International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 8, August 2016)

Analysis and Performance Evaluation of Twin Leaf form Spring for Damping Engine Vibrations in Agriculture Sprayer

Sachin Iche[1], Prof. Dr. F. B. Sayyad[2]

[1]*M.E (Mechanical Design Engineering) GS Moze College of Engineering, Balewadi, Pune, India*
[2]*Assistant Professor, Department of Mechanical Engineering, GSMCOE, Pune, India*

***Abstract* -Many a agriculture equipment operated as hand held or back mounted are operated using micro – petrol/gasoline engine. These engines range between 1 to 1.5 Kw power and are mounted on the frame that is held and supported on the back of the operator. Generally agriculture spray pumps are commonly used in this manner. The operations of these engines is not vibration free, these vibrations are damped using rubber bushes between engine base and mount plate. As these engine vibrations are substantial they lead to back pain and other health disorders hence need to be effectively damped. The Twin leaf form spring device uses the concept of stiffness of steel and shock absorbing capacity of poly vinyl rubber elastomer to create the desired damping effect. The arrangement will be introduced between the engine base and the mount plate along with foundation bolts. The paper presents the analysis of the elastomer inserts used for damping the top / bottom mount brackets and vibrational performance of the device as to amplitude, velocity and acceleration of the engine base before and after use of damper at various throttle openings.**

***Keywords*-Finite Element Analysis, Agriculture spray, Elastomer inserts, modal analysis.**

I. INTRODUCTION

In order to meet the food requirements of the growing population and rapid industrialization, modernization of agriculture is inescapable. Mechanization enables the conservation of inputs through precision in metering ensuring better distribution, reducing quantity needed for better response and prevention of losses or wastage of inputs applied. Mechanization reduces unit cost of production through higher productivity and input conservation. Farmers are using the same methods and equipment for the ages. In our country farming is done by traditional way, besides that there is large development of industrial and service sector as compared to that of agriculture. The spraying is traditionally done by labor carrying backpack type sprayer which requires more human effort hence the concept of high speed sprayer coupled to a gasoline/petrol engine was thought of and has been successfully used over the years. These engines range between 1 to 1.5 Kw power and are mounted on the frame that is held and supported on the back of the operator.

II. BACKGROUND

Vibration exposure from prolonged and regular work with powered hand-held tools, equipment or processes can have adverse effects on the hands and arms of users.

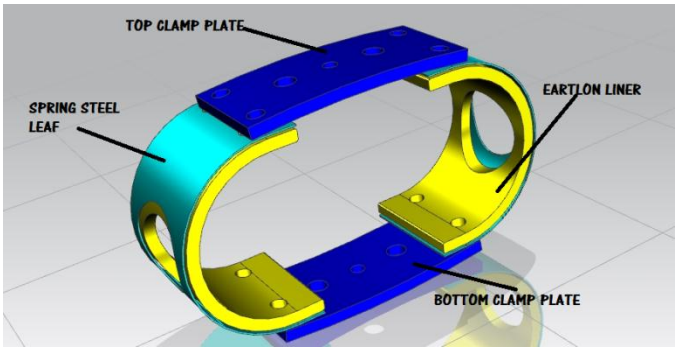
Without effective controls, workers using such equipment may suffer various forms of damage, collectively known as ‘hand-arm vibration syndrome’ (HAVS). This is a painful condition and the effects can include impaired blood circulation, damage to the nerves and muscles, and loss of ability to grip properly. The best known form of damage is ‘vibration white finger’ (VWF), which is a prescribed industrial disease.

Problem Statement:

Generally agriculture spray pumps are commonly used in this manner. The operations of these engines is not vibration free, these vibrations are damped using rubber bushes between engine base and mount plate. As these engine vibrations are substantial they lead to back pain and other health disorders hence need to be effectively damped.

Solution:

The Twin leaf form spring device uses the concept of stiffness of steel and shock absorbing capacity of poly vinyl rubber elastomer to create the desired damping effect. The arrangement will be introduced between the engine base and the mount plate along with foundation bolts.



Legislation and HSE guidance

Under health and safety legislation1,2,3 employers and machine makers must consider what action is necessary to reduce risks to health, so far as is reasonably practicable.

