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Modeling and Analysis of Railway Wagon

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ABSTRACT

Prediction of Dynamic behavior of Railway vehicle by using prototype is very costly, lengthy and tedious task so, now a day most of the railway companies and researchers are using virtual prototype of railway model and running it in virtual environment for predicting dynamic behavior of railway vehicle model. There is some popular software available for modeling like auto cad & pro-e, predicting dynamic behavior of vehicle model such as Ansis, Universal Mechanism etc.

At present steel material is used for hopper wagon, these are going to be replaced by aluminum alloy in the nearest future. In present work, I have designed and assembly of a proto type model of fright hopper wagon using CAD application. In PRO-E or CATIA software I have performed linear mode shape modeling and design by hopper wagon on track.

As the aluminum alloy has greater strength and less self weight, less fuel will be used in transportation and vertical force is reduced, hence less wear.

INTRODUCTION

Rail transport is the transport of passengers and goods by means of wheeled vehicles specially designed to run along railways or railroads. Rail transport is part of the logistics chain, which facilitates the international trading and economic growth in most countries [1, 2].

A typical railway/railroad track consists of two parallel rails, normally made of steel, secured to cross-beams. The sleepers maintain a constant distance between the two rails; a measurement known as the 'gauge' of the track. To maintain the alignment of the track, it is either laid on a bed of ballast or else secured to a solid concrete foundation, and the whole is referred to as Permanent way [3-5].

Indian railways, the largest rail network in Asia and the world's second largest under one management are credited with having a multi gauge and multi traction system. Indian Railways have been a great integrating force for more than 150 years. It has helped the economic life of the country and helped in accelerating the development of industry and agriculture [6]. From a modest beginning in 1853, when the first train steamed off from Mumbai to Thane covering a distance of 34 kms, since then there has been no looking back. It is interesting to note that though the railways were introduced to facilitate the commercial interest of the British it played an important role in unifying the country. Indian railways have grown into a vast network of 7, 031 stations spread over a route length of 63, 221 kms with a fleet of 7,817 locomotives, 5,321 passenger service vehicles, 4, 904 other coaching vehicles and 228, 170 wagons as on 31st March 2004.

Railways are ideally suited for long distance travel and movement of bulk commodities. Regarded better than road transport in terms of energy efficiency, land use, environment impact and safety it is always in forefront during national emergency. The track kilometers in broad gauge (1676 mm) are 86, 526 kms, meter gauge (1000 mm) of 63,028 kms, 16,001 km are electrified.

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The railways have 7566 locomotives, 37, 840 coaching vehicles, 222, 147 freight wagons, 6853 stations, 300 yards, 2300 good sheds, 700 repair shops, and 1.54 million work force. Indian Railways runs around 11,000 trains everyday, of which 7,000 are passenger trains [7].

Some Leading Indian wagon manufacturers:

Most wagons today are manufactured by private firms such as CIMMCO, Texmaco, HDC, Besco, Binny Engineering Works, Titagarh, and Modern. Public-sector organizations such as Burn Standard Co., Braithwaite, Jessops, Bharat Wagon and Engg. Co.

The following codes are used now for classifying freight cars. The classification scheme is not entirely systematic. Older wagons especially have codes that are not easily explained in this way. But in general an optional gauge code is followed by a type code which is followed by an indication of the coupler and whether the wagon is air-braked [8].

Introduction to Railway Bogie

A **bogie** is a wheeled wagon or trolley. In mechanics terms, a bogie is a chassis or framework carrying wheels, attached to a vehicle. It can be fixed in place, as on a cargo truck, mounted on a swivel, as on a train carriage or locomotive, or sprung as in the suspension of a caterpillar tracked vehicle.

A bogie is a structure underneath a train to which wheel axles (and, hence, wheels) are attached through bearings. If they are used there are usually two for each carriage, wagon and locomotive, or alternatively, they are at the connections between the carriages or wagons. The connections of the bogies with the cars allow a certain degree of rotational movement around a vertical axis.

Most bogies have two axles, but some cars designed for extremely heavy loads have been built with up to five axles per bogie. Heavy-duty cars may have more than two bogies using span bolsters to equalize the load and connect the bogies to the cars.

