Combating the corrosion

(Overcoming the perennial corrosion problem in wagon @ NTPC-Ramagundam)

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At NTPC Ramagundam we get coal from our dedicated SCCL mines through our MGR system as well as through Railways from other mines of Singareni. On an average, through MGR we handle a coal of 80 LMT per year. For this we have got a fleet of 192 BOBR wagons and 10 locomotives.

Particularly Ramagundam is having the problem of wagon body failure due to heavy corrosion. We lose about 1 mm thickness of our wagon sheet every year due to corrosion. The wagon sheet becomes perforated in a span of 3 to 4 years. This is forcing us to rebuild the wagon body once in four years. In between lot of patch work is also done to arrest the leakages of coal from the thinned and ultimately punctured body part of the wagon. Please refer to the figures in Annexure -A to have an assessment of body damage. This is increasing the body weight by about 3 to 3.5 tonnes and also wagon availability is also badly affected.

As a measure to combat this problem of corrosion and to find the root cause a detailed study has been referred to NIT, Warangal. They have conducted the study and concluded that the high sulphur content present in SCCL coal is responsible for this. Depending on source of supply, the sulphur is varying between 0.5% to 1.2% as against the other plants average of 0.3%. Sulphur when coming in contact with moisture prevalent in the coal creates Sulphuric acid causing corrosion on the wagon body part viz., side walls, end plates, doors, cross ridges and other structural reinforcements. They have suggested to adopt the means of protecting the wagon surface from getting exposed to coal directly. This study took place in the year 2000.

Subsequently, in the year 2001, NTPC R&D has taken up the study further and recommended to apply “Wear resistant epoxy/ceramic” to the entire interior of the wagons on experimental basis. Figures showing this experiment are at annexure B. This has been carried out on wagon Nos.027 and 160.

Details of the Wear resistant epoxy/ceramic used :

a) Name of the product : HPL -2221(Kote TM – 54)
b) Supplier : M/S Duromar, USA
c) Executed agency : M/S Wear Resist technologies P Ltd
d) Thickness of the coat : 2500 microns on sides & 4000 microns on wearing surfaces
e) Type of Reinforcement : MS wire mesh of 3mm dia.

The results of this experiment are not encouraging. Within two years of application, epoxy coating has got peeled off exposing the wire mesh parts. Original wagon body parts have got exposed to coal once again. Moreover due to exposure of wire mesh, the body has become rough and resulted in coal build up increasing the problems of coal discharge from wagons(Refer figures at Annexure –C).

Meanwhile, NTPC R&D/Site was exploring the other means of combating this problem of corrosion. During 2004, one of the wagon No.097, has been lined with 1.6mm SS sheeting on the inner surface. Brief description of the process is as follows.

1. Initially the total inside surface of wagon is thoroughly cleaned with water, wire brush and pressurized air.
2. Measurements are taken for the Side walls, slopes, cross ridges, longitudinal ridges, triangle plates and door panels for cutting the SS Sheets to the required size.
3. The SS Sheets are cut by means of plasma cutting machine.
4. The SS Sheets are formed to the required shape by means of locally developed jigs.
5. Then SS Sheets are fitted in the wagon by the skilled fitter with the help of certified welders
6. After completion of full welding of SS sheets, Dye penetration Test (DPT) of 100% welding is done in presence of FQA personnel

Details of the product used :

a) **Grade of the SS Sheet :** Grade 304, 2B Finish
b) **Dimensions of the sheet :** 1.6 X 1250 X 2500mm
c) **Type of welding electrodes :** E – 106 of M/s Ador fontech

Its performance has been observed after seven years and is found to be intact protecting the wagon body. Looking into the success and benefits of SS lining, it is decided to continue the exercise in other wagons too in a phased manner. Till now, we have completed SS Lining in 114 out of 192 wagons. In another two years, we are planning to complete the balance wagons too. The process details of SS lining are depicted in Annexure D.

SS Lining increases the wagon body weight by 1.5MT. Compared to weight increase due to patch work (3 to 3.5 tonnes), this is not much. Due to SS Lining, the wagon body strength is intact. Its ability to withstand impacts due to coal boulders etc., while loading and unloading is also enhanced.

Adding to the above advantages, due to smooth finished surface of SS Lining, the tendency of coal build up is also minimized. Residual coal in the wagons after unloading is almost nil. Weighments errors are also minimized. The payback period is around 2 year 6 Months. For details please see annexure E.

