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Design and Assembling of Freight Hopper Wagon

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Abstract

Estimation of the Railway vehicle dynamic behavior utilizing the prototype is exceptionally expensive, lengthy and dull task. Thus, the greater part of the researchers and railway organizations are utilizing a railway show which is a virtual prototype and running it in virtual environment for foreseeing dynamic behavior of railway vehicle demonstrate. There is some well-known programming accessible for demonstrating like auto cad and pro -e, foreseeing dynamic behavior of vehicle model, for example, ANSIS, UNIVERSAL MECHANISM and so forth. At introduce steel material is utilized for container wagon, these will be replaced by aluminum compound in the closest future. In show work, I have designed and assembly of a proto sort model of fright hopper wagon utilizing CAD application. In PRO-E programming I have performed straight mode shape displaying and outline by hopper wagon on track. As the aluminum composite has more noteworthy quality and less self-weight, less fuel will be utilized as a part of transportation and vertical force is diminished, consequently less wear.

Keywords: Railway Transport, Railway Bogie, CAD, Hopper Wagon, PRO-E and ANSIS

1. Introduction

Rail transport is the transport of travelers and merchandise by means of wheeled vehicles uniquely intended to keep running along railways or railroads. Rail transport is a piece of the coordination chain, which encourages the global exchanging and monetary growth in many nations. An average railway/railroad track comprises of two parallel rails, regularly made of steel, secured to cross-bars. The sleepers keep up a steady distance between the two rails; an estimation known as the "gage" of the track. To keep up the arrangement of the track, it is either laid on a bed of weight or else secured to a strong solid establishment, and the entire is alluded to as Permanent way. Indian railways, the biggest rail network in Asia and the world's second biggest under one administration are credited with having a multi gage and multi footing system. Indian Railways have been an extraordinary coordinating force for over 150 years. It has helped the financial existence of the nation and aided in quickening the advancement of industry and agribusiness. From a humble start in 1853, when the primary train steamed off from Mumbai to Thane covering a distance of 34 kms, from that point forward there has been no thinking back. It is interesting to take note of that however the railways were acquainted with encourage the business interest of the British it assumed a vital part in bringing together the nation. Indian railways have developed into a vast network of 7, 031 stations spread over a course length of 63, 221 kms with an armada of 7,817 locomotives, 5,321 traveler benefit vehicles, 4, 904 other training vehicles and 228, 170 wagons as on 31st March 2004. Railways are in a perfect world suited for long distance travel and development of mass wares. Respected superior to anything street transport in terms of vitality effectiveness, arrive utilize, environment effect and wellbeing it is dependably in bleeding edge amid national crisis. The track kilometers in broad gage (1676 mm) are 86, 526 kms, meter gage (1000 mm) of 63,028 kms, 16,001 km are energized. The railways have 7566 locomotives, 37, 840 instructing vehicles, 222, 147 cargo wagons, 6853 stations, 300 yards, 2300 great sheds, 700 repair shops, and 1.54 million work force. Indian Railways circles 11,000 trains ordinary, of which 7,000 are traveler trains. **Some Leading Indian wagon makers:** Most wagons today are made by private firms, for example, CIMMCO, Texmaco, HDC, Besco, Binny Engineering Works, Titagarh, and Modern. Open part associations, for example, Burn Standard Co., Braithwaite, Jessops, Bharat Wagon and Engg. Co. The accompanying codes are utilized now to classify cargo autos. The arrangement scheme is not by any stretch of the imagination systematic. More established wagons particularly have codes that are not effortlessly clarified along these lines. In any case, when all is said in done a discretionary gage code is trailed by a sort code which is trailed by a sign of the coupler and whether the wagon is air-braked.

