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Harmonic Response of A Rugged System Rack Used In Transport Vehicle

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ABSTRACT
Any Electronic or machine device which is designed to operate under Harsh environment environments and conditions, such as strong vibrations, extreme temperatures and wet or dusty conditions, depending on its operation are called as Rugged Systems. The design of the system makes it unique and robust which gives more reliability for its operation. The rugged system is used for carrying the sensitive items for one place to other place without damaging. The products like computers, guns, medicine, walk talky etc. to withstand harsh conditions. The rugged system provides the good conditions while traveling, it keep the devices clean, protected from water, dust, vibrations, and fire to and environmental conditions and more.
In this work to perform the harmonic analysis of the rugged system to check its stress and deformation levels, when it undergoes by damping forces while the vehicle is moving. The harmonic response of the two different materials at three different frequencies are determined.
Keywords- frequencies, harmonic response, rugged system, aluminum, stainless steel.

I. INTRODUCTION

Rugged is strongly made and capable of withstanding rough handling. A rugged system is a system specifically designed to operate reliably in harsh usage environments and conditions, such as strong vibrations, extreme temperatures and wet or dusty conditions. Military cases rugged transit containers and shipping cases are used from 18th century in 1775 by the Army and Navy. Airforce started in 20th century. America in 1850 There were hundreds of trunk manufacturers in the United States and a few of the larger and well known companies were Rhino Trunk & Case, C.A.Taylor, Haskell Brothers, Martin Maier, Romadka Bros., Goldsmith & Son, Crouch & Fitzgerald, M. M. Secor, Winship,
Hartmann, Belber, Oshkosh, Seward, and Leatheroid. One of the largest American manufacturers of trunks at one point—Seward Trunk Co. of Petersburg, Virginia. From 18th century trunks are using in military for carrying the equipments and these trunks are moderated to rugged systems with different structures. From 20th century the rugged systems are introduced and designed for safe carrying of equipment. COTS (kots), n. 1. Commercial off-the-shelf. Terminology popularized in 1994 within U.S. DoD by SECDEF Wm. Perry’s “Perry Memo” that changed military industry purchasing and design guidelines. January 1, 2001 The choices of rugged systems are broadening every year as the old military suppliers design to COTS guidelines, and commercial suppliers toughen their off-the-shelf offerings.
In May of 2011, Black Diamond Advanced Technologies of Tempe, Arizona, introduced the Modular Tactical System, or MTS. BDATech describes it as a "lightweight, wearable and rugged computer system that is integrated into the user's uniform and equipment, and optimized for dismounted C4ISR (command,
control, communications, computers, intelligence, surveillance, reconnaissance)."
From the last 20 years the company Steatite Rugged Systems In Europe’s supplying, designing and building rugged mobile computing devices Chandradeep Kumar [1]2014 He understanding control of many vibration phenomena which encountered in practice and Determining the nature and extent of vibration responselevels and verifying theoretical models and prediction are both major objectives.
A. G. Striz [2]1995. He invented new approach for the determination of the weighting coefficients for differential quadrature. It is useful for found that the HDQ method is more efficient than the ordinary differential quadrature (DQ) method, especially for higher order frequencies and for buckling loads of rectangular plates under a wide range of aspect ratios.
D.J. Mead [3]1990 says Harmonic response function for an infinite beam subjected to a single-point harmonic force and Equations are presented for the response of a single-bay beam with various support conditions and subjected to single-point harmonic excitation.
Mr.Rajendra Kerumali [4] 2014. find out load displacement characteristics of spring. and also he

discuss the compare linear and nonlinear behavior of spring and damper of vibration isolator.

Kefu Liu [5]2010. In this paper he studied about focuses on the optimum design of the damped dynamic vibration absorber (DVA) for damped primary systems.

E. Barkanov[6]1997 In this paper he discuss the behavior of structures with different damping models has been investigated using finite element and frequency response analyses.

Der-Wen Chang[7]2000 This paper he introduces the mathematics and procedures used in developing a time-dependent damping model for integration analyses of structural response.

