Resurfacing tramway rails

by W. Rausch and M. Koch, Rheinische Bahngesellschaft AG, Düsseldorf, J. Schattling and Dipl.Ing. R. Paschold, Esab GmbH, Germany

Worn tramway rails can be resurfaced by build-up welding the guide edges using the flux-cored wire submerged arc welding process. As can be seen from the printed rail dimensions, the curves display material wear and a so-called rut is formed. This causes the reference rail gauge to exceed the permitted dimension. In highly rutted curves, the rut can be as much as 15 mm.

Objectives

To restore the original dimensions of the grooved rails by repair welding. A highly economical welding process must make it possible to apply an alloy offering high wear resistance. It must be resistant to high curve pressure sliding/rolling wear.

Repair welding, which is mainly carried out at night, could help to avoid having to exchange rails or prevent the tramway being immobilised for periods of time.

The repairs

Grinding

Before welding, the groove in the rail must be thoroughly cleaned and the area of the rut must be metallically bright ground. After welding, the rail is given the required final contour through grinding.

System technology

The welding system comprises the following components:

- Transportable A6 Mastertrac automatic submerged arc welding machine with motor-driven rail mechanism consisting of components from the ESAB A6 modular system
- Welding power source ESAB LAE 800
- Compressor for OPC flux suction and recirculation

The automatic submerged arc welding machine for rail build-up and repair welding consists of components from the field-proven A6 modular system. The stationary A6 welding head is mounted on the tractor carriage using vernier attachments.

Figure 1: Introduction of the automatic welding machine in the track area or removal, during interruptions due to a tram passing

The tractor carriage has a rail gauge of 1,435 mm and can be run on the rail at a speed ranging from 0.1 to 2.5 m/min. Both axles of the carriage are driven to prevent the wheels from slipping through and to obtain a constant speed. The drive mechanism of the carriage can be disengaged so that it can also be moved manuallv.

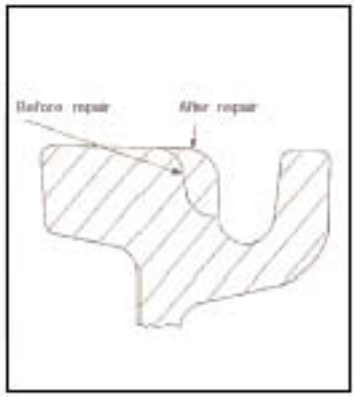
The PEG 1 control box includes all the control elements together with the remote controls for the power source. All the welding parameters are digitally displayed and can be rapidly and simply programmed before welding. The transistor control ensures the constant maintenance of the set welding data.

The pneumatic OPC flux suction produces flux recirculation.

The special version of the A6 Mastertrac automatic welding machine has been specially developed for the build-up and repair welding of rails. To clear the building site when a tram passes. the carriage is equipped with two lateral wheels to permit the automatic machine operator to ride outside the track area.

Welding process

Submerged arc welding is one of the high-performance welding processes. The high deposition rate which characterises the process permits higher welding speeds and shorter repair times compared with other welding processes. The process is characterised by high efficiency and perfect seam quality.



Cross-section of the rail head before and after repair by build-up welding.

Figure 3: Manual positioning of the automatic welding machine with a disengaged drive unit

The fusion performance can be further increased by 40% by using flux-cored wire rather than solid wire. So the flux-cored wire/flux combination OK Tubrodur I5.65/ OK Flux 10.62 is used for rail build-up welding.

Welding flux OK Flux 10.62 has a very good supportive effect in grooved rails. The resurfacing beads display an even surface with smooth transitions. The number of layers can be decreased compared with the previous technology.

Figure 2. A6S-automatic welding machine in operation
Components:
- *PEG1 controle box*
- *Modular components A6-S*
- *Pneumatic OPC flux suction*
- *Special rail carriage device*

The slag is self-releasing. The quiet welding process does not produce any smoke or radiation interference with the welding as the arc bums under a flux cover. Moreover, the finished weld product ensures a higher resistance to wear than conventional welding of the l8Cr/8Ni/6Mn (1.4370) type.

Welding parameters

- Welding current (A): 450-550
- Welding voltage (V): 30-32
- Welding speed (cm/min) 55-85

Performance comparison

This is where the performance capacity of the process makes itself evident. During practical tests with the modern flux-cored wire submerged arc welding process, as much as 35 m of rutted rail were resurfaced every night. This is possible as a result of the increased quota of pure welding time in the total repair time. The percentage of non-productive time is reduced; non-productive time due to electrode replacement and the like is eliminated, for example.

