STUDY OF HARMONIC RESPONSE OF A WAVE SPRING OVER A COIL SPRING FOR AN AUTOMOBILE SHOCK ABSORBER

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***Abstract*: The shocks are used in automobile in order to observe the impulse energy of a moving vehicle as a result it dissipate kinetic energy which provides cushioning effect and improves the ride quality. In general coil spring are used as a shock absorber in two wheeler, which gets compressed when the load is applied and extends when the load is removed. This creates a vibration in the system until all the energy is absorbed.**
This paper aims at analysing a wave spring over a coil spring numerically by harmonic analysis, considering the weight of the vehicle and the weight of two passenger. Further the design is optimized by considering different wave number of a wave spring. Modelling was done by using Nx 9.0 and for the analysis ANSYS 14.0.

***Keywords*: Wave spring, Coil spring, Harmonic analysis, Shock absorber, Nx, ANSYS**

I. INTRODUCTION

The spring is an important part of an automobile. Which absorbs the impulse energy of a moving vehicle as a result it dissipate kinetic energy which provides cushioning effect and improves the ride quality [1,2,3]

Bhaskar Kulkarni et, al. [1] has done the work on the analysis of wave spring for 2 wheeler automobile vehicle. In which he took three different types of wave spring and compared with the coil or the compression spring by considering stress and deformation. It was found that the wave spring with 7 wave number was found to have much stiffness than the coil spring and the weight can be reduced by 22%, 49 % less stress and 40 % less deflections when compared[4,5].

In this paper Harmonic response of coil spring as well as the wave spring (circular cross-session) are compared by considering the weight of the vehicle and 2 passenger average weights. Ansys Workbench is used for the analysis and Nx – CAD is used for the design propose.

II. MATERIAL

The material used is **SAE 4135 spring steel.** Which is low alloy steel containing Chromium and Molybdenum as straighteners. It is heat treated for good strength while maintaining its toughness.

Table 1.1: Material Property

Density	7850 kg/m^3
Tensile Strength	880 MPa
Modulus of Elasticity	200 GPa
Poisons Ratio	0.3

III. LOAD CALCULATION

A. Considering vehicle and single rider weight.

Vehicle weight = 150 Kg

Rider weight (single person) = 75 Kg

Total Weight (W) = Vehicle weight + Rider weight

= 150 + 75

W = 225 Kg

Force distribution over front and rare suspension = 2:3 or 40:60

⇨ For rare suspension 60% of 225 Kg

= 135 Kg

Considering dynamic loads it will be double

∴ Total weight, Wt1 = 270 Kg

= 2648 N

For single shock absorber weight

$= \frac{Wt1.}{2} = \frac{2648}{2}$

Total Weight (W1) = **1324 N**

B. Considering vehicle and rider and co-passenger weight.

Vehicle weight = 150 Kg

Rider weight (Two person) = 75 + 75 = 150 Kg

Total Weight (W) = Vehicle weight + Rider weight

= 150 + 150

W = 300 Kg

Force distribution over front and rare suspension = 2:3 or 40:60

⇨ For rare suspension 60% of 300 Kg

= 180 Kg

Considering dynamic loads it will be double

∴ Total weight, Wt2 = 360 Kg

= 3532 N

For single shock absorber weight

$= \frac{Wt2.}{2} = \frac{3532}{2}$

Total weight (W2) = 1766+882

= **2648 N** (Considering additional load for safety)

IV. ANALYSIS

Analysis is done by using ANSYS WORKBENCH 14.0. The file was imported to ansys in .step format. The mesh details and boundary condition are defined below:

Table 1.2: Mesh Property

Physics Preference	Mechanical
Relevance	25
Advanced size function	Curvature
Element Mesh type	Hex Mesh Type
Curvature Normal Angle	45°
Min. Element Size	1.0 mm
Max. Face Size	10.0 mm
Max. Size	10.0 mm
Growth Rate	1.5
No. of Nodes	403374
No. of Elements	201662
Standard Deviation	32.89

