard material involved, as well as the high weld restraint conditions.

Material for the cutting edge

In the selection of cutting edge material it is important to reach a balance between hardness and toughness. This is our guideline for material selection:

Material	Typical Hardness, HB	Maximum recommended plate thickness	Typical impact toughness, -40°C
HARDOX 500	500	50 mm	30 J
HARDOX 400/450	400/450	80 mm	45/35 J
HARDOX HiTuf	350	120 mm	70 – 95 J

Welding methods

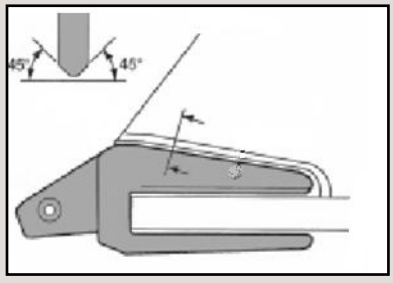
Recommended welding methods for welding of buckets are MMA, MIG/MAG, FCAW.

Bevelling of the Cutting Edge

The front of he cutting edge should be bevelled to the angle recommended for the specific adapter. If oxy-fuel cutting is used for bevelling, the cutting operation is recommended to be performed submerged in water. This in order to reduce softening. For minimizing the risk for hydrogen cracking it is important not to exceed the cutting speeds recommended for oxy- fuel cutting of HARDOX wear plates, see TechSupport #16: Cutting of HARDOX. Stress raisers like sharp edges has to be ground off.

Joint preparation

The fitting surfaces of the cutting edge and the adapter should be ground smooth. All paint, rust, grease and dirt should be removed from the surfaces to be welded. If possible, joints should be bevelled for achieving full weld penetration. The gap between the adapter and the cutting edge should be as small as possible to minimize residual stresses in the weld.



Preheating recommendations

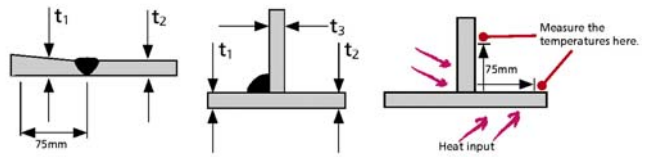
The entire adapter as well as the cutting edge, extending 75 mm from the adapter, should be preheated to the highest of the recommended preheat temperature given by the manufacturer of the adapter/cutting edge. The temperature should be measured on the opposite side of the heated side. It is important to prevent hardness loss in the cutting edge by not exceeding temperatures of 200-250 °C. Do not preheat the entire length of a cutting edge already welded into a bucket. Thermal expansion of the cutting edge may cause cracking in the rear cutting edge welds.

Preheating recommendations of HARDOX

Preheat requirement

Combined plate thickness [mm] [Inch]	≤ 10 ≤ 3/8	≤ 20 ≤ 3/4	≤ 30 ≤ 1 1/4	≤ 40 ≤ 1 5/8	≤ 50 ≤ 2	≤ 60 ≤ 2 3/8	≤ 70 ≤ 2 3/4	≤ 80 ≤ 3 1/8	≤ 90 ≤ 3 1/2	≤ 100 ≤ 4	≤ 110 ≤ 4 3/8	≤ 120 ≤ 4 3/4	> 120 > 5 1/8
HARDOX HiTuf	No preheating								75°C 170F	100°C 210F	150°C 300F		
HARDOX 400					75°C 170F			100°C 210F			175°C 350F		
HARDOX 450					100°C 220F			125°C 260F			175°C 350F		
HARDOX 500			100°C 210F	125°C 260F	150°C 300F	175°C 350F							
HARDOX 600		150°C 300F	175°C 350F		Austenitic 100°C 210F electrodes				Austenitic 125°C 260F electrodes				

Calculation of the combined plate thickness
t1 + t2 + t3 = combined plate thickness.
t1= mean thickness within a distance of 75 mm /3 inches from the weld metal.



Welding consumables

Soft welding consumables, with a yield strength below 500MPa should be used. Such welding consumables reduce the residual stress level in the joint and thus the susceptibility to hydrogen cracking. If welding with MMA or FCAW, basic flux electrodes should be used giving a hydrogen content less than 5 ml/100 g weld metal.
If preheating can not be applied austenitic filler material could be utilized (Type AWS E(R) 307 or AWS E(R) 309). Austenitic consumables shall always be used for welding manganese steel adaptors to HARDOX cutting edges.

Recommended consumables for welding of HARDOX are given in TechSupport # 17: Welding consumables.