- **Gauge code**
    - M : (prefix) MG
    - N : (prefix) NG
- **Wagon type code**

- B : (prefix) Bogie wagon (sometimes omitted)
- BV : Brake van
- V : Brake/parcel van (see above for brake van codes)
- O : Open wagon (gondola)
- C : Covered wagon (boxcar)
- F : Flat car
- FK : Flat car for container transport
- FU : Well wagon
- LA : Low flat car with standard buffer height
- LB : Low flat car with low buffer height
- LAB : Low flat car, one end with low buffers, the other with high buffers
- R : Rail-carrying wagon
- T : Tanker (additional letters indicate material carried)
- U : Well wagon
- W : Well wagon
- K : Open wagon: ballast / material / refuse transport (older wagons)
- C : Centre discharge
- S : Side discharge
- R : Rapid (forced) discharge, bottom discharge
- X : Both centre and side discharge
- X : (also) High sided
- Y : Low (medium) side walls
- L : Low sided
- H : Heavy load

1.1. Railway Bogie

A bogie is a wheeled wagon or trolley. In mechanics terms, a bogie is a case or system conveying wheels, connected to a vehicle. It can be settled set up, as on a payload truck, mounted on a swivel, as on a train carriage or locomotive, or sprung as in the suspension of a caterpillar followed vehicle. A bogie is a structure underneath a train to which wheel axles (and, subsequently, wheels) are appended through orientation. In the event that they are utilized there are generally two for every carriage, wagon and locomotive, or then again, they are at the associations between the carriages or wagons. The associations of the bogies with the autos permit a specific level of rotational development around a vertical hub. Most bogies have two axles, however a few autos intended for to a great degree overwhelming loads have been developed with to five axles for each bogie. Overwhelming obligation autos may have more than two bogies utilizing traverse supports to even out the load and associate the bogies to the autos. Typically the train floor is at a level over the bogies, nonetheless, for a twofold decker train the floor of the auto might be bring down between bogies to expand inside space while remaining inside height restrictions.

2. Assembling of Railway Wagon

Assembly

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

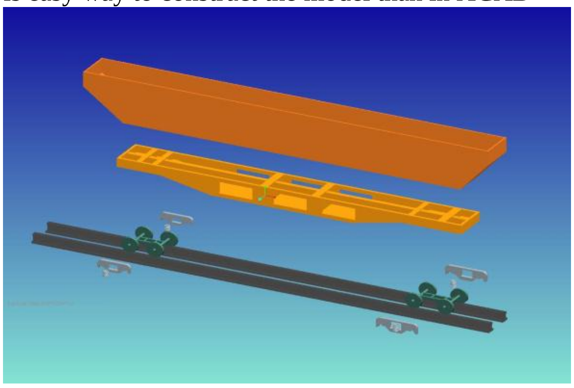

Figure 1. assembly parts of a railway wagon by using pro/e software

Hopper wagons must be unloaded by gravity with no external assistance and are subsequently likewise classed as self-discharging wagons. The larger part might be filled, when at rail or street level, by abnormal state release chutes (whose finishes are more than 70 cm over the highest point of the rails) or transport lines. Since a controlled amount of the load can be released at wherever the wagons might be sent anyplace and are even utilized separately. Railway companies likewise utilize hoppers as departmental wagons in upkeep of route trains for ballasting the track. Since the 1990s there has been a pattern for new hopper wagons to be worked as bogie wagons which have not yet been institutionalized by the UIC.

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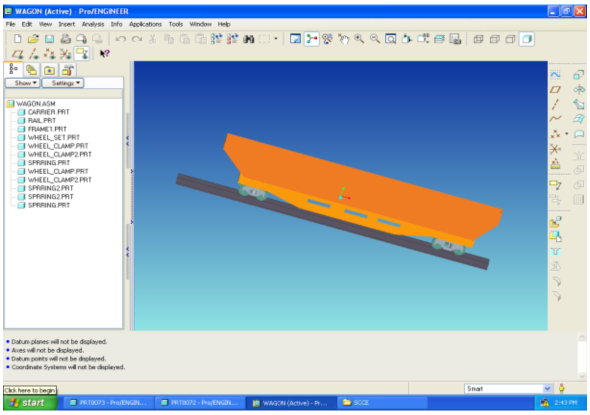


Figure 2. assembly of a railway wagon using pro/e software

The larger part of these are self-discharging hoppers which utilize gravity-unloading (hopper wagons and seat bottomed wagons), however what's more there are moreover:

- Side-tipping wagons (box tip, trough-tip or side-tip wagon)
- Bucket wagon, other open wagons without side entryways
- Some East German wagons with steel floors were erroneously assembled in this class

In 1998 the Deutsche Bahn had around 12,000 hopper wagons, 10,000 seat bottomed wagons and 1,000 side-tipping wagons. Notwithstanding hopper and seat bottomed wagons there were likewise wagons with opening rooftops. Normal loads for these wagons are a wide range of mass merchandise, similar to coal, coke, metal, sand or rock. Since mass merchandise are regularly moved in huge amounts, these wagons are oftentimes utilized as a part of supposed unit or square trains that lone include one kind of wagon and just move one sort of item from the dispatcher to the beneficiary. A transporter wagon, in railway terminology, is a wagon (UIC) or railroad auto (US) intended to convey other railway gear. Regularly, it is utilized to transport hardware of an alternate rail gage. Much of the time, a transporter wagon is a smaller gage wagon for transporting more extensive gage gear, permitting cargo in a more extensive gage wagons to achieve goals on the smaller gage network without the cost and time of transshipment into a smaller gage wagons.

3. Analysis and Simulation

3.1. Static Analysis

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

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

The model of hopper wagon is given in fig.3

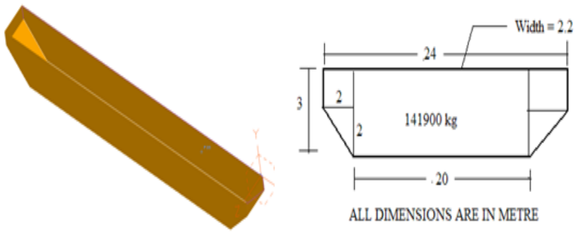


Figure 3. Solid model of Hopper in pro/e software

The material properties assigned for both steel as well as aluminium hopper wagon are given in table 1 and density values are given in table 1.

Table 1: Material property table

	unit	**Steel**	**Aluminium**
Modulus of elasticity (E)	N/m^2	2.68e+011	6.89 e+010
Poisson's Ratio (m)	Unit less	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

Table2: Density table

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

Calculation of Pressure on each surface:

Let's considering lignite coal,

Coal Density = 1290 Kg/m^3

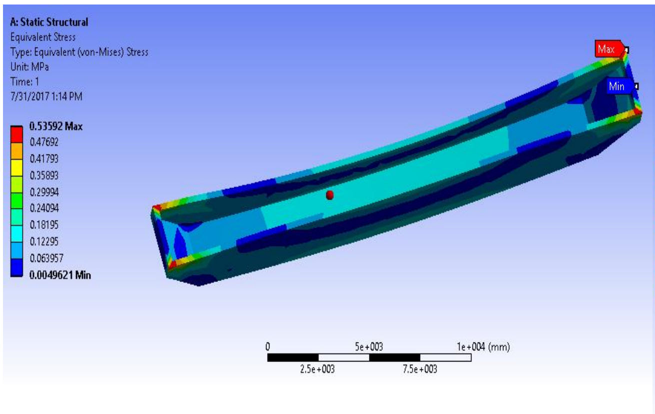
Volume = 110 m^3

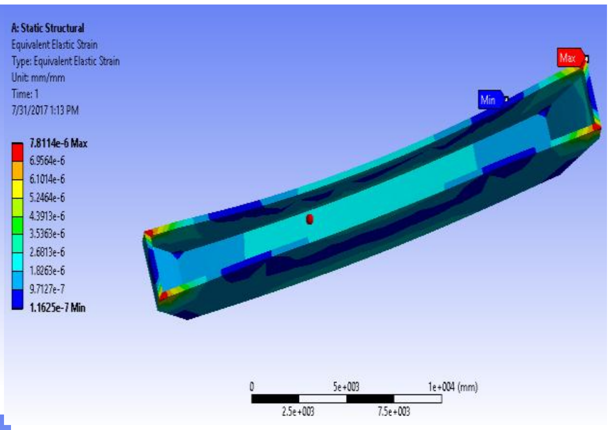
$$\text{Mass} = \frac{141900}{110} \text{ Kg}$$