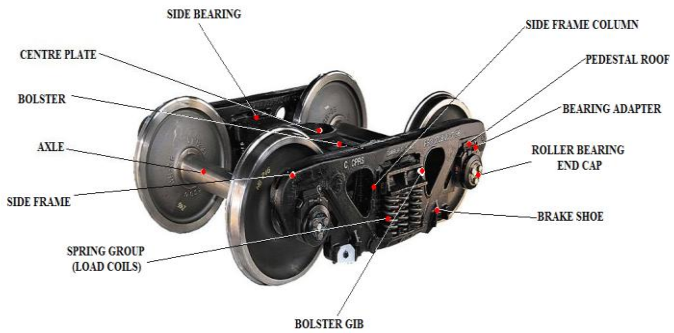

Fig 1: schematic diagram of Railway bogie

Usually the train floor is at a level above the bogies, however, for a double decker train the floor of the car may be lower between bogies to increase interior space while staying within height restrictions.

Assembling of railway wagon

This assembly was done in the pro/e software this is easy way to construct the model than in ACAD

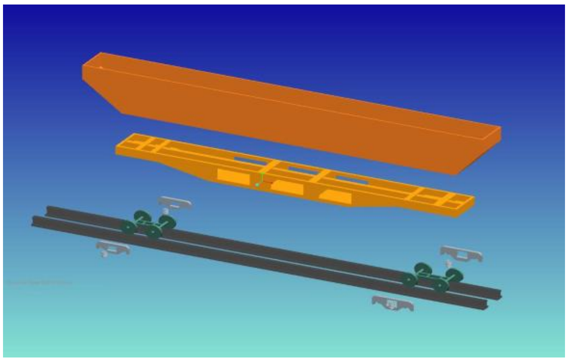

Fig 2: assembly parts of a railway wagon by using pro/e software

Hopper wagons can only be unloaded by gravity with no external assistance and are therefore also classed as self-discharging wagons. The majority may be filled, when at rail or road level, by high-level discharge chutes (whose ends are more than 70 cm above the top of the rails) or conveyor belts. Because a controlled amount of the load can be discharged at any place the wagons may be sent anywhere and are even used individually. Railway companies also use hoppers as departmental wagons in maintenance of way trains for ballasting the track.

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Since the 1990s there has been a trend for new hopper wagons to be built as bogie wagons which have not yet been standardised by the UIC.

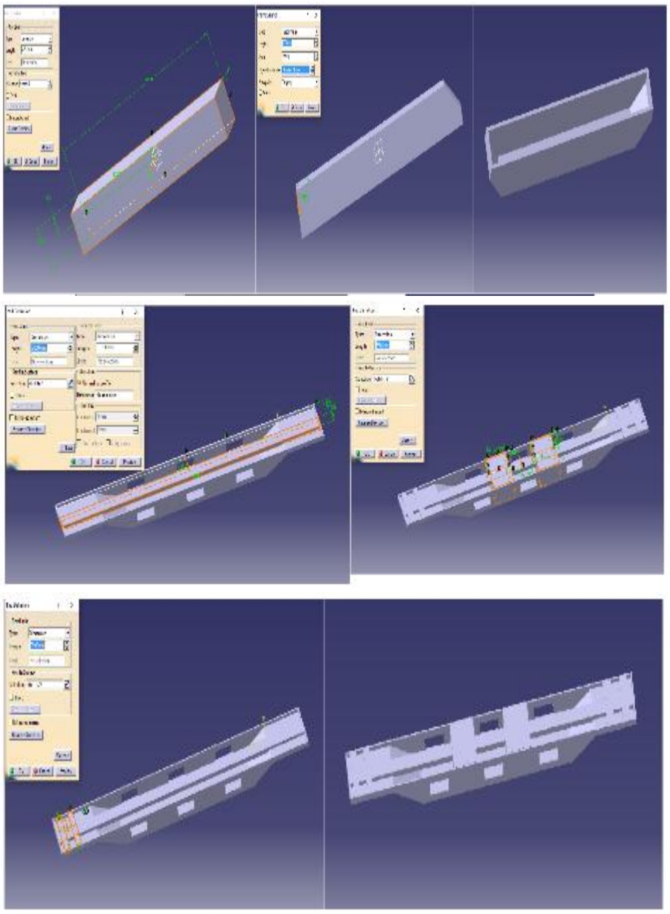

Fig 3: assembly of a railway wagon using pro/e software

The majority of these are self-discharging hoppers which use gravity-unloading (hopper wagons and saddle-bottomed wagons), but in addition there are also:

- Side-tipping wagons (box tip, trough-tip or side-tip wagon),
- Bucket wagon, other open wagons without side doors
- some East German wagons with steel floors were incorrectly grouped in this class

In 1998 the Deutsche Bahn had about 12,000 hopper wagons, 10,000 saddle-bottomed wagons and 1,000 side-tipping wagons. In addition to hopper and saddle-bottomed wagons there were also wagons with opening roofs.

Typical loads for these wagons are all sorts of bulk goods, like coal, coke, ore, sand or gravel. Because bulk goods are often moved in large quantities, these wagons are frequently used in so-called unit or block trains that only comprise one type of wagon and only shift one type of product from the dispatcher to the recipient.

A transporter wagon, in railway terminology, is a wagon (UIC) or railroad car (US) designed to carry other railway equipment. Normally, it is used to transport equipment of a different rail gauge. In most cases, a transporter wagon is a narrower gauge wagon for transporting a wider gauge equipment, allowing freight in a wider gauge wagons to reach destinations on the narrower gauge network without the expense and time of transshipment into a narrower gauge wagons.

ANALYSIS AND SIMULATION

Static Analysis

In present work, hopper wagon made of two different material steel and aluminum is analyzed statically. The step followed is as under:

1. Modeling
2. Assigning Material properties
3. Boundary Conditions

The material properties assigned for both steel as well as aluminium hopper wagon are given in table1 and density values are given in table 2.

Table 1: Material property table

	Unit	Steel	Aluminum
Modulus of elasticity (E)	N/m^2	2.68e+011	6.89 e+010
Poisson's Ratio (m)	Unitless	0.29	0.33
Shear Modulus (G)	N/m^2	8.0155e+010	2.6e+010
Mass Density	Kg/m^3	7820	2740
Yield Stress	N/m^2	3.80e+008	5.0e+008

Table 2: Density table

Product	Density (Kg/m^3)
Lignite Coal	1290
Ballast	1200
Bituminous coal	1346
Anthracite coal	1470

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Calculation of Pressure on each surface:

Let's considering lignite coal,

Coal Density = 1290 Kg/m^3

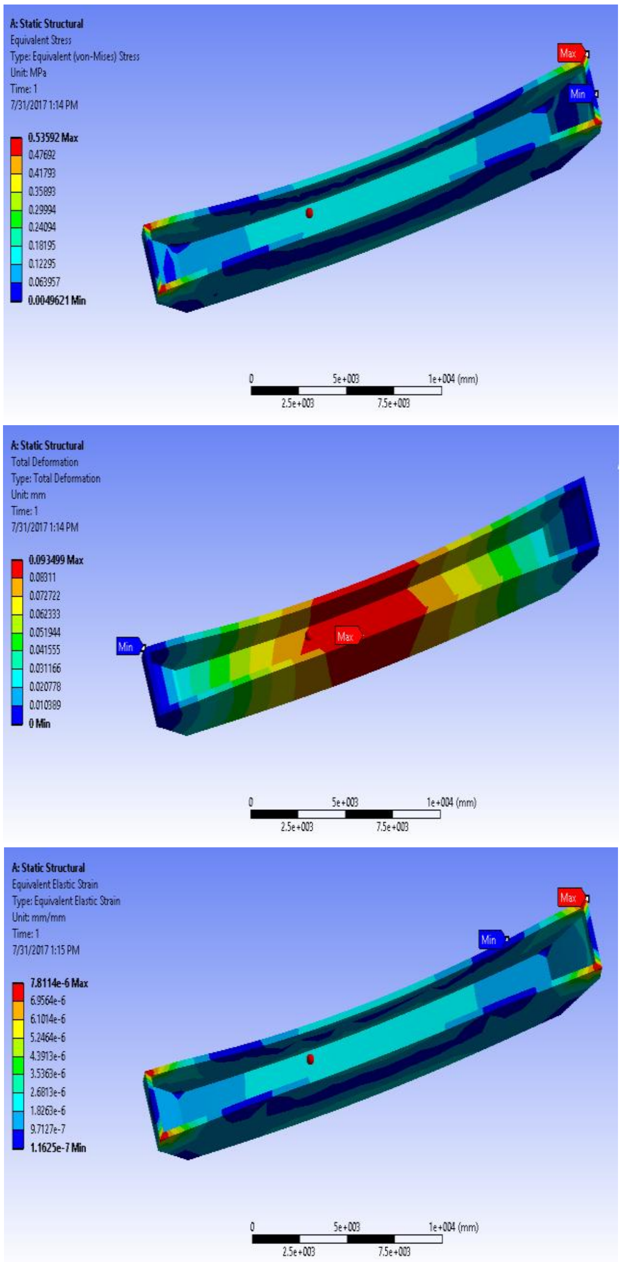
Volume = 110 m^3

$$\text{Mass} = \frac{141900}{110}\ \text{Kg}$$

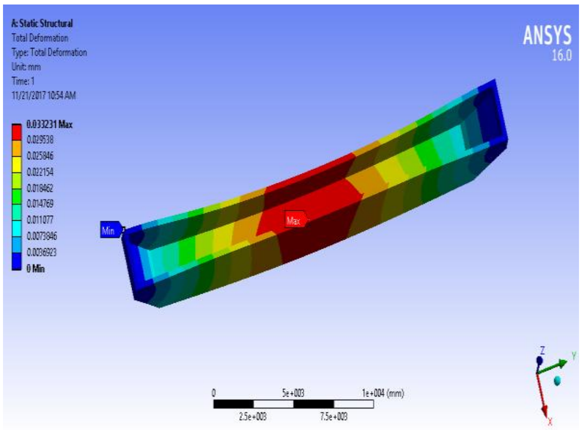
F = ma = 14190 * 9.81 = 139203.9 N

So, Total force = 139203.9 N

Aluminium



Steel



Result

	TOTAL DEFORMATION	STRAIN	STRESS
Steel	0.033231	2.8441E-6	0.55239
Aluminum	0.093499	7.8114E-6	0.53592

CONCLUSION AND SCOPE FOR FUTURE WORK

modeling: according to dimensions the model of hopper wagon made up of steel and aluminum, The mass momentum of the car body, wheel axle set are been designed by using pro/e software and cad software . From the comparison of steel and aluminum material hopper wagon alloy of these two gives the best result of having the liter weight , less stress acting are acting due to this the train is going to move in the safe way

Assembly: the assembly includes the combining of the all the parts which are designed or modeled from the pro/e this assembled part further goes to the analysis hear the two types static analysis and dynamic analysis. From static analysis the maximum von mises stress value and maximum comparing von-mises with yield stress of material, factor of safety can be calculated. And from the dynamic analysis values of the lateral and vertical forces, derailment quotient, longitudinal and lateral creep forces coming on tangent and curve track

From the comparison of steel and aluminum material hopper wagon, the percentage reduction in vertical and

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normal forces, longitudinal and lateral creep forces by using aluminum material of is calculated.

- Reduction in wheel set vertical force is 7.7%
- Reduction in lateral creep force is 4.6 to 8.67 %
- Reduction in longitudinal creep force is 6.85 to 8.0%
- Reduction in wheelset normal force is 5.7 to 9.5%

So it is to be conclude from the above results that aluminium is better and economical than steel.

Scope for Future Works

Railways itself a wide area for the research work, some the challenges are always there such that, to increasing load carrying capacity of freight wagons, to reduce self weight of freight wagon to reduce fuel required, to increase speed of the train in tangent track and in curve passing, to increase comfort and safety of passenger coach etc.

College has already got some of the projects from the railway companies, which are as follows. There are more challenges involved in these projects.
1) Changing the material of BOBRN hopper wagon from steel to aluminium,
2) Replacing current two axle bogie to three axle bogie to carry more load,
3) Comparison of virtual dynamic software and their accuracy etc.

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