P.Veera Raju[8]2013 In this analysis says the High-technology structures to reduce the damping vibrations replace in advanced composites and light-weight structural components that are vibration-resistant.and also The effect of damping on the performance of isotropic (like Steel) and orthotropic (like Carbon Epoxy & E-Glass Epoxy) structures are analyzed.

R.S.Lakes[9] 2000 This paper he discuss about the composite materials of structures, and combination of stiffness and loss is desirable in damping layer and structural damping applications.

Rahul N. Yerrawar[10]2012.In this work he analyze to reduce the stiffness of the damper. He consider forced frequency range of 80 Hz to 150 Hz for the damper and he investigated to predict the resonance phenomenon of the damper.

Mohammad Javad Rezvanil[11]2011 in this paper he is Using the principle of total minimum potential energy, the governing partial differential equations of motion are obtained. The solution is directed to compute the deflection and bending moment distribution along the length of the beam. Also, the effects of two types of composite materials, stiffness and shear layer viscosity coefficients of foundation, velocity and frequency of the moving load over the beam response are studied.

II. MATERIAL USED IN RUGGED CASE

There are different materials that are used in outer case of rugged box, the material should be as strong as rock light weight and fire resistance etc. the present materials that are used in rugged case box are Cast Iron, copper alloys, aluminum alloys, and combination of high carbon steels. We are tacking the aluminum 6061 and structural steel in designing the rugged outer case

III. MODELING AND ANALYSIS

3.1 CREO-2

Creo is a family or suite of design software supporting product design for discrete manufacturers and is developed by PTC. PTC Creo is a scalable, interoperable suite of product design software that delivers fast time to value. It helps teams create, analyze, view and leverage product designs downstream utilizing 2D CAD, 3D CAD, parametric & direct modeling.

3-D Modeling of Rugged System Rack

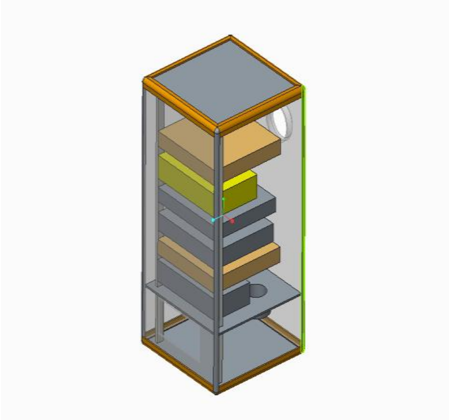

Figure: assembly of rugged system rack

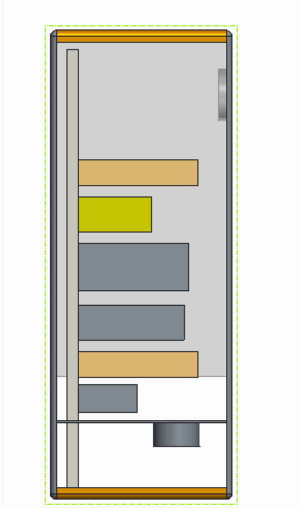

Figure: right view rugged system rack

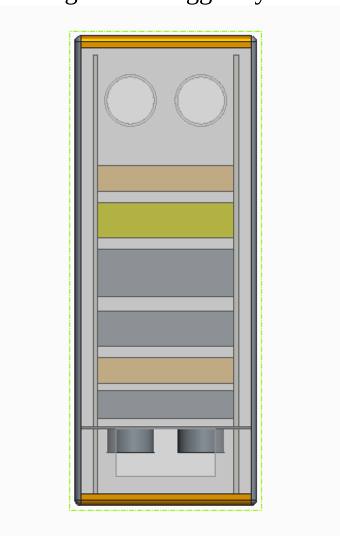

Figure: Front view rugged system rack

3.2 HARMONIC ANALYSIS

Any sustained cyclic load will produce a sustained cyclic response (Harmonic Response)

Harmonic analysis gives you the ability to predict the sustained dynamic behavior of your structure, thus enabling you to verify weather or not your design will successfully overcome resonance, fatigue, and other harmful effects of forced vibrations.

