Manufacture of Wear Resisting Liners by Welding Alloy Deposits on Mild Steel Plates

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Introduction

Austenitic manganese steel liners have the unique properties of developing rapidly a work hardened surface during service, while retaining adequate tough interior. Due to this work hardening characteristic, these liners have a property to withstand abrasion or sliding in service. As indigenously developed austenitic manganese steel liners are not abundantly available, Railways had to develop indigenous substitute for these liners. The attempt of manufacturing these liners by the alumino-thermic process has not yet met with success.

Experiments on standardising the technique of hardfacing using austenitic manganese steel deposits on mild steel plates were carried out in our laboratory followed by service trials on these hardfaced liners by putting them on steam locomotives.

This paper discusses the standardisation work and the service performance of hardfaced liners as compared to imported austenitic manganese steel liners.

Metallurgical consideration of manganese liners

Manganese content between 11 and 14 per cent in steels with 1 to 1.4 per cent carbon imparts a tough, wear resistant property after suitable heat treatment. With the large amount of manganese present, the critical temperature is sufficiently lowered and the critical cooling rate is so reduced that a martensitic structure will be formed on slow cooling. If the same steel is quenched rapidly from 1000°C, it will be austenitic and tough with ductility. Its power of resisting severe wear and yet retaining its appreciable toughness is unique. The rapidity with which it work hardens from 180-220 HB to 450-500 HB, when subjected to cold working conditions, is extraordinary. After workhardening, wear takes place extremely slowly and the material remains in service for longer periods, giving a much longer service life. Therefore, for liners it is an ideal material since it has a property to withstand abrasion or sliding wear in service.

Experimental Work

As these liners are mostly imported items, experimental work on standardising the technique of hardfacing mild steel plates using suitable indigenous electrodes as a substitute for liners were undertaken in our laboratory.

Electrodes

The vital considerations in hardfacing were to ensure that the weld deposits should necessarily have characterisitcs of work hardening on the surface.

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Literature survey indicated the two types of electrodes viz. austentitic manganese steel and austenitic stainless steel deposits, which could be used for this purpose. Therefore, four different brands of electrodes were taken up for service trials. Both synthetic and non-synthetic type i.e. alloyed core wire with both rutile as well as basic coated electrodes were used. Typical chemical analysis of all weld deposits of the four brands of electrodes are as follows :—

Sl. No.	*Type of Electrodes*	*Typical analysis*
1.	18 Cr 8 ni	% Cr — 19.85 % Ni — 8.48
2.	High Chrome	% Cr — 24.91 % Ni — 1.26 %Mn — 1.63
3.	18 Cr 8 Ni 5 Mn (for buffer layer)	% Cr — 18.05 % Ni — 8.06 %Mn — 4.8
4.	11W14% Mn	%Mn — 11.8 % Cr — 0.8

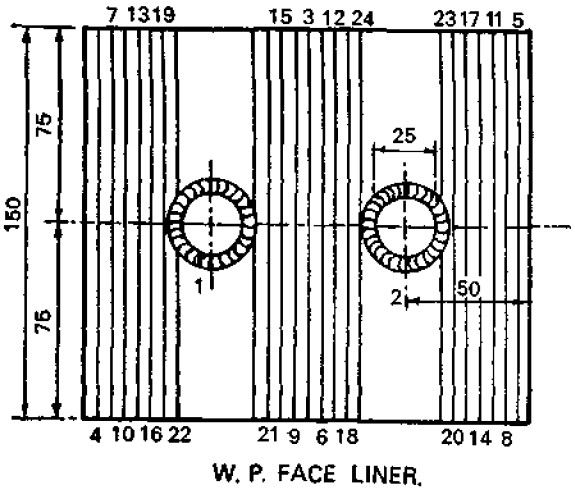
Mild steel plates of 12 mm thickness to either IS : 226 or IS : 2062 were used as base plates. To avoid distortion in addiition to using mild steel plates of 12 mm section, the plates were tack welded on a mild steel slab of size 350×175×100 mm (approx.)

The surface of the m.s. plate was cleaned of oxide films and defects if any.

