ABSTRACT -
Indian Railways plays a key role in transportation of goods and passengers across India. As part of our contribution we have taken up a project related to Indian Railways i.e., to optimize the present bogie design. After completion of this project we will be able to suggest some changes in the design so as to enhance the strength of the bogie and to optimize the material usage in its production. This will reduce the cost of its production. In this regard we have used PRO-E and CATIA and the analysis part is done using HYPERMESH. The main aim of this project is to optimize the design of the bogie of a goods train in order to reduce the material costs without significant reduction in load bearing capacity.

I. INTRODUCTION

Indian Railways (reporting mark IR) is an Indian state-owned railway company headquartered in New Delhi, India. It is owned and operated by the Government of India through the Ministry of Railways. Indian Railways has 114,500 kilometers (71,147 mi) of total track over a route of 65,000 kilometers (40,389 mi) and 7,500 stations. It has the world's fourth largest railway network after those of the United States, Russia and China. The Indian railways are also proposing to build the highest railway track in the world overtaking the current record of the Beijing-Lhasa Railway line. The railways carry over 30 million passengers and 2.8 million tons of freight daily. In 2011-2012 Railway earns an Rs 104278.79 core which consists of Rs 69675.97 cores from freight and 28645.52 cores from passengers tickets. It is the world's fourth largest commercial or utility employer, by number of employees, with over 1.4 million employees. As for rolling stock, IR owns over 240,000 (freight) wagons, 60,000 coaches and 9,000 locomotives. Railways were first introduced to India in 1853. By 1947, the year of India's independence, there were forty-two rail systems. In 1951 the systems were nationalized as one unit, the Indian Railways, becoming one of the largest networks in the world. IR operates both long distance and suburban rail services on a multi-gauge network of broad, meter and narrow gauges. It also owns locomotive and rolling stock, IR owns over 240,000 (freight) wagons, 60,000 coaches and 9,000 locomotives.

II. TYPES OF BOGIES

There are different types of bogies used all over India but frequently used bogies for freight carrying purpose are only few. They are:

1. Super service(ir) bradken
2. Barbar
3. Wegmann
4. Bradken
5. Linke hopmen
6. Aarpide control
7. Talbot
8. Feigues bogie
9. Closed freight wagon
10. Casnb bogie
11. Bogie covered type –BCNA

Table.1

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauge</td>
<td>1676 mm</td>
</tr>
<tr>
<td>Axle load</td>
<td>20.3 T</td>
</tr>
<tr>
<td>For CASNUB 22 HS-22.9 T</td>
<td></td>
</tr>
<tr>
<td>Wheel diameter</td>
<td>1000 mm</td>
</tr>
<tr>
<td>Wheel base</td>
<td>2000 mm</td>
</tr>
<tr>
<td>Type of axle bearing used</td>
<td>(i) Cylindrical Roller Bearing</td>
</tr>
<tr>
<td>(ii) Standard AAR Tapered Cartridge Bearing (Wide jaws)</td>
<td></td>
</tr>
<tr>
<td>(iii) Standard AAR Tapered cartrige bearing (narrow jaws)</td>
<td></td>
</tr>
<tr>
<td>Distance between journal centers</td>
<td>2260 mm</td>
</tr>
<tr>
<td>Distance between side bearers</td>
<td>1474 mm</td>
</tr>
</tbody>
</table>

| Type of side bearer     | (i) Roller Type                             |
| (ii) Constant Contact Type |
| (iii) Spring Loaded Contact Type Side Bearer |
| Type of pivot           | (i) Top And Bottom Pivot Internally Cast With Bolster- CASNUB 22W IRS Type |
| (ii) Spherical Type     |
| Anti-rotation features  | Anti-Rotation Lugs Have Been Provided Between Bogie Bolster And Side Frame And Brackets. |
| Type of brake beam      | (i) Unit Type Fabricated Brake Beam Supported And Guided In The Brake Beam Pockets. |
| (ii) Unit Type Cast Steel Brake Beam Suspended By Hangers From Side Frame Brackets. |
| Suspension system       | Long Travel Helical Spring.                 |
IV. DESIGNING OF WAGON AND BOGIE USING PRO-E AND CATIA

