A Dynamic Analysis on the Comparison of Helical and Wave Springs

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Abstract: Helical springs are mechanical parts used as shock Absorbers in various Engineering Designs. The design of Coil springs are fairly simple and they provide good suspension in mechanical machines. Various springs are used in Automobiles and other day to day devices. From clock to Airplanes, a spring is being used in almost every machine. The design of coil spring is slightly changed in order to obtain a Wave spring, which is also helically twisted and of same size and Material. A 3D virtual model of both the springs is made in Solidworks software and dynamic Analysis is done, in order to calculate the best spring design. Wave springs are the alternatives of helically twisted coil springs, which are being used in various designs. The present research work tries to find out the comparison between the nature and behavior of coil spring and wave spring based on various applied loads. The size of both the springs is kept same in the whole work and the results obtained with the help of Solidworks software are analyzed using various [parameters. The stress, deflection and natural frequency of springs are calculated on varying load of 125 kg, 200 kg & 280 kgs. The results obtained are calculated for two different materials, namely stainless steel and Berillium Copper. The maximum value of Stress is obtained in the coil spring for a load of 280 kgs, when the material of such spring is selected as Stainless Steel. The results also shows that the maximum Value of Deflection is achieved in case of a coil spring with a load of 280 kgs and the material selected for this analysis was Berillium copper. Finally, The Natural Frequency is also calculated for all the twelve cases and out of which the maximum value of Natural Frequency obtained is 109 Hertz, and this value corresponds to a coil spring of stainless steel material and the load applied over the spring was 125 kgs in that case.

Keywords – Helical Spring, Coil Spring, Wave Springs, Static Analysis, Dynamic Analysis.

1. Introduction –

An automobile industry consists of number of parts and each part having some importance characteristics. Helical spring is one of them and used for the purpose of suspension system. In 1901 Mors of pairs shock absorbers introduce in automobile for suspension. The main intention is to introduce suspension system to prevent higher shock vibration transformed to passenger. The suspension system also use to pick up stabilities of automobile and minimize jerk effect transfer to body and engine and suspension use to absorb impacts a and dampers to control spring motion. Generally the nature of spring is to stored kinetic energy in the form of strain energy. Spring release this strain energy into environment without producing any kinds of effects. Kinetic energy is introduced due to irregular road, jerk and break. A spring is an elastic object used to store mechanical energy. Springs are usually made out of spring steel. There are a large number of spring designs; in everyday usage the term often refers to coil springs.

To study of several cases of helical spring and wave we have found number of modification had done in the past to purpose of new design, minimize deformation and minimize stress value in helical spring under the application of load. The main purpose of modification is to increase life of helical spring and reduce weight without produce any effect on load carrying capacity of helical spring. As we have observed that diameter and material essential parameter are major parameters for modification in design. So we got idea from past study which based on experimentally, analytically and computational method. Here in this work considered important parameter analysis wave spring and helical spring.

2. Introduction to SolidWorks and Ansys:

SOLIDWORKS is a feature based, parametric solid modeling program. As such, it's use is significantly different from conventional drafting programs. In conventional drafting (either manual or computer assisted), various views of a part are created in an attempt to describe the geometry. Each view incorporates aspects of various features (surfaces, cuts, radii, holes, protrusions) but the features are not individually defined. In feature based modeling, each feature is individually described then integrated into the part. The other significant aspect of conventional drafting is that the part geometry is defined by the drawing. If it is desired to change the size, shape, or location of a feature, the physical lines on the drawing must be changed (in each affected view) then associated dimensions are updated. When using parametric modeling, the features are driven by the dimensions (parameters). To modify the diameter of a hole, the hole diameter parameter value is changed. This automatically modifies the feature wherever it occurs – drawing views, assemblies, etc. Another unique attribute of SOLIDWORKS is that it is a solid modeling program. The design procedure is to create a model, view it, assemble parts as required, then generate any drawings which are required. It should be noted that for many uses of SOLIDWORKS, complete drawings are never created.

ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software Implements equations that govern the behavior of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyze by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

3. Design of Helical and Wave Spring:

Here in this section the simulation and analysis describe wave spring and helical spring analysis and simulation perform by computational method. Design of wave spring prepare on SOLIDWORKS design modular (SOLIDWORKS V5R20) we have used defined boundary condition of wave spring. Helical spring profile shown in Fig.3.1 and design data located at Table.1

Table.1 Design data of Helical Spring

S.NO.	NAME	DIMENSION	UNIT
1	Outside Diameter, OD	100	mm
2	Inside Diameter, ID	80	mm
3	Mean Diameter	90	mm
4	Wire Diameter	10	mm
5	Length of spring	275	mm
6	Pitch of spring	10	mm
7	Mass of Helical Spring	1.3237	kg

Fig:1 Helical Spring

3.1 WAVE SPRING PROFILE

Design of wave spring prepare on SOLIDWORKS design modular (SOLIDWORKS V5R20) we have used defined boundary condition of wave spring. Wave spring profile shown in Fig.3.1 and design data located.

Table.2 Design data of Wave Spring

S.NO.	NAME	DIMENSION	UNIT
1	Outside Diameter, OD	100	mm
2	Inside Diameter, ID	80	mm
3	Mean Diameter	90	mm
4	Thickness of strip	04	mm
5	Length of spring	275	mm
6	Pitch of spring	6	mm
7	Mass of wave Spring	1.0617	kg

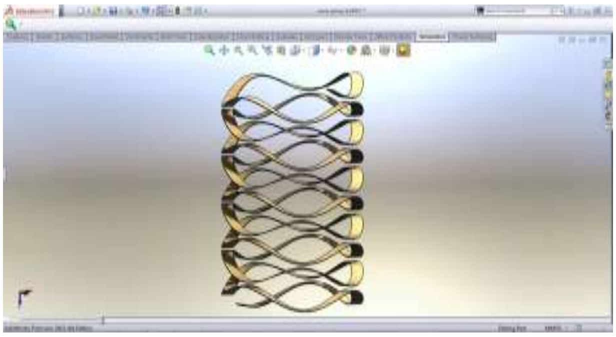

Fig:2 Wave Spring

4. Comparison of 4. Various Results:

4.1 Variation of Maximum stress with respect to load in coil Spring

The following graph depicts the variation of Maximum stress induced in the wave and coil spring with respect to variation in load. As it is clear that the stress in the spring increases proportionally with respect to the load placed over the spring. The variation between stainless steel and beryllium copper is very similar.

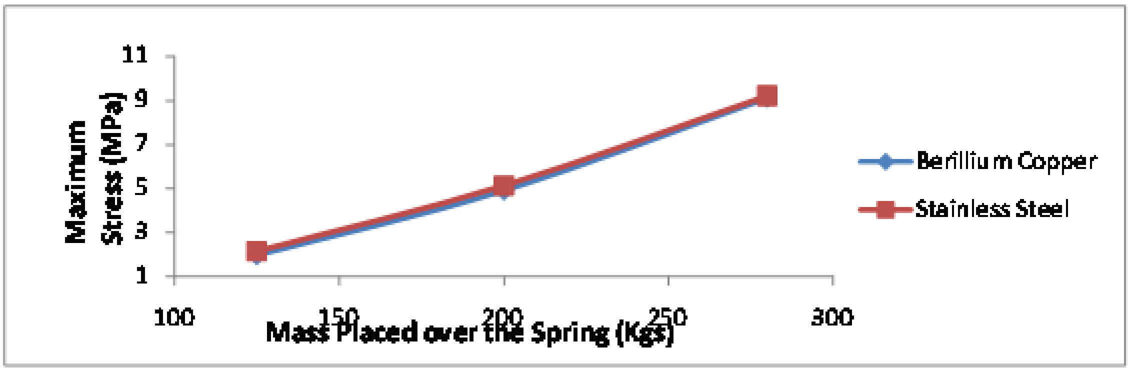

Fig: 4.1 **Variation of Maximum stress with respect to load in coil spring**

4.2 Variation of Maximum Deflection in spring length with respect to load in coil spring

The following graph depicts the variation of Maximum deflection induced in the wave and coil spring with respect to variation in load. It is clear that the deflection in the spring increases proportionally with respect to the load placed over the spring. The deflection in beryllium copper increases with a much higher rate than that of stainless steel material