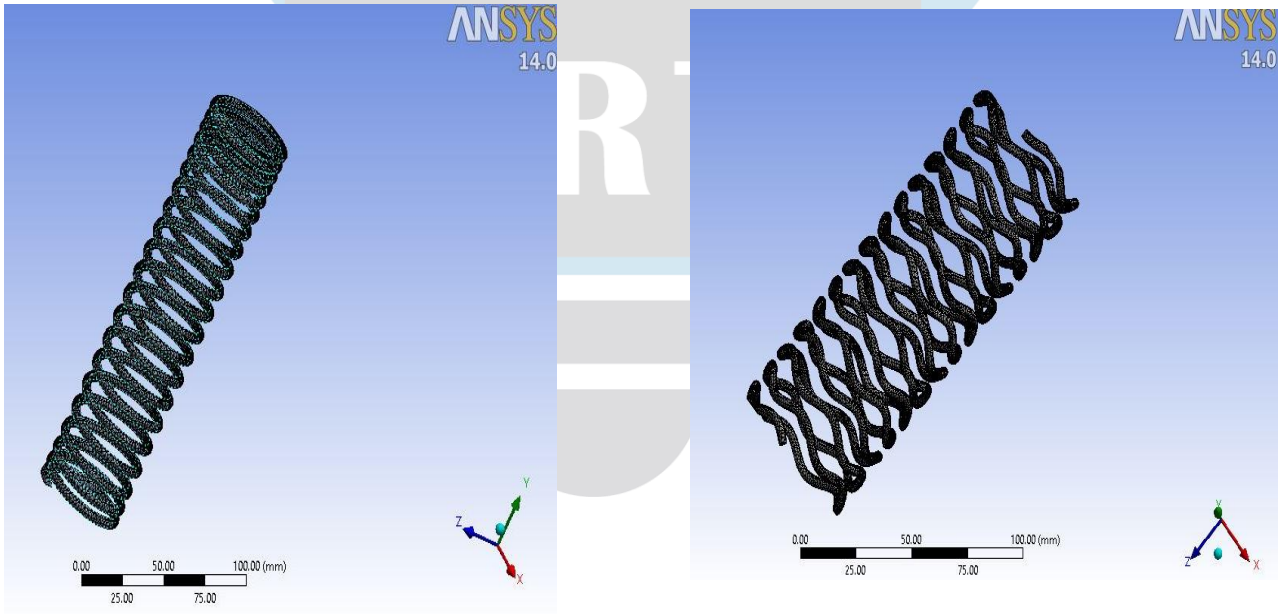


Fig. 1.1: Mesh image of coil and wave spring

A. Load 1324N

i. Compression Spring

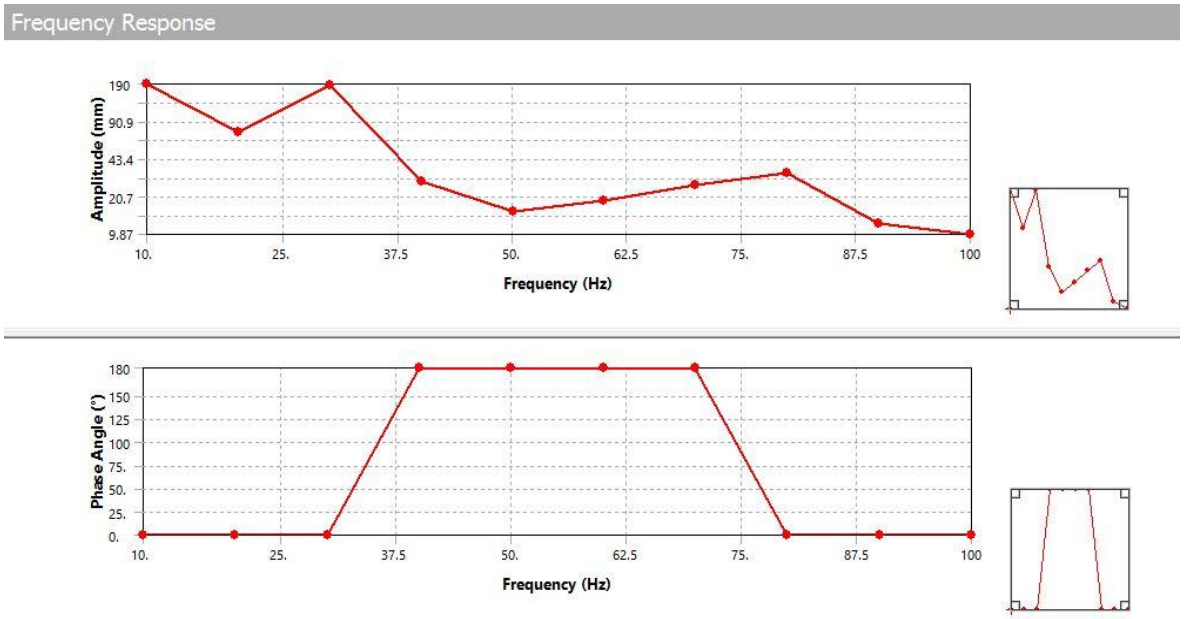


