STATIC AND HARMONIC RESPONSE ANALYSIS OF AN AUTOMOTIVE SHOCK ABSORBER

Project report submitted

In partial fulfillment of the requirements of the degree of

Master of Technology

in

Automobile Engineering

by

ABHISHEK SHARMA

Roll No. 1801540001

Under the Supervision of

MR. SURENDRA KUMAR YADAV
(Asstt. Professor)

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

SCHOOL OF ENGINEERING AND TECHNOLOGY

K.R. MANGALAM UNIVERSITY

GURUGRAM, (HARYANA)

Session: 2019-2020

CERTIFICATE

It is certified that the work contained in the project report titled "**STATIC AND HARMONIC RESPONSE ANALYSIS OF AN AUTOMOTIVE SHOCK ABSORBER**" by the following student:

Name of the Student	Roll Number
Abhishek Sharma	1801540001

Has been carried out under my/our supervision and that this work has not been submitted elsewhere for a degree.

MR. SURENDRA KUMAR YADAV

(Assistant Professor)

School of Engineering and Technology

K R Mangalam University, Gurugram, Haryana, India

DECLARATION

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

(Name(s) of the student)	(Roll No.)	(Signature)
Abhishek Sharma	1801540001	

Date: 03/06/2020

APPROVAL SHEET

This project report entitled Static and Harmonic Response Analysis of an Automotive Shock Absorber by Abhishek Sharma is approved for the degree **of M.Tech (Automobile Engineering), School of Engineering and Technology.**

Dean (SOET)

Supervisor

Mr. Surendra Kumar Yadav

(Asstt. Professor)

DEAN
School of Engineering & Technology (SOET)
K.R. Mangalam University
Sohna road, Gurugram
Haryana 122103

ACKNOWLEDGEMENT

It gives me immense pleasure to express my deepest sense of gratitude and sincere thanks to my highly respected and esteemed guide **MR. SURENDRA KUMAR YADAV**, for his/their valuable guidance, encouragement and help for completing this work. His/Their useful suggestions for this whole work and co-operative behaviour are sincerely acknowledged.

I would like to express my sincere thanks to Dr./Mr. **MR. SURENDRA KUMAR YADAV** for giving me this opportunity to undertake this project. I also wish to express my indebtedness to my parents as well as my family member whose blessings and support always helped me to face the challenges ahead. At the end I would like to express my sincere thanks to all my friends and others who helped me directly or indirectly during this project work.

Place: Gurugram

Date:03/06/2020

Student Name: - Abhishek Sharma

Roll Number: - 1801540001

ABSTRACT

Shock absorber is a hydraulic pump like mechanical device that is installed in vehicle to control unwanted movement of a spring mounted vehicle. In this study, two different materials are used as potential shock absorber materials and their performance is calculated using FEA analysis. The materials used in this study and structural steel and aluminum alloy 6061. The stresses, deformations, fatigue life and vibrational analysis of both the shock absorbers are compared. It is studied that the steel shows excellent stress resistance even at heavy loads and the fatigue life of steel is higher than that of aluminum. However, both the materials show approximately equal vibrations when the loading is applied. The study suggests that both these materials can be used in the shock absorber, however because of high strength and high fatigue life characteristics, steel is preferred over aluminum.

