REDUCTION IN THE IMPACT FORCE ON A VEHICLE USING SPRING DAMPER SYSTEM

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Abstract—In the design of an automobile, the most important task is to minimize the occurrence and consequences of automobile accidents. Too many passengers die or injure every year because of accidents. Most of the vehicle manufacturing companies are unable to control these accidents. We are coming across the many accidents which were the result of poor designing and maintenance. The vehicles should have active safety system which will avoid the accidents as much as possible and passive safety system which will reduce the damage and loss of lives. The spring damper system is a passive safety system which will decrease the impact of accident. In this systems spring will store the energy and damper will dissipate the energy. This spring damper system reduces the impact of accident by increasing the time of collision as the spring needs some time to compress it totally. In this to check the amount of reduction in impact force when two bodies collide is analyzed with the spring damper system and without the spring damper system. The Impact force is significantly reduced with the spring damper system.

Keywords— Impact, Accident, Spring, Damper, Collision, Force, Crash, Safety.

INTRODUCTION

From the beginning of human life in order to move from one place to another we are using different Transportation systems, at the early stage people used horses, Carts but after inventing the engines people are ready to use vehicles like bikes, cars and buses. But today there is no guarantee that we will reach the destination safely. It is important to know the risk factors associated with vehicular transportation. It is very important to know various factors that will influence the impact of an accident. In present most of the vehicles are manufactured with the bumper which will break under the load. Now the world is looking for the spring damper system which will dissipate the energy without causing damage for a specified range of speeds.

A cushioning model is made to test the impact force was explored using a metal ball and varying thicknesses of polyster, it is found that the collision time is increasing with thickness of sponge up to some thickness and which makes less force on the metal ball[1]. A friction element was introduced into the bumper to improve on the impact and kinetic energy absorption capacity. The simulation revealed that the energy absorption capacity of the bumper was improved with the addition of a friction element. To validate these results experiments were conducted[2]. To mitigate the degree of damage to passengers caused by automobile collisions, a friction damper was built and used in experimental tests to test its effectiveness in impact energy attenuation. The study revealed that energy absorption capacity of a bumper can be improved with the addition of a friction damper [4].

MATHEMATICAL MODEL OF SPRING DAMPER SYSTEM

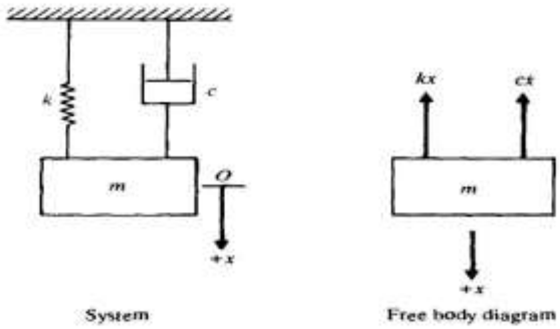

Fig. 1 Basic Spring Damper System

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = 0$$

Where m = mass, c = damping coefficient, k = stiffness, x = displacement, t = time

Effect of the Spring Damper Parameters on the Dynamic Behavior of the System:

MATLAB is used to solve the ordinary differential governing equation. The fixed parameters for the analysis are Mass= 5000kg and Initial velocity=30m/s.