Fig. 1.2: Frequency response for deformation in mm

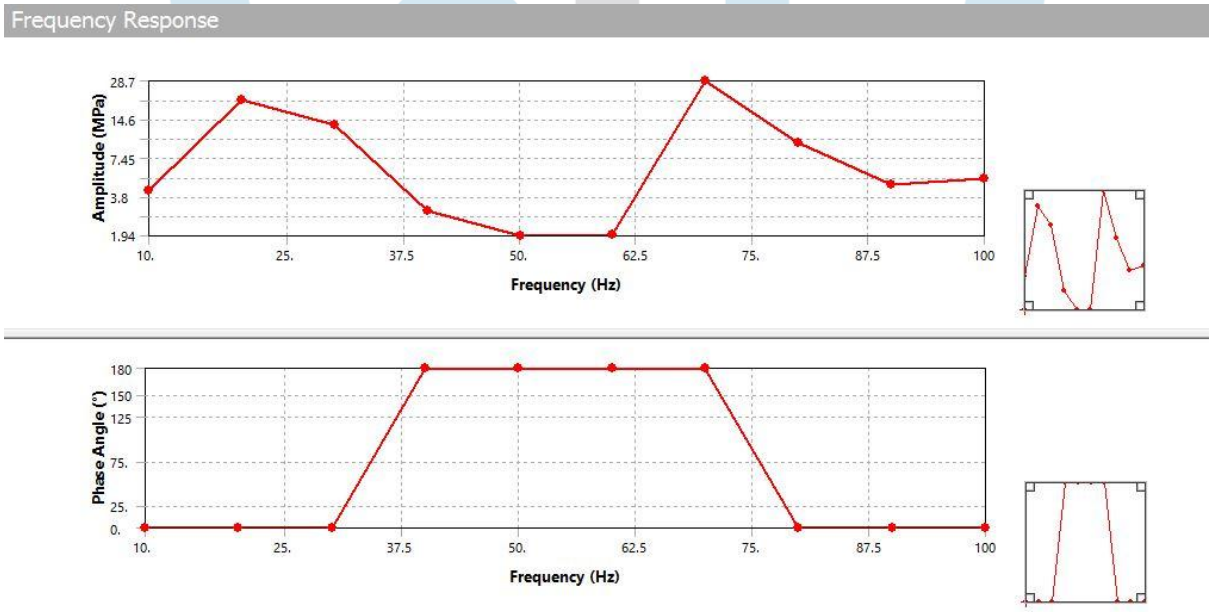
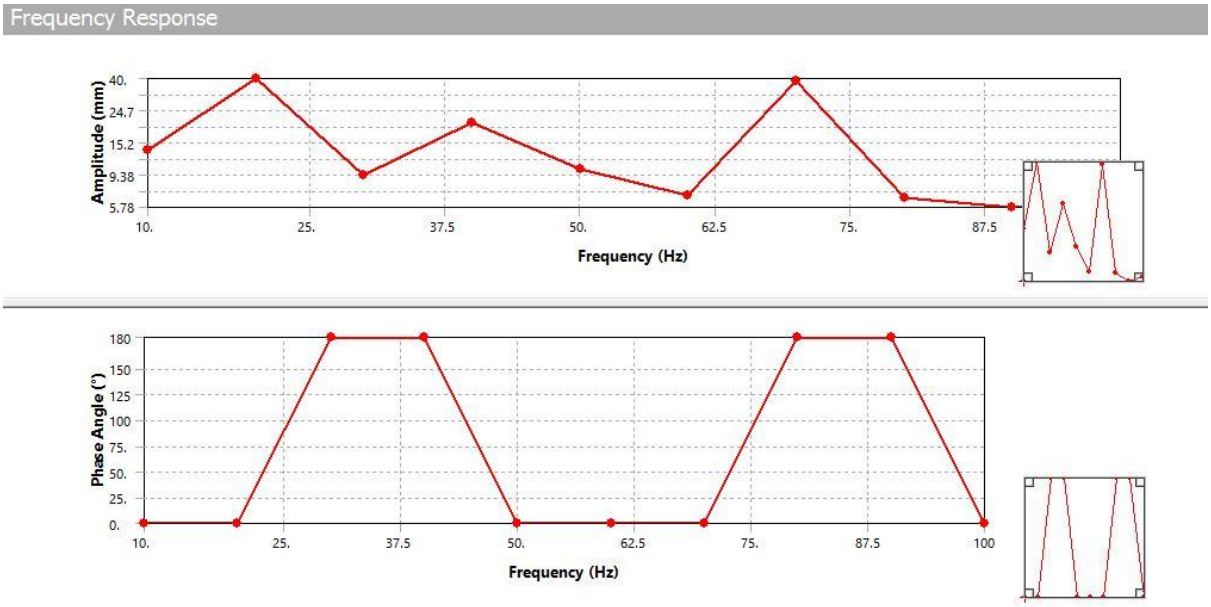