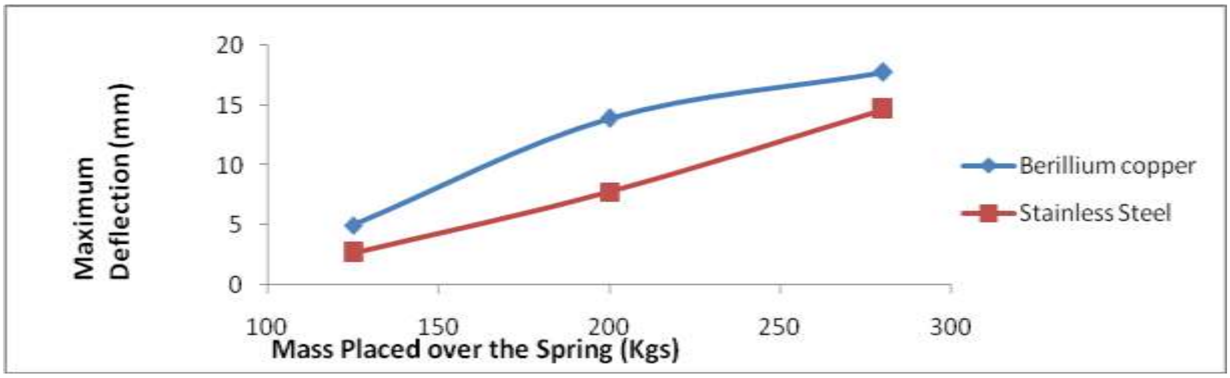

Fig: 4.2 **Variation of Maximum Deflection in spring length with respect to load in coil spring**

4.3 Variation of Maximum stress with respect to load in coil spring

The following graph depicts the variation of Maximum stress induced in the wave and coil spring with respect to variation in load. It is clear that the stress in the spring increases proportionally with respect to the load placed over the spring. The variation between stainless steel and beryllium copper is very similar in wave spring as well.

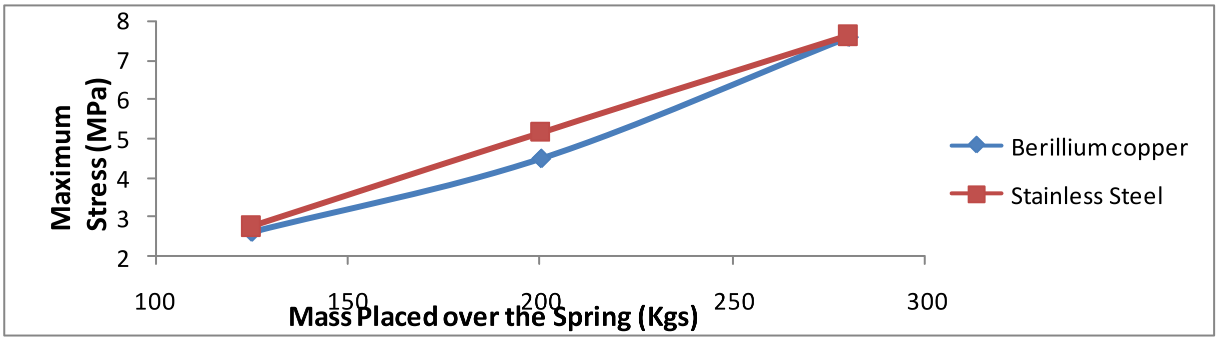

Fig: 4.3 **Variation of Maximum stress with respect to load in wave spring**

4.4 Variation of Maximum Deflection in spring length with respect to load in coil spring

The following graph depicts the variation of Maximum deflection induced in the wave and coil spring with respect to variation in load. It is clear that the deflection in the spring increases proportionally with respect to the load placed over the spring. In wave spring as well, the deflection in beryllium copper increases with a much higher rate than that of stainless steel material.