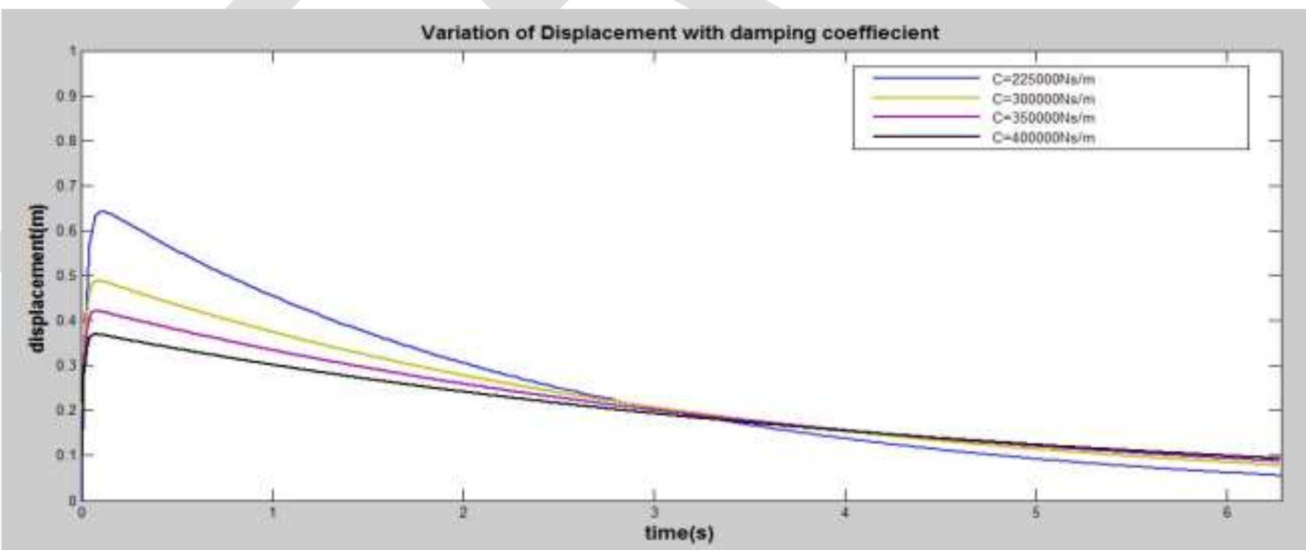

Fig. 2 Displacement variation with damping coefficient

Above graph we can indicates that with increase in damping coefficient, maximum displacement is decreasing and the peak is shifting towards the Y-axis. So it will help us in determining the spring parameters.

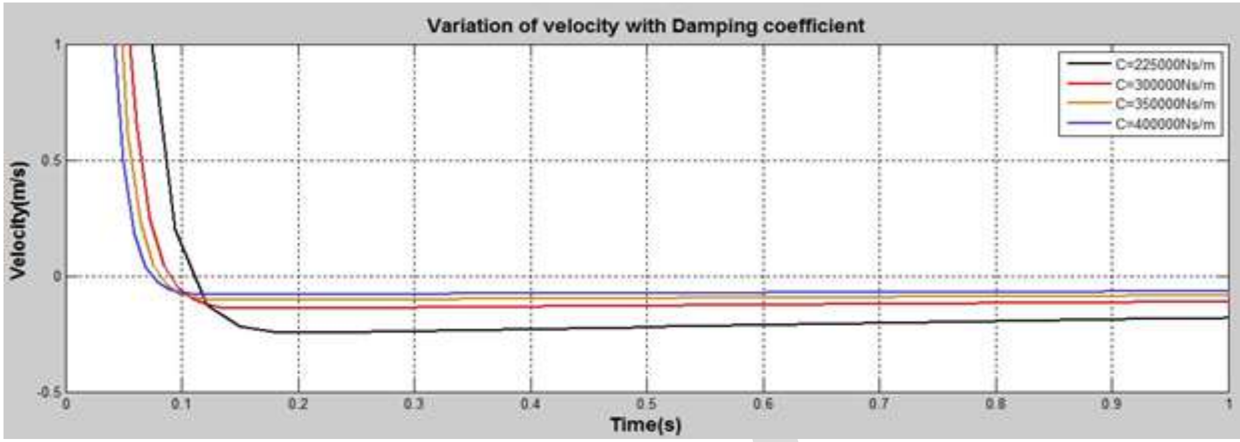

Fig. 3 Velocity variation with damping coefficient

Above graph we can indicates that with increasing damping coefficient the zero velocity is shifting towards the Y-axis and high negative velocity is with the less damping coefficient, it is indicating the less time to come to rest.