When welding with MMA:

- Only draw MMA electrodes enough for one hour of use. Otherwise moisture pick up of exposed low hydrogen electrodes may become too high and cause weld cracking.
- Store electrodes in a 100°C cabinet.
- Rebake previously opened packages of electrodes in a ventilated oven at 200- 260°C for eight hours before using.

Welding procedures

To minimize the residual stresses in the welds, the adapters should be welded **following the welding sequences recommended by the manufacturer of the adapter.** Proposals for suitable welding sequences for different types of adapters are shown in the following context.

Flush Mounted Adapter

1 To reach the best weld quality, perform welding in the horizontal position.
2 If preheating is required, preheat both cutting edge and adapter before tack welding

3 Use sequences for tack welding as shown in the picture. Minimum length of the tack welds should be 50 mm.

4 Weld the adapter according to the sequences shown in the drawing.

5 Recheck temperature on both cutting edge and adapter before each pass

6 Use a large number of passes with less weld deposit to fill the groove.

7 Provide a good weld fusion between adapter and cutting edge. Incomplete fusion may result in underbead cracking.

8 Start welding in the mid section of the cutting edge and continue out to the ends

9 After finished welding, put thermal insulation on the cutting edge for slow cooling.

Figure 1

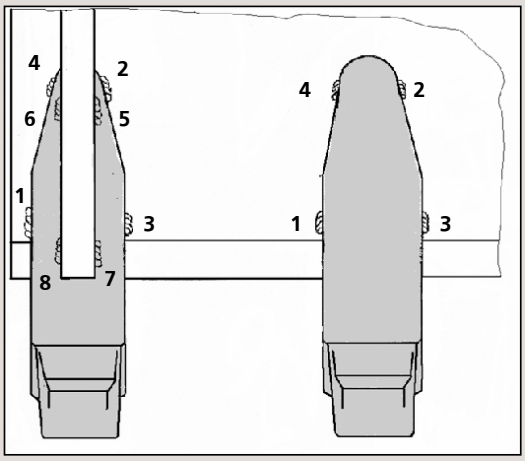


Figure 2

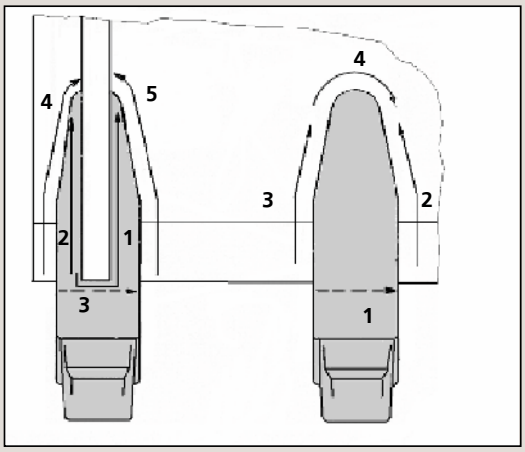
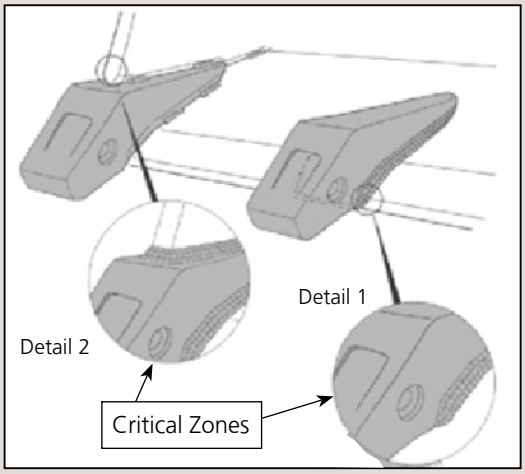


Figure 3



Welding in the critical zones

1 If possible, avoid to weld in the critical zones. Start/ finish the welds 15 to 25 mm off the critical zones.

2 If welding is necessary, do not start or finish welding in the critical zones. Starts and stops are the most susceptible to cracking.

3 The surface and toes of the welds in the critical zones should be ground smooth.

4 It is important to achieve full penetration in the joint between side edge and the adapter, see detail 2, figure 3.

Bottom Strap Adapter

1 To reach the best weld quality, perform welding in the horizontal position.

2 If preheating is required, preheat both cutting edge and adapter before tack welding

3 Use sequences for tack welding as shown in fig. 4. Minimum length of the tack welds should be 50 mm.

4 Complete all welding on the bottom side of the edge first. Follow welding sequences as shown in fig 5.

5 Turn the cutting edge over and complete the remains welding on the top side using the weld sequences shown in fig 6.

6 Recheck temperature on both cutting edge and adapter before each pass

7 Use a large number of passes with less weld deposit to fill the groove.

8 Provide a good weld fusion between adapter and cutting edge. Incomplete fusion
may result in underbead cracking.

9 Start welding in the mid section of the cutting edge and continue out to the ends
10 After finished welding, put thermal insulation on the cutting edge for slow cooling.

