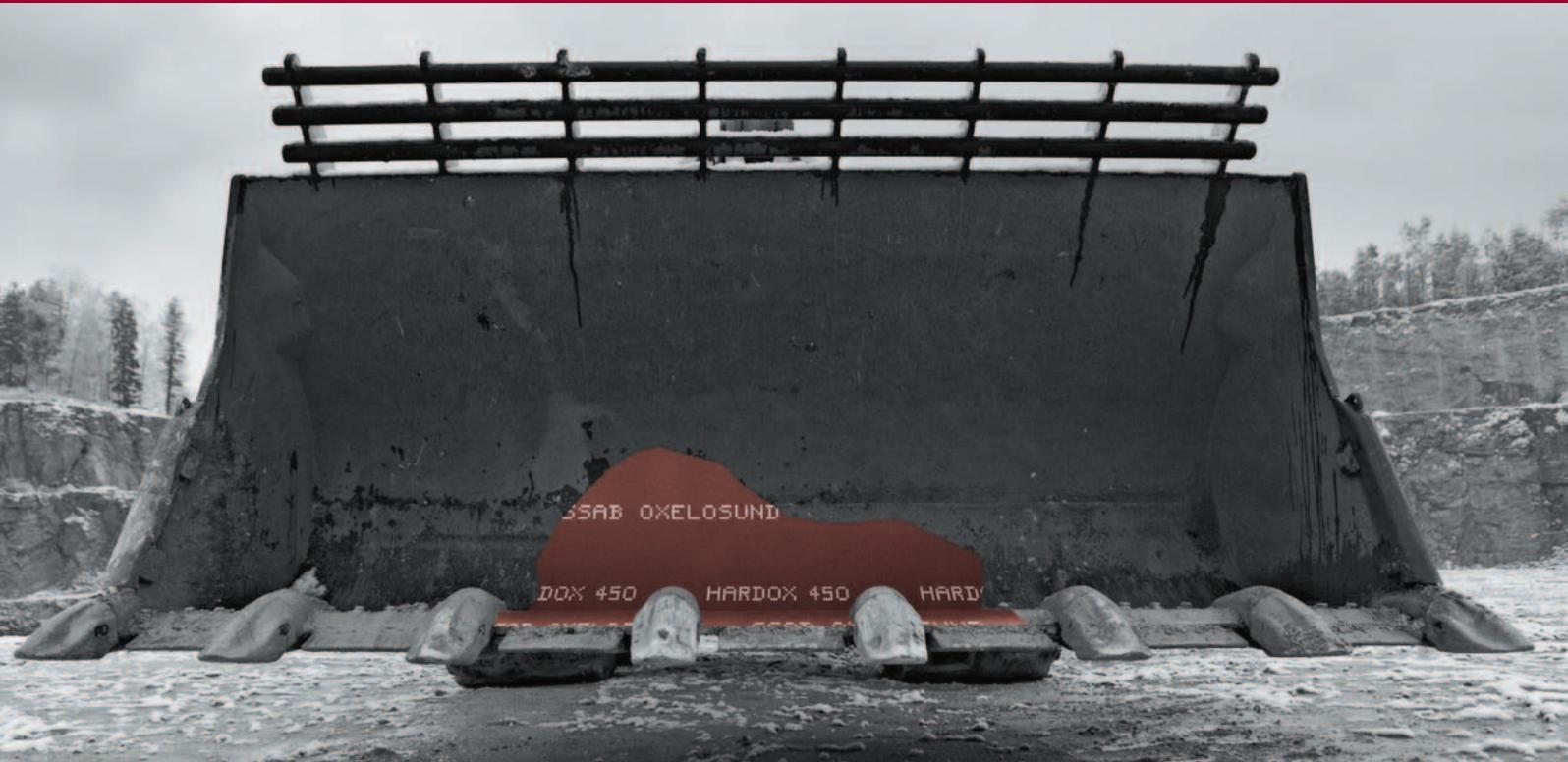


## TECHSUPPORT #29

### 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 [mm]	Typical impact toughness, -40 °C [J]
Hardox 500	500	50	30
Hardox 400/450	400/450	80	45/35
Hardox HiTuf	350	120	70–95

### WELDING METHODS

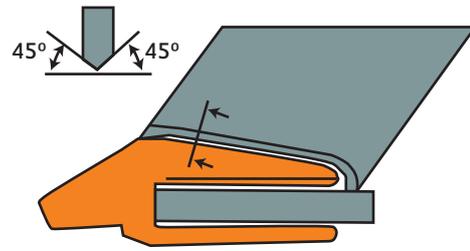
Recommended welding methods for welding of buckets are MMA, MIG/MAG, FCAW.