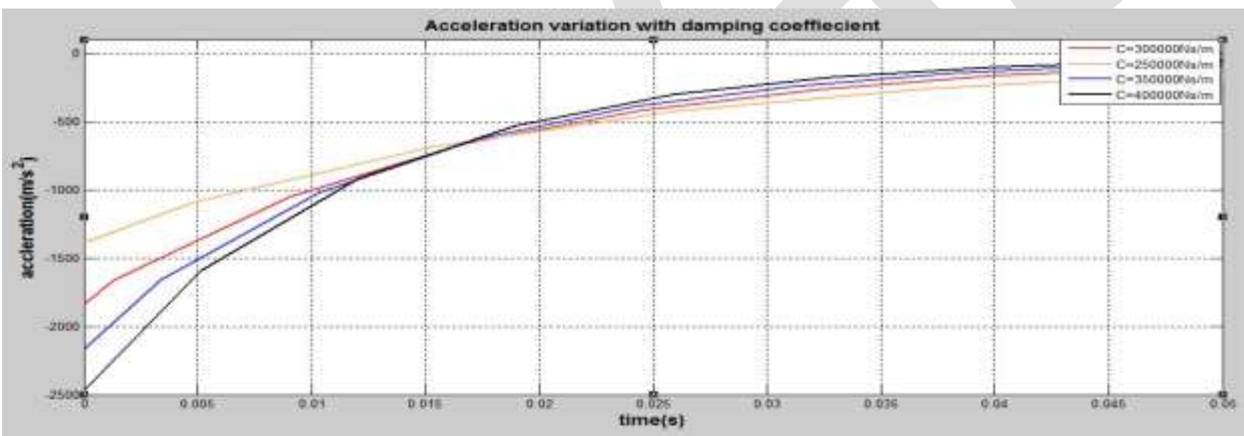

Fig. 4 Acceleration variation with damping coefficient

This graph indicates with high damping, high acceleration is occurs. It implies that spring attains maximum displacement in less time.

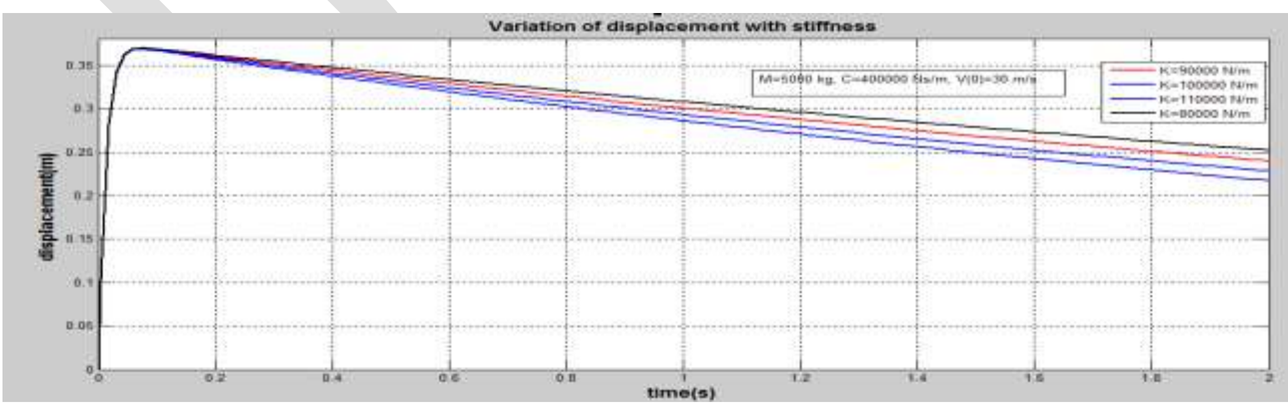

Fig. 5 Displacement variation with stiffness

This graph indicates that variation in stiffness is having negligible effect on the maximum displacement and with increase in stiffness the spring is coming to rest within less time.

