Rail welding and reconditioning the permanent way

XA00102920

Repair and maintenance

– the permanent way

In general, it can be assumed that 40% of the total cost of track is the cost of the rail itself. Such a high percentage indicates that anything that can be done to prolong the life of the rails will impart considerable financial savings.

The rate of wear is dependent on the type of rail, traffic, load and speed. Maintaining the track to keep the ride as smooth as possible will also reduce the maintenance requirements for the rolling stock and consequently reduce further damage to the rail system.

ESAB's rail welding programme

ESAB maintains continuous contact with the European rail administrations and public transport organisations and has a high-quality programme of suitable welding consumables and equipment available for these partners. Some ESAB products are co-developed for special applications taking into consideration the different national regulations. This means that our products can be found all over Europe in the installation and repair of tracks for high-speed trains, trams and underground trains, as well as in rack railways, factory railways, craneways and so on. The ESAB product programme for welding rails includes:

A. Consumables for:
- joining
- rebuilding
- surfacing

B. Machines for:
- on site operation
- shop fabrication

Rail grades

Track rails must have high strength and be wear-resistant. Carbon manganese steels with a varying carbon content are therefore used.

The table below shows the data for the more common European rail grades. However, all the steels listed here are steels with reduced weldability and therefore require special welding methods and highly-experienced welders.

Wear is higher at crossings due to high impact, which explains why these components are also made from austenitic manganese steel (AM).

Cross-section of repair-welded rail profiles.

Rail grades

Standard prEN13674-1	Grade	Chemical composition C %	Si %	Mn %	Cr %	Tensile strength MPa
	R200	0.40–0.60	0.05–0.35	0.80–1.25	–	680–830
	R220	0.50–0.65	0.15–0.50	0.80–1.20	–	min. 780
	R260	0.60–0.80	0.10–0.50	0.80–1.30	–	880–1030
	R260Mn	0.55–0.75	0.10–0.50	1.30–1.70	–	880–1030
	R320Cr	0.60–0.82	0.30–0.90	0.80–1.30	0.80–1.30	min. 1080
UIC 866	AM	0.90–1.30	~ 0.4	11.0–14.0	–	~ 670

Machines optimised for rail maintenance repair welding

ESAB offers turnkey packages of consumables and equipment for rail welding maintenance to suit different needs.

Welding machines include diesel powered CV/CC welding generators. Static lightweight converter type welding power sources that can be combined with heavy-duty wire feed units of both AVC and standard types. Optimised for hard facing overlay welding the automatic, programmable surfacing unit Railtrac BVR 1000 is available. Separate brochures are available for all equipment needed for rail repair.

Power sources and wire feeders

AristoArc 400 or KHM 350/500 and Mobilemaster 4 cv/cc

AristoArc 400 is a robust solid-state inverter power source incorporating the most up to date technology available today. An easy to use machine optimized for welding stick electrodes. Together with the **Mobilemaster 4 cv/cc** off the arc wire feeder it is possible to weld the open arc flux cored wires ESAB has available for rail repair.

The Mobilemaster picks up control voltage from the arc voltage supplied by the welding machine therefore not requiring separate AC feed voltage. On site the AristoArc 400 needs a stable 3-phase generator being able to supply at least 21 kVA.

The Railtrac BVR automatic overlay welding aid with an extra transformer runs together with this power-source/feeder combination.

KHM 350 or **KHM 500** diesel driven DC cv/cc welder with 1 and 3-phase power outlets.

These versatile heavy-duty site welders are perfect for remote welding where power outlets are not available. A combination with the Mobilemaster 4 cv/cc and the Railtrac BVR makes this trio a perfect choice. The Railtrac BVR requires a small control transformer if one of the above options is chosen.

Wire feeder for demanding applications

AristoMig 400 and AristoFeed 48

This arrangement is top of the line regarding welding power source and feeder. The inverter power source together with the AristoFeed 48 is a perfect match. The power source can handle both semi-automatic and stick electrode processes.

PSF welding guns

An ESAB PSF 405 or 505 self-cooled gun with a euro type attachment is required. They are available in two different standard lengths. Keep in mind that longer gun packages require more maintenance to avoid feeding problems.

Railtrac BV – programmable equipment for hardfacing rails

Railtrac BV is a programmable automatic machine for mechanizing the repair and hardfacing of rail profiles using flux-cored welding wire. The equipment can easily be assembled, programmed and controlled by one person. The system comprises two snap fasteners, a rigid aluminium profile, a carriage, a weaving unit, a control box and a remote control unit. Different programs can be used to produce the most consistent weld metal thickness possible.

Railtrac BV has a welding speed of 100-1500 mm/min, a weaving width of 1-80 mm and a maximum effective weld length of 1,500 mm. The AristoMig 400 and AristoFeed 48, KHM 350/500 and Mobilemaster 4 cv/cc are recommended as matching welding equipment.

