International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 04, April-2015

Study and Analysis of Doors of BCNHL Wagons

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***Abstract*- With the economy of India growing at a very healthy pace, the freight traffic has naturally been growing too. Since the extent of addition to the route kilometrage of Indian Railway is not rapid enough, a quantum jump in the unit wagon capacity is the need of the hour. A case for developing heavy axle load wagons on IR is, therefore, inevitable for our sustenance. In the last decade (since 2000-10) the route kms of IR have increased by just 6.5% whereas the freight traffic (NTKms) has increased by 90.6%. This, despite an increase in wagon lead kms of just 2.4%, has largely been possible because the unit wagon capacity has increased by over 21.5% in the same period.The capacity of wagon in terms of axle load has been increased from 20.32t to22.9t.**

Railway freight stock *(*wagons) is used for carrying goods in bagged form or in bulk form, machines, ores etc. from one place to another place. For a strong economy an efficient transportation system is necessary. Major portion of the revenue of railway comes from freight operation. Rail freight uses many types of goods stock. Currently Indian railways use less capacity wagons in comparison to other players in international market.

Over the last decade Indian Railways has adopted various measures to improve the operational and commercial performance of its rail freight operations. These include an increase in the permissible axle-loading for major commodities; improvement in wagon utilization by improving wagon turn-round times together with incentives to customers and more focus on availability and reliability by adopting modern techniques of maintainability.By improving reliability and availability it is possible to transport maximum volume of goods (throughput) fromone place to other in time.

1. INTRODUCTION

Rail freight uses many types of goods wagon. these include covered wagons for general merchandise, flat wagons for heavy or bulky loads, well wagons for transporting road vehicles; there are refrigerator vans for transporting food, simple types of open-topped wagons for transporting bulk material, such as minerals and coal, and tankers for transporting liquids and gases. When considered in terms of ton-miles or tonne-kilometres hauled per unit of energy consumed, rail transport can be more efficient than other means of transportation. Most coal and aggregates are moved in hopper wagons or open wagons that can be filled and discharged rapidly, to efficient enable handling of the materials. Importance of new and improved design of wagon was felt which can transport maximum volume of goods (throughput) from one place to other in time. Heavy haul freight trains are demand of time. Indian railway has taken an ambitious project of optimization of existing bogie to suit heavy haul wagon for the operation of heavy haul freight train on dedicated freight corridor.

BCNHL wagon is a Bogie covered wagon for carrying bagged commodities like cement, fertilizer and food grain etc. It is an 22.9t axle load (Gross load 22.9x4=91.6t) wagon. The design significantly increases rake throughput of bagged commodities compared to existing BCNA/BCNAHS rakes. BCNA and BCNAHS both are Bogie covered wagon, superstructure are same only difference in Bogie. In BCNA wagon there are CASNUB 22NLB Bogies whereas in BCNAHS wagon there are CASNUB 22HS Bogies.

BCNHL wagon is also fitted with CASNUB 22HS Bogies. By using BCNHL wagon, approximate increase in rake throughput in case of cement, foodgrain and fertilizer is 40%,31% and 20% respectively. Pay to tare ratio for BCNHL wagon is 3.4 where as it is 2.3 for BCNA wagon.

For loading and unloading, BCNA wagons have been provided with Door consisting two part, upper portion consists two part swing door (Almirah type) and lower portion is a flap door which positioned vertically down and rest on wagon sole bar in open condition.While in BCNHL wagons full length two part door (Almirah type) has been provided.BCNA/BCNAHS Wagons are running since long time. Doors of BCNA/BCNAHS wagons are sturdy and robust and very less problem found with these doors. But these doors cannot be fitted on BCNHL wagons due to infringement with maximum moving dimension (MMD). Width of BCNHL wagon has been optimized. Every wagon or other Rolling stock such as Locomotive or Coaching Stock are designed within prescribed limit and this is called Maximum Moving Dimensions(MMD). At present the MMD decided by Railway Board is shown in a diagram No. 1D-2004 of Indian Railway Schedule of Dimension-Revised 2004.