3.2 ANALYSIS RESULTS OF RUGGED SYSTEM RACK WITH SPRING SUPPORT MATERIAL: ALUMINUM

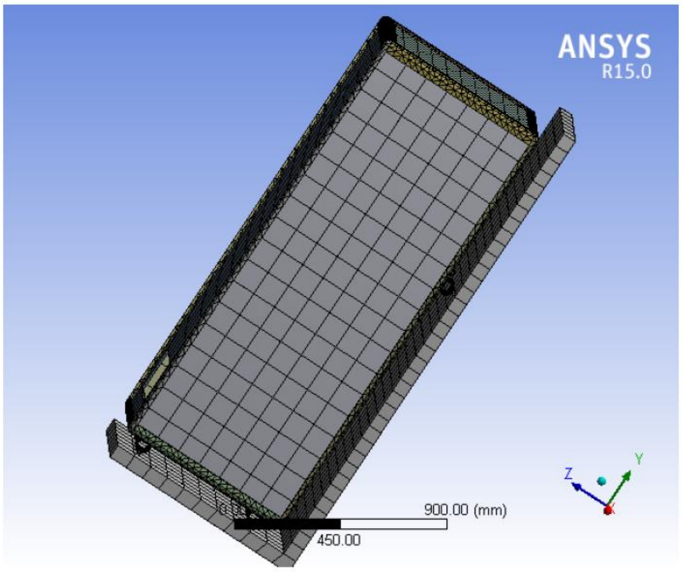

Figure: meshing of the rugged system rack

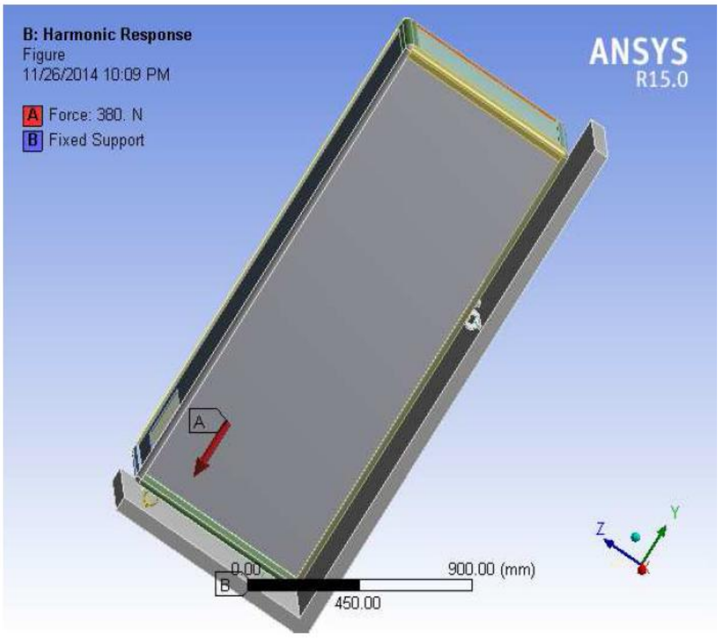

Figure: harmonic response of the rugged system rack

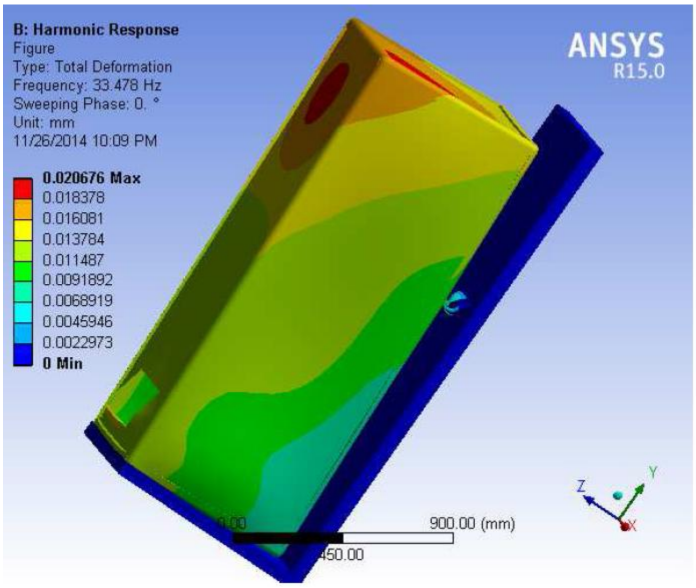

Figure: total deformation of the rugged system rack at frequency 33.478 Hz

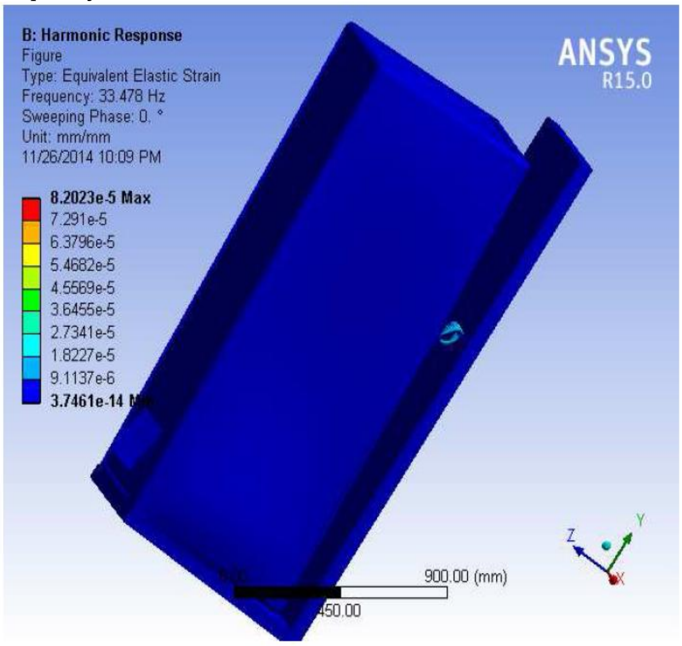

Figure: equivalent elastic strain of the rugged system rack at frequency 33.478 Hz

