Repair of rails on-site by welding

By Bengt Dahl and Björn Mogard, Swedish National Rail, Borlänge, Sweden
B Gretoft and B Ulander, Esab AB, Gothenburg, Sweden

This paper reviews damage on railway tracks and how repair is performed by welding. The described procedures are mainly based on practice from Swedish National Rail.

Repair of rails on-site by welding

The first ride with a steam locomotive on railway was carried out on the 21th of February 1804 in Wales.

It was an one cylinder steam engine that pulled a trackload of 10 tons and 70 passengers. The ride was however not fullfilled because of rail breakage. The rail was made from cast iron in 1 m lengths.

With the entrance of steam locomotives demands for higher performance of the rail were required. Cast iron rail was now replaced by wrough iron rail.

The first direct reference to joining of rails is from the year 1820. It must, however, be assumed that they were forged joints by very skilled blacksmiths. The introduction of arc welding meant a review of application of welding processes and their development to suite the specific and perculiar requirement of the construction, maintenance and repair of railway tracks.

Track repair and replacement of components are a great cost for any railway. Additional costs like delays and work that is not programmed as in the case of failure must also be considered.

Maintaining the track to keep the ride as smooth as possible will also reduce the maintenance requirements of the rolling stock and consequently reduce further damage to rails and crossings.

The wear of the rail starts soon after installation into the track no matter what kind of traffic is travelling on it. The regular ponding of rail joints which the passenger hears during a journey is the audible manifestation of impact working which eventually results in deformation of rail ends. A similar phenomenon occurs when passing through crossings. The service life of the rail before it needs repair may be as short as a few months or it may last for several years depending on what type of traffic the route carries.

By weld surfacing of track components, crossings, switches etc. which are subject to higher wear than the plain rail, length of service can be substancially prolonged at a lower cost than to replace the worn component with a new one.The weld repair cost of a crossing is about 20% compared to installation of a new one. In the British Rail System there are about 30,000 crossings and about 17,000 of them need to be repaired each year. Corresponding figures in Sweden are 21,000 crossings of which 7,000 need to be repaired each year.

ESAB has worked closely with Swedish National Rail to provide a package of consumables that are ideally suited for track repairs. The consumables within the package were designed for the widest range of service conditions regardless of the traffic type, speed and loading.

1. The rail

1.1 Rail grades

The rails are designed for strength and wear resistance . This is achieved by using high carbon manganese steels. The rail grades generally used in western Europe correspond to UIC 860.

Complex crossings are made from C/Mn steels. The crossings can either be constructed by bolted joints or electro-slag welded. The crossings are subject to much higher wear than any other track component so the use of austenitic manganese steels (AM- steel) has become popular due to their good combined wear and impact properties. The composition and mechanical data of the rail steels are given in table 1.

The weldability of the rail material is an important consideration since welding is a significant process in the production of track components and their subsequent repair and maintenance. The desirable wear properties and strength of the rail are achieved at the expense of the weldability and toughness. Because of this the rail material has to be classified to steels with reduced weldability. Consequently welding procedures for both construction and repair have been developed as well as training of welders to produce high weld quality.

Table 1. Rail grades

Quality		Chemical composition				Tensile strength N/mm^2
		%C	%Mn	%Si	%Cr	
UIC860						
Grade	700	.40–.60	.80–1.25	.05–.35	–	680–830
	900A	.60–.80	.80–1.30	.10–.50	–	880–1030
	900B	.55–.75	1.30–1.70	.10–.50		"
	1100	.60–.82	.80–1.30	.30–.90	.80–1.3	≥ 1080
Crossings						
UIC 866						
AM-steel		.9–1.3	11–14	.4	–	~670

1.2 Rail and track length

The rail produced in Sweden has a length of 40 meters and is then flash-butt welded in the workshop to produce long rails (LWR). A common length of LWR in Sweden is 360 m. The rail length and LWR length vary from country to country. The LWR are then transported on special wagons out into the track , where they can be welded into continuous tracks.

Today the tracks are very often continuously welded. British Railways has for example a total track length of approximately 38,000 km of which 50% is continously welded. In Sweden the figures are 12,000 km respectively 5,500 km. In Norway and Denmark all tracks are continuously welded. The track lengths are there 4,500 resp. 2,500 km. The joining is either performed by Thermit welding or by MMA, so called mould welding.

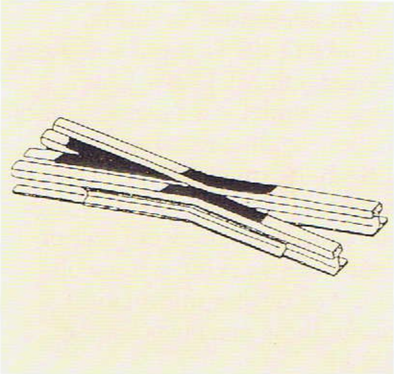

Fig 1. Black area exposed to wear.

2. Rail damage

This occurs all over the rail system. It is mainly caused by repeated impact, fatigue and wear from the running traffic, but also spontaneously by locked wheels or locomotive driving slip (wheel burns). Material imperfections such as flaws, porosity or non metallic inclusions often take part in and accelerate the damage;

Significant of damage on plain rail line are cracks of different sizes caused by bending and rolling contact fatigue. Deformed rail ends are also found, caused by impact when the wagon wheels pass over the rail gaps. (Not valid for continuously welded rail).

Much damage is related to the switches:

- crossings are subjected to impact loading. This is concentrated to the tip section and adjacent wings where the wheel rolls from the narrowing tip onto the wing rails or vice verca, see fig 1. Damaged parts are deformed and often cracked.
- the switch blades are exposed to and damaged by the flange pressure from the wheels. The blades are worn down gradually.
- the same applies to the part of the rail that is supporting the switch blades.