1.1 BCNA/BCNAHS WAGON

Doorwidth-1204mm,Door height-1985mm (Top Swing Door-1390mm height, Lower Flap Door-621mm height)

BCNA/BCNAHS WAGON

1.2 BCNHL WAGON

Door width-1204mm, Door height-1985mm

BCNHL WAGON

2. RELEVANCE OF PROPOSED WORK

Complete BCNHL wagons including doors are made of stainless steel. Since inception of BCNHL wagons, Railway is facing problem to running these wagons with introductory 'Godrej Almirah type swing doors. As per field performance report of Zonal Railways and after inspection, it has been found that doors of BCNHL wagons are getting damaged severely. In view of those different Yards, Depots, Loading and unloading points were visited to find out the real causes of door damaging. After analyzing it concludes on following probable causes:

(i) Due to big size of doors, it is difficult to handle.
(ii) Door sheet is thin (1.6mm) but uses of several linkages makes door heavy.It is difficult to open and closing of such big and heavy doors.
(iii) Due to number of linkages in the door,these do not get fully closed and there remains some gap between door and side wall.
(iv) Due to gap between door and side wall, water seepage reported inside the wagon in rainy season and damaging the bagged commodities. At loading points laborers use hammers for tight closing of doors and due to hammering doors and its parts get bent and damage.
(v) During running of train, bags fell on the door and increase the gapbetween door and side wall and increases chances of pilferage.
(vi) Workers use hammer, rods etc for opening and closing of doors at unloading and loading point and doors are getting damage frequently.
(vii) Due to use of number of linkages in the door and by mishandling in the field at loading and unloading points, linkages are getting loose or broken and in such cases there is a chance of hitting fixed structure when doors are left in open condition. Some such cases have also been reported.
(viii) Door sheet is very thin(1.6mm) and getting bend easily.

In view of the above facts, to make availability of wagons and to obtain better reliability it is necessary to modify the door design of BCNHL wagons.

2.1 AVAILABILITY

Availability is the probability that a system or component is performing its required functions at a given point in time or over astated period of time when operated and maintained in aprescribed manner. Availability depends on both reliability and maintainability.

2.2 RELIABILITY

Reliability is defined as the probabilitythat a component/system, when operating under given conditions,will perform its intended functions adequately for a specified period of time without interruptions. It refers to the likelihood that equipment will not fail during its operation.

2.3 MAINTAINABILITY

Maintainability is expressed as the probability that an item will remain in a serviceable condition for a given period of time or restored to a specified condition within a given period of time.

3. METHODOLOGY

For modifications of doors of BCNHL wagons following procedure has been adopted:-

(i) Collected door failure data of BCNHL wagons from different wagon maintenance workshops, depots loading and unloading points.
(ii) Reports received from different Zonal Railways regarding problems and failure of doors of BCNHL wagons.
(iii) Detailed study of failure data to find out causes.
(iv) Meeting with users (officials of loading and unloading firms), maintenance officials for feasibility and suitability of provisions.
(v) After knowing the causes of failure, analysis of suggestions and computer simulations, modifications are made by design changes to minimize the problems.

Quality tools have been applied to find out the best among modified versions. Trend Chart has been plotted for comparative performance study.

4. ANALYSIS

Since inception of BCNHL wagons, several field problems with doors of these wagons have been noticed. Owing to severe field performance issues in BCNHL door, two part sliding doors are being fitted in older BCNHL wagons while two part sliding and single sliding doors are being fitted in newly produced BCNHL wagons.

Analysis has been done considering maintenance system, quality assurance and using quality control tools.

4.1 Pertinent Factors Leading To Door Related Issues

(i) In BCN/BCNA type wagons, a door unit consisting 2 hinge and one flap door was provided. In these wagons hinge doors moved longitudinally along the wagon sides while flap door fallen in vertical downward at the time of opening and not infringing to SOD. But in BCNHL wagons due to extra width it was impossible

to use BCN/BCNA type doors. So, imperative need to stay within MMD even with open doors, need for water sealing (essential for the target bagged cargo as cement/food grain/fertilizer) special type of linked door were provided.