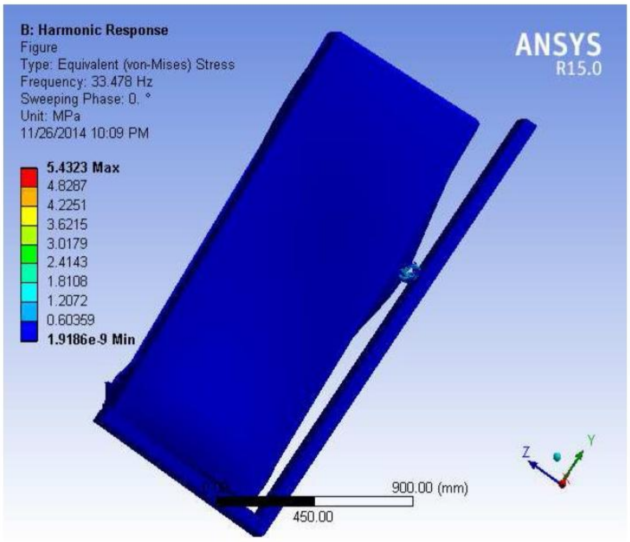

Figure: equivalent stress of the rugged system rack at frequency 33.478 Hz

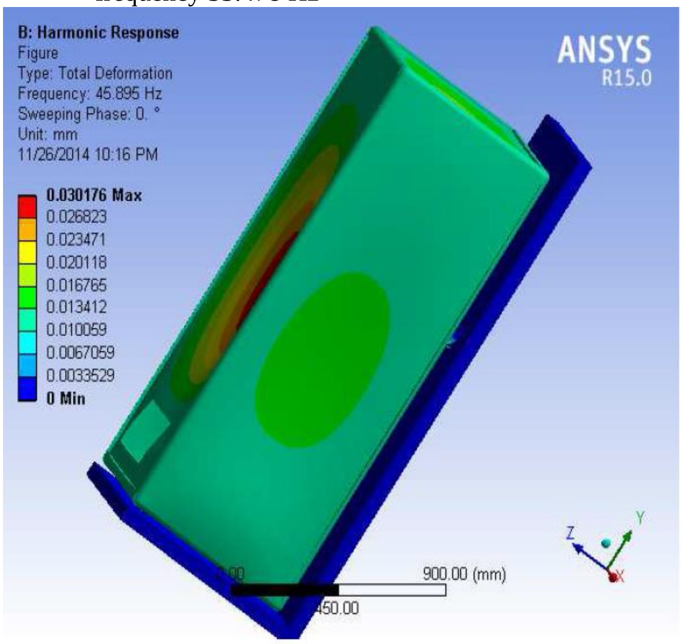

Figure: Total deformation of the rugged system rack at frequency 45.895 Hz

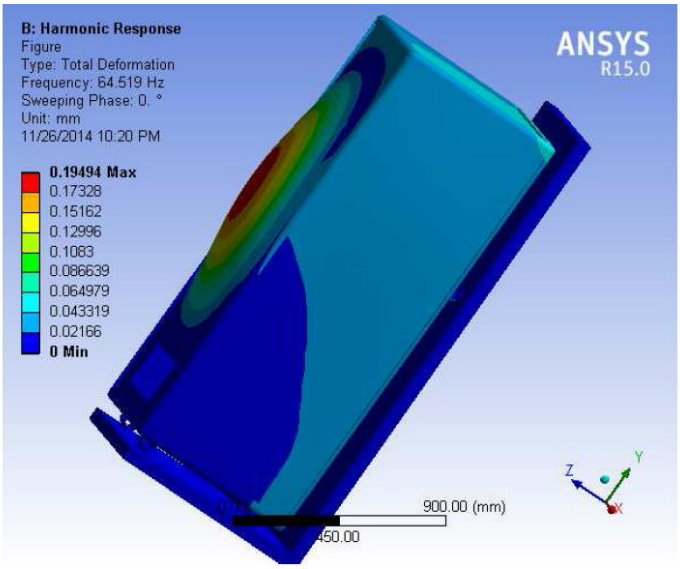

Figure: Total deformation of the rugged system rack at frequency 64.519 Hz

3.3 ANALYSIS RESULTS OF RUGGED SYSTEM RACK WITH SPRING SUPPORT MATERIAL: STEEL

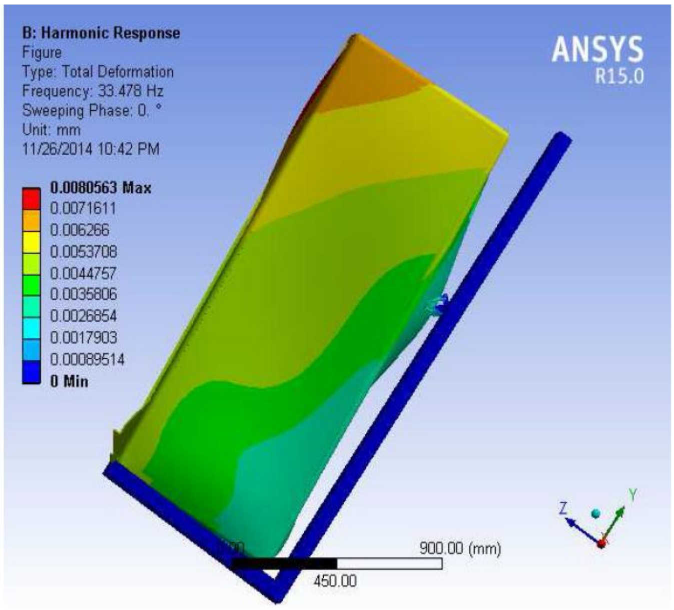

Figure: Total deformation of rugged system rack at frequency 33.478Hz

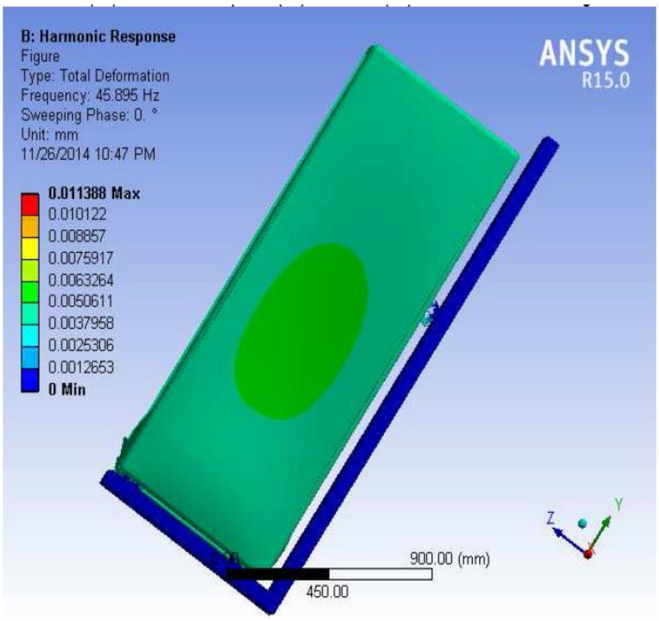

Figure: Total deformation of rugged system rack at frequency 45.895Hz

