International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Development of Transportation Structure of Industrial Trolley

V. D. Kolate[1], B. G. Hippargi[2]

[1]KJEI's Trinity Academy of Engineering, Pune, Maharashtra, India

Abstract: ***In Industry there any many delicate component like electronic goods, computers, delicate parts in heavy construction vehicles etc. that we need to always handle, carry & transport over the long distance. There are many chances which may lead to component damage or breakage during its handling, carry & transport. Heavy machineries, base frame structures, automotive vehicles, etc. are equipped with various light weight structure and joints. During transportation they are subjected to various harmonic and random vibration loads. Due to this road vibration coming on structural component, there is high chance of resonance occurrence which may lead to complete damage of the component. Such various failures are observed during transportation. Hence, there is a necessity to have some arrangement which can prevent such damage. Thus, this Industrial trolley will give the benefit of safe handling & carrying within the company premises also safe transportation over the long distances. Design of Industrial trolley by using anti vibration mount is used to carry transportation goods which absorb all types of vibrations & safeguard the equipment, forms basis of project.***

Keywords: Industrial trolley, Vibration absorber, Safeguard the equipment in transportation, Amplitude, Frequency, Harmonic analysis, vibration test, etc.

1. Introduction

This project brings the new concept for providing safety to the transportation good. The developed structure is named as the Industrial trolley. Industrial trolley concept is based on the principle of use of vibration absorber such as spring, rubber or any other type of damper, damper to minimize the vibration to the carrying component during the transportation. In the current scenario there is no structure available which will absorb the vibration coming to the transpiration goods to greater extent. Due to the road conditions more vibration from vehicle to carrying goods are transferred. There is huge possibility of the breakage, damage to the carrying product due to heavy vibration in it. The material which we carry can be critical having number of joints, critical component which demand for safe transport of them. Now-a-days we use the thermo Cole, bubble wrap, isolating clothes, isolating boxes to avoid the vehicle vibration to the carrying goods. Because of the use of these vibration isolator the vibration are reduced to some extent but not eliminated fully. This brings in the concept of generation of the new structure which will absorb the all road to vehicle to goods vibration to greater extent. This forms the basis of the project. In the Civil structure there are similar kind of vibration absorber are used but they cost heavily. Main purpose of such structure is to absorb the earth's vibration & prevent the infrastructure from it. In the factory, due to use of the heavy machineries large amount of the vibrations are generated. These vibrations are then transferred to the earth by means of some instrument or vibration absorber to earth. This type of vibration absorbers are the special kind of instrument & designed for individual application. Such that same kind of vibration absorber cannot be used for absorbing the other machine vibration. Due to the special requirement these costs heavily and cannot the flexibility in the entire aspects. The concept which has been generated here can be used for carrying, transportation within factory or over the long distance. This structure can also be used for similar size component & not required to make any new structure, thus providing the flexibility in all aspect. We can make use of any readily cheapest available vibration absorber in the market for the cost minimization and checking its suitability for the purpose. If the requirement demands for the high vibration absorption, we can make use of the different vibration absorber like hydraulic damper, pneumatic damper, etc.

2. Literature Review

K. S. Kamble et al. Studied; Measurement of seat vibrations in three orthogonal axes for analyzing RMS acceleration levels is done. Road surface profile and rotating parts are sources of vehicle vibration. Accelerometers are used for measuring seat vibrations at varying conditions of speed and road profiles. Measured vibrations are compared with ISO 2631-1(1997) and ride comfort level is estimated. Apart from the National Highways the road conditions are uncomfortable for the driver. Hence such road conditions can induce more vibration to the carrying goods [1].

Shivaji B. Jadhav et al. Studied , Hybrid carbon possesses more vibration capacity than conventional steel leaf spring. And also it has good performance characteristics as compared with other materials with similar design specifications. Leaf spring is developed with the hybrid carbon (glass fiber & carbon fiber) to absorb maximum vibration & remove the conventional metal leaf spring [2].

T. S. Dol et al. Studied, The main sources of vibration are engine strokes, load on engine and road inputs & vibrations transfer to the frame. Hydraulic engine mount is use for damping vibrations. The mount will become active with help of DC solenoid. This new configuration of hydraulic engine mount will give superior damping. The use of hydraulic engine mount will be beneficial in agricultural applications [3].

R. Ranjithkumar et al. Studied, Car bumper is designed with different material like ABS Plastic and S2 Glass Epoxy other than metal. Impact analysis is done on the car bumper for different speeds & Stress, Displacement and strain value observed are less than the margin [5].