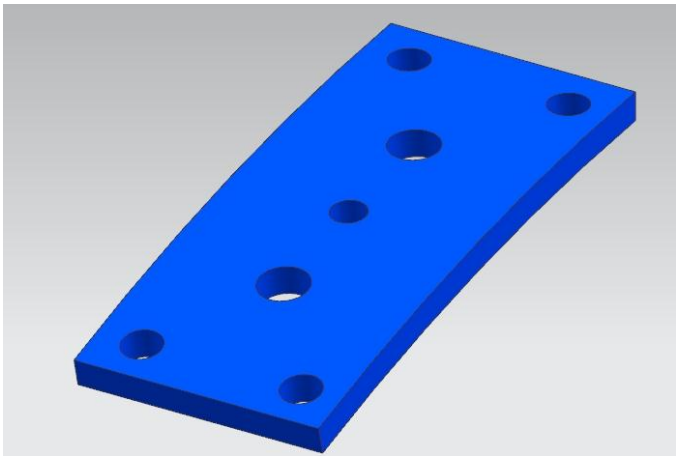
International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 8, August 2016)

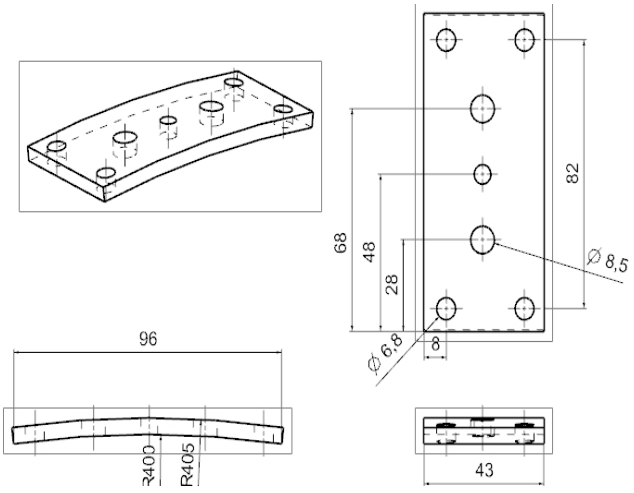
HSE has published authoritative guidance, *Hand-arm vibration* (HS(G)88),4 as a source of reference for those involved in identifying and controlling the risks of HAVS. It contains extra technical details to complement the case studies and includes sections on: hazard and control programmes; technical ways to reduce vibration; clinical effects and the health surveillance programme; and measuring hand-arm vibration. A list of other relevant publications is included in the 'Further reading' section.

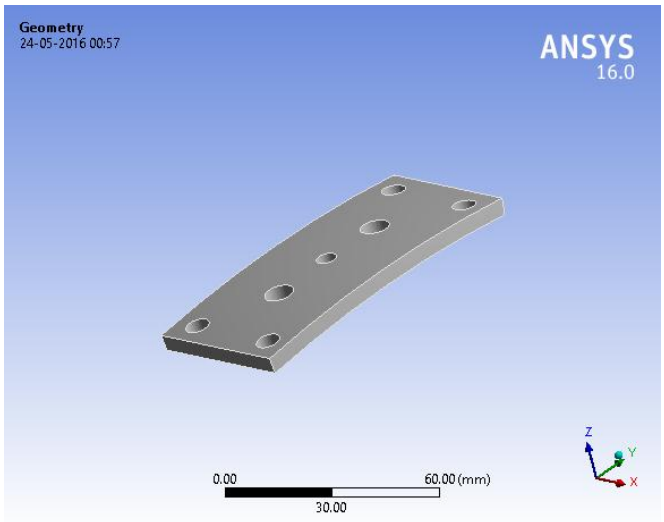
III. Methodology Of Analysis

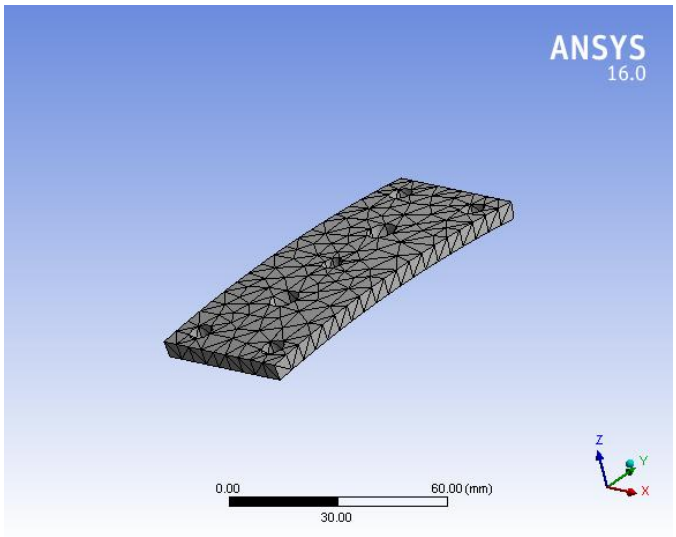
1. Solid model of the components were made using UG-NX
2. Data was transferred using STEP203 file exchange system
3. The Analysis was done in ANSYS 16.0