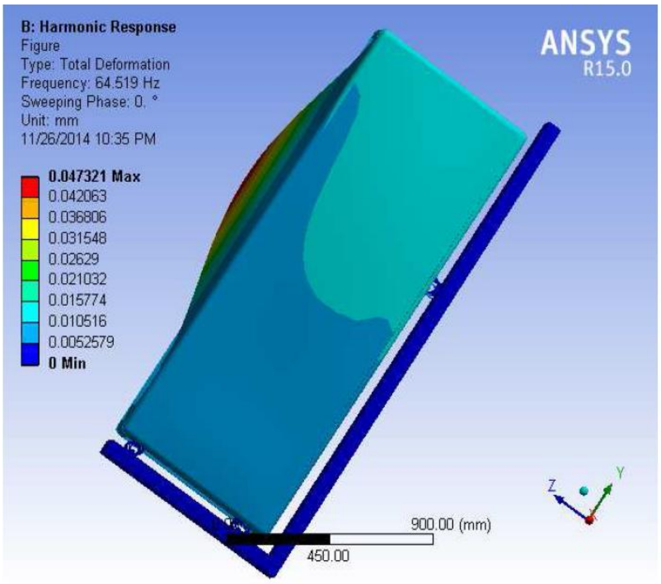

Figure: Total deformation of rugged system rack at frequency 64.519Hz

3.4 ANALYSIS RESULTS OF RUGGED SYSTEM RACK WITH OUT SPRING SUPPORT
MATERIAL: ALUMINUM

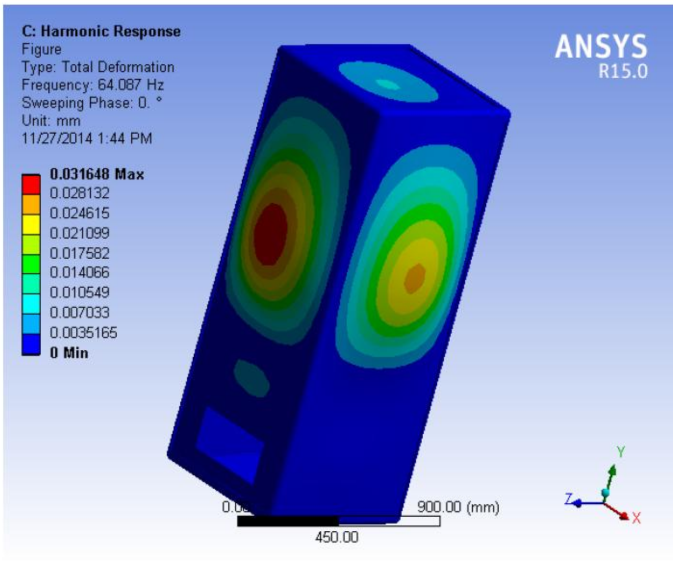

Figure: Total deformation of rugged system rack at frequency 64.087Hz

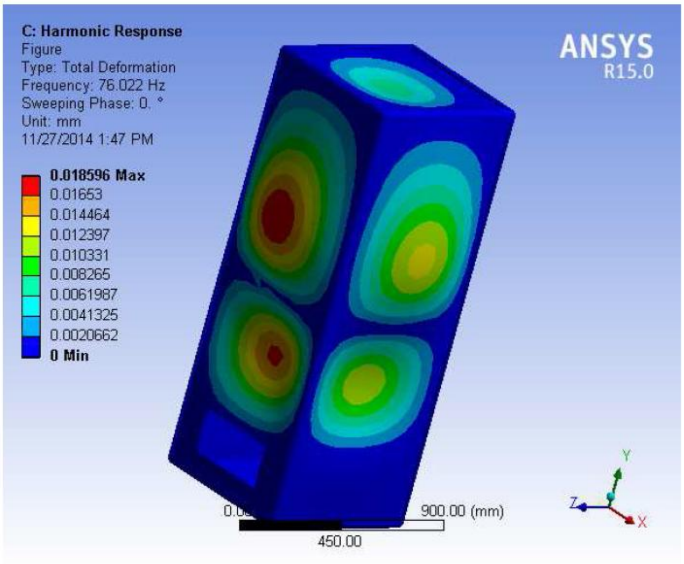

Figure: total deformation strain of rugged system rack at frequency 76.022Hz

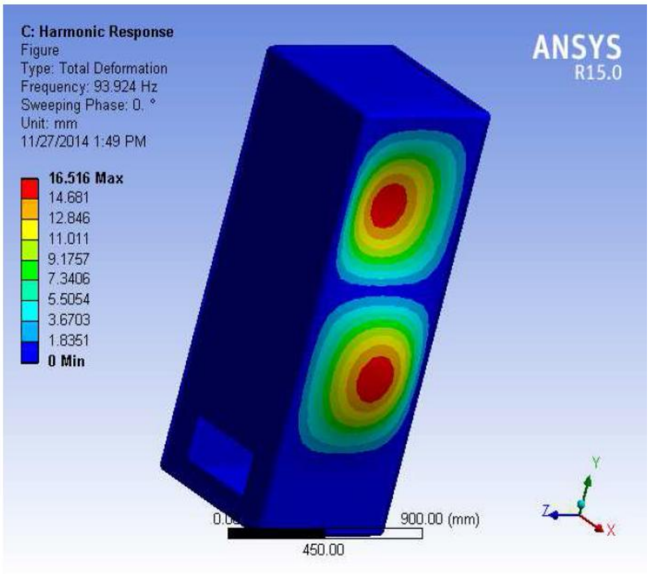

Figure: total deformation of rugged system rack at frequency 93.924Hz

3.5 ANALYSIS RESULTS OF RUGGED SYSTEM RACK WITH OUT SPRING SUPPORT

MATERIAL : STAINLESS STEEL