(ii) The lesser length and higher height(than BCN/BCNA) of BCNHL meant for extra vertical stacking and it was expected to be efficiently utilized in loading of commodities. Due to special designed door, a loading chart was circulated to ensure adequate gap next to the door. To achieve higher stack height, the loading infrastructure (loading arm conveyors) were expected to be modified/upgraded for efficient loading in BCNHL. But in reality, extra loading in BCNHL is being attempted with the older/existing loading infrastructure, thus resulting in poor loading discipline, with the lading falling on the door and laterally on side wall causing damage to the door and side structure and incomplete disregard of loading recommendations of ensuring adequate gap/space next to the doors. These reasons causing bulging of doors and restrict easy opening of doors at unloading point necessitates using of more force of any means/hammering and causing more damage to doors.

(iii) Operations of wagons are permitted with properly closed/secured doors but it is noticed that doors are not properly closed at loading and unloading points and in case of loosening/breaking of door hinges, it may hit fixed structures.

(iv) Due to miscreant's activities, doors get damaged.

4.2 Modifications

To resolve the field issues of door problems, maintenance problems, BCNHL wagons have been modified and Following five designs variants(design 'A' to design 'E') of BCNHL wagons have been developed so far whereas design 'G' is for next phase of production:

(i) BCNHL Design 'A'-Material of Body and Door: Stainless Steel as per Indian Railway Specification IRS:M 44.Single pipe Air Brake arrangement with Hinge door (Godrej Almirah type Swing door).

(ii) BCNHL Design 'B' - Material of Body and Door: Stainless Steel as per Indian Railway Specification IRS:M 44.Twin pipe Air Brake arrangement with Hinge door (Godrej Almirah type Swing door).

(iii) BCNHL Design 'C'- Material of Body and Door: Stainless Steel as per Indian Railway Specification IRS:M 44.Twin pipe Air Brake arrangement with Single Sliding door.

(iv) BCNHL Design 'D' - Material of Body and Door: Microalloyed Steel as per Indian Railway Specification IS:2062-E450 Quality BR with Cu. Twin pipe Air Brake arrangement with Single Sliding door

(v) BCNHL Design 'E'- Material of Body and Door: Microalloyed Steel as per Indian Railway Specification IS:2062-E450 Quality BR with Cu. Twin pipe Air Brake arrangement with Bogie Mounted Brake System, Single Sliding door.

(vi) BCNHL Design 'G' - Material of Body and Door: Microalloyed Steel as per Indian Railway Specification IS:2062-E450 Quality BR with Cu. Twin pipe Air Brake arrangement with Bogie Mounted Brake System, Two Part Sliding door.

Initially Design 'A', Design 'B' and Design 'C' type BCNHL wagons are completely (including doors) made of stainless steel but observing cost and maintenance problem, material of wagon body and doors changed to 'Microalloyed Steel' as per Indian Railway Specification IS: 2062-E450 Quality BR with Cu. Design 'D' Design 'E' and Design 'G' type BCNHL wagons are completely (including doors) are made of microalloyed steel.

Composition of stainless steel and microalloyed steel are depicted as below:

(a) STAINLESS STEEL AS PER INDIAN RAILWAY SPECIFICATION IRS:M 44

Chemical composition of such type of stainless steel is as under:

ELEMENT	PERCENTAGE
Carbon	0.03 max.
Silicon	1.00 max.
Manganese	0.8-1.5
Chromium	10.8-12.5
Nickel	1.50 max.
Phosphorus	0.03 max.
Sulphur	0.03 max.
Titanium	0.75 max.

(b) MICROALLOYED STEEL AS PER INDIAN RAILWAY SPECIFICATION IS:2062 -E450 QUALITY BR WITH CU:

Elements such as niobium,vanadium and titanium added singly or in combination to obtain higher strength to weight ratio combined with better toughness, formability and weldability as compared to unalloyed steel of similar strength.