Analysis Of Top / Bottom Clamp Plate:





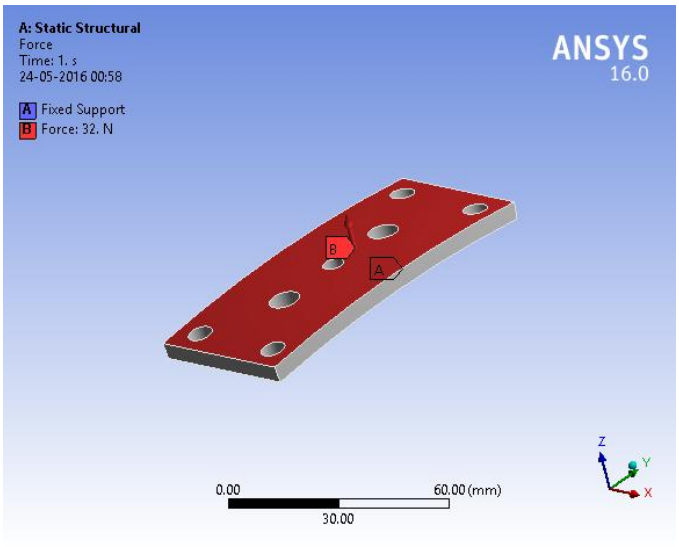


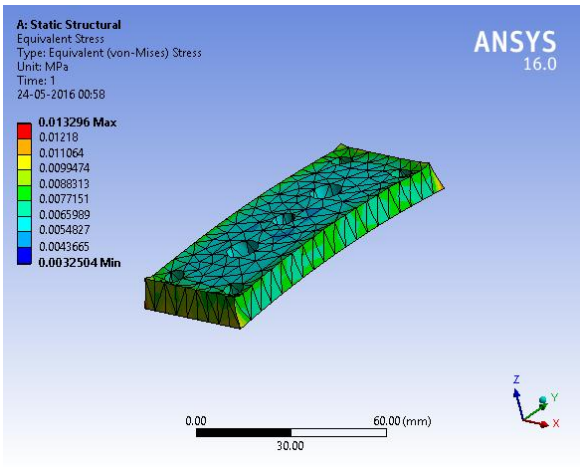


Nodes	2114
Elements	991

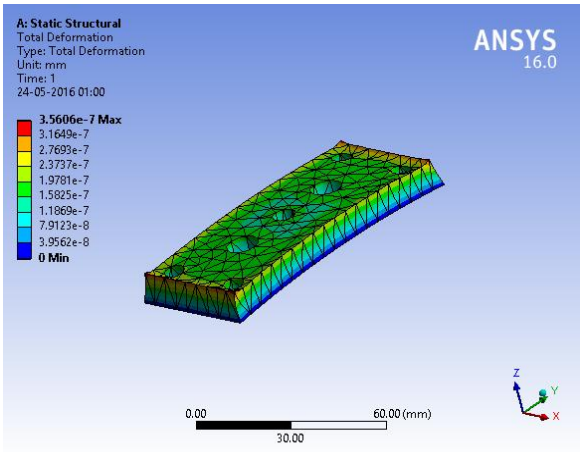
Material of component : Delrin
Allowable stress in material : 26 N/mm2

International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 8, August 2016)



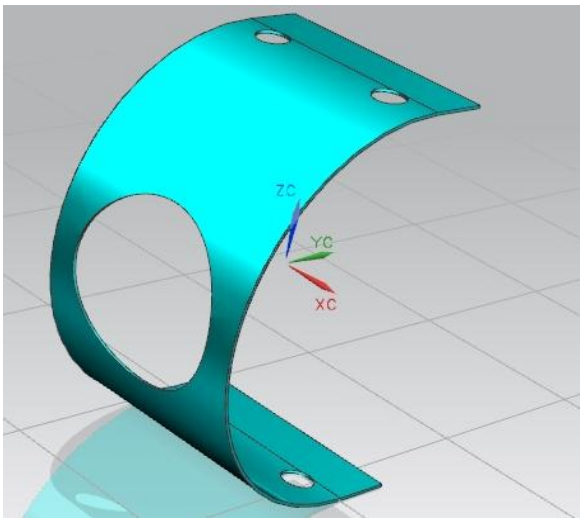


As the maximum stress value is well below the allowable limit the top/bottom clamp bracket is safe.