Fig. 1.3: Frequency response for stress in Mpa

B. Load 2648N

ii) Wave spring(4 wave)



1.4: Frequency response for deformation in mm

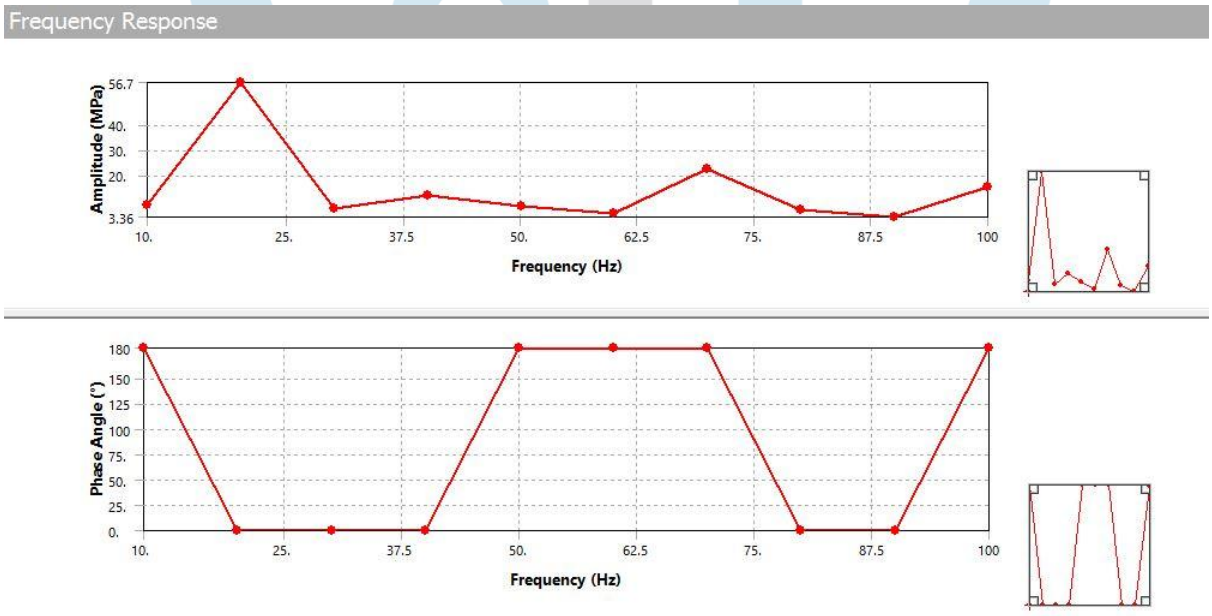


Fig. 1.5: Frequency response for stress in Mpa

iii. Wave spring(7 wave)

