Source: www.railnews.in/india-receives-first-ge-locomotive-under-2-5-billion-deal/

FABRICATION WELDING OF LOCOMOTIVE FRAMES

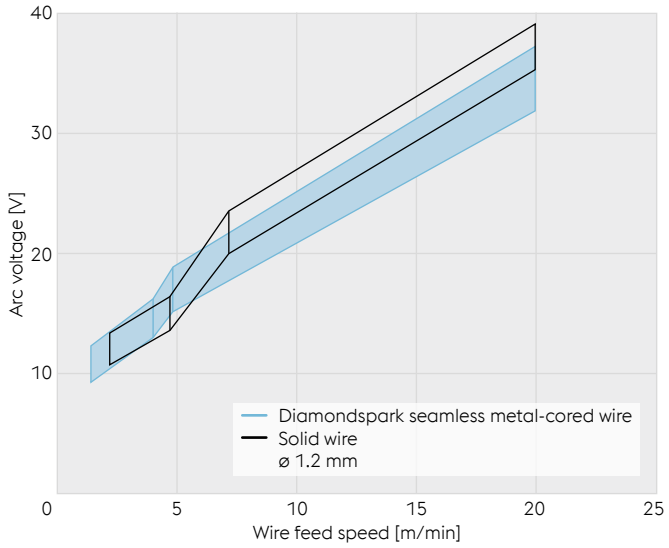
General Electric, India

Thousand locomotives in ten years' time. In 2015, General Electric India received a letter of award from the Indian Ministry of Railways for the supply and maintenance of 1000 diesel locomotives of their Evolution Series. Part of the US$ 2.5 billion joint venture contract is a US$ 200 million investment by General Electric in a new factory in Marhowrah in the state of Bihar which will become operational in the second half of 2018. The first locomotives from this factory are scheduled to be delivered in 2018 and production of the full diesel locomotive fleet will take 10 years. The project is part of the Indian railway modernization program. BÖHLER HL 51 T-MC metal-cored wire was selected as primary filler material for welding the locomotive bogies.

Number one requirement – fatigue proof welds.
The frames of the locomotives – named bogies in railway terminology – are crucial components because they not only carry the weight in motion of locomotive and wagons, but are additionally subjected to dynamic loads when in service on the railroad. The selected welding process and filler material needed to be productive and, at the same time, provide a superb weld quality to avoid fatigue in service. Three different solutions were tested for the structural welds; GMAW, FCAW and MCAW with respectively AWS ER70S-6, E71T1 and E70T15 classified filler materials. Metal cored arc welding (MCAW) with BÖHLER HL 51 T-MC was selected for its high productivity and for the best results in weld trials inspected with ultrasonic NDT. A first mock-up frame welded with BÖHLER HL 51 T-MC was sent to the General Electric laboratories in the USA to be subjected to its test program for approval of welding procedures. An investigation into mechanical test properties of the welds formed an important element of the test sequence which eventually resulted in acceptance of the welding procedure.

Mock-up frame welded with BÖHLER HL 51 T-MC – a metal-cored wire from the Böhler Welding Diamondspark series. Production of the frames has meanwhile started at General Electric's existing production facility in Pune in the state of Maharashtra to be scaled up when the new factory in Marhowrah becomes operational.

A cost-efficient and technically proven solution. Coming from a situation with GMAW with solid wire as the dominant process and filler material, a productivity improvement can be obtained with cored wire in general. For this particular application - the manual welding of butt and fillet welds in downhand and horizontal-vertical position with conventional GMAW power sources - metal-cored wires are the best choice. Compared to solid wire, BÖHLER HL 51 T-MC has a wider box of welding parameters for productive spray arc welding. In the case of fillet welds this translates into more weld length per unit of time. With butt welds a higher deposition rate is obtained. It must be noted that, although substantial, the productivity gain is limited by the deposition rate or travel speed a welder can physically handle. Another advantage, but now compared with flux-cored wire, is that BÖHLER HL 51 T-MC can also be used for welding root passes of butt welds, making it a flexible filler material.



Parameter box of BÖHLER HL 51 T-MC compared with solid wire

General Electric India has developed special fixtures to control distortion of the bogies due to the heat cycle of welding and keep the dimension within limits. The wide parameter box and ease of parameter setting with BÖHLER HL 51 T-MC enables a good fine-tuning of the welding parameters to reduce the heat input.

Spray arc welding is also beneficial in avoiding lack-of-fusion defects, which are notorious initiators of fatigue. Lack-of-fusion defects are easier formed with solid wire and short arc welding. In this respect, use of BÖHLER HL 51 T-MC promotes defect-free welds. The wire has optimized characteristics for fillet welding through a special formulation of the powders in the filling. Welder skill always plays a decisive role, but with this filler material it is easy to produce X-Ray and UST sound welds with nice wetting on the plate edges and no undercut, and without any post weld labor.
Many of the welders at General Electric were used to working with GMAW power sources and did not find much difficulty in changing from solid to metal-cored wires. After taking part in locally organized Böhler Welding trainings programs on the use of BÖHLER HL 51 T-MC, they are capable to consistently produce the high quality welds required for the bogies – even at various joint locations with difficult access.

GENERAL ELECTRIC INDIA – WELDING OF LOCOMOTIVE BOGIES WITH BÖHLER HL 51 T-MC

Project summary with customer benefits

FILLER MATERIALS, BASE MATERIALS AND WELD REQUIREMENTS

Filler material

BÖHLER HL 51 T-MC Ø1.2mm
EN ISO 17632-A: T46 6 M M21 1 H5/T42 5 M C1 1 H5
AWS A5.36 : E70T15-M21A8-CS1-H4/ E70T15-C1A6-CS1-H4
Shielding gas M21
CE approved

Base materials

IS 2062-E 350 B0 (plate)
G 20 Mn 5+QT (cast components)

Weld types

Butt and fillet welds in PA, PB and PC position

Mechanical requirements weld

YS >360 MPa
UTS>500 MPa
E>22mm
CVN >27J at 0°C
Preheating (100°C) and SR (550°C/ 90 min.) for cast components

Additional weld requirements

Welds free of lack-of-fusion defects and porosity
Excellent wetting onto plate edges
Absence of undercut
Good welding productivity in downhand and horizontal-vertical position

CUSTOMER BENEFITS

» Defect free welds with highest resistance to fatigue
» Increased deposition rates for downhand butt welds
» Increased travel speed for downhand fillet welds
» Control of distortion by easy arc setting and fine tuning of parameters
» Welder-friendly filler material
» Minimal to no post weld labor
» Moisture proof filler material with very low weld metal hydrogen