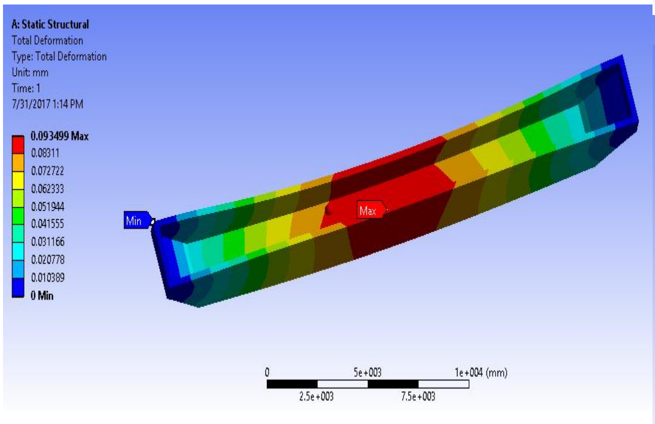
F = ma = 14190 * 9.81 = 139203.9 N

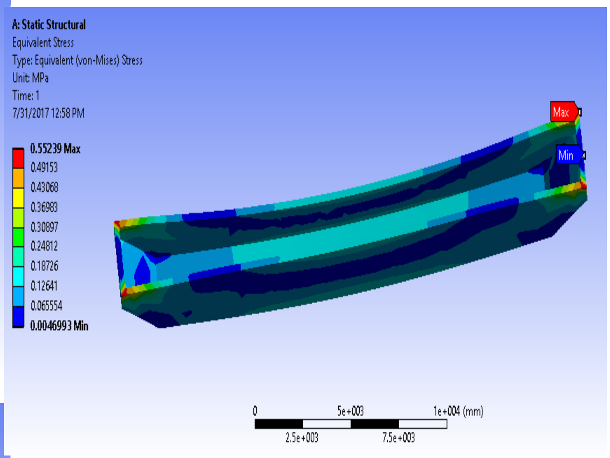
So, Total force = 139203.9 N

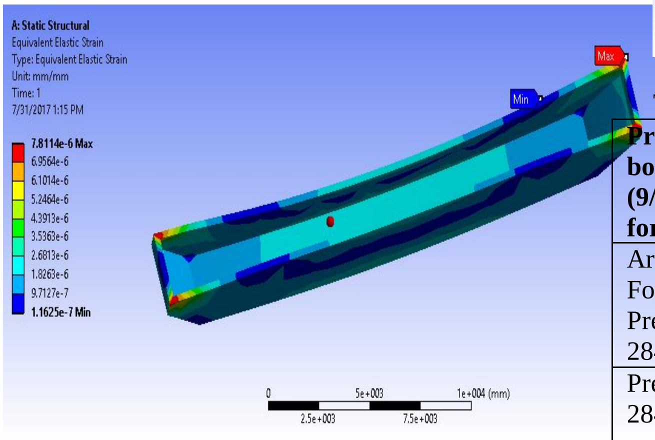
Aluminium











Steel

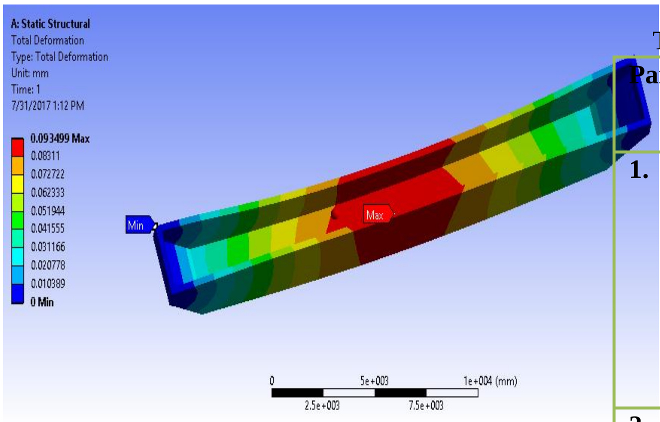


Table 3: Calculated pressures on the walls

Pressure on bottom side ($9/10^{th}$ of total force)	**Pressure on side walls ($1/10^{th}$)**	**Pressure on cross walls**
Area = 44 m^2 Force=125835N Pressure= F/A= 28473.52 N/m^2	Area = 60 m^2 Force=139204 N Pressure = F/A= 2320.065 N/m^2	Area = 6.22 m^2 Force=27840.7N Pressure = F/A= 4476.009 N/m^2
Pressure= 28473.52 N/m^2	Pressure=1160.03 N/m^2 (per 1 side wall)	Actual pressure =P=P/sqrt(2)= 3165.0 N/m^2