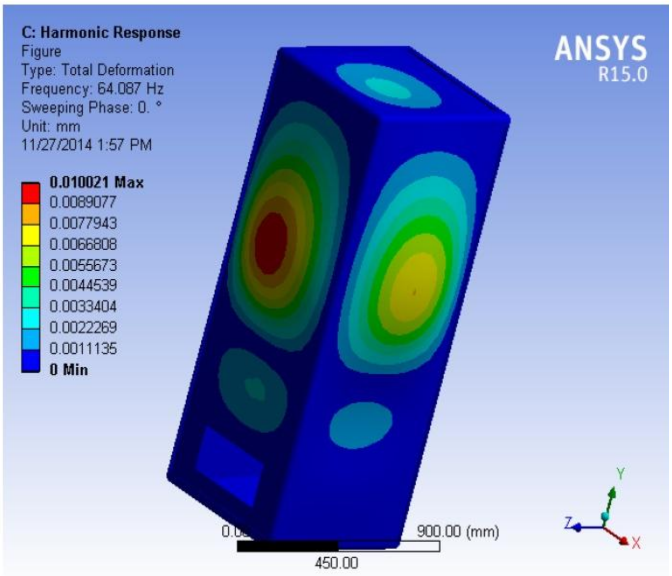

Figure: Total deformation of rugged system rack at frequency 64.087HHz

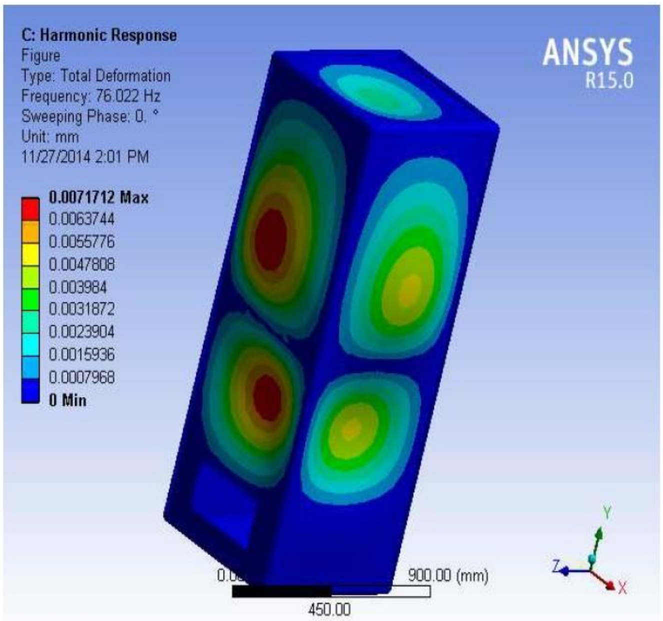

Figure: Total deformation of rugged system rack at frequency 76.022Hz

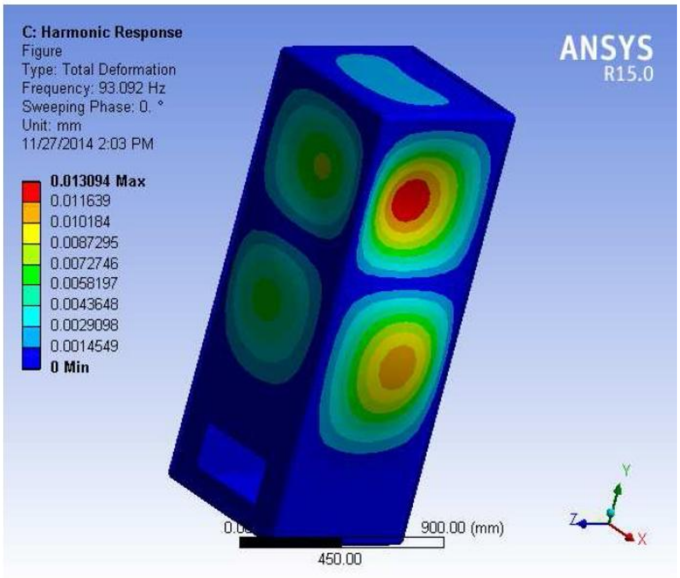

Figure: Total deformation of rugged system rack at frequency 93.092Hz

IV. RESULTS AND CONCLUSION

Analyses have been performed on the rugged system rack with spring support and without spring support at three different frequencies for both stainless steel and Aluminum and the results are shown below.

4.1 ANALYSIS RESULTS OF RUGGED SYSTEM RACK WITH SPRING SUPPORT