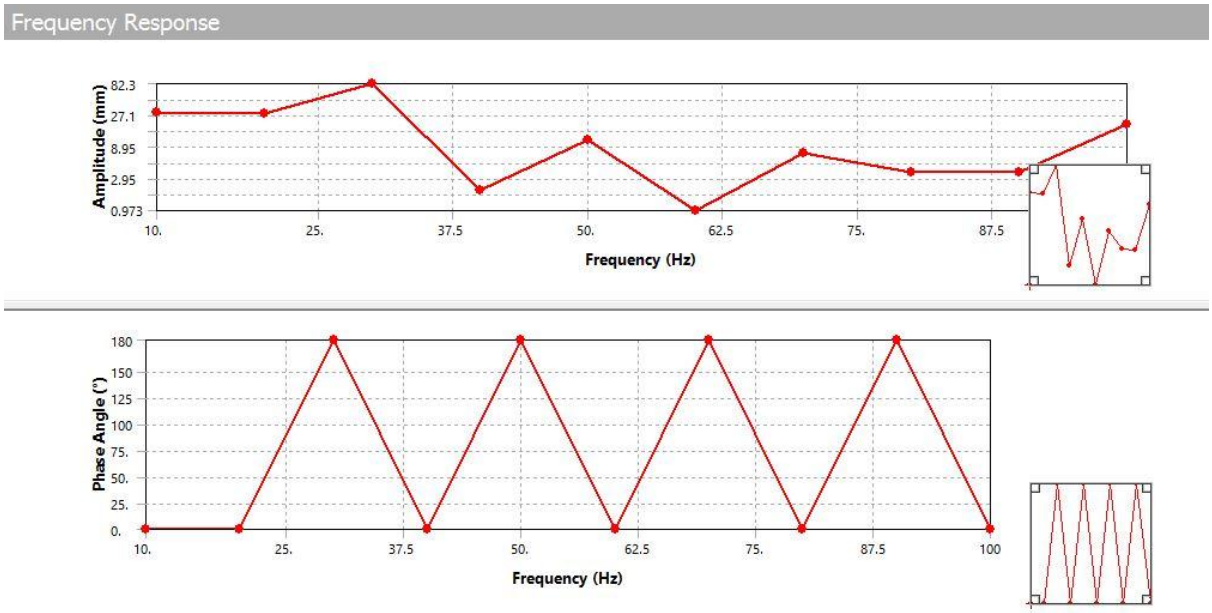


Fig. 1.6: Frequency response for deformation in mm

