CONSTRUCTION OF SPECIAL WAGON FOR TRANSPORTING FUEL TO THE POWER HOUSES

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The process of joining metals by fusion welding is now one of the most important links in industries. In the power industry, welding plays a vital role, from the fabrication of steel structures for power houses to boilers on to transmission towers, and again in the construction of transport vehicles for fuel. Welding is found everywhere.

Coal requirement for the power houses is mostly transported in railway wagons, and most of these wagons are fully welded structures.

Our factory is one of the largest wagon manufacturers in this country and has been supplying wagons to the Indian Railways and exporting them to several countries, catering to a diverse range of traffic needs. Its special wagons are made to meet specific requirements for transporting minerals, ores and fuel in their many forms.

CONCEPT

In keeping with the trend of setting up super thermal power plants near the coal mines, "MGR" (Merry Go Round) Wagon is the rail-road system of coal transportation from mine to plant.

The concept of coal transportation by rail was mainly to :

a. Reduce the transportation time,

b. Reduce infrastructural requirement vis-a-vis conventional method,

c. Do away with/reduce dependence on the labyrinthine concept of conveyor system,

d. Reduce maintenance cost.

e. Improve efficiency, and have an overall reliable system, and

f. Reduce burden on already overloaded tracks of the Indian Railways.

A closed circuit track (about 400 KM) is laid between the coal loading point at the coal mine and unloading point at the power house. A rake normally of 20-30 wagons hauled by a Diesel Electric Locomotive has to perform 10-12 complete loading/unloading cycles in one day.

DESIGN FACTORS

Loading of these wagons at the mine is done under an overhead surgebin provided with "Flood Loading" gates, while the rake is in motion at an approx. speed of 0.8 KMPH, and unloading at the power house end, over a 200 M long track hopper (unloading installation) while running through at a controlled speed of upto 8 KMPH. The unloading hopper track is equipped with line side equipment (LSE) for activating wagon doors in groups of upto 15 wagons simultaneously.

The wagons are fitted with spring loaded current collectors at diagonal corners to pick up electrical signals from the LSE which actuate the electro-pneumatic control valves, for opening the bottom discharge doors for coal discharge from wagon to conveyor.

CONSTRUCTION

Welding has now become the principal method of joining materials used on the Indian Railways. Its use is extensive not only as a repair and maintenance tool but also as the principal joining process in building and construction of rolling stock.

The MGR wagons are fully welded type, normally utilising three processes of welding, i.e. submerged arc - fully automatic, MAG - semi-automatic, and the manual metal arc welding process. The running welding length in terms of 4/5 mm fillet welds, is approx. 1500 M. The material used in the construction of the wagon are generally copper bearing, conforming to IS:226 Fe410CUS. Most of the welding is designed for single pass 6 mm fillet. The joints are welded on both sides to reduce stress concentrations at the root of the fillet welds. Most of the welding is done in the down-hand position by extensive use of welding positioners, manipulators and special adaptations for MAG machine. At the location of high stress, special precautions are taken in the design and procedure. Weld termination and corner intersections and cross welds have scallops provided.

SUB-ASSEMBLIES

It is important to visualise the assembly procedure, and the fabricator should break up the weldments down to sub-assemblies to determine :

a. Cost saving; The sub-assemblies spread the work; more men can work on the job simultaneously.

b. The possibility of distortion or residual stresses in the finished weldment is reduced when the weldment is built from sub-assemblies.

c. Good fitup is obtained : Poor fitup can be costly.

d. A joint can be preset or prebent to offset expected distortion.

e. When possible, it is desirable to break the weldment into natural sections so that the welding of each can be balanced about its own neutral axis.

f. Welding the more flexible sections first faclitates any straightening that might be required before final assembly.

g. In-process inspection (before the job has progressed too far to rectify errors) is facilitated.

USE OF JIGS, FIXTURES AND POSITIONERS

Jigs, fixtures and welding positioners should be used to decrease fabrication time. In planning assemblies and sub-assemblies, the fabricator should decide if jig is simply to aid in assembly and tacking or whether the entire welding operation is to be done in the jig. The considerations listed below are significant :

a. The jig must provide the rigidity necessary to hold the dimensions of the weldment and stresses due to distortion.

b. It must provide easy location points and be easy to load and unload.

c. Camber can be built into the weldment to control/ counteract distortion or provide the camber where necessary in the finished job.

d. Welding positioners maximise the amount of welding in the flat downhand position, allowing use of larger electrodes, and automatic/ semi-automatic welding.

UNDERFRAME CENTER SILL

The backbone of practically all freight wagons consists of two rolled 'Z' sections placed toe to toe and welded along the edges of the two upper flanges. Submerged arc welding using 5 mm dia wire and flux locally procured, conforming to AWS F6A2EM12K was used. We have used MW-1 wire and BRD-1 flux. During the welding process the underside of weld is backed up with welding flux or a copper bar. The two 'Z' sections are placed in a fixture and manually clamped by a series of wedges to maintain the inside dimension. A camber of about 20 mm is built in the fixture so that the sections are held at a camber during welding operations. Welding is accomplished by a welding head mounted on a side boom having track motor and frictional drive mechanism.