3. Research Methodology

The base structure for the project is made up of from the standard L channels. The rubber mount has been used as the vibration absorbing element. Finite element analysis has been carried out on this structure to find out what is maximum amplitude & at which frequency it occurs. The FEA has been carried out on the structure with & without anti-vibration rubber mount. The boundary condition of the model has been considered that it is fully constrained at the bottom. Further it has been considered that approx. 5kg of load is acting on the platform. Base excitation is in the form of acceleration which has been given of 2 times of the gravity. These boundary condition were taken same on both the model for comparison. The testing is carried out on both the model & seen that peaks which occur at particular modes shapes are matching with the same modes in FEA & hence can be validated.

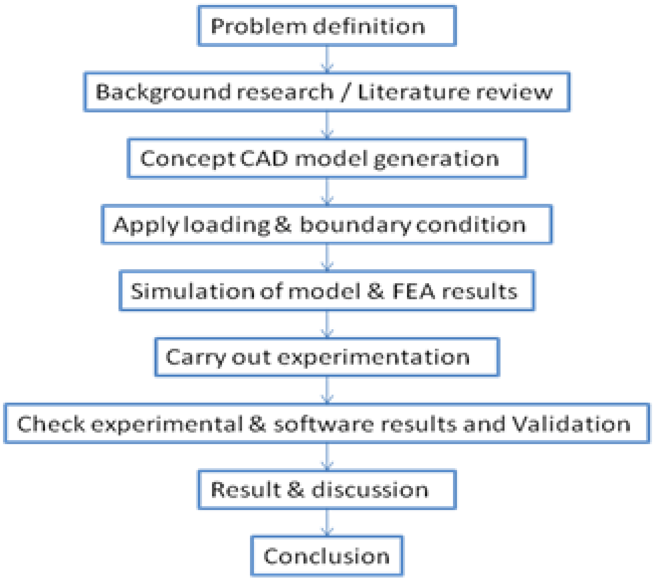


Figure 1: Industrial Trolley Development Methodology

4. Problem Statement

In Industry there any many delicate component like electronics goods, vehicles, bike, car, engine & transmission, construction machineries, calibrating instruments that we need to always handle, carry & transport over the long distance. There are many chances which can make the component brake during its handling, carry & transport. Thus, this Industrial trolley will give the benefit of safe handle & carry within the company premises also safe transportation over the long distances with the help of same industrial trolley. Heavy machineries, Base frame structures, automotive vehicles, etc. are equipped with various light weight structure and joints. During transportation they are subjected to various harmonic and random vibration loads. Various failures are observed during transportation. Hence, design of artificial rubber mount damper called Industrial trolley to carry transportation loads which absorb all types of vibrations & safeguard the equipment forms objective of project.

5. Design & Development of Industrial Trolley

Initially studied was carried out for checking availability of existing structure used for the vibration absorption. Further study was carried out on the automobile absorption system to understand how to protect carrying good from the vibration coming from the roads. Studied was also done for understanding that is there any vibration absorber system present in the aero plane for carrying goods. Similar for the ships, as they also faces many vibration from the ocean waves and ship observes continuous pitching, yawing, rolling. This may tend to damage of carrying goods. Studied some of the vibration absorbing elements used in the civil construction. But it was found vary heavy in terms of cost & weight. Developing similar concepts found difficult to achieve the cost goal.

Based on this theme, modeling of two structures finalized considering that it is a prototype model. One with the vibration absorber & one without the vibration absorber. The element used for the vibration absorber is rubber mount being a readily available in the market & very cost effective. Used some of the L shape channel which can carry the sufficient load. Made some platform for keeping the small item goods. The same two model were gone through the FEA for checking the difference between the vibration absorbing capacities. It is assumed that some carrying specimen CG is acting at the center of the platform which is denoted. Below are some of the pictures of model and joints. During transportation they are subjected to various harmonic and random vibration loads. Various failures are observed during transportation. Hence, design of artificial rubber mount damper called Industrial trolley to carry transportation loads which absorb all types of vibrations & safeguard the equipment forms objective of project.

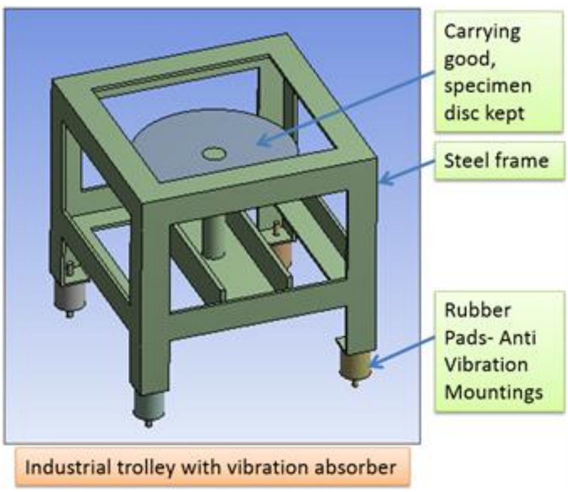


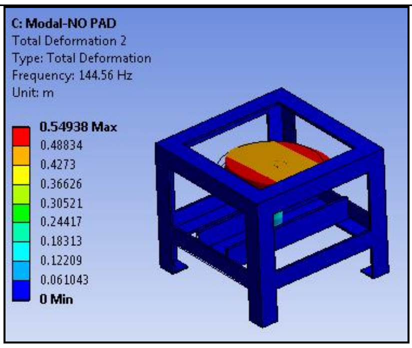
Figure 2: Industrial Trolley with Anti-Vibration Rubber Mount

6. FEA of Industrial Trolley

In this project, we have done analysis of the industrial trolley structure with and without anti-vibration rubber mount. For this analysis following information is used.