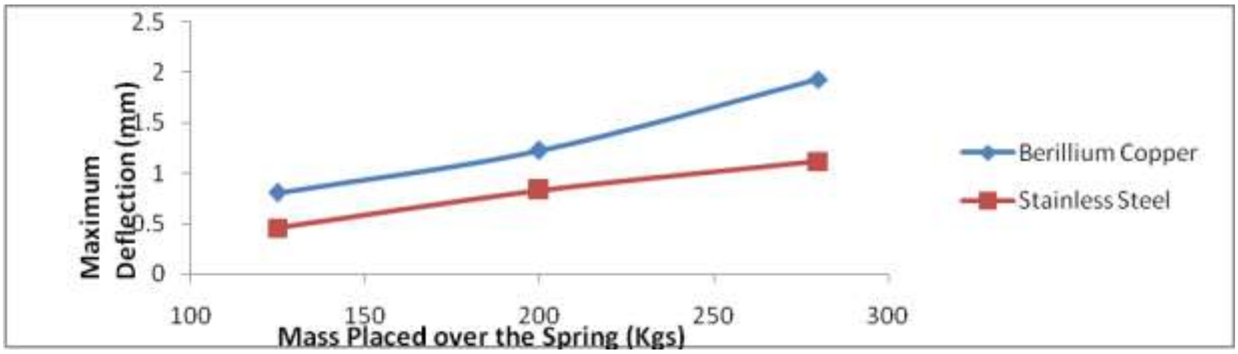

Fig: 4.4 **Variation of Maximum Deflection in spring length with respect to load in Wave spring**

7.5 Variation of Maximum Natural frequency of the spring with respect to load

The following graph depicts the variation of Maximum natural frequency of the wave and coil spring with respect to variation in load. It is clear that the value of natural frequency is constant for all the values of test mases, but it is visble that, in stainless steel material the frequency has a much higher value.

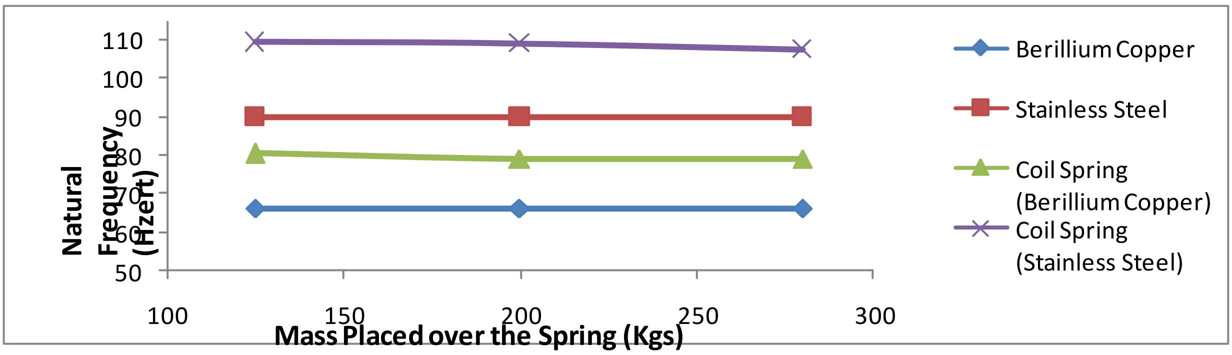

Fig: 4.5 **Variation of Maximum Natural frequency of the spring with respect to load**

4.6 Combined Graphs:

4.6.1 3D Variation of Maximum stress with respect to load:

A 3D graph shown below is making it clearly visible that the maximum value of stress is obtained in the coil spring when the mass placed over the spring is 280 kgs.

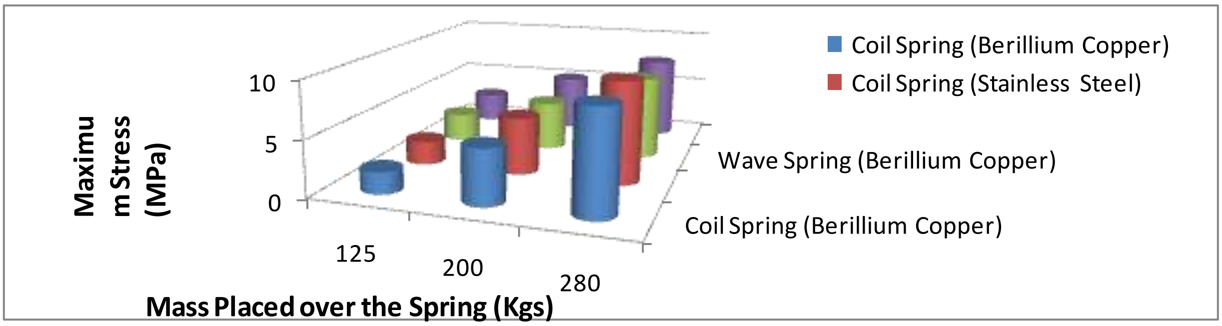

Fig: 4.6 **3D Variation of Maximum Stress of the spring with respect to load**

4.6.2 3D Variation of Maximum Deflection with respect to load:

A 3D graph shown below is making it clearly visible that the maximum value of deflection is achieved in the coil spring, when material used is beryllium copper and it's value is 16 mm when the mass placed over the spring is 280 kgs.