Table of Contents

List of Figures viii

CHAPTER 1 INTRODUCTION 1

1.1 Shock Absorber 1

1.2 Working of shock absorber 1

1.3 Applications of shock absorber 2

1.4 Types of Shock absorber 3

1.4.1 Mono tube Shock absorber 3

1.4.2 Twin tube Shock absorber 4

1.4.3 Elastomeric /Rubber buffer type 5

1.4.4 Collapsing safety shock absorber 5

1.4.5 Pneumatic Cylinders 5

1.4.6 Self-compensating hydraulic cylinders 6

1.5 Different techniques to absorb shock 6

1.5.1 Hysteresis of structural material 6

1.5.2 Dry friction method 7

1.5.3 Solid state, tapered shock absorber 7

1.5.4 Fluid Friction 7

1.5.5 Magnetic effects 7

CHAPTER 2 LITERATURE REVIEW 8

CHAPTER 3 METHODOLOGY 18

3.1 Engineering Data 18

3.2 3D Model 21

3.3 Mesh 21

3.3.1 Contacts 22

3.4 Boundary Conditions 23

3.5 Solution 24

3.6 Results 24
3.6.1 Static Analysis 24
3.6.2 Fatigue analysis 25
3.6.3 Vibration analysis 26
CHAPTER 4 RESULTS AND DISCUSSIONS 27
4.1 Workflow diagram 27
4.2 4.2 Static structure Analysis 27
4.2.1 4.2.1 Total deformation 28
4.2.2 4.2.2 Von-mises Stresses 29
4.2.3 Equivalent Elastic Strain 30
4.2.4 Factor of Safety based on tensile stresses 31
4.2.5 Factor of safety based on shear criteria 33
4.3 Fatigue Analysis 35
4.3.1 Life 35
4.3.2 Damage 37
4.3.3 Factor of Safety 38
4.3.4 Bi-axiality indication 39
4.3.5 Fatigue sensitivity Analysis 40
4.4 Harmonic Analysis 42
4.4.1 Amplitude vs frequency 42
4.4.2 Phase angle vs frequency 43
4.4.3 Vibration induced deformation 45
4.4.4 Vibration induced Von-mises stresses 46
CHAPTER 5 CONCLUSION 50
References 51

List of Figures

Figure 3.1 Materials properties of structural steel. 19
Figure 3.2 Materials properties of Aluminum alloy NL. 20
Figure 3.3 S-N Curve graph 20
Figure 3.4 *3D view of shock absorber.* 21
Figure 3.5 Image of generated mesh in ANSYS 22
Figure 3.6 Mesh details. 22
Figure 3.7 Applied boundary conditions on Aluminum alloy. 24
Figure 3.8 Fatigue analysis criterions graphs. 25
Figure 4.1 Work-flow diagram of ANSYS window. 27
Figure 4.2 Contour of total deformation produced in structural steel 28
Figure 4.3 Contour of total deformation produced in aluminum alloy. 29
Figure 4.4 Contour of Von-mises stresses produced in structural steel. 29
Figure 4.5 Contour of Von-mises stresses produced in aluminum alloy. 30
Figure 4.6 Contour of equivalent elastic strain produced in structural steel. 30
Figure 4.7 Contour of equivalent elastic strain produced in aluminum alloy. 31
Figure 4.8 Contour of factor of safety based on tensile stress of structural steel. 32
Figure 4.9 Contour of factor of safety based on tensile stress of aluminum alloy. 33
Figure 4.10 Contour of factor of safety based on shear stress of structural steel. 34
Figure 4.11 Contour of factor of safety based on shear stress of structural steel. 35
Figure 4.12 Contour of life based on fatigue analysis of structural steel. 36
Figure 4.13 Contour of life based on fatigue analysis of structural aluminum alloy 37
Figure 4.14 Contour of maximum value of damage based on fatigue analysis of structural steel 37
Figure 4.15 Contour of maximum value of damage based on fatigue analysis of aluminum alloy 38
Figure 4.16 Contour of factor of safety based on fatigue analysis of structural steel 39
Figure 4.17 Contour of factor of safety based on fatigue analysis of aluminum alloy 39
Figure 4.18 Contour of bi-axiality indication based on fatigue analysis of structural steel. 40
Figure 4.19 Contour of bi-axiality indication based on fatigue analysis of aluminum alloy 40
Figure 4.20 Graph of fatigue sensitivity analysis of structural steel 41
Figure 4.21 Graph of fatigue sensitivity analysis of aluminum alloy. 42
Figure 4.22 Graph Amplitude vs frequency response of structural steel 43

Figure 4.23 Graph Amplitude vs frequency response of aluminum alloy. 43
Figure 4.24 Graph of phase angle vs frequency response of structural steel. 44
Figure 4.25 Graph of phase angle vs frequency response of aluminum alloy. 45
Figure 4.26 Contour of vibration induced deformation based on harmonic analysis of structural steel. 45
Figure 4.27 Contour of vibration induced deformation based on harmonic analysis of aluminum alloy. 46
Figure 4.28 Contour of vibration induced von-mises stresses based on harmonic analysis of structural steel. 46
Figure 4.29 Contour of vibration induced von-mises stresses based on harmonic analysis of aluminum alloy. 47
Figure 4.30 Complete list of results of total analysis done on both structural steel and aluminum alloy NL. 48