1. Summary: To carry out Harmonic Analysis of Trolley.
2. Situation: To verify peak mode shapes with testing value
3. Loadings: Vertical Acceleration
4. Boundary Condition's: Fully Constrained at bottom.
5. Material Properties: Steel
Modulus of Elasticity: 200GPa
Poisson's ratio: 0.30
Density: $7.85e^{-6}$ kg/mm^3
Yield Strength: 520 Mpa
6. Dimensions of the structure:
Height – 1031.6 mm
Width – 403.2 mm
Length – 914.4 mm
7. Boundary Conditions for Industrial Trolley without anti-vibration rubber mount:
Fully Constrained at the bottom
4.6 Kg Load on platform
Fixed support – Anti vibration rubber mount
Input Excitation – 2g acceleration

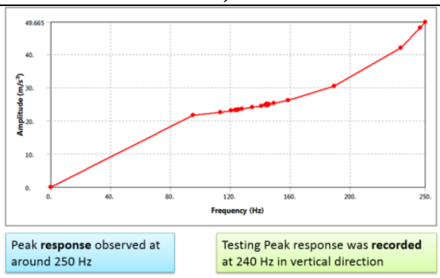
Output is measured on the cantilever end such that disc in this case here.



a)

Mode	Frequency [Hz]
1.	124.11
2.	144.56
3.	322.78
4.	327.99
5.	361.58

b)



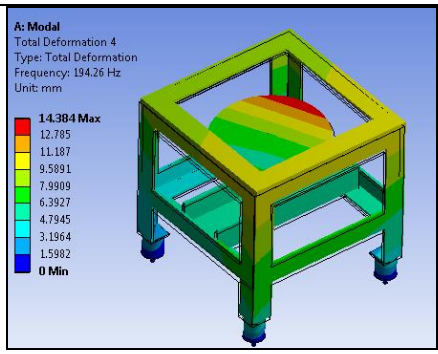
c)

Figure 3: FEA of Industrial Trolley without Anti-Vibration Rubber Mount

The figure 3 shows the finite element analysis of industrial trolley without anti-vibration rubber mount. The total maximum deformation for the frequency of 144.56 Hz of industrial trolley without anti-vibration rubber mount model is 0.54938 m and total minimum deformation is zero as shown in figure 3 a). The modes shapes for industrial trolley without anti-vibration rubber mount model having five modes shape and their frequency are shown in figure 3 b). The plot of amplitude versus frequency is shown in figure 3 c). In this plot the peak response is observer around 250 Hz and testing peak response is recorded at 240 Hz in vertical direction.

Dimensions of Anti-Vibration Rubber mount used are:
Rubber pad diameter – 50 mm
Height of rubber pad – 30 mm
Stiffness – 55 N/mm
Mounting bolt size – M8

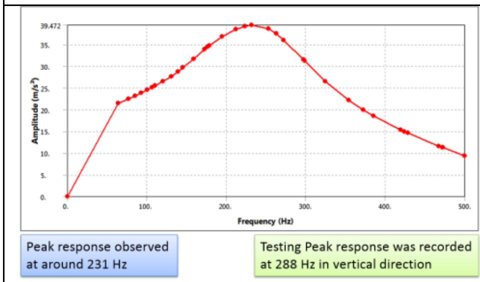
The figure 4 shows the finite element analysis of industrial trolley with anti-vibration rubber mount. The total maximum deformation for the frequency of 194.26 Hz of industrial trolley with anti-vibration rubber mount model is 0.01438 m and total minimum deformation is zero as shown in figure 4 a). The modes shapes for industrial trolley with anti-vibration rubber mount model having five modes shape and their frequency are shown in figure 3 b). The plot of amplitude versus frequency is shown in figure 3 c). In this plot the peak response is observer around 231 Hz and testing peak response is recorded at 288 Hz in vertical direction.



a)

Mode	Frequency [Hz]
1.	92.368
2.	119.85
3.	158.46
4.	194.26
5.	252.73

b)

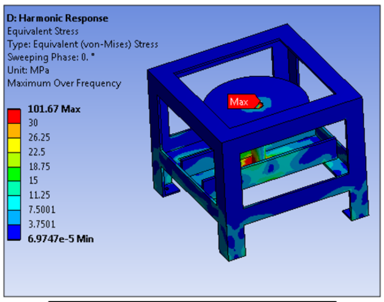


c)