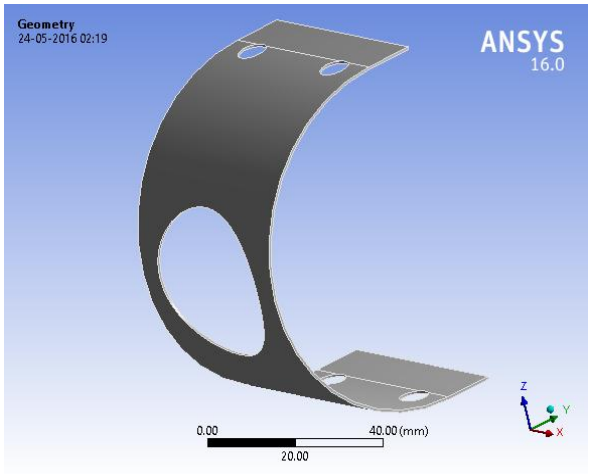
Maximum deformation under the action of weight of engine is negligible.

Analysis Of The Spring Steel Leaf:

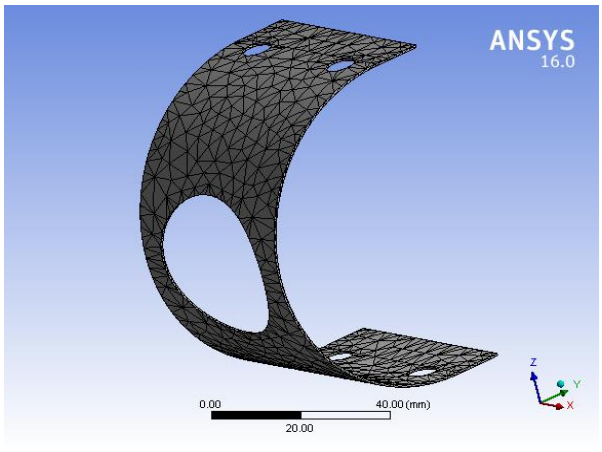


Material: Spring Steel

Maximum allowable stress=233 N/mm2

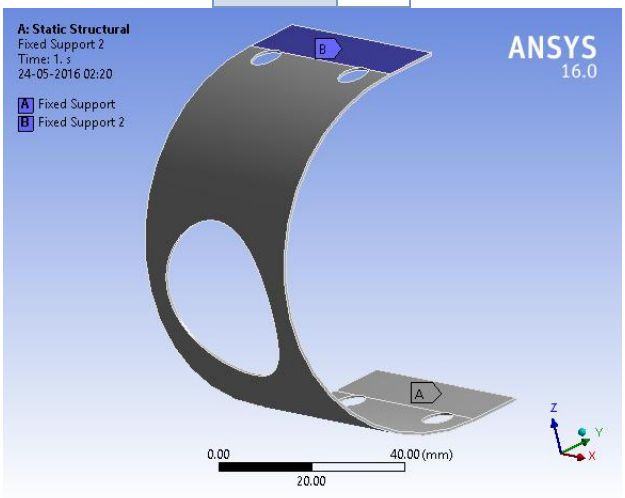


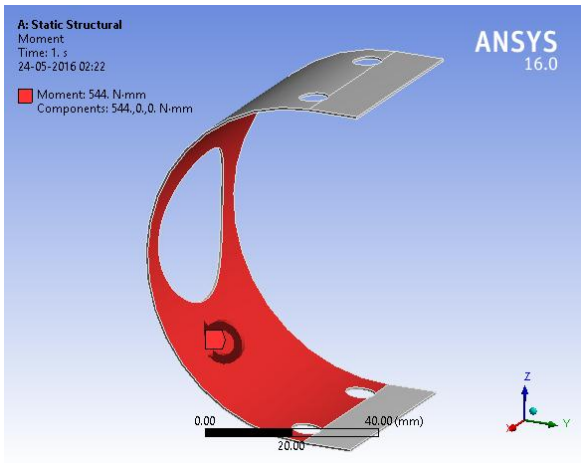
International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 8, August 2016)

