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Design Development and Analysis of Viscous Damper for Vibration Reduction in Hand Held Power Tool

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Abstract - Hand-arm vibration (HAV) is vibration transmitted from a work processes into workers' hands and arms. It can be caused by operating hand-held power tools, hand-guided equipment, or by holding materials being processed by machines. Multiple studies have shown that regular and frequent exposure to HAV can lead to permanent adverse health effects, which are most likely to occur when contact with a vibrating tool or work process is a regular and significant part of a person's job. Hand-arm vibration can cause a range of conditions collectively known as hand-arm vibration syndrome (HAVS), as well as specific diseases such as white finger or Raynaud's syndrome, carpel tunnel syndrome and tendinitis. Vibration syndrome has adverse circulatory and neural effects in the fingers. The signs and symptoms include numbness, pain, and blanching (turning pale and ashen).so these vibration reduce by using viscous damper.

Key Words: Hand-held vibrating tools, Hand-transmitted vibration level, Hand Arm Vibration syndrome. Damper design, Piston Design.

I. INTRODUCTION

The increasing demands of high productivity and economical design led to higher operation speeds of machinery and efficient use of materials through lights weights structures. These makes the trend of resonance condition more frequent the periodic measurement of vibration characteristics of machinery and structures become essential to ensure adequate safety margins. Any observed shifts in the natural frequencies or other vibration characteristics will indicate either failure or a need for maintenance of the machine. The measurement of the natural frequencies of the structure or machine is useful in selecting the operational speed of nearby machinery to avoid resonant condition. The theoretically computed vibration characteristics of a machine or structure may be different from the actual value due to the assumptions made in the analysis. In many applications survivability of a structure or machine in a specified vibration environment is to be determined. If the structure or machine can perform the expected task even after completion of testing the specified environment, it is expected to survive the specified conditions. Hand-arm vibration (HAV) is vibration transmitted from a work processes into workers' hands and arms. It can be caused by operating hand held power tools, hand-guided equipment, or by holding materials being processed by machines. Multiple studies have shown that regular and frequent exposure to HAV can lead to permanent adverse health effects, which are most likely to occur when contact with a vibrating tool or work process is a regular and significant part of a person's job. So, we design and analysis for discuss damper for reduction hand held power machinery.

II. DESIGN OF VICIOUS DAMPER

The design of damper were done analytically as well on ANSYS software for the following.

A) Analytical Damper body Design:

Material selection,

Table 1 show the Ultimate Tensile strength and Yield strength in N/mm2 for EN08

Designation	Ultimate Tensile strength N/mm2	Yield strength N/mm2
EN08	380	270

Table 1: Ultimate Tensile strength and Yield strength in N/mm2 for EN08

Factor of safety is taken as 20.

fc_{all} for damper body is,

fc_{all} = $Ultimate$ Tensile $Sterngth/Factorofsafety$

= 380/20

= 1.90N/mm2

Hoope's stress due to exhaust gas pressure:-

Maximum pressure induced in system due to steam= 3 bar

fc_{act} = $Pd2t$

fc_{act} = 0.3 ×282×4

fc_{act} = 1.4 N/mm2

As, $fc_h < fc_{all}$;

Damper body is safe.

B) Analysis Damper body Design:

Geometry is modeled in catia and imported with igs format in Ansys workbench for analysis