Chemical composition of such type of stainless steel is as under:

ELEMENT	PERCENTAGE
Carbon	0.22
Silicon	0.52
Manganese	1.65
Phosphorus	0.045
Sulphur	0.045

Alloying elements such as Cr, Ni, Mo and B may be added but Cr and Ni either singly or in combination, shall not exceed 0.50 % and 0.60% respectively. Copper 0 may be present between 0.20 to 0.35 %.

4.3 Modifiedversions

(i) ORIGINAL DESIGN STAINLESS STEEL DOORS OR Ist GENERATION DOORS (FOR DESIGN 'A')

In this, a door unit (of Stainless Steel) consist of two part (fabricated), fitted with 6 hinges with center locking from inside.

Regular monitoring of BCNHL rakes done at different loading/unloading points, depots for performance and on the basis of observed performance and several complaints regarding water sealing and door distortions modifications are done as below:

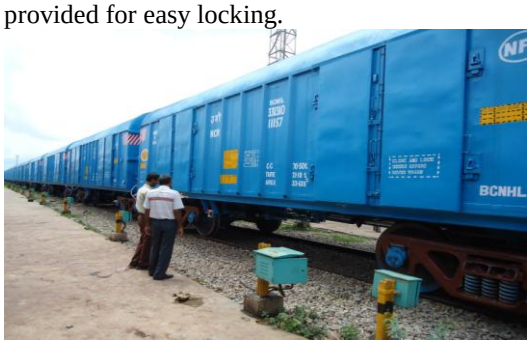
(ii) MODIFIED-I STAINLESS STEEL DOORS OR IInd GENERATION DOORS (FOR DESIGN 'A')

In this a door unit(of Stainless Steel) consist of two part(fabricated), fitted with 6 hinges with center locking from inside. Long cotters are provided on top side of door while latches on bottom side of door for water sealing and better locking of doors.

BCNHL WAGON (STAINLESS STEEL) WITH HINGED DOOR

(iii) MODIFIED-IISTAINLESS STEEL DOORS OR IIIrd GENERATION DOORS(FOR DESIGN 'B')

In this a door unit (of Stainless Steel) consist of two part(fabricated), fitted with 6 hinges (SS) with center locking from inside and outside alongwith short cotters are provided on top and bottom side of door for water sealing and better locking of doors. Tower bolt on inside of left door and long barrel bolt on outside for better locking are provided. Latch on bottom side also provided for easy locking.



BCNHL WAGON (STAINLESS STEEL) WITH MODIFIED HINGED DOOR

(ii) MODIFIED-III STAINLESS STEEL DOORS OR IV GENERATION DOORS (FOR DESIGN 'B')

In this a door unit(of Stainless Steel) consist of two part(pressed), fitted with 4 flat hinges (SS) with center locking from inside and outside alongwith horizontal tower bolts are provided on door for water sealing and better locking of doors. Due to pressed structure, weight of doors are reduced

(iii) MODIFIED-IV SINGLE SLIDING DOORS OF STAINLESS STEEL (FOR DESIGN 'C')

In this a door unit (of Stainless Steel) consists of single piece sliding door with bottom mounted rollers for sliding.

BCNHL WAGON (STAINLESS STEEL) WITH SINGLE SLIDING DOOR

(iv) MODIFIED-V SINGLE SLIDING DOORS OF STAINLESS STEEL(FOR DESIGN 'C')

In this a door unit (of Stainless Steel) consists of single piece sliding door with top mounted rollers for sliding.

SS single Sliding Door

(v) MODIFIED-VI SINGLE SLIDING DOORS OF MICROALLOYED STEEL (FOR DESIGN 'D')

In this a door unit (of microalloyed Steel) consists of single piece sliding door with top mounted rollers for sliding alongwith securing and locking.