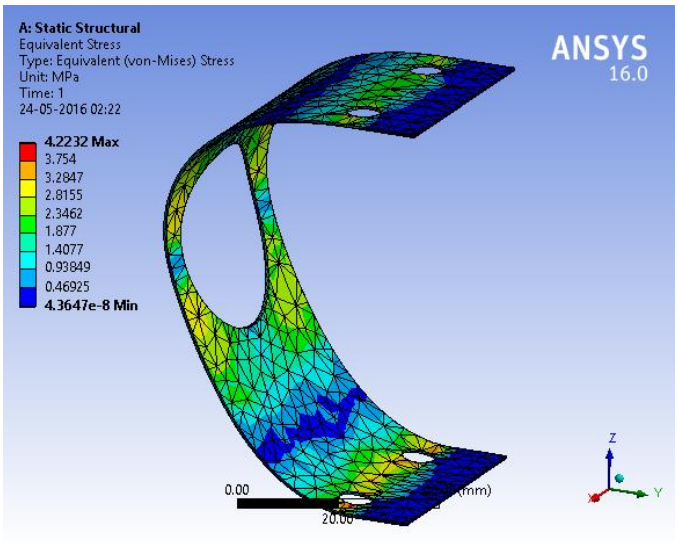


Mesh parameters:

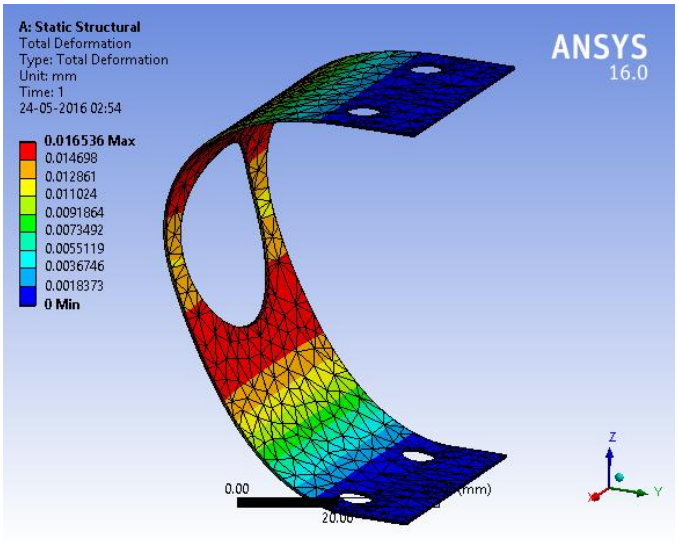
Nodes	5899
Elements	2614







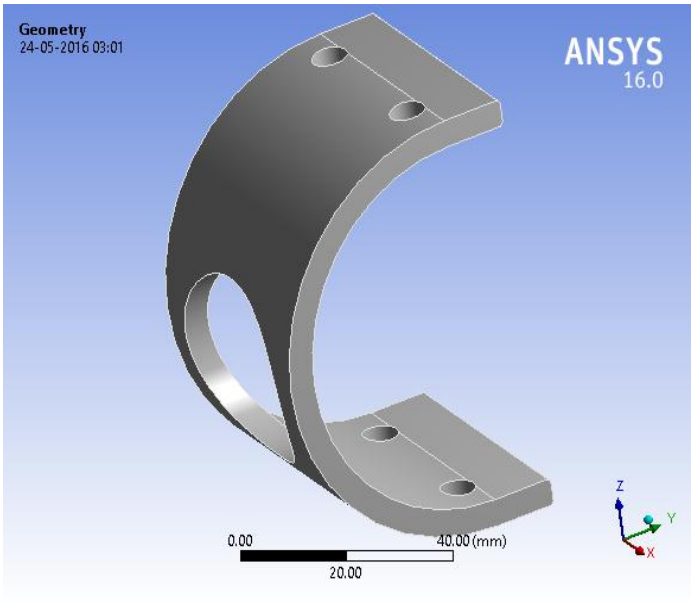
As the maximum stress value is well below the allowable limit the spring steel leaf is safe.

