"EFFICIENT TANDEM MIG WELDING OF BOGIE LONGITUDINAL GIRDERS FOR RAIL VEHICLES" - CASE STUDY

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INTRODUCTION

Welding – ELH Eissenbahn Laufwerke GmbH & Co. KG Halle, a well known medium-sized company, supplies bogies to wagon manufacturers for both the domestic and export markets. The longitudinal girders, which are more than 3 metres long and are made of 16mm thick steel plates, are welded on a robot system supplied by Carl Cloos Schweisstechnik GmbH, Haiger Germany. The Tandem high capacity welding process, where two welding wires are melted simultaneously, enables both improved seam quality and considerably higher weld speeds to be achieved.

"The Tandem system gantry, on which the robot is inverted and moves over a turn-tilt table, is twelve metres long."

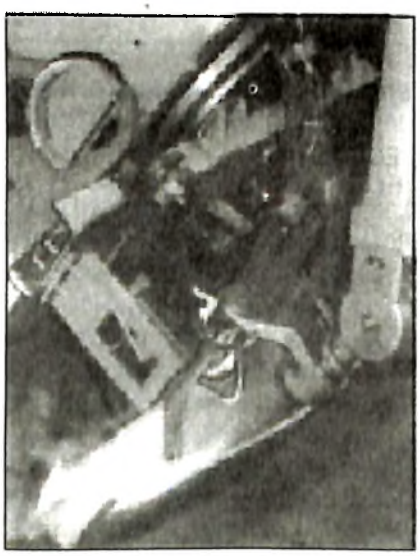
"In the days of the German Democratic Republic, the bogies frames were all manually welded", says Rainer Schimming, welding engineer and head of ELH quality management. "Each weld seam had to consist of a root pass, intermediate and final pass to meet the prescribed criteria. There was no sign of any automation.

The requirement for automation only arose in 1990 after reunification when RAW Halle - which was now part of the Bundesbahn - was compelled to make money on its own in the new market economy. Manual labour and quality requirements meant automation was required".

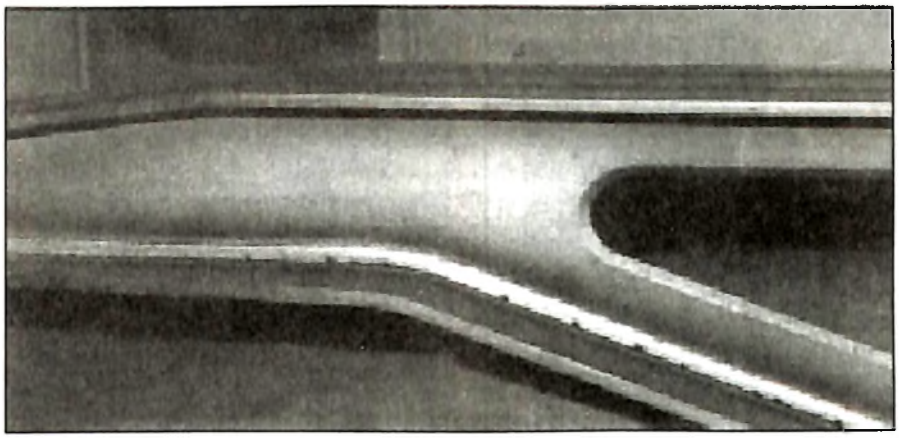
"In addition", adds graduate engineer Volker Hedergott, "RAW Halle had permanent supply contracts with the Kombinat Schienenfahrazeugbau (combined collective rail vehicle construction) - later the Deutsche Waggonbau-Union - where passenger carriages and goods wagons were manufactured. At peak times five complete new wagons were manufactured a day, each on two bogies. The first circumferential seam welding system for automatic MIG/MAG welding of buffers was installed at RAW Halberstadt shortly after reunification. And as happens, RAW Halle told, we will have to use robots to automate the welding operations; otherwise we will not be able to guarantee our customers the quantities and delivery times that we have promised".

Safety made by robot

Bogies are safety critical components and therefore it is essential that all manufacturers have their quality assurance systems audited. This is particularly important when the manufacturing methods used are changed. The result was clear; all micrographs, breaking tests, structural analyses, hardness tests etc. on the



"Due to the facts that two passes are required with Tandem high capacity welding, the operational capacity of the system in two-shift operation is already so high that a three-shift operation is required for the subsequent manufacturing process for the bogie frames".