BCNHL WAGON (MICROALLOYED STEEL) WITH SINGLE SLIDING DOOR

(vi) MODIFIED-VII RETROFITABLE TWO PART SLIDING DOORS FOR ALL TYPE OF STAINLESS STEEL HINGED DOORS (FOR DESIGN 'A' DESIGN 'B' DESIGN 'C')

In this a door unit (of microalloyed Steel) consists of two part sliding door with top mounted rollers for moving in a guide channel.

BCNHL WAGON (MICROALLOYED STEEL) WITH TWO PART SLIDING DOOR

It can be retrofitted in older BCNHL wagons with hinged type doors.

(vii) MODIFIED-VIII TWO PART SLIDING DOORS (FOR DESIGN 'G')

In this a door unit (of microalloyed Steel) consist of two part sliding door with top mounted rollers for moving in a guide channel. It is similar to retrofitted two part sliding doors with some modification.

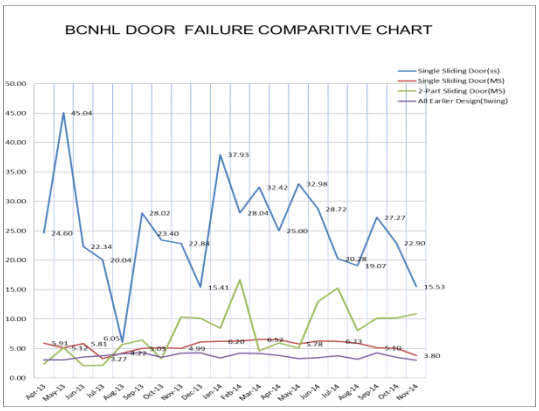
BCNHL WAGON (MICROALLOYED STEEL) WITH TWO PART SLIDING DOOR (MODIFIED)

After successful performance of retrofitted two part sliding doors in design 'A' design 'B' design 'C' type BCNHL wagons, it has been adopted with some modifications for newly built BCNHL wagons design 'G' also.

It is obvious that following type of doors have been provided in BCNHL type wagons:

(i) Godrej type hinge door fitted with link (material-Stainless Steel)
(ii) Single Sliding doors (material-Stainless Steel)
(iii) Single Sliding doors (material-Microalloyed Steel)
(iv) Two Part Sliding Doors(material-Microalloyed Steel)

5. CONCLUSION



After observing field performance of several modified doors, two part sliding doors of microalloyed steel have been adopted for next lot production of BCNHL wagons (Design 'G'). Advantages of two part sliding doors are:

1. Manual handling of doors are easy.
2. Door sheet is made of 4mm thick microalloyed steel making it sturdy.
3. Roller units consisting two vertical rollers and one horizontal roller is provided for smooth and linear motion. Three Roller units are provided in each part of door.
4. Hasp has been provided at hand reach position from ground level for easy closing of doors.
5. Field performance report is better and damage report is very less.

ACKNOWLEDGEMENTS

It is a great pleasure to express my sincere gratitude and profound regards to Dr. P.K.BHARATI, Professor and Head of Department, department of Mechanical Engineering, Integral University, Lucknow (UP) for his constant encouragement, invaluable guidance and help during course of work. Words are in adequate to acknowledge the great care and keen interest taken by him in all aspect of the present work. My association with him throughout the project activity was a great process of learning.

I express my deep appreciation and gratefulness to Prof. Faiz Mohammad, Professor of Mechanical Engineering, Integral University, Lucknow (UP)for his constant encouragement and cooperation.

Special thanks are also to Prof. Shadab, Prof. K.Moed, Prof. Sahnawaz, Department of Mechanical Engineering Integral University, Lucknow (UP)for encouragement participation, cooperation and help.

REFRENCES

(1) Annual Reports of Research Design And Standards Organisation.
(2) Indian Railway Technical Bulletin.
(3) Maintenance manual for wagons.
(4) Indian Railway conference association Part-III
(5) Indian Railway Schedule of Dimensions, Revised-2004.
(6) Total Quality Management by Prof. K. Shridhar Bhatt
(7) Maintenance Engineering And Management by Prof. R.C.Mishra and Prof. K.Pathak