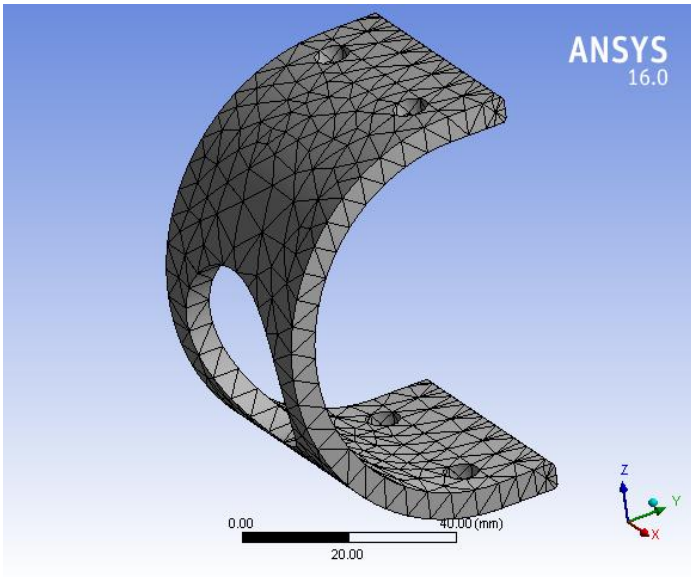


Maximum deformation owing to the moment applied is negligible.

International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 8, August 2016)

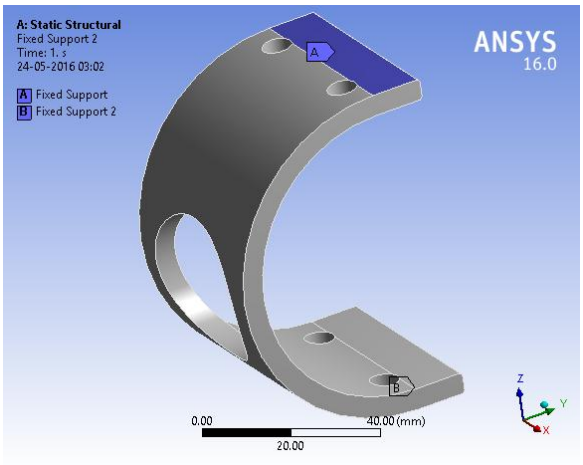
Analysis Of Eartlon Liner:

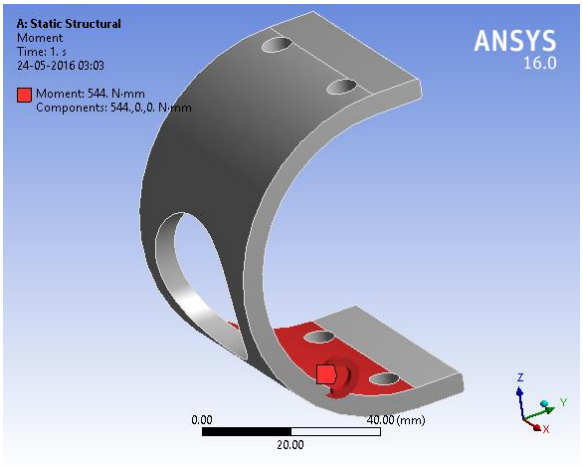




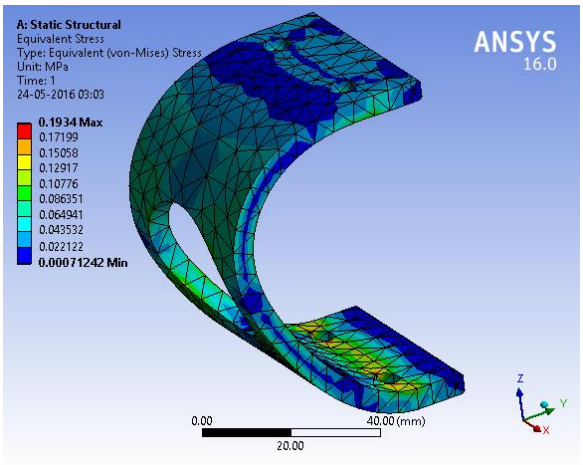
MESH PARAMETERS :

Nodes	4006
Elements	1866
Mesh Metric	None

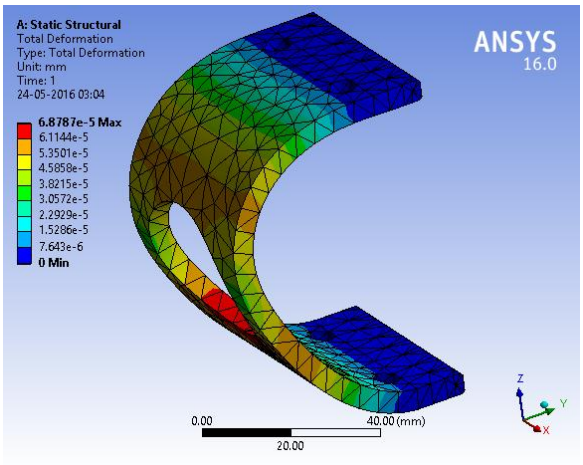




International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 8, August 2016)