"With the MIG Tandem process, high quality weld seams are achieved on bogie longitudinal Girders."

double HV seams on original parts which had been welded by robot and inspected as working samples on work specimens were acceptable. Welding approval from Deutsche Bahn AG was a mere formality. Since then Q1 and DIN/ISO 9001 have follwed this certification and, of course, customer specific audits.

In 1992, Cloos installed the first MIG/MAG robot welding system for the fabrication of bogies at RAW Halle. The system included a Romat welding robot with cable assembly, control cabinet, welding power source and two five metre long vertical turning units. These components were arranged in front of the robot for a parallel set-up and in-line piece part flow for prefabrication.

The robot was mounted on a freely programmable floor-mounted linear track to weld the very large bogies longitudinal girders for wagons for the Russian state railway. However as a result of their reputation as a reliable and quality-conscious supplier, Deutsche Bahn decided to have their standard bogie type Y-25 manufactured in Halle. Extensive preparation was not required: the two turning units for the Y bogie longitudinal girders were fitted with new workpiece fixtures, and of course the robot parameters were reset.

Just two years later with 10 lon-gitudinal girders a day a system capacity was exhausted. RAW Halle needed a second robot system and the deciding factors were : "positive experiences with the technology, the training of programmers and operators and the service department.

As Mr. Volker Hedegrott remembers: "From the start, the new system for the bogie fabrication with 16 longitudinal girders in double shift operation was based on a considerably higher throughput, without losing any of the weld seam quality. Cloos had at that time already developed the Tandem process with two welding wires which makes such weld speeds possible due to the higher deposition rate. This meant that we were able to fully meet these requirements. The advantage is that Cloos has more than fifty years experience in Shielded Gas welding, twenty years of it in the field of robot welding which is main business in addition to the development and manufacture of welding power sources, special purpose machines and welding torches".

Extensive test welds on original parts were carried out before the system was installed at RAW Halle at the end of the year 1997/98. Customer and supplier were completely satisfied with the results, which passed all the quality tests.

With the Tandem system, the robot is suspended on a twelve metre long gantry and moves over a turn-tilt table. This kind of workpiece fixture was required because of the weld seam preparation (single-bevel preparation), which required a PA welding position. The workpiece not only has to be turned on one plane but also tilted in order to achieve an optimum seam quality. With the principle of bringing the wire coil as close to the robot as possible, it carries the two 300kg wire drums, each. At peak times, the wire lasted about one week only.

The transverse girders for each bogie are welded on the first robot installation.

TANDEM TECHNOLOGY

MIG/MAG welding is one of the most efficient methods of joining and is used in both manual and automated applications in many industrial sec-tors. It offers excellent process reliability and joints of the best quality.

Growing pressure on costs had already resulted in efforts being made to increase the productivity of the welding process.

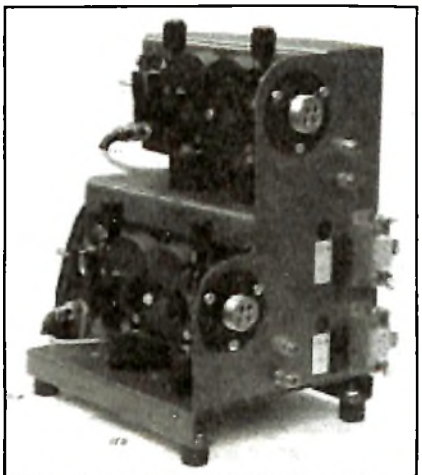
In order to increase the efficiency of MIG/MAG welding the technique of multiwire welding normally used for submerged arc welding became more established and Cloos developed their **double wire** welding process. Both wires come together in a contact tube, which has two openings through which the two wires are fed to the arc. With this process both wires have the same potential and only the wire feed speeds can be varied. The development of sophisticated power sources and increased demands in welding

technology required the further development of the double wire welding process and led to the introduction of the TANDEM welding process. Potentially separated welding wires are arranged at a certain angle in a specially- designed welding torch. In addition to the wire feed speeds all relevant values can now be varied independently of each other. This results in excellent seam quality with low spatter, increased deposition rates and a considerable increase in the welding speed.