Surfacing or joining
– rely on ESAB

Our viewpoint is to supply products optimised for rail repair welding. To achieve this, the ESAB consumables R&D department work closely with major European railway administrations. ESAB can supply a combination of OK brand electrodes, OK Tubrodur open arc flux cored wires and equipment to help minimise the time needed to carry out repair work and decrease the element of human error.

Joint welding with stick electrodes using the mould technique

Today, modern track installations involve mainly continuously welded rail. As well as the alumino-thermic joining process, coated electrodes are successfully used for joining rail sections. The foot, web and the head are welded with OK 74.78, OK 48.30. A notch free root in the foot of the rail is acquired using OK Backing 21.21, a special type of consumable support used in the initial stages of joining the rail.

When joining with stick electrodes the foot, web and head are welded using electrodes as OK 48.30 or OK 74.78. The final surfacing layer is welded with OK 83.28.

For surfacing, special flux cored wires have been developed by ESAB, for on site welding. The wires are self shielded.

The following products optimised for joining carbon-manganese rail grades can be found in the table below.

Consumables for joining

Rail MPa	Backing device	Stick electrodes	Top layers
< 685	OK Backing 21.21	OK 48.30, OK 74.78	OK 83.28
< 885	OK Backing 21.21	OK 48.30, OK 74.78	OK 83.28
< 1080	OK Backing 21.21	OK 74.78	OK 83.27

Joining of rails – Stick electrode OK 83.28 and OK 74.78 and OK Backing 21.21.

Turnouts

Concerning turnouts, the switchblade and support rail are prone to wear due to flank pressure from the passing wheels.

Consumables for repair and surface welding

Stick electrodes	Flux cored wires
OK 83.28	OK Tubrodur 15.41
OK 83.27	OK Tubrodur 15.43
OK 67.43, OK 67.52	OK Tubrodur 14.71

Turn-outs – Stick electrode OK 83.28.

Crossings C-Mn and 14% Mn types

Nowadays, coated electrodes and flux-cored wires are utilised in both manufacture and repair of C-Mn grade crossings. On site repair work benefits from open arc flux cored wires, as they do not require gas shielding. For hardfacing overlay on site use OK 83.28 stick electrode or OK Tubrodur 15.43 and for joining OK 74.78. See table below for recommendations.

Consumables for crossings made of C-Mn-steel

Crossing MPa	Stick electrodes Joining	Top layers	Flox cored wires Top layers
<685	OK 74.78	OK 83.28	OK Tubrodur 15.43
<885	OK 48.30	OK 83.28	OK Tubrodur 15.43

14% Mn or Hadfield steel crossings require other types of consumables compared to C-Mn grades. They also require another welding procedure. Mn steel is used because of its excellent resistance against shock and abrasion. The occurrences of casting defects at manufacture sometimes appear but are not detected until the crossing has been in service for some time. When defects or wear occur, surface welding is carried out.

Consumables for crossings made of manganese steel

Stick electrodes	Flux cored wires
OK 67.43, OK 67.45, OK 67.52	OK Tubrodur 14.71
OK 86.08, OK 86.28, OK 86.30	OK Tubrodur 15.60
	OK Tubrodur 15.65

C-Mn-crossings – Stick electrode OK 83.28, flux cored wire OK Tubrodur 15.43.

Rail ends and plain rail

Rail ends are subjected to impact and wear down. Stopping, braking and starting also cause the rail surface to wear, wheel burns are an example.

Consumables for repair and surface welding

Rail MPa	Stick electrodes	Flux cored wires
< 685	OK 74.78	OK Tubrodur 15.41
< 885	OK 83.28	OK Tubrodur 15.41
< 1080	OK 83.27	OK Tubrodur 15.43

Plain rail – Stick electrode OK 83.28 or flux cored wire OK Tubrodur 15.43 for hardfacing, OK 74.78 for joining.

Rail ends – Stick electrode OK 74.78 and OK 83.28, flux cored wire OK Tubrodur 15.43.

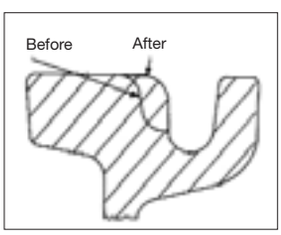
Reconditioning of rails for tramways

Tram rails suffer heavy wear on curved sections by flank pressure from the wheels. ESAB has developed an effective welding method to recondition the rail profile. At the same time, the rail acquires excellent wear protection. An ESAB A6S ArcMaster welding machine which travels along the rail has been developed. Using the submerged arc welding method, welding takes place using the high-performance flux cored wire OK Tubrodur 15.65/OK Flux 10.62.

Reclaiming tram rails, in the case of heavy wear on grooved rails on curved tracks for example, the following welding consumables can be used.

Consumables for repair and surface welding

Stick electrodes	Flux cored wires	Flux cored wires/ Fluxes (SAW)
OK 67.45, OK 67.52	OK Tubrodur 14.71	OK Tubrodur 15.65/
OK 83.28	OK Tubrodur 15.43	OK Flux 10.62
OK 86.30	OK Tubrodur 15.65	



Automatic tram rail welding machine in operation. Components:
– A6S Welding head
– PEH 1 control box
– OPC flux recovery unit
– Special rail tractor

Build-up of crossing – Stick electrode OK 86.30.