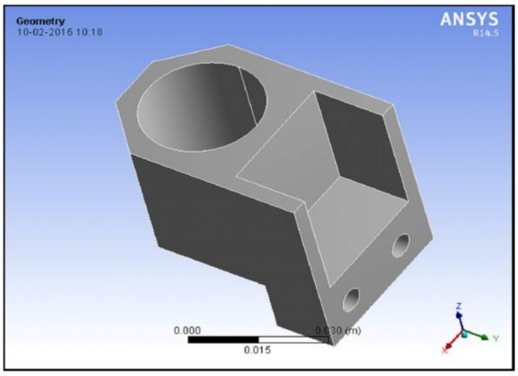

Fig1: Damper body

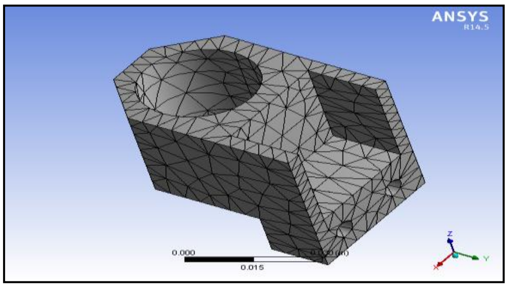

Fig2: Meshing of damper body

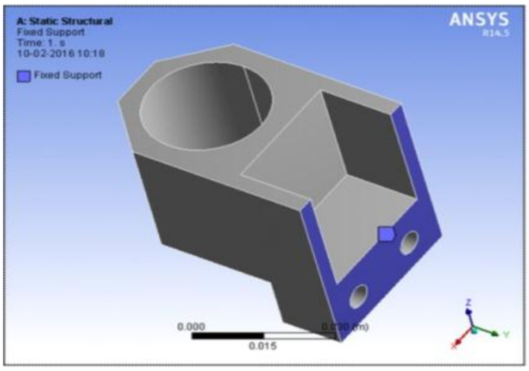

Fig3: Boundary Condition, Fixed support along z-direction

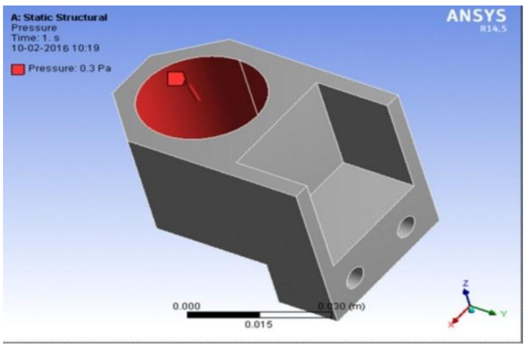

Fig4: Boundary Condition, Circumferential stress applied along z-axis

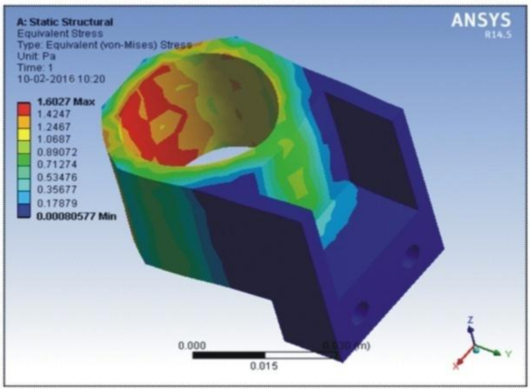

Fig5: Von Mises Stress, Equivalent stress

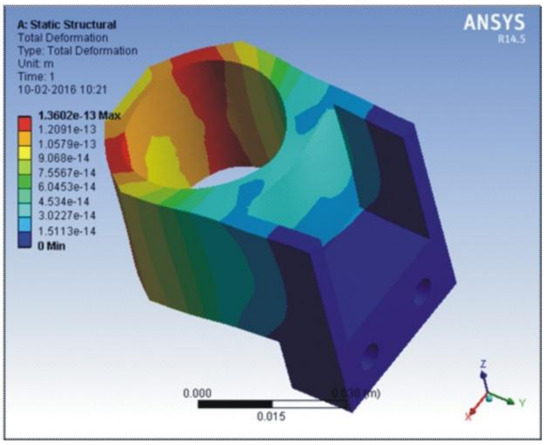

Fig6: Total deformation of damper bod

C) Analytical Design of Piston Rod:

Table 2 show the Tensile strength and Yield strength in N/mm2 for EN08

Ref :- (PSG – 1.12)

Designation	Tensile Strength N/mm^2	Yield Strength N/mm2
EN24	800	680

Table 2: Ultimate Tensile strength and Yield strength in N/mm2 for EN24

Factor of safety is taken as 20

f_{call} for damper body is,

$f_{call} = Ultimate\ tensile\ strength/Factor of safety$

$= 800/20$

$= 40N/mm^2$

Direct Tensile or Compressive stress due to an axial load:-

Piston force = Pressure x area

$= 0.3 \times (\pi/4)\ 28^2$

Piston force = 184N

Calculate Actual compressive stress,

$f_{cact} = \frac{W}{A}$

$f_{cact} = \frac{W}{\frac{\pi}{4}\times 12^2}$

$fc_{act} = 184 \ \pi 4 \times 122$

$fc_{act} = 2.62 \ N/mm^2$

As, $fc_{act} < fc_{all}$;

Piston rod is safe in compression.