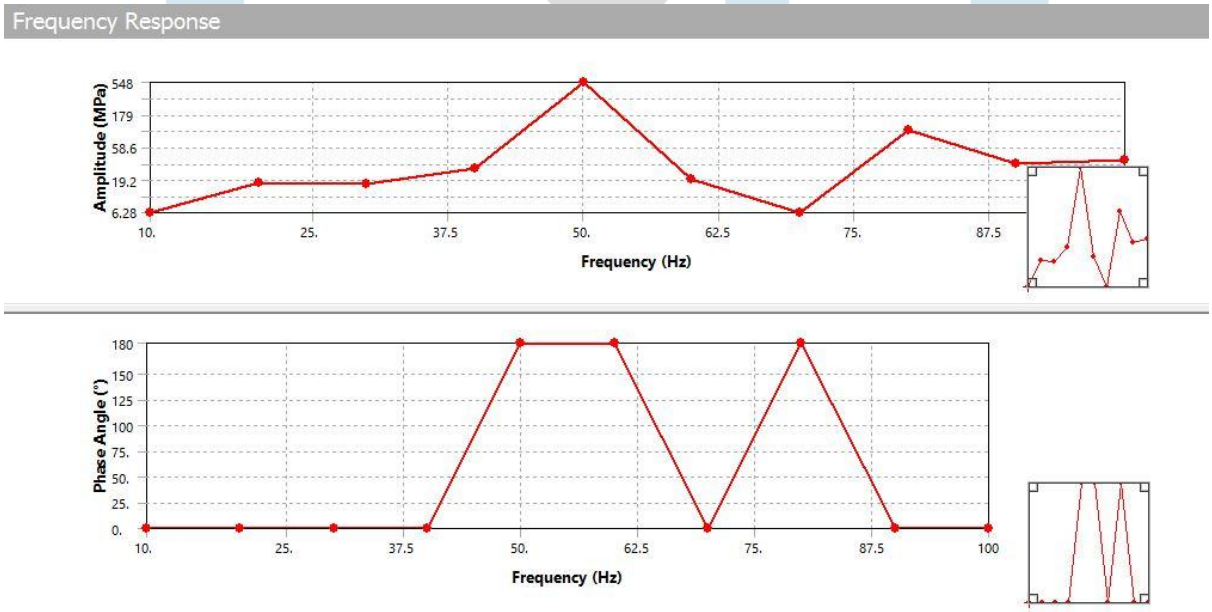
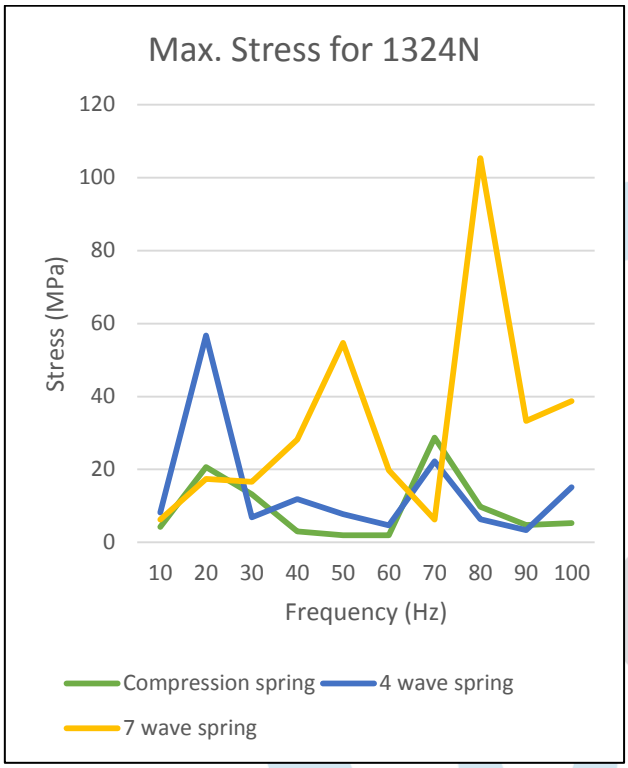