Figures 2–7 show common types of rail damages.

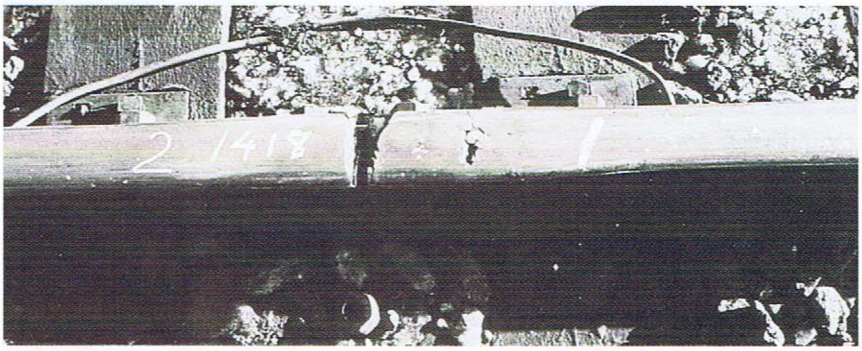

Fig. 2 Damaged rail ends

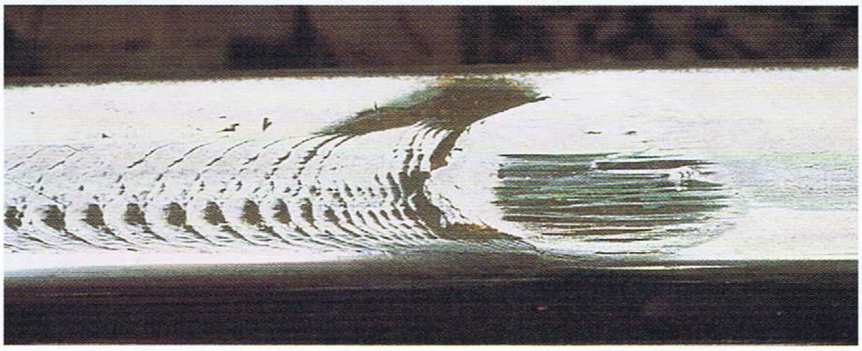

Fig. 3 "Wheel burn"

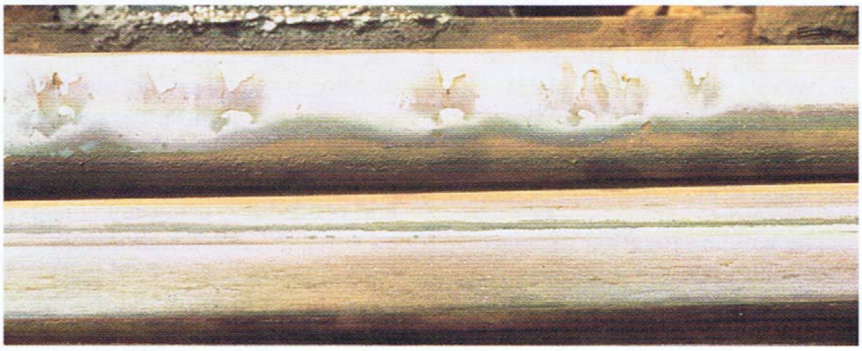

Fig.4 "Squats" rolling fatigue

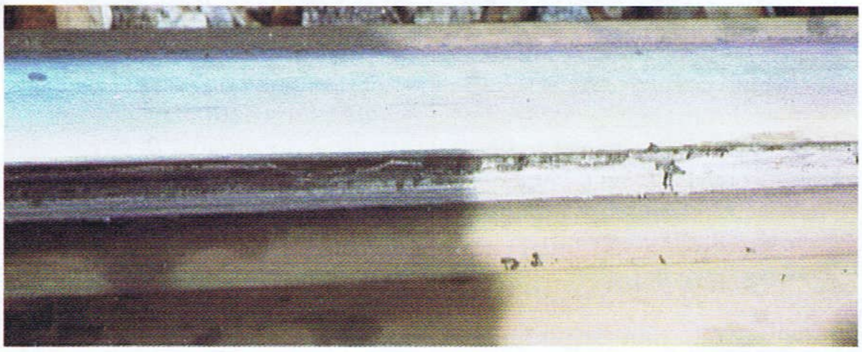

Fig.5 Worn switch blades

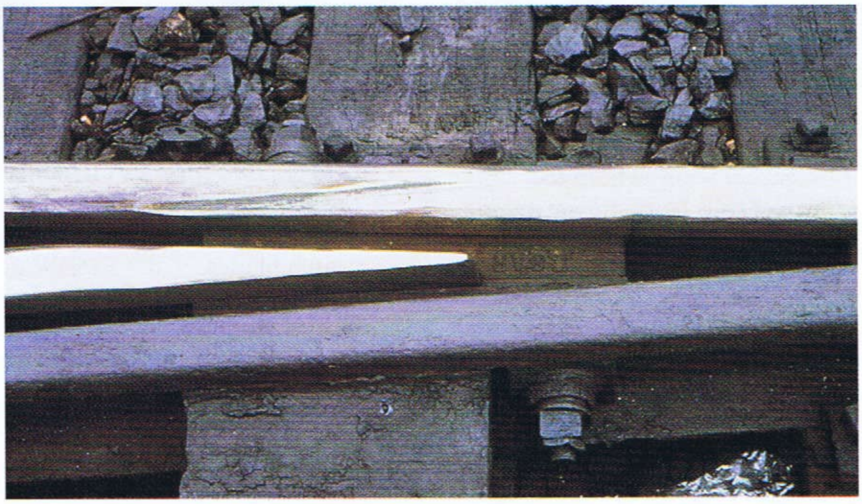

Fig.6 Worn C-Mn crossing

Fig. 7 Cast defect AM-steel crossing

3. Welding processes, consumables and machines

3.1 MMA welding

During the so called "the golden age of railways", i.e 1910–1935, welding processes of many types were applied and the benefits of using welding were very quickly appreciated.