D) Analysis of Design of Piston Rod:

Geometry is modeled in catia and imported with igs format in Ansys workbench for analysis

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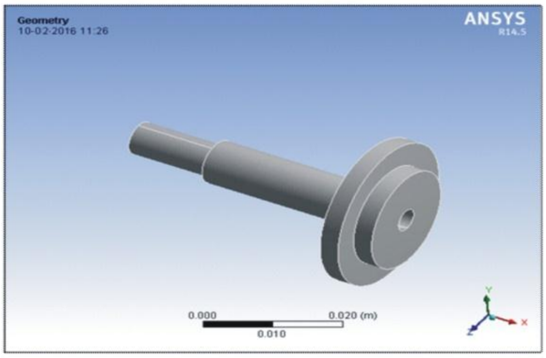

Fig7: Piston

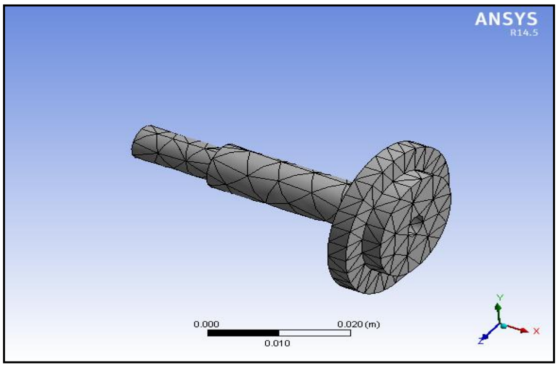

Fig8: Meshing of Piston

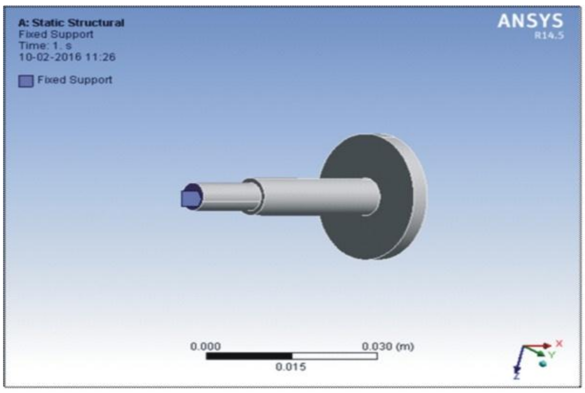

Fig9: Boundary Condition, Constraint applied at end along x-axis

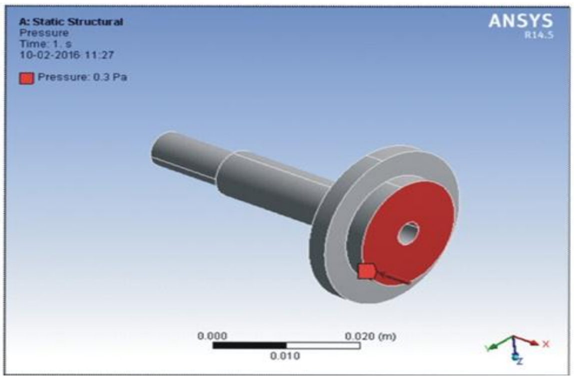

Fig10: Boundary Condition,Pressure applied from top end along x-axis

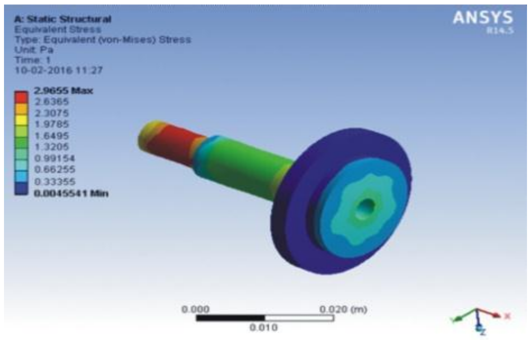

Fig11: Von Mises Stress, Equivalent stress of piston

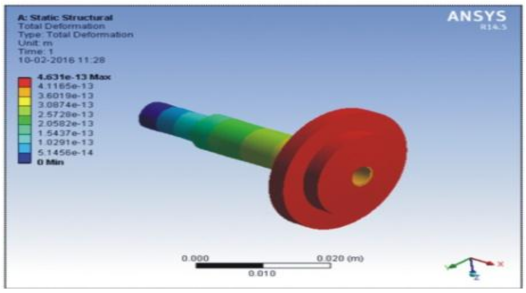

Fig12: Total deformation of piston.

III. RESULT AND DISCUSSION

Table 3 show the FEM results values.

Part Name	Maximum theoretical stress N/mm2	Von-misses stress N/mm2	Maximum deformation mm	Result
Damper body	1.4	1.6	1.36 x 10-13	Safe
Piston	2.62	2.9	4.63 x 10-13	Safe

Table 3: FEM results

IV. CONCLUSION

1. Maximum stress by theoretical method and Von-misses stress are well below the allowable limit, hence the damper body is safe
2. Damper body shows negligible deformation under the action of system of forces.
3. Maximum stress by theoretical method and Von-misses stress are well below the allowable limit, hence the piston is safe
4. Piston shows negligible deformation under the action of system of forces.

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