Our project deals with the material optimization of the railway wagon. For those purpose we have selected the most used type of wagons for freight purpose i.e., Closed Type Goods Wagon. These types of wagon are used to transport goods and commodities that cannot be exposed to the environment openly like Cement, Chemical and Food Commodities etc. Based on the design, the whole wagon can be divided into 2 parts broadly

1. Upper Part (Shell) and
2. Lower Chassis (Bogies - Two in number)

The Shell part of the wagon is modeled in Pro-E. The Structure of the shell of the wagon is based on its framework. This framework consists of channels of different cross section which are welded together. The Steel Sheets are riveted to these channels to make up shell as a whole.

A. Steps Involved In Modeling the Wagon Shell:

1. The sketch of the cross section was sketched.
2. This sketched was extruded along the length.
3. The bottom and top support C-Channels are extruded.
4. The advantage of the symmetry of the wagon design is used with mirror option.
5. The C-Channel at the front and back side are extruded.
6. The L-Channels at the two sides of the shell are extruded.
7. The C-Channels and L-Channels are used to attach the top and bottom support channels rigidly.
8. The channels extruded are arrayed along the length.
9. Two doors are cut on the two sides symmetrically.
10. All the channels are thickened with the thickness measured earlier from the real wagon.
11. The frame and the sheet work are colored differently for better visualization.

Thus the shell part is modeled and it is saved in IGES format which is then imported to Hyper Mesh for further analysis on the structure.

B. Designing process of bogie in CATIA

As our project specifies about the optimization of the design and material of a Wagon, we have RE-DESIGNED the basic structure of the bogie. We have removed the bulky parts of the bogie and later we have developed the design using CATIA software.

We have removed the parts of that play the importance of housing the brake system. The housing system cannot be optimized because the system itself requires certain space and material for it to sustain for longer period.

We have only designed the major parts which take in huge amount of stresses when the bogie in motion.

C. The design of axle system

The axle system does suffer from loading. So, we have also designed the axle system. The axles are also developed using the CATIA software.

V. ANALYSIS USING HYPER MESH

A. Meshing the bogie

The Bogie is meshed based on the different parameters:

1. Conversion of the design into a solid
2. Using tetra mesh in 3D option. The maximum and minimum values of the element size are 30.000 and 20.000 respectively

B. Geometry clean up:
The meshed bogie thus formed must be checked for free edges.

This is done by using the AUTOCLEAN UP option.

C. Quality of meshing of the bogie:

1. The bogie has generated approximately some 5500000 nodes when the element size is described as .80000
2. We have changed the option by keeping the element size as 30.00000 and we have generated approximately 70000 nodes.
3. The aspect ratio and war page is tested.
VI. OUR RESULTS

At the housing of the chassis, a small fillet section was missed which would have contributed to reduce more stress lines.

VII. CONCLUSION

As per the topic chosen the complete design and analysis of the bogie are performed and results are obtained. The design developed can be an alternative to the present design. The material that we have used is stainless steel, which will probably be used in manufacture of wagons in the near future.

VIII. FUTURE SCOPE OF THIS PROJECT

- The project can be further carried out to optimize the material usage in the fabrication of wagon.
- Design of the wagon based on stainless steel can be studied as wagon made of stainless steel would reduce the maintenance cost incurred for the ordinary steel wagons.
- Analysis of wagons fabricated with welding rather than riveting can be done.

REFERENCES

1. IIT-K Students, "Design and Optimization of a Passenger Bogie", Kanpur, journal
5. Wagon Work Shop, Guntapalli
7. CATIA Tutorials, “CATIA V5 help”
8. Hyper Mesh Tutorials, “Hyper Mesh Help Online”