The welding together of rails i.e. to eliminate the joint, was at this time carried out by the Thermit welding process, but also oxy-acetylene and Manual Metal-Arc welding processes (MMA). In the mid 1920:s the MMA welding process was first applied to the resurfacing of worn parts in crossings. From then on MMA welding process has been the successful process. ESAB´s available MMA-electrodes and procedures for repair of rail on-site have been developed in cooperation with Swedish National Rail. The products in question are presented on page 11.

3.2 FCAW welding

Since there is a long and positive experience of the MMA welding alloys, it was logical to transfer these alloys into semi automatic welding processes. Considerable work has been undertaken by Esab Development Department to evaluate different materials and procedures using self shielded wires (FCAW). Laboratory tests combined with field tests have shown to fulfill the requirements. With the self shielded wires this process becomes still more attractive for welding on-site as there is no need to supply and transport gas. The products are presented on page 11.

The semi automatic process reduces the number of passes and restarts, and thereby minimises the amount of failures and defects. With a small wire diameter, ø 1.6 mm, it is easy for the welder to control the weld pool and to have a better influence on the welding. Furthermore the metal deposition rate is higher and consequently the welding speed. This in its turn means a faster job and less labour cost.

The cost of repairing a crossing can be reduced by 50% compared with previously used MMA. Of course FCAW can not replace MMA in all repair . There will always be repairs that due to different circumstances, are more suitable for MMA welding, for instance small repairs and where accessability is limited.

3.3 On-site machines

The semi automatic weld process with self shielded wires has been successfully adopted partly because this process can operate from the same existing portable power supply as used for MMA welding. ESAB, LUA 400 is an universal rectifier for MMA and with a wire feeder unit MED 304 it is ready for flux cored arc welding. LUA 400 is designed to be lightweight but sufficiently robust for on-site welding.

An alternative to this is NOMAD 400 Silenced with wire-feeder unit MED 304. This is a bigger model in a range of combination welding machines from ESAB. Normad 400 Silenced can supply additional power to operate tools, lightening etc. Important when working is done on-site. For further information about these machines contact ESAB.

4. Welding procedures and techniques

4 . 1 General

Track material is made of either carbon manganese steel or austenitic manganese steel ref. table 1.

The welding of these steels must be treated quite differently. Carbon manganese steel rail is susseptible to air hardenability and particular attention must be directed to the attainment and maintenance of preheat, interpass temperature and cooling rates. Contrary to this, the austenitic manganese steels are sensitive to hot shortness and will readily crack if subjected to temperatures in excess of about 200°C. These steels can be identified by the fact that they are none magnetic.

Some general aspects on welding:

- Welding must not be carried out in rain or falling snow and shielding must be used in strong wind.
- Stick electrodes, to be used, should be redried and kept at approx. 120°C in a heating cabinet, when not required for immediate use.
- Deformed or cracked rail material must be removed to sound metal before welding. Subsequent examination is carried out by non destructive testing (dye penetrant)
- Heavy deformation and deep cracks in carbon manganese steels are removed by oxy-fuel gas cutting or flame gouging. A preheat of 100° C should be applied. Contrary to this, defects in AM steel are removed by grinding and not preheated.
- When grinding, light pressure must be used to avoid overheating.
- Areas to be resurfaced should be ground to a minimum depth of 2 mm, finishing off diagonally across the rail. Transition to the rail surface must be gradual, about 45°.
- Welding shall always start immediately after the preheating temperature is stable (C/Mn steel).
- Each run must be thoroughly deslagged and brushed before welding the next run. This is to minimize the risk of defects occurring in the deposited weld metal.
- The start and finish of each run should always be staggered to each other. Fig. 8 illustrates two possible alternatives.
- Each complete layer of weld metal shall than be brushed and lightly ground to a flat smooth surface and checked for defects, using penetrant.

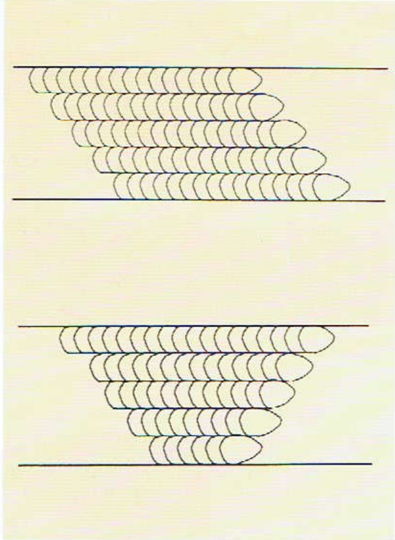

Fig. 8

- When preheating carbon manganese steel rail the area to be repaired and a distance of 100–200 mm on each side should be heated. This shall be applied in a slow gradual manner. Temperature deviations may not vary more than +150°C or –50°C from what is recommended.

4. 2 Application descriptions

The procedures described are based upon practice by the Swedish National Rail, but are principally the same in most western European countries. One of the rail grades used in Sweden differs somewhat from the UIC qualities, i.e 700 given in table 1. Corresponding quality used in Sweden is designated 800. The differences between the two are however very small and have no significance for the welding procedure.

The most common applications are reviewed as follows:

1 - defects on the plain rail
2 - rail ends damage
3 - joining of rails
4 - switch blades and support rail damage
5 - resurfacing crossings of carbon manganese steel and austenitic manganese steel.