Material: Aluminum			
Frequency Hz	**Total deflection mm**	**Equivalent elastic strain**	**Equivalent stress MPa**
33.487	0.02	8.2×10^{-5}	5.43
45.895	0.03	1.02×10^{-4}	6.27
64.519	0.19	1.85×10^{-4}	12.86
Material: Stainless steel			
33.487	0.0080	3.13×10^{-5}	5.59
45.895	0.0113	3.86×10^{-5}	6.45
64.519	0.0473	7.58×10^{-5}	12.68

4.2 ANALYSIS RESULTS OF RUGGED SYSTEM RACK WITHOUT SPRING SUPPORT

Material: Aluminum			
Frequency Hz	**Total deflection mm**	**Equivalent elastic strain**	**Equivalent stress MPa**
64.087	0.0316	3.72×10^{-6}	0.26
76.022	0.0185	3.19×10^{-6}	0.22
93.924	16.516	2.34×10^{-3}	166.24
Material: Stainless steel			
33.487	0.010	1.18×10^{-6}	0.22
45.895	0.0071	1.25×10^{-6}	0.24
64.519	0.0130	2.79×10^{-6}	0.53

From the above analysis we observe that the stainless steel rack has less deflections and stresses compared to that of the Aluminum. And we also observe that the stresses for the Aluminum rack are below the yield strength of the material. Hence we prefer Aluminum over Stainless steel for the rugged system rack. the maximum allowable deflection in the Aluminum structure should be less than one “mm”. So the designed model within the safe limit and to withstand the high dynamic vibrations and shocks.

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