ANALYSIS OF IMPACT FORCES WITH TWO BOXES USING IMPACT FUNCTION MODEL IN HYPERWORKS

Common Assumptions made during the analysis

- Contact between the bodies and the ground is frictionless.
- Impact function model is considered for the analysis.
- Geometry of the bodies is assumed as cubical.
- Bodies are made of hard metals, so force exponent is assumed as 2.
- Joint between the bodies and ground is Translational joint.
- The spring used is Coil spring.
- Mass of the boxes is 5000 kg.
- Initial speed of translating boxes is 30000 mm/s.
- Spring stiffness is 90 N/mm, Damping coefficient is 300 Ns/mm for the spring damper system
- Contact properties for the IMPACT function model are stiffness coefficient 10^7 N/mm and maximum damping coefficient is 50 Ns/mm, depth of penetration is assumed as 2 mm.

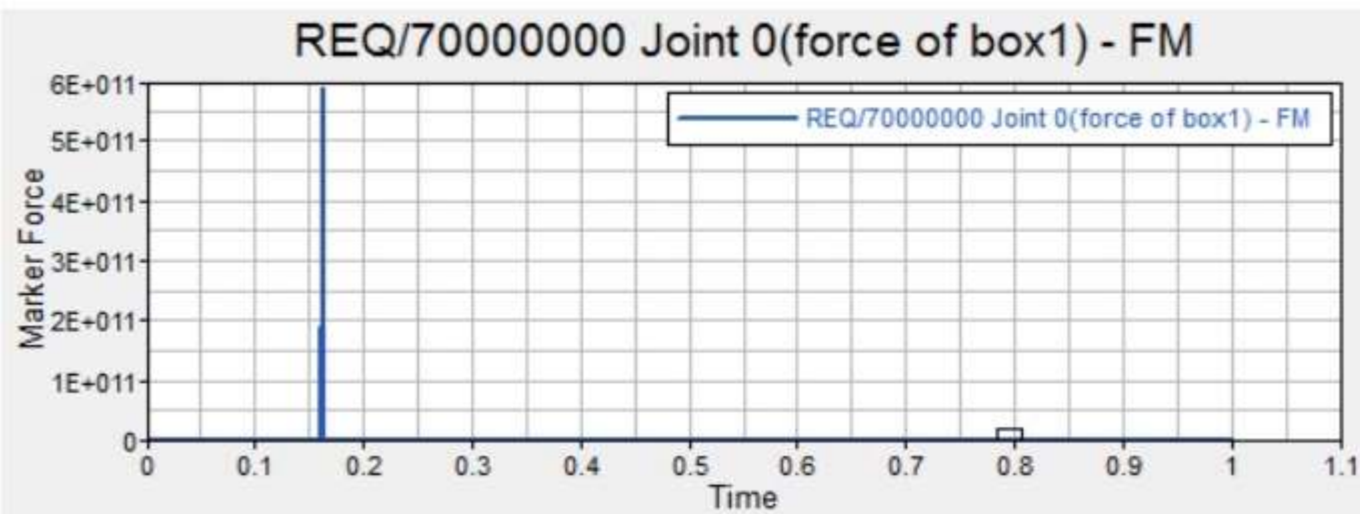

Fig. 6 Two free boxes without spring damper

In this it is assumed that the two boxes are moving towards each other with an initial velocity of 30000 mm/s. During the collision an impact force of magnitude $6*10^{11}$ N is observed, which is of very high magnitude and thus creates high impact stress which will cause the damage to the vehicle.