4.2.1 Plain rail

Despite different origin and manifestation of damage, repair is principally the same.

Technique

To avoid distortion after welding, mountings are released 1–3 sleepers on each side of the damage. The rail is raised about 5 mm, using wedges.

Area to be repaired and 100 mm on each side is preheated.

Welding is made longitudinally and by weaving the electrode 30–35 mm.

Last made layer is hammered and ground immediately after the welding.

Webs are then removed and heated area is allowed to cool. 900B and 1100 must be cooled very slowly. After this a final grinding is performed.

Preheating temperatures:

Steel grade	Temperature °C
800	300 – 350
900A, B	300 – 350
1100	400 – 450

Note
If stringer beads <30 mm width are used, preheat temperature should be raised by 50°C

Recommended consumables for plain rail

MMA

OK 74.78	ø 5 mm	190-260A
OK 74.79	ø 5 mm	250-300A

FCAW

OK Tubrodur 15.41	ø 1.6 mm	200-230A 29-31V
OK Tubrodur 15.43	ø 1.6 mm	200-230A 29-31V

Figures 9-10 show a repaired weel burn.

Fig. 9 After welding

Fig. 10 After grinding

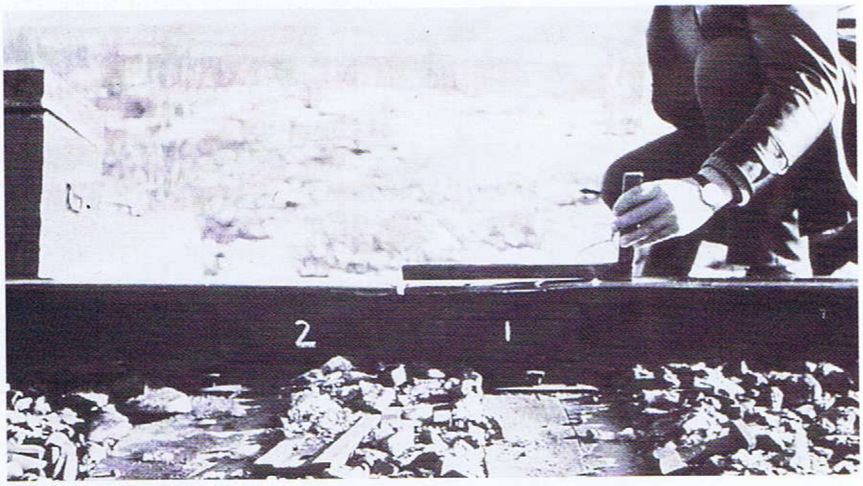

Fig. 11 Deformed rail ends

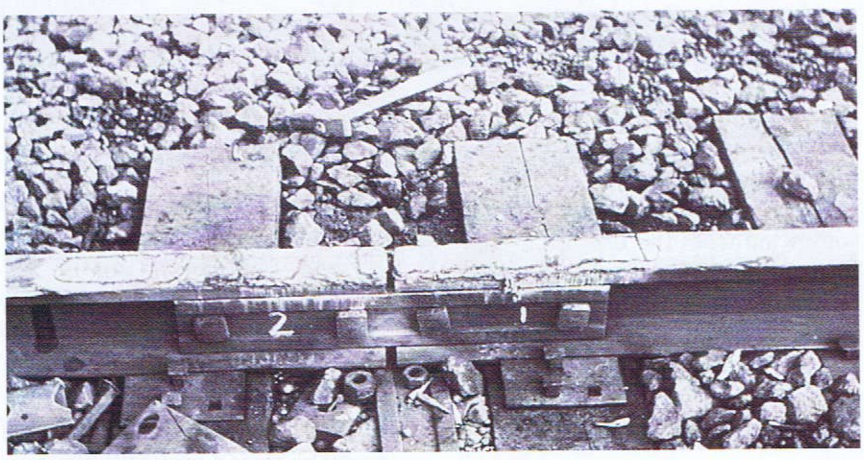

Fig. 12. Both rail ends welded

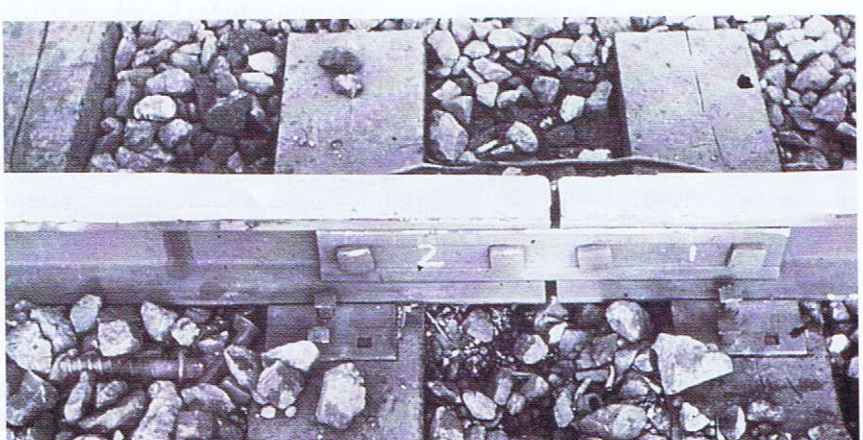

Fig. 13. Rail ends after welding and profiling

4. 2. 2 Rail ends

Rail ends should be attended to when worn about 2 mm.

Technique

Area to be repaired and an extra 100 mm are preheated.

Welding is made longitudinally starting from the very end of the rail. The bead should be weaved about 30–35 mm.

Last layer is hammered and ground directly after welding.

Correct profile is produced by grinding after slow cooling.