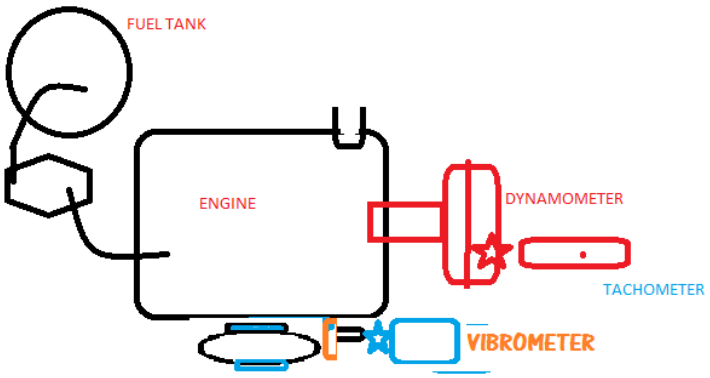
As the maximum stress value is well below the allowable limit the EARTLON LINER is safe.



Maximum deformation owing to the moment applied is negligible.

Performance Evaluation As To Performance Of Twin Leaf Spring Damper For Various Throttle Opening Of The Engine.

Schematic of the test rig is as follows :



Equipment used for trial are as follows:

a) *Digital Tachometer:* This is used to measure engine speed at various throttle openings.

b) *Digital Vibrometer:* This is used to displacement and acceleration parameters of the engine for various throttle openings.

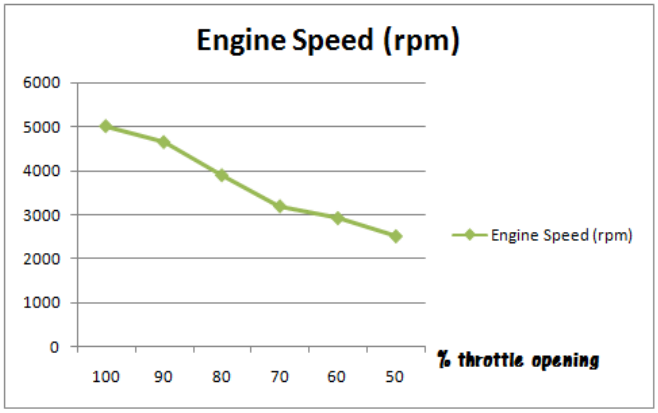
Procedure Of Trial:

1. The engine is started.
2. The throttle is taken to full opening position to generate maximum rpm @no load condition.
3. Speed at engine output pulley is measured.
4. The vibration parameters of displacement and acceleration are measured.
5. The throttle is closed by 10% (i.e. 90 % throttle opening is maintained) approximately
6. Speed at engine output pulley is measured.
7. The vibration parameters of displacement and acceleration are measured.
8. Similar set of readings are repeated and tabulated in result table below.

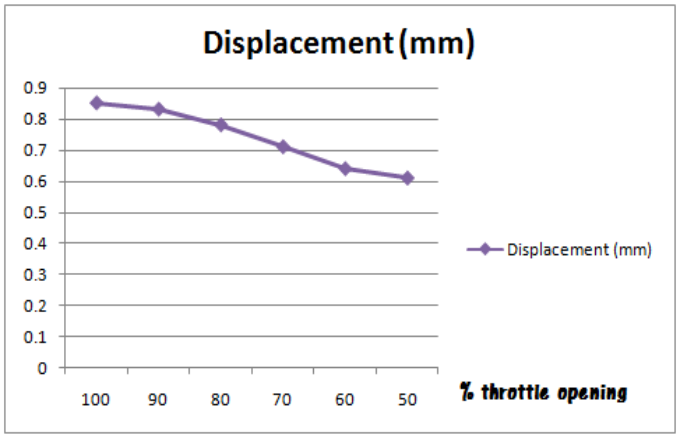
International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 8, August 2016)

Result Table :