Advantages of SS lining in wagons :

a) Increase in the availability of wagons
b) Wagons availability for schedule maintenance is increased.
c) Body patch work has become nil in SS lined wagons.
d) Coal spillage on track reduced leading to less cleaning activity in track maintenance
e) Coal does not stick to the wagon surface and thus unloading is faster. This helps especially in rainy season while handling wet coal

The first SS Lined wagon has already passed a period of 12 years (2004 to 2016) and till date the SS lining is intact and we expect a further life of 8 more years (total 20 years) as against the non-SS lined wagon body life of 4 years.

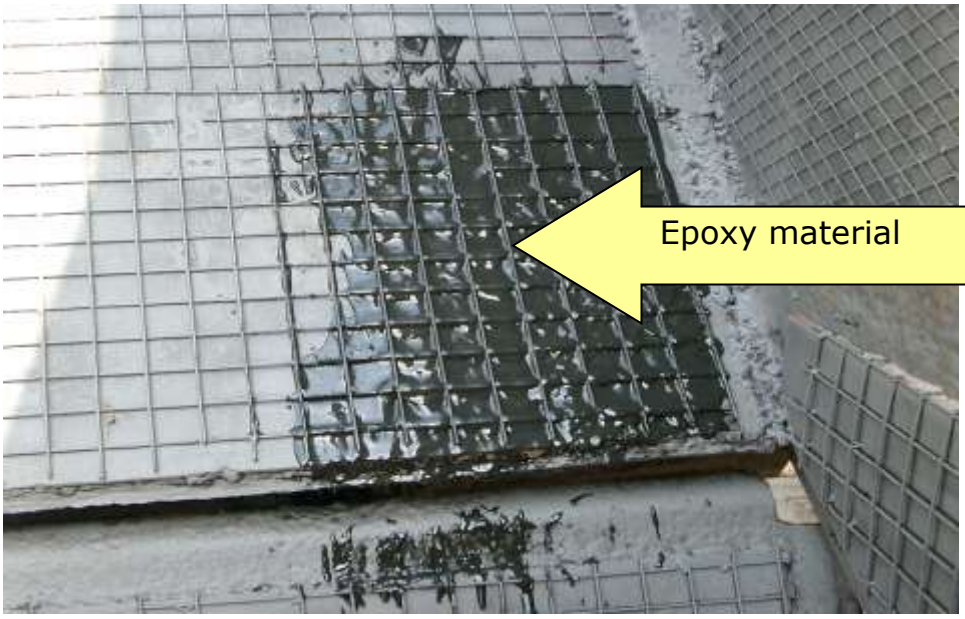
This is the success story of RSTPS to encounter the high sulphur Singareni coal corrosion problems in wagons.