Figure 4: FEA of Industrial Trolley with Anti-Vibration Rubber Mount

7. Life of Industrial Trolley

Structure life is also calculated for Industrial Trolley with and without Anti-Vibration Rubber Mount model. Life of the component is estimated from the S. N. curve of steel. As it can be seen from the Figure 5 the maximum stress of 101 Mpa occur in industrial trolley without anti-vibration rubber mount for which the life is $2e^5$ cycles. Also, it can be seen that the maximum stress of 5 Mpa occur in industrial trolley with anti-vibration rubber mount for which the life is $1e^5$ cycles i.e. infinite life as shown in figure 6.



SN CURVE FOR STEEL

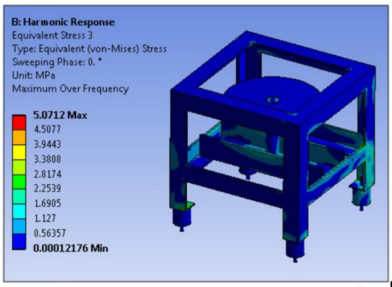
Cycles	Alternating Stress (MPa)
10	3999
20	2827
50	1896
100	1413
200	1069
2000	441
10000	262
20000	214
1E+05	138
2E+05	114
1E+06	86.2

Max equivalent stress of 101MPa

Industrial trolley without damper

Maximum stress obtained is 101.67 MPa resulting in around 2e5 Cycles

Figure 5: Life calculation of industrial trolley without anti-vibration rubber mount



SN CURVE FOR STEEL

Cycles	Alternating Stress (MPa)
10	3999
20	2827
50	1896
100	1413
200	1069
2000	441
10000	262
20000	214
1E+05	138
2E+05	114
1E+06	86.2

Max equivalent stress of 5MPa

Industrial trolley with damper

Maximum stress reduced to 5MPa resulting in around 1e6 cycle i.e Infinite Life

Figure 6: Life calculation of industrial trolley with anti-vibration rubber mount

8. Conclusion

1) The vibration absorber model prepared abosorbs the vibration to greater extent.
2) Acceleration level in Industrial trolley without anti vibration rubber mount is observed to be 48g at a frequency of 250Hz.
3) Acceleration level in Industrial trolley with anti vibration rubber mount is observed to be 5.6g at a frequency of 288Hz.
4) Acceleration level are reduced by 42.4g.
5) Testing peak frequency of 250Hz for Industrial trolley without anti vibration mount is in marginal limit of frequency of 240Hz calculated in FEA.
6) Testing peak frequency of 288Hz for Industrial trolley without anti vibration mount is in marginal limit of frequency of 231Hz calculated in FEA.

Hence if we make use of such structure for carrying good, then carrying good will be highly safeguarded during transportation.

References

[1] K. S. Kamble, H.V. Vankudre, C. S. Pathak "Applicability of ride Comfort Standard ISO 2631-1(1997) on Indian Road Condition."

[2] Mr. Shivaji B. Jadhav, Prof. Mr.V. H. Waghmare, "Vibration Analysis of Hybrid Composite Leaf Spring."

[3] T. S. Dol, D. N. Korade., "Design Development of Hydraulic Engine Mount, Isolation for Improved Vibration Damping."

[4] R.V.Rajale, R.R.Navthar, M.P.Nagarkar "Optimization of Suspension System for Whole Body Vibration."

[5] R.Ranjithkumar, J.P.Ramesh, "Modelling And Analysis Of A Car Bumper Using Various Materials By FEA Software", International Conference On Recent Advancement In Mechanical Engineering &Technology' 15.

[6] Arti Mankar, Pravin P. Hujare, "Investigations on Performance of Free Layer Damping Treatment"

[7] M. B. Gulve, S. B. Belkar,"Analysis of effect of change in operational/constructional parameters on the performance of twin tube hydraulic shock absorber"

[8] Mr Pradip B. Sontakke, Mr N. Vivekanandan, "Vibration analysis and reduction in vibrations of steering wheel of an agricultural tractor"

[9] A.A.Koli, M.M.Tayde, "Design Development and Analysis of Viscous Damper for Vibration Reduction in Hand Held Power Tools"

Mr. VijaysinghChavan and Prof. Chandrashekhar S. Dharankar, "Design and Fabrication of Non-linear Damper for Vehicle Suspension"

Author Profile

Mr. V. D. Kolate received the B.E. and M.E. degrees in Mechanical Engineering from Savitribai Phule Pune University in 2011 and 2014, respectively. Currently, he is working as Assistant Professor in Mechanical Engineering Department of KJEI's Trinity Academy of Engineering, Pune.