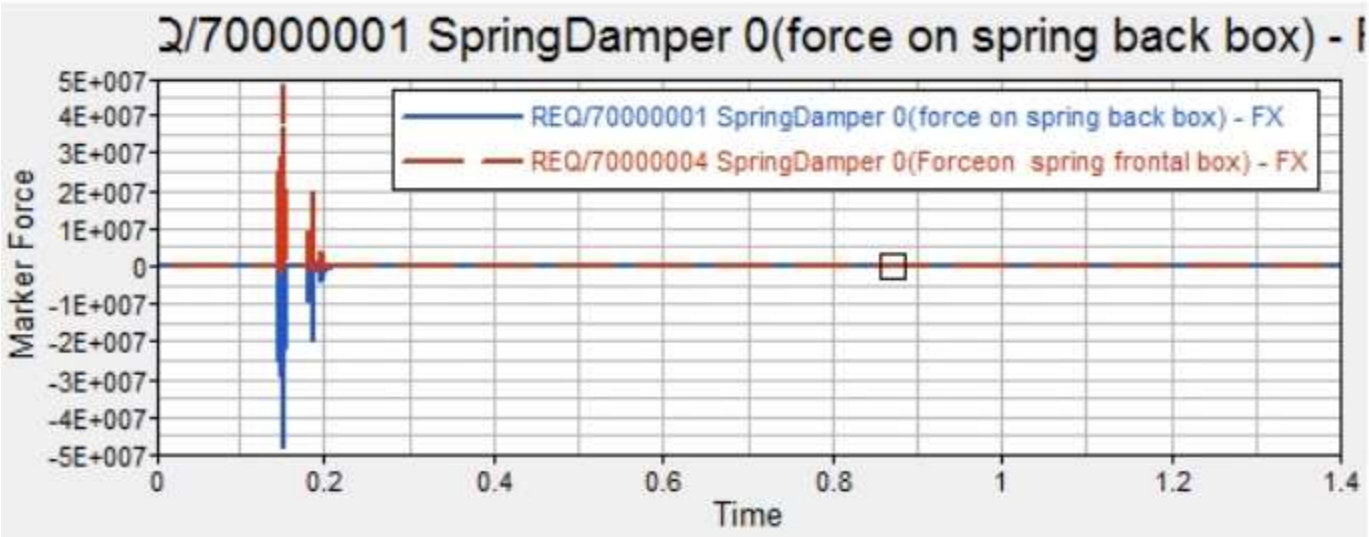

Fig. 7 Two free boxes and one of them with spring damper

In this a spring damper system is attached to the one of the boxes. So during the collision the impact force magnitude considerably reduced to $5*10^7$ N which is 14000 times lesser than without spring damper.