ANNEXURE -A

ANNEXURE-B

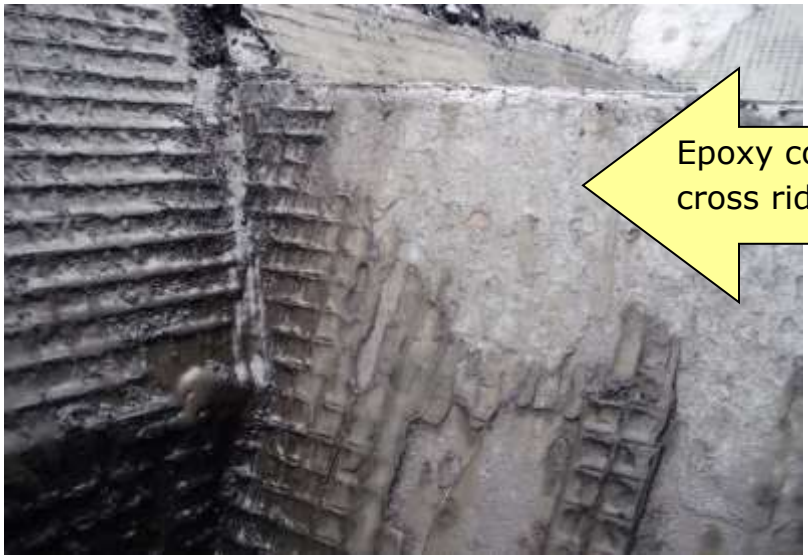
Wire mesh fitment work in progess

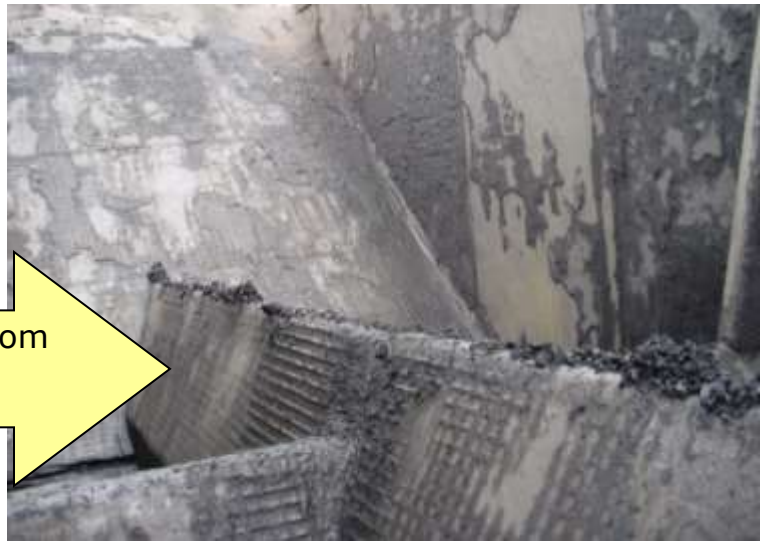
Epoxy material pouring work in progess



Epoxy material

ANNEXURE-C


Epoxy coating peeled off from cross ridges


Epoxy coating peeled off from longitudinal ridges


Epoxy coating peeled off from side walls of wagon body exposing parent material

ANNEXURE-D

Thorough cleaning of total inside surface of wagon with pressurized air, wire brush.

Marking the measurements for cutting with plasma cutting machine.

SS Sheets are bent in the bending machine to the required shape.

SS Sheets are fitted in the wagon by the skilled fitter with the help of certified welders

Wagon doors are also lined with SS Sheet

Dye penetration test (DPT) is done in presence of FQA personnel

SS Lining in the wagon after completion of fitting and welding work

ANNEXURE-E
PAY BACK PERIOD CALCULATIONS

CALCULATION-1		
1	Once in four years we are doing total structural repair of wagons with MS Material. Cost of the material and service per wagon	
	Total Quantity of MS sheets/angles/channel replaced during st repairs	8 MT approx.
	Cost of each MT of steel	Rs. 42000.00
	Cost for 8 MT of steel	Rs. 3,36,000.00
	Service cost for st repairs of wagon	Rs.1,60,000.00
	Total cost for carrying out structural repair of wagon once in four years	**Rs. 4,96,000.00 - A**
2	**Cost of SS lining in one wagon**	
	a) Cost of 1.56 MT of 1.6mm thick SS Sheet @ 1,85,000.00 per MT	Rs. 2,88,600.00
	b) Cost of 50 Kg SS Electrodes @ 5445.00 per Kg	Rs. 2,72,250.00
	c) Service cost of SS lining for 110 sq.metres area of wagon @ 735.00 per sq.metre	Rs.80,850.00
	d) Total cost for doing SS lining in one wagon	**Rs.6,41,700.00 - B**
3	Seeing the condition of SS lined wagon no:097 at present, it is expected that the SS lined wagon body will last for minimum 20 years.	
4	If we are doing only structural repair of wagon without ss lining, the total cost incurred in twenty years for structural repair works (5 X A)	Rs.24,80,000.00 approx
5	Net saving per wagon in 20 years	Rs. 18,38,300.00
6	Net saving per wagon per year	**Rs. 91915.00 - C**
CALCULATION-2		
Due to smooth finished surface of SS Lining, the tendency of coal build up is also minimized. Residual coal in the wagons after unloading is almost nil. Weighments errors are also minimized. Cost benefit on account of this as follows:		
1	Residual coal in each wagon saved due to ss lining	50 Kg approx
2	Trips per day	3
3	Trips per year (3X365)	1095
4	Total residual coal saved per wagon per year (1095X50)/1000	54.75 MTs
5	Landed cost of coal	Rs 3000/- per ton
6	Toal cost saving per year (54.75X 3000)	**Rs 164250/- - D**
7	Total savings per year = C+D	**Rs 256165/- -E**
8	Pay back period = B/E	2 years 6 months approx