### BEVELLING OF THE CUTTING EDGE

The front of the cutting edge should be bevelled to the angle recommended for the specific adapter. If oxy-fuel cutting is used, it is important not to exceed the cutting speeds specified for this method in order to minimize the risk for hydrogen cracks, see TechSupport #16: Cutting of Hardox. Stress raisers like sharp edges has to be ground off.

### JOINT PREPARATION

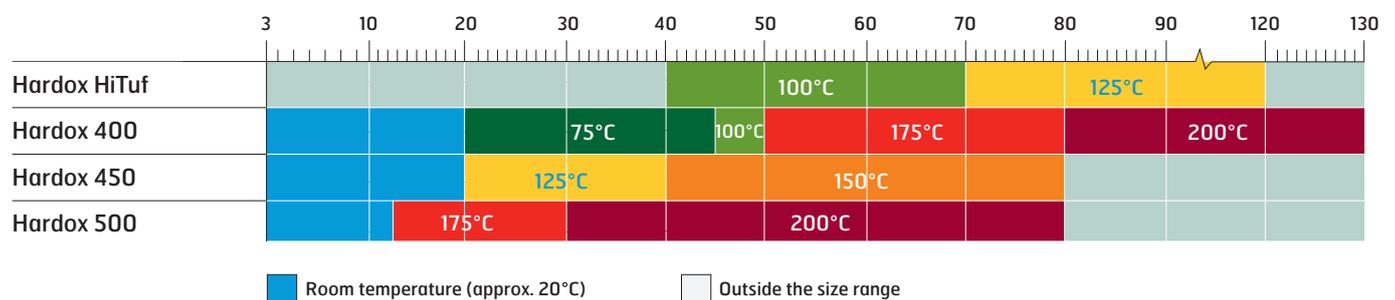
The fitting surfaces of the cutting edge and the adapter should be ground smooth. All paint, rust, grease and dirt should be removed from the surfaces to be welded. If possible, joints should be bevelled for achieving full weld penetration. The gap between the adapter and the cutting edge should be as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



### 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.

#### MINIMUM RECOMMENDED PREHEAT AND INTERPASS TEMPERATURES FOR DIFFERENT SINGLE PLATE THICKNESSES [mm]



### WELDING CONSUMABLES

Soft welding consumables, with a yield strength of up to approximately 500 MPa 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 stainless austenitic consumables could be utilized of type AWS 307 or AWS 309. Austenitic consumables shall always be used for welding manganese steel adaptors to Hardox cutting edges.

More detailed information regarding the selection and handling of consumables are described in TechSupport #60