Know-how welding methods and technologies

Through the years, ESAB has acquired an in-depth knowledge by developing equipment and consumables in close contact with railway authorities.

Rails are made of high carbon steels and are therefore only suitable to be welded under certain conditions. In order to minimise hardening in the heat-affected zone and minimise the risk for cracking, the required pre-heating and interpass temperatures must be strictly observed and maintained.

The rail grade or quality is the deciding factor for the correct temperatures, which range between 300 and 400°C. Cooling should be as slow as possible. In some cases post heat treatment is necessary. The rail administrations' technical regulations provide detailed information on this subject.

Economics

Track repair and the replacement of rail components represent a substantial cost for any railway. Repair by welding has shown considerable cost saving advantages. By weld-surfacing track components, length of service can be substantially prolonged at a lower cost than if worn components are replaced with new ones. Repairing a crossing by welding constitutes only 20% of the replacement cost.

Although the flexibility and mobility of manual metal arc welding using covered stick electrodes guarantee the continued use of this method, many rail companies are looking for more efficient welding methods. Flux-cored wire application achieves higher deposition rates and helps to shorten weld times considerably. Moreover, the welding process using flux-cored wires can be mechanised. In order to take full advantage of flux-cored wire welding, ESAB has developed a programmable device for the mechanised surface welding of rails. For high and consistent quality surface welding the costs can be halved in comparison to manual welding using stick electrodes. In addition, Railtrac BV leads to considerable improvements in the working conditions of the personnel.

Customer services

ESAB have always encouraged a technical dialogue with potential users regarding welding problems and their solutions. Considerable development work has been carried out, much of it having been initiated by various state and private railway companies. The knowledge and experience which has been acquired has been incorporated into the current package of products, which have secured substantial cost-saving benefits in service.

ESAB are always available to provide advice on consumables selection for a given application as well as practical on-site assistance with preparation and welding procedures.

Extensive laboratory facilities equipped with ultra-modern technology provide the back-up. The capa–bilities extend from analytical, investigative and experimental services to the monitoring of service conditions and testing.

Mostly all ESAB stick electrodes for repair and maintenance are delivered in VacPac™ wrappers.

Part numbers for equipment

Basic station	Item number
Railtrac BV 1000	0398 145 002
Control cable L = 5 m Railtrac – Feeder	0457 360 880
AristoMig 400	0458 625 880
AristoFeed 48-4 MA4	0458 806 984
Remote adapter kit	0459 681 880
Complete assembling Aristo	ORTU ARI 001
Wheel kit	0458 707 880
Bogie 3x1/16”R V-groove	0366 902 904
Feed roller 1/16” x 3	0366 966 894
Connection set 10 m	0456 528 881
PSF 505 3 m	0458 401 884
Contact tip 1.6 mm	0468 502 010
PSF Teflon liner beige	0457 969 884
Welding cable 400A	0700 006 890
Elbow coupling OKC	0365 557 001

AristoFeed MA4 feeders in this brochure are supplied for use with autostart and remote control functions included in Railtrac BV and BVR 1000.

Part numbers for consumables

OK 48.08	48084041G0	4.00 mm Ø VacPac 1/2 pack
OK 67.45	67453230G0	3.25 mm Ø VacPac 1/2 pack
OK 67.45	67454030G0	4.00 mm Ø VacPac 1/2 pack
OK 67.52	67453230G0	3.25 mm Ø VacPac 1/2 pack
OK 67.52	67454030G0	4.00 mm Ø VacPac 1/2 pack
OK 74.78	74784040G0	4.00 mm Ø VacPac 1/2 pack
OK 74.78	74785040G0	5.00 mm Ø VacPac 1/2 pack
OK 83.28	83284030G0	4.00 mm Ø VacPac 1/2 pack
OK 83.28	83285040V0	5.00 mm Ø VacPac 1/1 pack
OK 83.30	83305040V0	5.00 mm Ø VacPac 1/1 pack
OK 86.08	86084040V0	4.00 mm Ø VacPac 1/1 pack
OK 86.08	86085040V0	5.00 mm Ø VacPac 1/1 pack
OK 86.28	86284040V0	4.00 mm Ø VacPac 1/1 pack
OK 86.28	86285040V0	5.00 mm Ø VacPac 1/1 pack
OK 86.30	86304030V0	4.00 mm Ø VacPac 1/1 pack
OK 86.30	86305030V0	5.00 mm Ø VacPac 1/1 pack
OK Tubrodur 14.71	1471167730	1.6 mm Ø 16 kg basket
OK Tubrodur 15.43	1543167730	1.6 mm Ø 16 kg basket
OK Tubrodur 15.65	1565167730	1.6 mm Ø 16 kg basket

For more details on consumables and equipment consult your nearest ESAB representative.

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