Welding in the critical zones

1 If possible, avoid to weld in the critical zones. Start/ finish the welds 15 to 25 mm off the critical zones, see fig 7, detail 1.

2 If welding is necessary, do not start or finish welding in the critical zones. Starts and stops are susceptible to cracking.

3 The surface and toes of the welds in the critical zones should be ground smooth.

4 It is important to achieve full penetration in the joint between side edge and the adapter, see fig 7, detail 2.

Figure 4

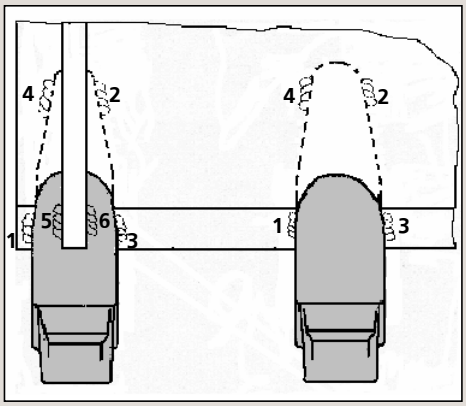


Figure 5

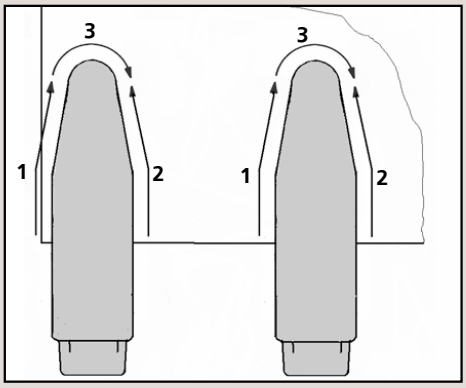


Figure 6

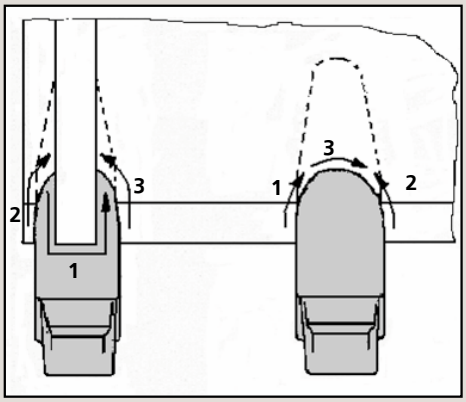
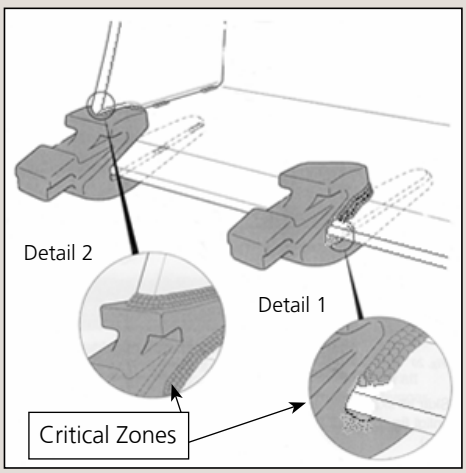


Figure 7



Top Strap Adapter

1 To reach the best weld quality, perform welding in the horizontal position.

2 If preheating is required, preheat both cutting edge and adapter before tack welding

3 Use sequences for tack welding as shown in the fig. 8. Minimum length of the tack welds should be 50 mm.

4 Complete all welding on the top side of the edge first. Follow welding sequences as shown in fig 9.

5 Turn the cutting edge over and complete the remains welding on the bottom side using the weld sequences shown in fig 10.