## 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.

### 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.

FIGURE 1

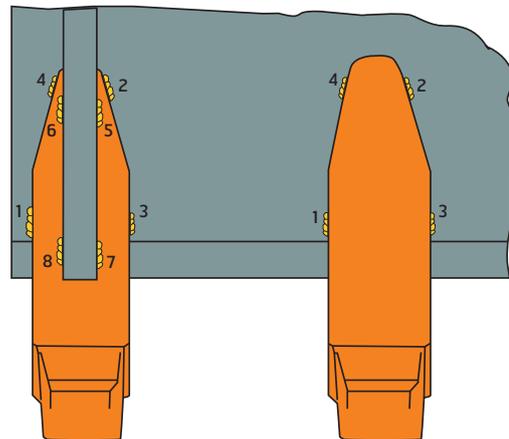


FIGURE 2

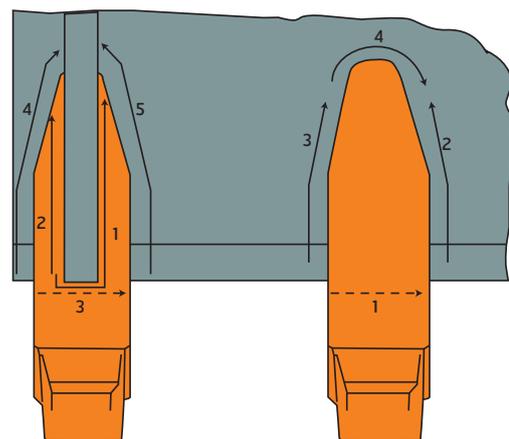
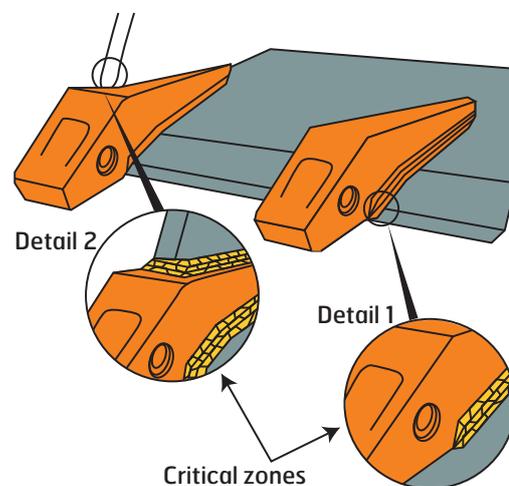


FIGURE 3



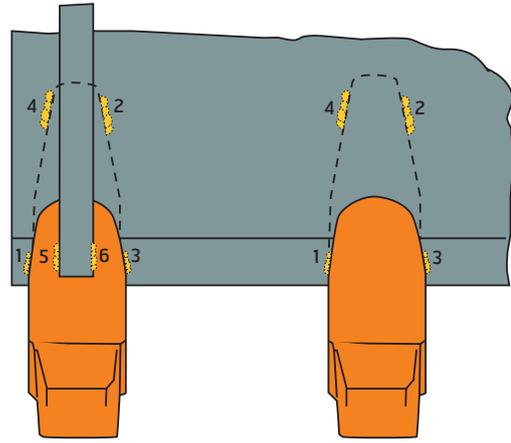
## Bottom Strap Adapter

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 figure 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 figure 5.
5. Turn the cutting edge over and complete the remains welding on the top side using the weld sequences shown in figure 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 under-bead 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 figure 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 figure 7, detail 2.

FIGURE 4



FIGURES

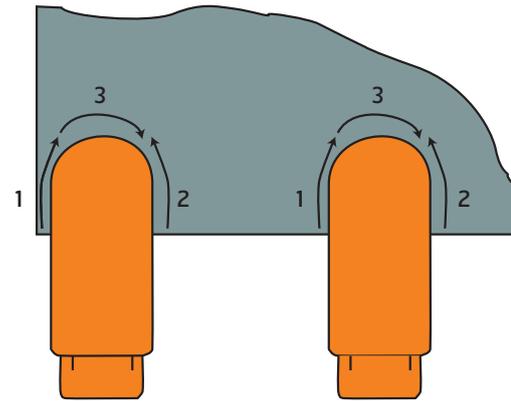


FIGURE 6

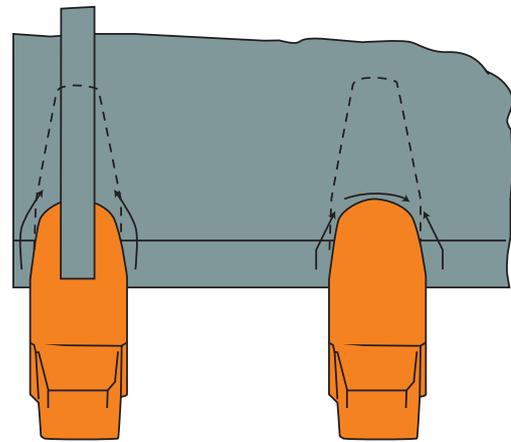
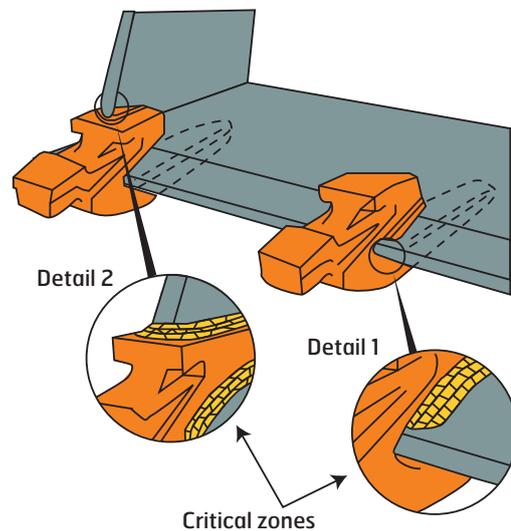