To enable traffic when a more extensive repair is made half of the railhead is repaired at the time.

Figures 11–13 show the different steps when weld repairing damaged rail ends.

Both rail ends can be built up simultaneously if the gap between them is short i.e. <5 mm. The gap can be bridged using an electrode core wire as a backing. For larger gaps OK Backing 21.21, normally used as a backing when joining rail, can be fitted in between the rail ends as a support for welded beads.

Experience in Sweden shows that weld metal suitable for rail ends and crossings should have a hardness exceeding that of the rail material by 20–30% for optimum durability within 100 mm from the extreme rail end. For distances exceeding this the weld metal should yield a hardness corresponding that of the rail material. The welding is performed according to fig. 14.

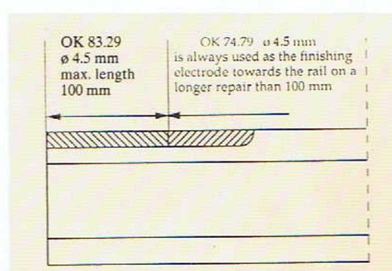

Fig. 14

Preheating tempertures:

Rail grade	Temperature °C
800	300
900A, B	300
1100	400

Note

If stringer beads < 30 mm width are used, preheat temperature should be raised by 50°C

Recommended consumables for rail ends

MMA

OK Selectrode 83.29	ø 4.5 mm	250–300 A	
OK 74.79	ø 4.5 mm	250–300 A	

FCAW

OK Tubrodur 15.43	ø 1.6 mm	200–230 A	29–31 V

4. 2.3. Joining of rails —mould welding

The technique described has been used by Swedish National Rail for many years. The Norwegian Rail and Danish National Railways have similarly approved the method using ESAB products.

Technique

The gap between rail ends to be joined should be 15–18 mm.

The rail ends are raised 1.5–2 mm to avoid shrinkage effects.

Preheating is made to a distance of 200 mm from the rail ends.

OK Backing 21.21, measuring 200x60x13 mm, is placed and fixed under the joint opening, fig.15. The backing contributes to a smooth transition between weld and rail material. This is very important as the fatigue strength of welded joints is to a great extent dependent on the shape of the weld and the degree of freedom from notches.

Welding starts at the foot, fig 16. Bead sequence is according to fig 17. On completion of the foot, beads overlapping the upper side should be smooth. No undercutting is allowed. The backing is removed and the weld "down under " is checked using a mirror.

After controlling the working temperature, coppershoes are placed on both sides of the rail, according to figure 18. Web and head are then welded with the same type of electrode continuously.

On welding the web the electrode should be following the mould walls in a squared pattern, making short stops in the corners. Too long an arc may cause porosity in the weld metal. The arc length is checked by quick dipping of the electrode in the weld pool at intervals. Electrodes changes are carried out quickly to prevent the slag from solidifying. As the electrode reaches the rail head the electrode movement should be changed to weaving. The upper 6–8 mm of the rail head may be welded by an alternative electrode yielding a harder weld metal i.e a hardness similar to the hardness of the rail.

After welding is finished, the coppershoes are removed and the rail head is hammered and ground while still hot. Fig. 19 shows a completed weld.

Stress relieving is undertaken before temperature has reached 350°C on cooling; the joint and the adjacent material, 100 mm on either side, are heated to 600–650°C for 10 minutes. Uniform slow cooling is achieved by surrounding the area by mineral wool pads.

Railhead and the sides of the foot are ground to correct profile. All notch like defects, such as undercuts on the upper surface of the rail foot, have to be ground out.

Preheating temperatures:

Rail grade	Temperature °C
800	350
900A	400

Recommended consumables for joining of rails

OK Backing 21.21			backing for welding foot
OK 74.78	ø 5 mm	240–250 A	foot, web and head
OK Selectrode 83.28	ø 5 mm	240–250 A	for surface layer of rail head

Fig.15 Mounting of backing.

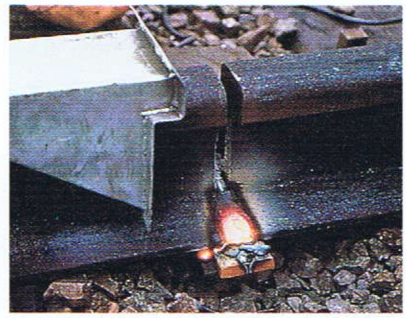

Fig.16 Welding of the foot

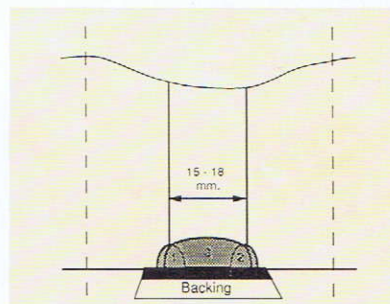

Fig.17 Bead sequence when welding the foot

Fig. 18 Coppershoes mounted for mould welding of web and head

Fig.19 Complete weld before grinding

4. 2. 4 Switch blades

Technique

Very thin parts of the blade or where pieces have been broken away should be ground according to fig. 20

To avoid shrinkage effects the area to be welded is raised by about 20 mm to form the shape of a curve. This is done by inserting wedges underneath the blade and by pressing down the tip.

Area to be repaired and adjacent rail, 100 mm either side, are preheated.

Preheating temperatures:

Rail grade	Temperature °C
800	350
900 not allowed to weld	

Welding is carried out vertically up with a start according to fig. 21. Subsequent beads are finished off on the first made bead according fig. 21 b and c. When ready, the pad is ground while still hot. New pads are made the same way until the end of the blade is reached, fig. 21 d.

After cooling wedges are removed and the blade is finally ground and adopted to the support rail.