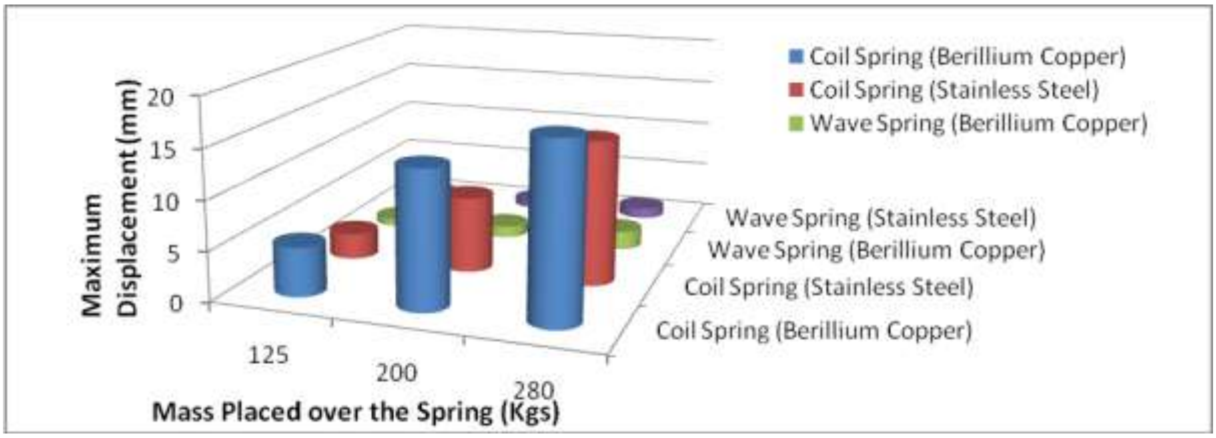

Fig: 4.7 **3D Variation of Maximum Deflection of the spring with respect to load**

4.6.3 3D Variation of Maximum Natural frequency with respect to load:

A 3D graph shown below is making it clearly visible that the maximum value of frequency is achieved in the coil spring, when material used is Stainless steel and its value is 109 Htz when the mass placed over the spring is 280 kgs.

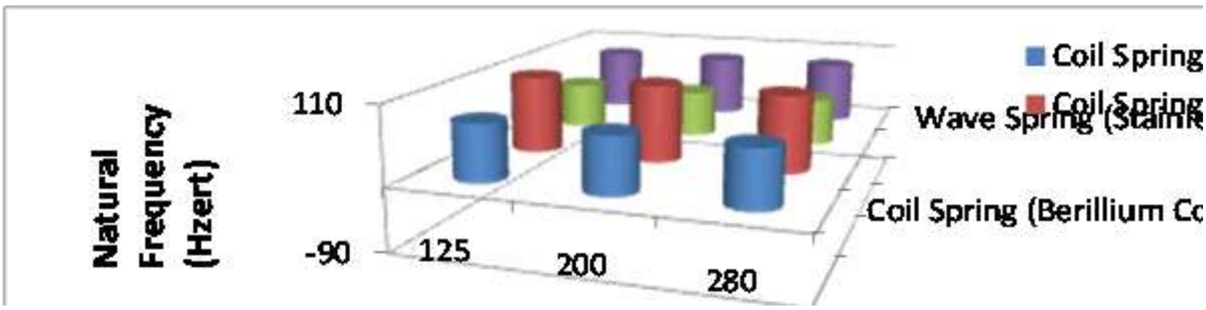

Fig: 4.8 **3D Variation of Maximum Frequency of the spring with respect to load**

5. Conclusions:

After the study of Wave and Helical spring we obtained following conclusions and scope for future work is mentioned in brief.

- Analysis on wave springs has been done by Dynamic Analysis approach and results were validated compared with the coil spring of the shock absorber.
- By performing Dynamic analysis comparison of wave spring with coil spring we can deduce the Natural frequency of all the cases and have to ensure precautions to avoid the condition of resonance..
- Results shows that Wave springs possess 24% less deformation and 45% less stresses when compared with helical spring and weight is also reduce by 9%.
- The stiffness of the spring material increases, total deformation decreases and corresponding stresses will increase.

The natural frequency increases with respect to change in material and spring type and the maximum value obtained in coil spring is 109 htz whereas in wave spring it is 90 Htz.

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