FIGURE 7



## 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 figure 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 figure 9.
5. Turn the cutting edge over and complete the remains welding on the bottom side using the weld sequences shown in figure 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 under-bead 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

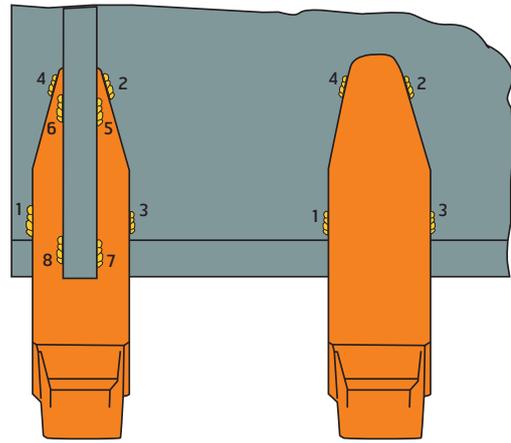


FIGURE 9

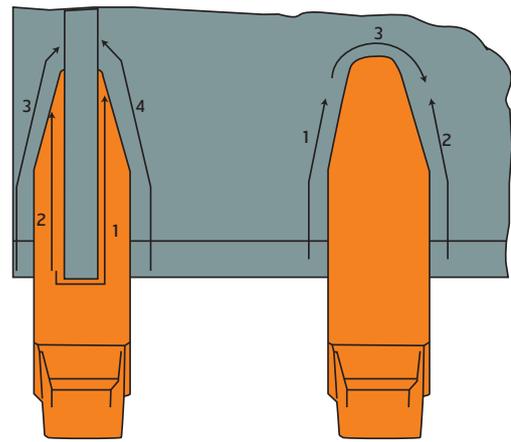
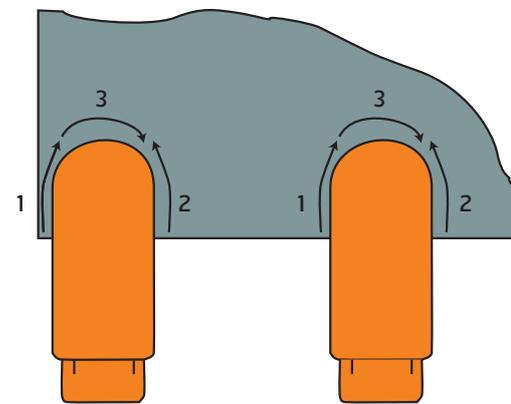


FIGURE 10



## 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 according to figure 11.
3. Avoid welding at the centre of plate of the cutting edge which is shown in figure 12.

FIGURE 11

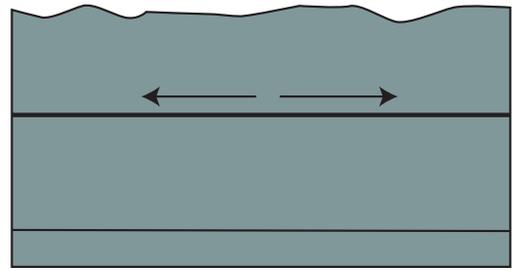
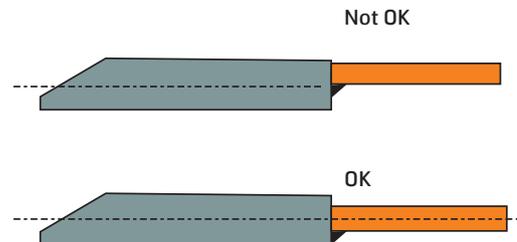


FIGURE 12



## 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.

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