4 .2.5 Support rails

In connection with the reconditioning of the switch blades the condition of the support rail should be controlled.

Technique

Rail to be welded is raised about 5 mm to counteract distortion after welding, if not possible, it is most essential to hammer each completed bead when welding.

The minimum length to be welded should be 500 mm, passing the end of the switch blade.

Area to be rectified and 100 mm on each side are preheated.

Welding is carried out in the same way as for switch blades, see 4.2.4.

Preheating temperatures:

Rail grade	Temperature °C
800	350
900A	350

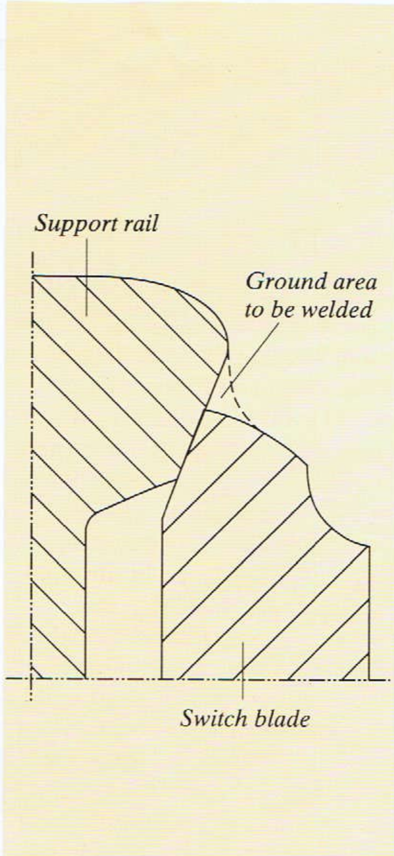

Fig.20 Shaping upper part of switch blade

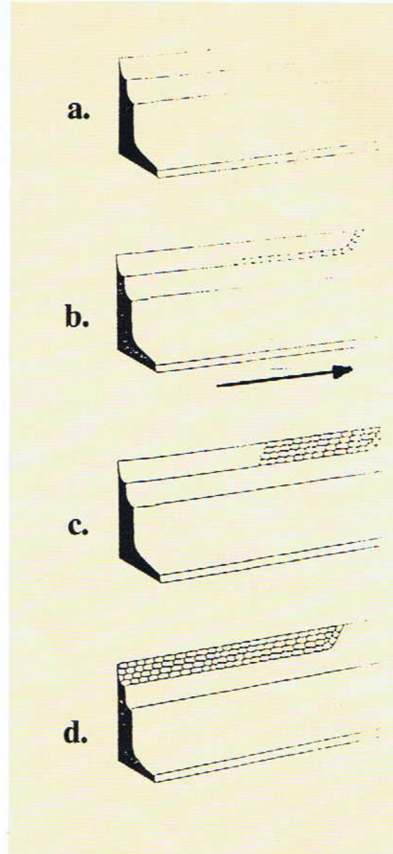

Fig.21 Bead sequence. The arrow shows welding direction.

Recommended consumables for switch blades*

MMA		
OK Selectrode 67.45	ø 4 mm	120–140 A
OK Selectrode 67.52	ø 3.25	120–140 A
FCAW		
OK Tubrodur 14.71	ø 1.6 mm	140–300 A 24–27 V

Recommended consumables for support rails*

MMA		
OK 74.78	ø 4 mm	150 – 190 A ferritic type
OK Selectrode 83.28	ø 4	150 – 190 A "
OK Selectrode 67.45	ø 4	120 – 140 A austenitic type
FCAW		
OK Tubrodur 15.43	ø 1.6 mm ferritic type	200 – 230 A 29 – 31 V
OK Tubrodur 14.71	ø 1.6 mm stainless type	140 – 300 A 24 – 27 V

* NOTE.
There is some disagreement among "railway people" whether to use an austenitic or a ferritic type to obtain maximum durability. To our knowledge both types perform satisfactorily.

4.2.6 Carbon manganese crossings

Repair, carried out in track, is preferably carried out before the amount of wear or deformation exceeds 6 mm in depth.

Technique

To counteract distortion of the tip during welding, the mountings in the sleepers should be released under the damaged part. Wedges are used to raise the area to be welded by 5–10 mm.

The entire area to be rectified and 100 mm on each side is preheated. Welding with stick electrodes is performed by longitudinally weaved beads, 30–35 mm when possible, building up the pad to the full width of the area with successive runs. When FCAW is applied the first step is to make longitudinal beads along the most worn parts, i.e. the edges. This is to support the subsequent welding which implies weaving across the entire area to be repaired, see fig. 22.

The last layer is hammered and ground after upon welding, while the metal is still hot.

After the repaired area has cooled down the wedges are removed and final grinding is carried out to attain the correct profile. The rail is then mounted back on the sleepers.

Preheating temperatures:

Rail grade	Temperature °C
800	300
900	300

Note

If stringer beads <30 mm width is used, preheat temperature should be raised by 50°C

Figure 23 shows a weld repaired crossing

4. 2.7 Austenitic-manganese crossings

The repair is carried out preferably before the damage exceeds a depth of 6 mm.

Technique

Mountings in sleepers under the crossing are released and the crossing is raised by wedges. With this quality of crossings preheat is not applied and the temperature is kept low during the welding. The interpass temperature must not exceed 200°C.

To keep the heat input low stringer beads are used, no weaving. Also bead length should not be longer than 100 mm for MMA and 600 for FCAW welding. Start and end craters are thoroughly ground before welding is continued. Runs are deposited in a sequencial manner until the whole area is resurfaced with one layer. Every bead should be lightly peened while the weld metal is still hot.