Fig. 1.7: Frequency response for stress in Mpa

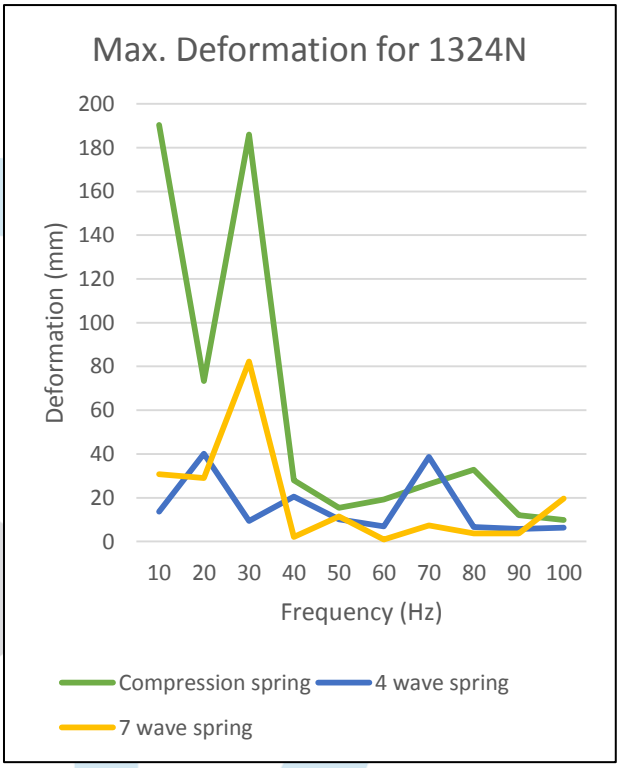
V. RESULTS & DISCUSSION

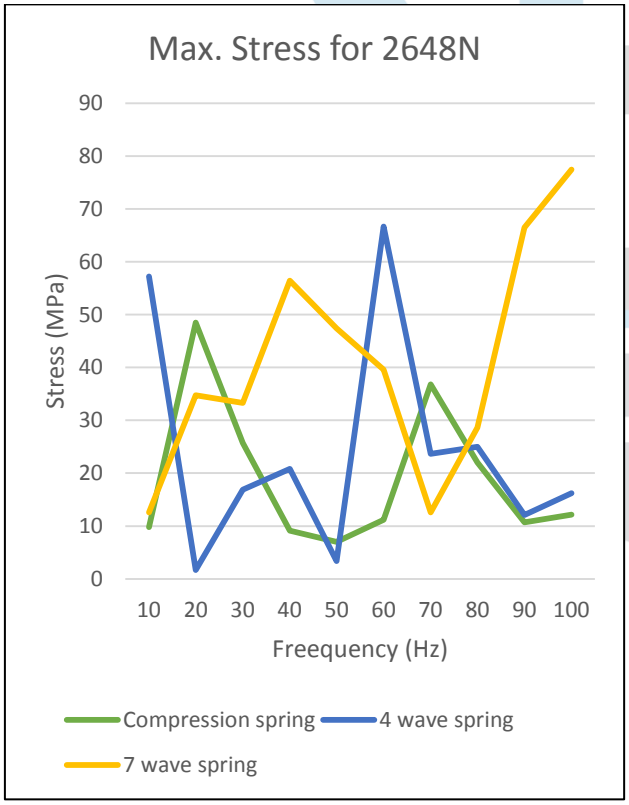
The frequency response of the stress and deformation for the load of 1324N and 2648Nis shown below.

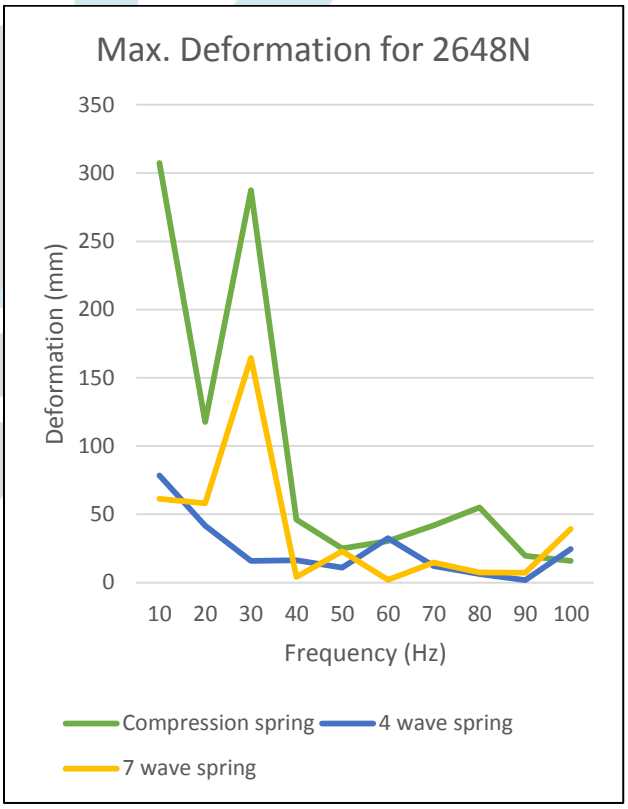
A. Max. Stress



B. Max. Deformation







VI. CONCLUSION

The present work is to optimise the weight of the motor vehicle by replacing the coil spring with the wave spring.

From the results and discussion

1. The maximum stress value for the compression spring and the wave spring are below the yield strength of the material.
2. Even though the stress value for wave spring of 7 wave is grater then the compression spring at some points, but it is in desirable limit.
3. The maximum deformation for the types of spring used is also in the required limit.
4. The deformation of the both the wave spring is considerable lower than the compression spring.
5. The strength to weight ratio of the wave spring is much higher than the compression spring.
6. The wave spring with 7 wave number can be consider as a replacement for the coil spring in automobile vehicle.

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