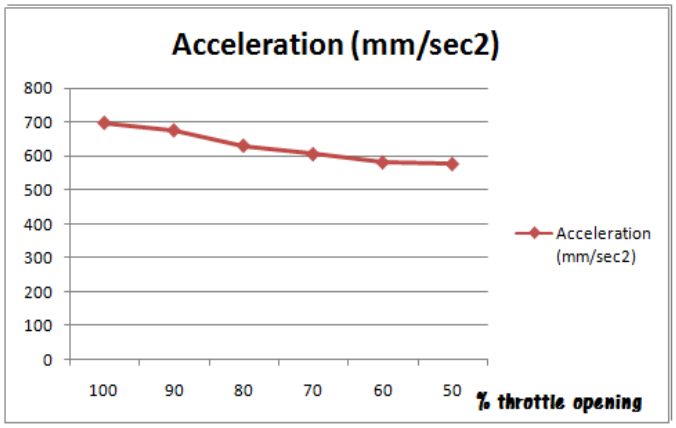
SR .NO	% Throttle opening	SPEED	Displacement (mm)	Acceleration mm/sec2
1	100	5000	0.85	698
2	90	4640	0.83	676
3	80	3890	0.78	631
4	70	3190	0.71	606
5	60	2920	0.64	582
6	50	2510	0.61	577



The engine speed increases with increase in throttle opening



Engine vibration displacement increases with increase in throttle opening as engine speed increases but is maintained well below 1mm by use of the twin leaf spring damper.



Engine vibration acceleration increases with increase in throttle opening as engine speed increases but is maintained well below 1m/sec2 by use of the twin leaf spring damper.

IV. Final Result And Discussion

1. The top/bottom clamp bracket analyzed using ANSYS shows stress well below allowable limit and deformation is negligible hence it is safe under given system of loads.
2. The spring steel leaf analyzed using ANSYS shows stress well below allowable limit and deformation is negligible hence it is safe under given system of loads.
3. The eartlon liner analyzed using ANSYS shows stress well below allowable limit and deformation is negligible hence it is safe under given system of loads.
4. Engine speed increases with increase in throttle speed.
5. The displacement value of acceleration increases with engine speed but is maintained well below 1mm by the twin leaf design.
6. The acceleration value of vibration by use of the twin leaf design is maintained well below 1m/sec2 which is far below permissible limit of 6.8 m/sec2 for hand arm vibration in hand tools.

V. Future Scope

1. Comparative analysis between the different materials for outer leaf will be done.
2. Comparative analysis between the vibration parameters with conventional butyl rubber dampers and twin leaf dampers will be done.

REFERENCES

[1] John C. Snowdon, Vibration isolation: Use and characterization (Applied Research Laboratory, Pennsylvania State 20 July 1979)

[2] J. K. Baker, Vibration Isolation (Published for the Design Council, The British Standard Institution, and the Council of Engineering Institutions by Oxford University Press, 1975)

[3] T. P. C. Bramer, G. J. Cole, J. R. Cowell, A. T. Fry, N. A. Grundy, T. J. B. Smith, J. D. Webb, D. R. Winter bottom, Basic Vibration Control (Sound Research Laboratory Limited, 1977)

[4] Kripa K. Varanasi, Vibration Damping Using Low-Wave-Speed Media with Applications to Precision Machines (Massachusetts Institute of Technology, June 2004)

[5] John D. Ferry, Viscoelastic properties of polymers 3rd Edition, 1980.

[6] Department of Mechanical Engineering, Viswanadha Institute of Technology & Management, Static and dynamic analysis on composite leaf spring in heavy vehicle –pp-74-89.

[7] IOSR Journal of Mechanical and Civil Engineering,Analysis of Steel and Composite Leaf Spring for Vehicle (IOSR-JMCE)e-ISSN: 2278-1684 Volume 5, Issue 4 (Jan. - Feb. 2013), PP 68-76.

BIBILOGRAPHY

Sachin Iche was born in Gwalior City in 1980. He received the B.E. degrees in Mechanical engineering from the Amravati University in 2003. He is currently pursuing Masters of Engineering in Design. He is working on Analysis and performance evaluation of twin leaf form spring for damping engine vibrations in agriculture sprayer his interest includes Mechanical design engineering.

Dr. Farook B. Sayyad Professor Mechanical Engineering. G. S. Moze College of Engineering, Pune. Born in 1978, Maharashtra India. He received the Bachelor of Engineering. in Mechanical branch from Shivaji University in 2000.
He has completed his ME from Shivaji University in 2002. Further he completed his PhD. From Singhaniya University. He is working as Professor in Mechanical Engineering Dept. of GS Moze College of Engineering Balewadi Pune. His work of interest is Mechanical Vibration. He has 14 years of teaching experience. He is the author of 8 national and 20 international papers. He is also known author of 2 reference books and 20 text books in mechanical engineering.