Rectification of the tip and the rail wings are made in principally

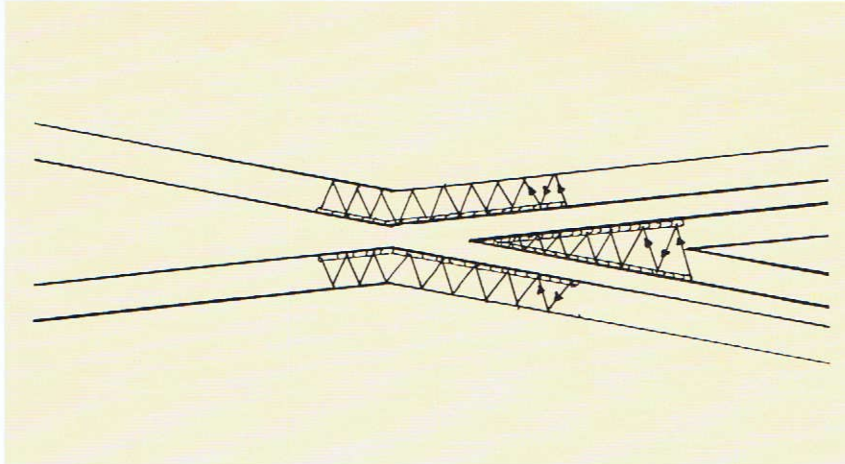

Fig. 22. Welding sequence.

Fig. 23 Repaired C-Mn crossing before profiling

Recommended consumables for carbon manganese crossings

MMA		
OK Selectrode 83.28	ø 5 mm	approx. 250 A
OK Selectrode 83.29	ø 4.5	300 A
FCAW		
OK Tubrodur 15.43	ø 1.6 mm	200 – 230 A 29 – 31 V

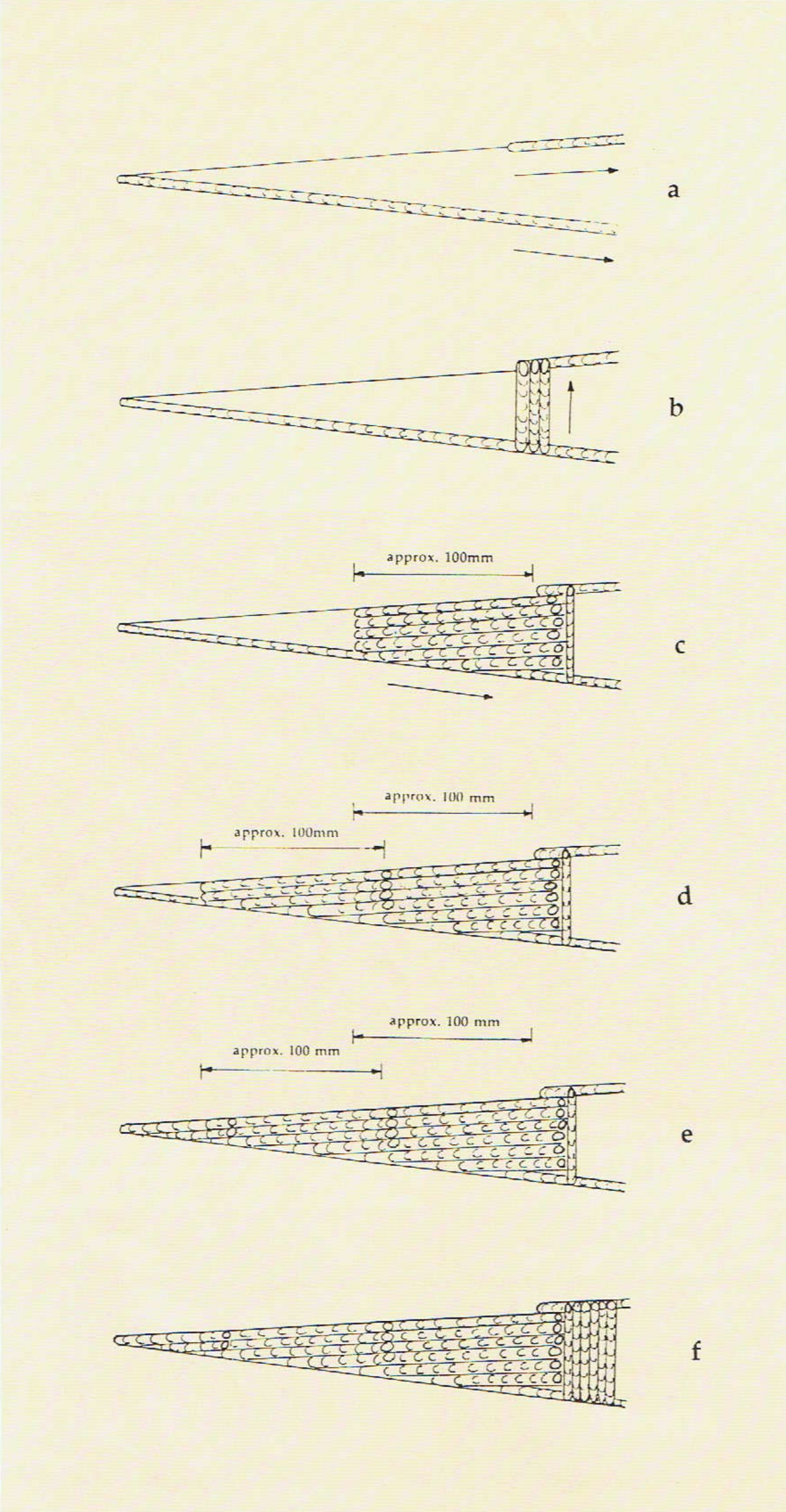

Fig. 24 a-f. Bead sequence when repairing an austenitic manganese crossing. MMA welding.The arrows show the welding direction.