Table 4: details of the input parameters

Parameter details			**Steel hopper wagon**	**Aluminium hopper wagon**
1.	Mass and moment of inertia of car body (80 ton pay load)	Mass (Kg)	91872.3	83714.2
		Roll ($Kg.m^2$)	67841.3	45753.8
		Pitch ($Kg.m^2$)	3.26E+006	2.8864E+006
		Yaw ($Kg.m^2$)	3.28E+006	2.89E+006
2.	Mass and	Mass	1625.0	1625.0

	moment of inertia of wheel axle set	(Kg)		
		Roll ($Kg.m^2$)	1290.6	1290.6
		Pitch ($Kg.m^2$)	118.5	118.5
		Yaw ($Kg.m^2$)	1290.6	1290.6
3.	Mass and moment of inertia of Bogie frame	Mass (Kg)	2475.0	2475.0
		Roll ($Kg.m^2$)	2789.0	2789.0
		Pitch ($Kg.m^2$)	3267.0	3267.0
		Yaw ($Kg.m^2$)	4414.5	4414.5
4.	Stiffness of primary and secondary suspension	Fx (N/m)	3.2E+006	3.2E+006
		Fy (N/m)	3.2E+006	3.2E+006
		Fz (N/m)	6.3E+006	6.3E+006
		Tx (N/m)	2000	2000
		Ty (N/m)	2000	2000
5.	Side lateral damper	N/m	6.0E+007	6.0E+007
6.	Side yaw damper	N/m	3.0E+007	3.0E+007

4. Conclusion

1.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

2. 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 normal forces, longitudinal and lateral creep forces by using aluminum material of be 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 wheel set 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.

5. 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.

References

[1] Cheng hai tao, Dynamic Simulation of freight car considering the car body's flexible property, SI Fang rolling stock research institute.

[2] Ravi S. Kochak and Ambuj Sharma, Development of virtual prototype domestic container rail car, 16th European MDI Users' Conference, Berchtesgaden, Germany, 14-15 November 2001.

[3] Robert F. Harder, Dynamic Modeling and Simulation of Three-Piece North American Freight Vehicle Suspensions with Non-linear Frictional Behavior Using ADAMS/Rail, 5th ADAMS/Rail User's Conference Haarlem 10-12 May 2000.

[4] Coenraad Esveld, Investigation of the train accident on 22 July 2004 near Pamukova, Turkey, Esveld Consulting Services BV, 3 September 2004.

[5] Krzysztof Zboinski, Dynamical investigation of railway vehicles on a curved track, European Journal of Mechanics - A/Solids, Volume 17, Issue 6, 1998, Pages 1001- 1020.

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 09
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[6] Hans True, Recent advances in the fundamental understanding of railway vehicle dynamics, Journal of Vehicle Design, Volume 40, pp- 251-264 (2006).

[7] Mark Hoffmann, A thesis on Dynamics of European two axle freight wagons, Technical University of Denmark, Kongens Lyngby 2006.

[8] Dukkipati V. Rao & Joseph R. Amyot, computer simulation on rail vehicle dynamics, Published 1988.

[9] Dukkipati V. Rao, vehicle dynamics, Published 2000, pp-181-322.

[10] Chapter 10, Universal Mechanism, Manchester benchmarks for rail vehicle simulation, pp-1-41.

[11] Getting started Using ADAMS/Rail, User's Manual ADAMS/Rail version v2007r2.10.0

[12] http://www.railway-technology.com, access on June-2008.

[13] http://www.irfca.org/faq/faq-stock2.html, access on June-2008.

[14] http://www.rdso.gov.in, access on June-2008