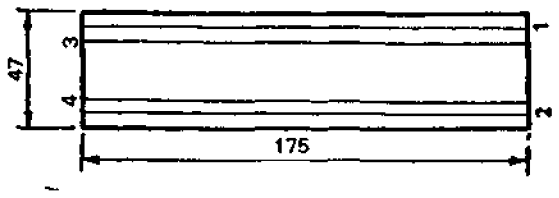
Welding Particulars

While hardfacing with the combination of brands of electrodes i.e. one for the buffer layer and the other for surface layer, straight beads in buffer layer were deposited using current in the higher side of the recommended range with slight weaving so as to obtain a deposit of thickness of about 1.5 mm thickness. The beads in the surface layer were deposited uniformly with weaving to obtain a surface layer of about 2.5 mm thickness free from any welding defect. In any case, the total thickness of hardfaced surface was kept to about 4.0 mm.

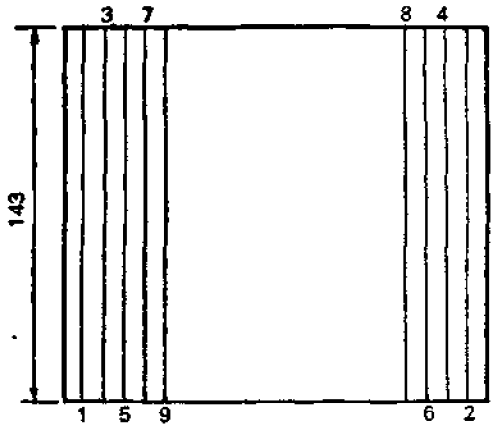
Nature of current and amperage used was as per the recommendation of the manufacturers. Welding speed was kept between 160 to 170 mm per minute. 4 mm. dia. electrodes were used. Care was taken to ensure that the interpass beads were properly cleaned.



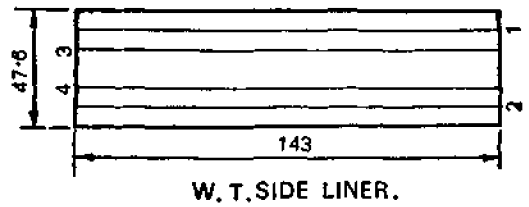
W. P. FACE LINER.



W P SIDE LINER.



W. T. FACE LINER.



W. T. SIDE LINER.

NOTE :—ALL DIMENSIONS ARE IN M M

A TYPICAL SKETCH SHOWING THE WELDING SEQUENCE FOLLOWED FOR HARD FACING OF MILD STEEL PLATES FOR MANUFACTURE OF WP/WT LINERS FOR STEM LOCOMOTIVES.

Machining and testing of the test plates

On completion of welding, the tack welds were removed by flame gouging. The mild steel backing plate was machined to get the desired thickness of the liners. The hardfaced layer was ground smooth. During grinding it was ensured that the thickness of weld deposit after grinding was 3.0 mm minimum.

The finished test plates were subjected to dye-penetrant tests and were found to be free from surface defects.

Service trials

Laboratory tests cannot fully evaluate a given hardfacing material. Again it is difficult to simulate all the conditions present in the service applications on a laboratory scale, which limits the use of laboratory tests to predict in advance the service performance. Therefore, service trials with the hardfaced liners are carried out on two BG steam locomotives on Southern Railway.

Mild steel plates of two different sizes were hardfaced using the above electrodes following the sequence shown in fig. 1. The welding parameters mentioned earlier were followed. The trial hardfaced liners were secured by fillet welding with the mild steel face on to the axles boxes and fitted on leading and trailing coupled axle boxes. The service performances were observed half yearly for about 4 years. It was observed that the liners hardfaced by 11-14% Mn steel deposits gave best performances followed by high chromium deposits. The liners hardfaced with 18/8/5 deposits showed the presence of cracks after about 15 months' service.

Conclusion

From the above service trial reports it can be concluded that mild steel plates hardfaced with austenitic manganese steel deposits can be used safely in place of imported rolled manganese steel liners until it is indigenously manufactured. These hardfaced liners work out to be costlier to imported liners but it can be used as indigenous substitution. Attempts may also be made in the country to manufacture these liners by aluminothermic welding process.

The growing demands for manganese steel liners or wear plates in industries offer plenty of scope for manufacturing these plates by hardfacing using suitable electrodes on mild steel plates since technical complications involved in casting and rolling of austenitic manganese steel liners have restricted its production in the country.