UNDERFRAME

Other than the centre sill and side sills, the members of the underframe are the cross ridges, end ridges, bolsters and hopper arrangements. These items are all pre-fabricated and welded prior to fitment on the underframe to keep distortion to the bare minimum, which is very important to achieve the stipulated test results of the wagon. Assembly of the underframe is made on a fixture which is designed to hold the parts in alignment with emphasis on welding accessibility as well as the control of shrinkage and distortion. The sub-assemblies mentioned above are finally assembled on the underframe laid on fixture, tack welded and the dimensions checked. Welding of the underframe is accomplished in three stages as described below. All welding was done by using Vordian electrodes.

a. On the fixture itself where the underframe is assembled on the top side bottom position.

b. On the rotator/positioner. Here welds that normally cannot be done in the down-hand position on the fixtures are completed. Positioners for welding the complete underframe assembly have contributed, over other factors, to the speed and quality of welding.

c. On the Clamp-down stage. The underframe is taken off the maipulator and put into the clamp down jig in the top side top position and the rest of the welding of the underframe is completed.

The above stages have been designed so that all welding is accomplished in the down-hand position, using E 6013, 4 & 5 mm dia electrodes (Vordian). However at critical locations, E 7018 low hydrogen electrodes (Ferroweld - 2) are used. The welding procedure and fixture have been adopted to minimise residual stresses during welding, and to have a fairly true and dimensionally accurate end-product.

SUPERSTRUCTURE

The body side and body end, some components of which are pre-fabricated and are assembled on a fixture-cum-manipulator, are welded using MAG process. The MAG sets (wire feed units) are mounted as an overhead monorail and move along as per the welder's requirement. The general parameters for welding are - spray transfer mode, 200-300 amps 34, 36 Volts, 20 mm stickout, arc travel speed of about 45, 55 cm/min. Gas mixture used is 80% Argon, 20% CO_2 marketed under the brand name of ARGOSHIELD-20 by Indian manufacturers. Filler, solid wire 1.2 mm dia to AWS ER70-S6 specification is used. (ESAB-MW-1).

The hopper doors are of IS961 or Sailma 350 steel and the electrode used was AWS 7018 (Ferroweld-2). The hopper doors, hopper arrangements are also done as sub-assemblies on separate sub-assembly jigs.

The major sub-assemblies are normally assembled on a fixture. For convenience, one body side is assembled first and tack welded to the underframe. Then the two body ends are assembled one after the other and tack welded to the underframe and other corresponding members. Finally the second body side is placed in position and tack welded.

The assembled wagon, in tack welded condition, is mounted on a rotator/manipulator, which is so designed as to act as a clamp down arrangement and prevents distortion while also accommodating the shrinkage.

WELD QUALITY CONTROL

While welding, particular care is to be taken to maintain the proper sequence and the correct welding technique. Almost all the welding is done in the down hand position.

Welding specifications are followed to continuously check all welding. Production joint conditions are tested periodically. Visual examination and applicable instrumental test such as amp. test are conducted to control welding currents used by welders and overall weld quality. All critical dimensions are checked and documented after stage inspection and clearance by client-nominated Inspectors.

All welding personnel and procedures are qualified and certified in accordance with applicable codes.

SOME SALIENT DATA

It is typical for a wagon having Height - 3.735 M, Length - 13.43M, Hopper Slope - 46°, Pay load - 60 ± 2 tons, Haulage capacity - 85 tons, Volumetric capacity - 75 m^3, Normal Speed - 60 KMPH, Max. Speed 75 KMPH. Energising Voltage - 24-32 Volt. DC (+) Pol for door opening and DC (-) Pol for door closing.

The wagon is fitted with gradual release air brake system conforming to the technical requirement as laid down in UIC : 540, and also with hand brake equipment.

Complete discharge of wagon is in less than 20 seconds; wagon superstructure and underframe shall be capable of holding loads upto 150% of the designed payload.

Microwave barrier plates are fitted on the wagon to indicate the exact position of the wagon at the unloading station. Visual indicators are also provided to indicate that doors are fully closed and securely locked.

TESTS

Of the number of prescribed tests, only a few are being mentioned, vis-a-vis results of our wagon :

	Check	Results of our Wagon
i.	Major dimensions	: OK
	Tare Weight	: OK
	Volumetric Capacity	: OK

ii. **Deflection Test** : The structure members are checked for deflection under static load during loading and unloading at cycles of 50%, 100%, 125% and 150% of the designed payload.

No permanent set or undue deflection was observed in our wagons.

iii. **Door opening reliability test :** Doors are opened and closed 2000 times and should register no failure. This was achieved commendably in our case.

iv. **Load discharge test :** This is to be carried out under static condition for complete and quick discharge in less than 20 seconds. Build-up of residual coal in successive loading and unloading must not exceed 500 Kgs.

- Discharge time recorded during shop test in our case was between 8 to 10 seconds.

- *Residual coal build-up* : This is the residue of coal inside the wagon not discharged during the normal course of discharge operation. The build-up may be caused by all or any of the following : Improper slope, mismatch of components, unevenness of the side and end members, distortion of members due to incorrect welding sequence, and faulty welding technique.

  During test of our wagons, the build-up registered was Nil to negligible in all but one wagon which had a residual coal of 100 Kgs. as against the 500 Kgs. acceptable limit. Total coal in each wagon was about 60 tons.

v. **Speed Control Test :** The speed control was set on creep with a speed of 4 KMPH during test. Speed registered was almost constant with a maximum variation of 3.8 to 4.3 KMPH which is within acceptable limits.

CONCLUSION

In conclusion, it must be mentioned that the importance of accuracy in fabrication and maintaining the design dimensions cannot be overemphasised. It will be borne out by the guarantees and liquidated damages for performance, which is mandatory on the part of the manufacturer.