Recommended consumables for austenitic manganese crossings

MMA			
OK Selectrode 86.28	ø 4 mm	180 A	
FCAW			
OK Tubrodur 15.65	ø 1.6 mm	200–230 A	29–31 V

the same way. Fig. 24 a-f show the general welding procedure.

First the "support beads" are made according to sketch a. Then three beads are welded transverse the tip, sketch b. Pads, 100 mm long for MMA and between 100–600 for FCAW, are weldedparallell to one side of the rail, sketch c-e. When the narrowing part is ready welding continues with transverse runs backwards. They are started and finished off on the first made support beads.sketch f.

Immediately after the welding is finished the whole area is ground.

Wedges are removed and final grinding is carried out to attain the correct profile. The crossing is mounted back to the sleepers.

Summary

There is no doubt that repair of track by welding has considerable cost saving advantages compared to replacement by new components. In general it can be assumed that 40% of the total cost of the materials for a kilometer track is that of the rail itself. Such a high proportion of cost therefore indicates that anything that can be done to prolong the life of the rails will impart considerable financial savings.

ESAB has always encouraged technical dialogue and cooperation with potential users regarding welding problems and their solutions. The knowledge and experience gained in this cooperation has been incorporated within the current package of products which have secured substantial cost saving benefits in service.

About the authors:

Bengt Dahl is Chief Welding Engineer at Swedish National Rail, Borlänge, Sweden.
Björn Mogard is Metalurgist at Swedish National Rail.
Bibi Gretoft is Product Manager, Repair & Maintenance, Esab AB, Göteborg, Sweden and
Björn Ulander is Development Engineer, Repair & Maintenance, Esab AB.

Product information

MMA

OK 74.78, OK 74.79 (high efficiency)

Typical weld metal composition

C	Si	Mn	Mo
0.06	0.35	1.5	0.35

Weld metal hardness ~250 HV

A basic AC/DC electrode for welding high tensile steels. Good notch toughness down to –60°C. Very suitable for mould welding of rail and for cladding on rail.

OK Selectrode 83.28, OK 83.29 (high efficiency)

Typical weld metal composition

C	Si	Mn	Cr
0.1	0.5	0.7	3.2

Weld metal hardness ~34 HRC

Chromium alloyed basic covered AC/DC electrodes for hardfacing and cladding on rails and rail crossing sections.

OK Selectrode 67.45, 67.52 (high efficiency)

Typical weld metal composition

C	Si	Mn	Cr	Ni
0.1	0.5	6	18	8.5

Weld metal hardness AW 190 HV
WH 40 HRC

Crack resistant electrodes for welding steels with very poor weldability and welding of austenitic manganese steels, hardenable steels and for stainless cladding.

OK Selectrode 86.28

Typical weld metal composition

C	Mn	P	S	Ni
0.75	14	0.02	0.01	3.5

Weld metal hardness AW 160–180 HV
WH 45 HRC

A basic fast electrode for hardfacing. It gives a tough nickel alloyed austenitic manganese weld metal, which work hardens during cold working. It is intended for worn parts made from austenitic manganese steels as for instance cast manganese steel rail crossings.

OK Backing 21.21

Is a sand briquette covered by fibre glass measuring 200 × 60 × 13 mm. It is used as a backing when joining rail ends by mould welding.
The backing gives a smooth and even transfer between the weld and the rail, which is important due to high fatigue strength requirements in this area of the joint.

FCAW

OK Tubrodur 15.41

Typical weld metal composition

C	Si	Mn	Cr	Al
0.15	max.0.8	1.6	3.5	1.5

Weld metal hardness 28–36 HRC

A self shielded cored wire. The weld metal is chromium manganese alloyed.
It is used for on site rebuilding of worn parts of C-Mn railway tracks, point frogs etc. where resistance to compressive loads is of prime importance. It is also useful as a buffer layer or intermediate hardness build up prior to use of harder materials.

OK Tubrodur 15.43

Typical weld metal composition

C	Si	Mn	Cr	Ni	Mo	Al
0.15	max.0.5	1.1	1.0	2.3	0.5	1.4

Weld metal hardness 30–40 HRC

A self shielded cored wire giving a chromium nickel molybdeum alloyed weld metal. Being self shielded it is ideal for on site rebuilding worn parts of C-Mn railway tracks, point frogs etc. where resistance to compressive load is of prime im-portance. It is also useful as a buffer layer of intermediate hardness build up prior to use of harder material.

OK Tubrodur 15.65

Typical weld metal composition

C	Si	Mn	Cr	Ni	Mo	V
0.3	0.55	13.5	16	1.7	0.8	0.6

Weld metal hardness AW 24 HRC
WH 53 HRC

A cored wire for self or gas shielded semi-automatic welding. It gives a martensitic austenitic work hardening deposit which has universal wear resistance. It is used for rebuilding of mild, low alloy and 13 % Mn steels. The weld metal combines excellent abrasion and impact resistance and is useable for such applications as railway point frogs etc.

OK Tubrodur 14.71

Typical weld metal composition

C	Mn	Ni	Cr
0.04	5.6	8.5	19.0

Weld metal hardness AW 230 HV
WH 41 HRC

A stainless "18/8/6–Mn" cored wire for self shielded welding. For cladding and joining of 13 %Mn steel and other steels which are difficult to weld with unalloyed and low alloyed consumables. The weld metal is extremely tough and able to absorb high stresses. Can also be used as buffer layer before hardfacing.

THE ESAB GROUP

Esab AB, Box 8004, S-402 77 Göteborg, Sweden
Tel. +46 31 50 90 00. Fax. +46 31 50 93 90.