6 Recheck temperature on both cutting edge and adapter before each pass

7 Use a large number of passes with less weld deposit to fill the groove.

8 Provide a good weld fusion between adapter and cutting edge. Incomplete fusion
may result in underbead cracking.

9 Start welding in the mid section of the cutting edge and continue out to the ends

10 After finished welding, put thermal insulation on the cutting edge for slow cooling.

Welding in the critical zones

See Bottom Strap Adapter- Critical Zones

Figure 8

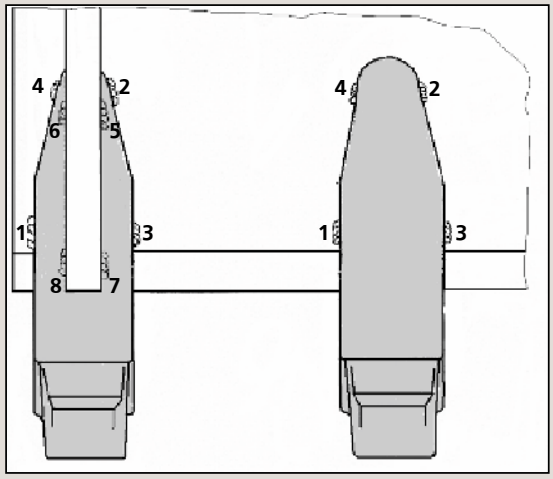


Figure 9

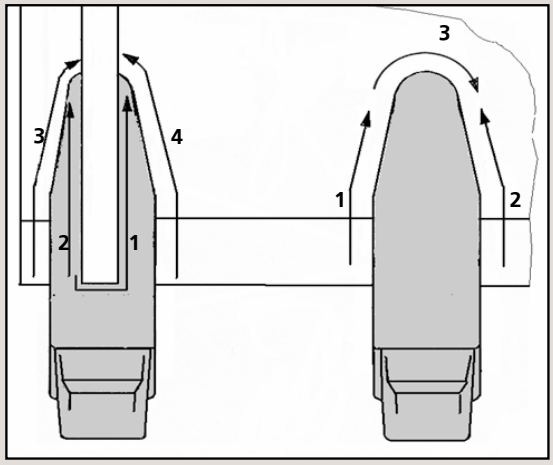
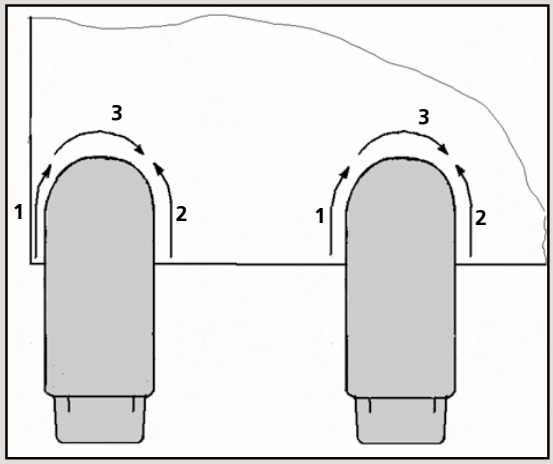


Figure 10



Welding of the cutting edge to the shell

1 Use preheating if necessary. Preheat also before tack welding.

2 Start to weld in the middle and continue out to the free edge, Fig 11.

3 Avoid welding at the centre of plate of the cutting edge, Fig 12.

Figure 11

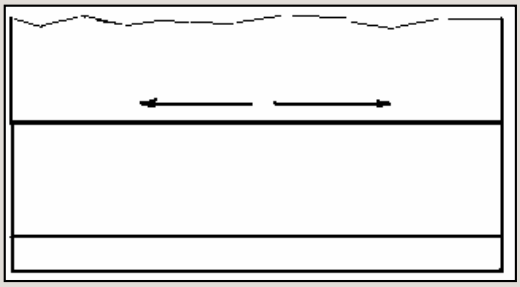
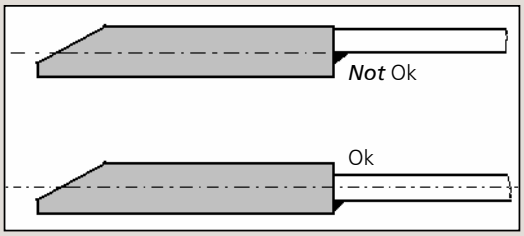


Figure 12



Assembling procedures

Two ways to weld the cutting edge and adapters to the bucket.

Advantages and disadvantages

Welding of cutting edge to the bucket prior to welding of adapters

+ Easier to centre the corner adapters against the side cutting edges.
+ Easier handling in the workshop.
- Preheating of the entire cutting edge can not be performed due to the thermal. expansion of the cutting edge that may cause cracking in the rear cutting edge weld.
- Increased residual stress levels in the cutting edge and rear cutting edge weld.

Welding of adapters to the cutting edge prior to welding edge to bucket

+ The entire cutting edge can be preheated (in furnace), which increases productivity.
+ Less stresses will be accumulated in the cutting edge and rear cutting edge welds.
- More difficult to centre corner adapters to the side cutting edges.
- More complex handling in the workshop.

HARDOX®
WEAR PLATE

SSAB
OXELÖSUND

SSAB Oxelösund AB
SE-613 80 Oxelösund
Sweden

Phone +46 155 25 40 00
Fax +46 155 25 70 73
www.ssabox.com
www.hardox.com

TS-29-Welding - cutting edge, bucket, adapter-uk-01-2004