The higher deposition rate of the process is an additional plus point.

Moreover, the seam quality is far superior to that of electrode welding. The shape of the build-up is closer to the final contour so that grinding work decreases noticeably.

Remark: The solid wire for submerged arc welding. OK Autrod 16.95, is also suitable. The lower deposition rate. however. reduces the efficiency of the process.

OK Tubrodur 15.65

Flux-cored wire electrode for hardfacing.

Classification: DIN 8555: MF7-250 KPR

Product description

OK Tubrodur I5.65 can be used self-shielded or gas-shielded for hardfacing on non-alloy or low alloy steels as well as on 13% Mn-hard-steels (such as 1.3401).

Submerged arc welding with OK Flux 10.65 or OK Flux 10.61 can be performed using the single wire or twin arc process. The beads have a very even surface and smooth transitions.

The work-hardened weld metal is martensitic-austenitic. It com-

bines excellent resistance to rolling and impact stresses related to abrasive wear.

Characteristic: rutile flux-cored wire

Protective gas: self-shielded without shielding gas CO_2 or mixed gas (80120)

Welding powder: OK Flux 10.62 (or OK Flux 10.61).

Welding deposit reference analysis

C	Si	Mn	Cr	Ni	Mo	V
0.3	0.5	14	17	1.8	0.8	0.6

Applications:

- Cap layers on wear-stressed welded joints on high manganese steels, such as X 120 Mn 12 (1.3401) and X 110 Mn 14 (1.3402)
- Repair of parts made of high manganese steels, such as excavator parts, breakers, hammers, wearing plates
- Build-up welding in shunt points, such as core pieces
- Build-up of worn rails, such as grooved rails for tramways
- Build-up of running tread on rails and so on

Current type and polarity: Direct current + Pol.

Hardness values: approx. 24 HRC as welded
45-52 HRC after work hardening

Figure 7: Two welding processes in night-time performance comparison on a rail curve
left: Two electrode welders using type 1,4370 covered electrodes resurfaced rail length: 6 m
right: Submerged arc automatic welding machine with two operators, using OK 15.65/0K 10.62 filler material resurfaced rail length: 20 m.

Figure 4: A6-S automatic welding machine during night-time operation. Flux-cored wire OK Tubrodur 15.65 (2.8 mm). Flux: OK Flux 10.62.

Figure 5: Top view of the build-up welded grooved rails. The beads display an even seam with smooth transitions. The layers upproximate the final contour wherever possible, so that a minimum of grinding work is required.

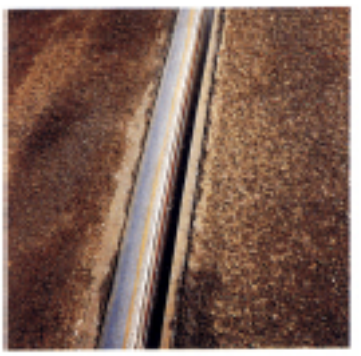


Figure 6: A resurfaced rail using build-up welding with the special Ah automatic machine. After welding with OK Tubrodur 15.65/OK Flux IO.52 ground to the final contour

Performance data

Diameter (mm)	Current strength (A)	Voltage (V)	Coils
Self-shielded			
1.6	270-290	25-28	13 kg coils
2.4	370-390	25-28	25 kg ring
Submerged welding			
2.8	500-550	30-32	25 kg ring

About the authors:
Mr W. Rausch was the welding engineer responsible for the tramrail-company Rheinische Bahngesellschaft **AG** in Düsseldorf. He left the company in 1994. **Mr M. Koch** is a member of one of the two welding teams, that are working on the rail with the SAW-process. They were involved in the development of the tailor-made A6-S automatic welding machine and in the choice of the hardfacing consumables. **Mr Joachim Schattling** is the ESAB-salesman in the Düsseldorf region. **Mr Rolf Paschold,** product manager at Esab GmbH Solingen (Germany). graduated in 1990 as a mechanical and welding engineer. He joined Esab in 1991 and is the sales support manager for welding consumables. Mr Paschold has always shown a special interest in tailor-made process applications developed together with the customer.