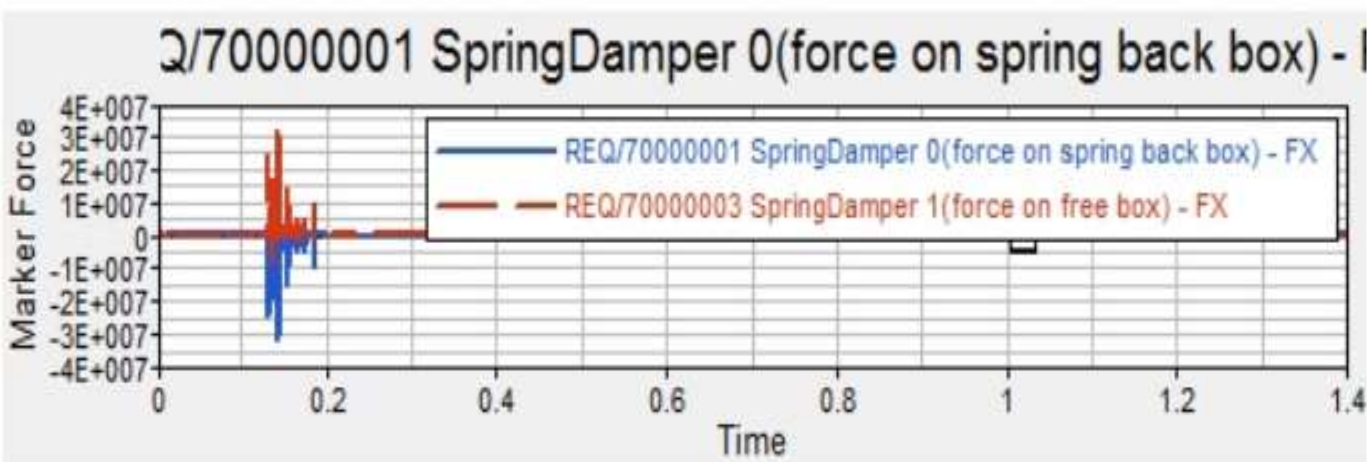

Fig. 8 Two boxes with two spring damper systems

In this the two boxes are attached to two different spring damper systems with the same properties. The magnitude of the force reduced by 1.67 times compared to the previous case in which spring damper is attached to only one box.

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CONCLUSION

The following conclusions are made from the work done

- With increase in damping coefficient, maximum displacement of spring is decreasing.
- With high damping, high acceleration is occurs. It implies that spring attains maximum displacement in less time.
- Variation in stiffness is having negligible effect on the maximum displacement and with increase in stiffness the spring is coming to rest within less time.
- Over damped system is used to reduce impact force.
- Low contact stiffness values lead to large rebound heights and large maximum penetration depths.
- Stiffness of the contact is not constant and it varies with the depth of penetration.
- Spring damper system reduces the impact force considerably.

REFERENCES:

1. Nond Hasbamrer, Increasing collision time through the use of cushioning, ISB Journal of physics, June 2009.
2. Kusekar Sambhaji Kashinath, Chunge Abhijit Balasaheb, Review of design and analysis of bumper beam, International journal of industrial electronics and electrical engineering, ISSN: 2347-6982, Volume-2, Issue-2, Feb-2014.
3. Galal A. Hassaan, Optimal design an anti-accidents vehicle –buffer, International journal of Research in Engineering and Technology(Impact: IJRET) ISSN(E): 2321-8843; ISSN(P):2347-4599, Vol-2, Issue-5, May-2014, 161-168.
4. K.Ashok Kumar, N.Boominathan, D.Akhilan, Design and analysis of automobile bumper with the capacity of energy release, IOSR Journal of Mechanical and Civil Engineering(IOSR-JMCE), e-ISSN: 2278-1684, p-ISSN: 2320-334X,Volume-11, Issue-2, Version-II (Mar-Apr. 2014), PP 21-27.
5. Wong, C.X., Daniel, M.C. and Rongong, J.A. (2009) Energy dissipation prediction of particle dampers. Journal of Sound and Vibration, 319 (1-2). pp. 91-118.
6. A. Agyei-Agyemang1, G. Y. Obeng2, P. Y. Andoh1, P.Y.(2014)Experimental Evaluation of the Attenuation Effect of a Passive Damper on a Road Vehicle Bumper, World Journal of Engineering and Technology, 2, 192-200.
7. P. Gawthrop, S. Neild and D. Wagg, "Semi-active damping using a hybrid control approach", Journal of Intelligent Material Systems and Structures, Vol.23, No.18, 2012, pp.2103-2116.
8. K. Li and A. Darby, “An approach to the design of buffer for a buffered impact damper”, Structural Control and Health Monitoring, Vol.17, No.1, February 2010, pp.68-82.
9. Abe, G. and Richardson, J.A. (2006) Alarm timing, trust and driver expectation for forward collision warning systems, Applied Ergonomics, 37: 577-586.
10. G. Geldhof, Semi-active vibration dynamics control of multi-cart systems using a magnetorheological damper, M.Sc. Thesis, Chalmers University of Technology, Goteborg, Sweden, 2013.
11. R. Baig , S. Pugazhenthi, Design optimization of an active vibration isolation system, International Journal of the Physical Sciences, Vol.6., No.30, Nov-2011, pp.6882-6890.
12. A. Emarakbi, “Analysis of a new front-end structure offset impact: mass-spring-damper models with piecewise linear characteristics”, International Journal of Vehicle Systems Modelling and Testing, Vo.5, No.4, 2010, pp.292-311.