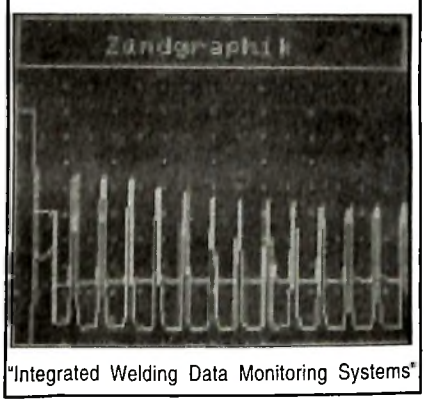
Further development of this process resulted in the complete separation of the two circuits. In its simplest case the TANDEM welding process requires two welding torches closely arranged behind each other. Both circuits are each fed by one welding power source and this separation results in an optimum control of the common arc. In addition to the improved setting options, which extended

"GLC 503 Quinto Profi Tandem Welding Power Sources."

the possible uses of this process, the TANDEM process results in better weld seam quality and reduced spatter compared with the double wire process.



"Wire drive unit CK78 DR/O Tandem"



"Integrated Welding Data Monitoring Systems"

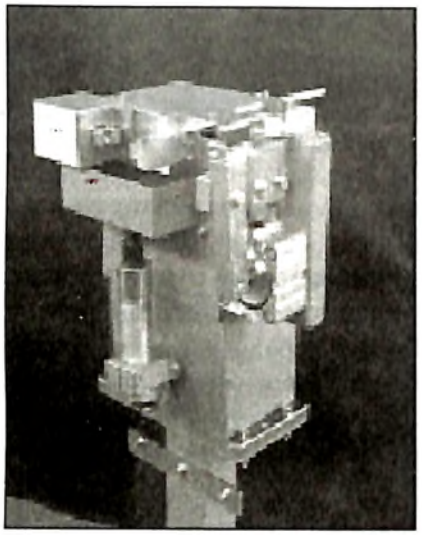
TECHNOLOGY

The TANDEM welding process is characterized by two potential separate welding wires, which are melted in one arc. A TANDEM welding torch has two contact tubes, positioned closely together with separate potentials. The welding wire is supplied by two separate wire drive units each of which is connected to a welding power source.

TANDEM Equipment

The TANDEM equipment consists of :

- Computer controlled welding power sources
- Coupling module
- Connection cable assemblies
- Wire drive units



- Welding torch cable assemblies
- TANDEM welding torch

Additional Equipment

- Mechanical cleaning for TANDEM welding torch
- Wire decoiling device for large coils or wire drum
- Additional wire drives mounted on the TANDEM torch
- Weld data monitoring software for the welding power source
- PC-Software for networking the power sources
- Equipment for arc sensor.

Control

The setting and storage of the welding parameters can be carried out depending on the application in either.

- the welding power source, or
- in an external controller (e.g. robot controller)

The welding power sources have the following interfaces :

- digital input/output signals
- analogue voltage inputs
- digital inputs for program selection

Digital input/output signals

The signals for :
- Start welding
- Pulse on
- Weld torch air blast etc.

are sent from an external control to the welding power source.

The welding powr source supplies the following control signals :

- Power OK
- Wire OK
- Gas OK
- End welding program etc.

Signal form : Digital signals

Parameter setting : Operating panel on the two sources

Parameter optimization : Operating panel on the power sources

Change over of parameters : manually by the operator

Parameter storage : In the welding power sources

PROCESS

The TANDEM welding process which has been developed for automated welding has already received an excellent response from industry. It helps to increase considerably the efficiency of new systems as well as systems already in use. The comparison of the deposition rates shows particularly clearly the size of the potential efficiency as opposed to other welding process.

The high deposition rate when using the TANDEM process shows that the:

- welding speed is increased considerably.
- and the heat input is thereby clearly reduced.

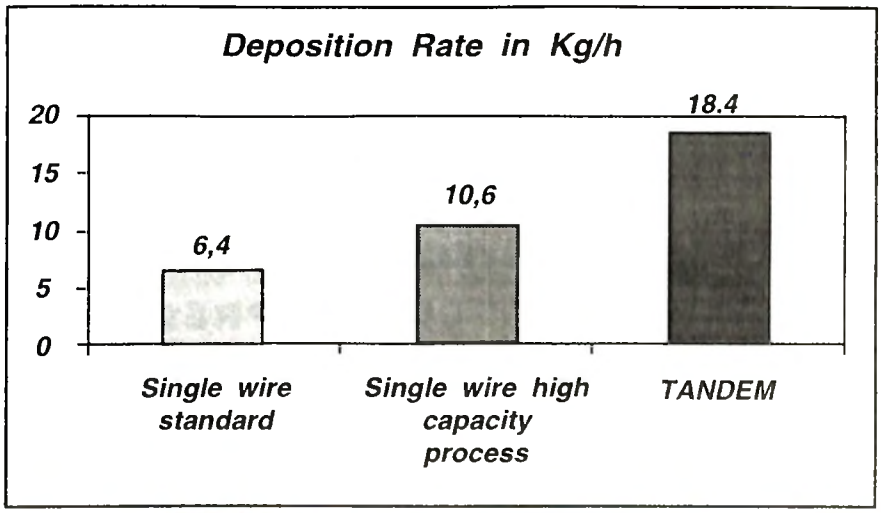
The TANDEM welding process can be used with the following materials:

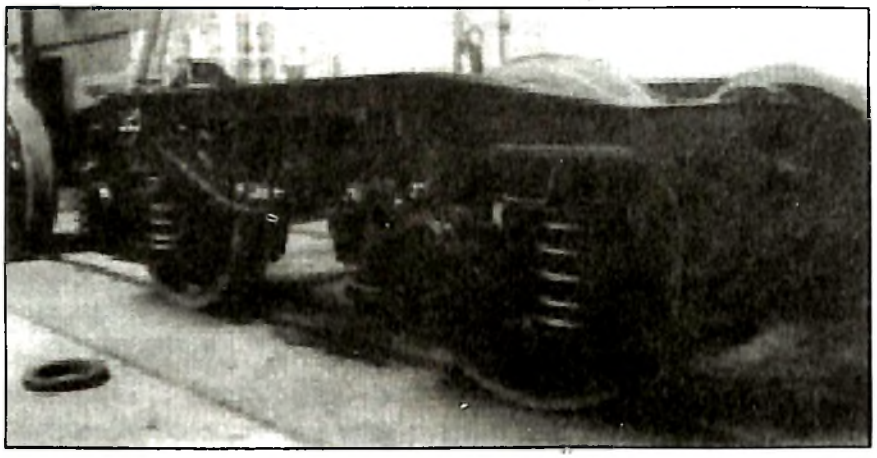
- Steel
- Aluminium
- Chromium nickel

Solid wire can be used.

As the welding power sources are operated separately the following variations are possible :

- Wire 1 and wire 2 have the same wire diameter
- Wire 1 and wire 2 have different wire diameters
- Wire 1 and wire 2 are of different materials (e.g. SG1 and CrNi43)
- Welding with/without pulse-separately adjustable for each wire
- Single wire welding with wire 1 or wire 2 use of TANDEM equipment for single wire welding.





"These types of bogies are supplied by ELH to the Deutsche Bahn AG, the Swiss Ferriere Cattaneo, the Italian Firema, Greenbrier Europe, Hoesch, SNCF, VTG and WLK, even to the Finnish railway RV."

SENSOR TECHNOLOGY

The following sensors are suitable for use in connection with the TANDEM welding process :

- Tactile sensors (e.g. gas nozzle sensor) for detection of the seam start
- Arc sensor fast-track for seam tracking
- Laser vision sensors for special welding tasks.

It should be mentioned that the Fast-Track arc sensor is completely integrated in the TANDEM welding process. Both wire 1 and wire 2 can supply the necessary corrective data. This capability is not just of considerable advantage when welding with only one wire, but also if there is a change in the weld direction.

FABRICATION

If all general conditions and parameters are correct, the seam quality with robot welding is so excellent that in no way could it be achieved with manual welding.

Furthermore, it is proved that the weld process is stable, the test and control cycles prescribed are automatically extended which reduced the expenditure. Since only two passes are required with the Tandem process - one root and one final pass - the operational capacity of the system in two-shift operation was sufficient to meet the manufacturing processes for the bogie frames".

Another important condition is that opeators and programmers are properly qualified because they are responsible for the quality of the robot welded seams. An effective training course is essential" but the application of the robot technology can only be learnt by daily practical experience. A lot of assistance required from the manufacturer, for example when the path contours had to be programmed for other bogie types and the weld parameters had to be determined". Six such weld programs - for longitudinal and transverse girders - are to be stored in the robot controller.

CONCLUSION

The finished bogie is given a quality acceptance report, with its original measured values, determined via optoelectronic measurement on prescribed critical points. When one sees that on a length of 3.2 metres, the misalignment on the longitudinal axis of 0.3 millimetre, then one will understand the quality achieved. This quality is due to the robot solution provided by Cloos Schweisstechnik GmbH, Germany.