Analysis of Shock Absorber Coil Spring Using Fem Approach

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Abstract-A shock absorber is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. The shock absorbers duty is to absorb energy. In this project a 3D model of coil spring is created using Creo software. Structural analysis and modal analysis are done on the shock absorber by varying material for spring, structural Steel, Brass and Berylliums copper. Structural analysis is done to validate the strength and modal analysis is done to determine the displacements for different frequencies for number of modes. Comparison is done for three materials to verify best material for spring in Shock absorber. Modeling is done in Creo parametric 2.0 and analysis is done in ANSYS 15.0.

Keywords: Coil spring, modal analysis, Structural analysis, shock absorber

I. INTRODUCTION

A spring is defined as an elastic body, whose function is to compress when loaded and to recover its original shape when the load is removed. A spring can also be said as a device that absorbs energy from an applied force. Springs are elastic bodies that can be twisted, pulled, or stretched by some force.

Shock absorbers are an important part of automobile and motorcycle suspensions, aircraft landing gear, and the supports for many industrial machines. Large shock absorbers have also been used in structural engineering to reduce the susceptibility of structures to earthquake damage and resonance.

A coil spring is a length of flexible wire wound into a coil. The coil shape allows the spring to flex in a linear path against itself. Coil spring rate is determined by coil wire material (steel, titanium, carbon fiber, etc.), coil wire thickness, and the length of the active coil wire.

II. PARAMETERS OF COIL SPRING

Table I Parameters of coil spring

Parameter	Coil spring
Mean Diameter (Dm)	60mm
Coil Diameter (d)	12 mm
Number of turns (n)	12
Pitch (p)	24mm
Free length (Lf)	300mm

III. INTRODUCTION TO CREO

Creo parametric 2.0 is a feature based, parametric solid modeling program. As such, it's use is significantly different from conventional drafting programs. 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 then associated dimensions are updated. In Creo parametric 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.
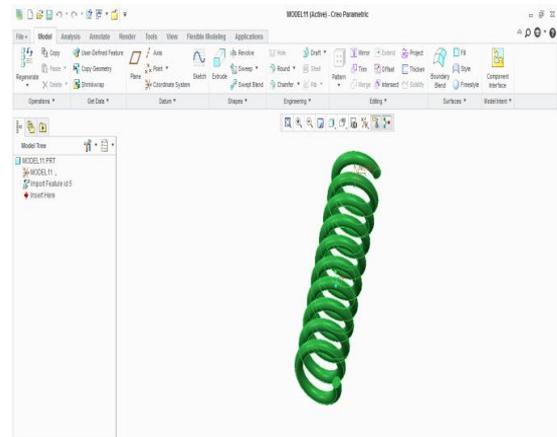
Fig 1 shows model of coil spring in Creo

Fig.1 Coil spring

IV. STRUCTURAL ANALYSIS OF COIL SPRING USING BERYLLIUM COPPER, BRASS AND STRUCTURAL STEEL AS SPRING MATERIAL

Structural analysis is the study of the static response of the structures under the loads. In structural mechanics is to determine the deflections of a object or structure under load conditions. Static analysis used to determine displacements, stresses, etc. under static loading conditions. ANSYS can compute both linear and nonlinear static analyses. Nonlinearities can include plasticity, stress stiffening, large deflection, large strain, hyper elasticity, contact surfaces, and creep.To study the

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98

effect of deflection for various materials, a load is applied on coil spring for different materials by keeping the length constant. The load is considered as 1791.79N for single shock absorber weight.

For Beryllium Copper coil spring the deformation and stress is 29.63 mm and 639.48 MPa as shown in fig. 2 and fig 3 respectively.
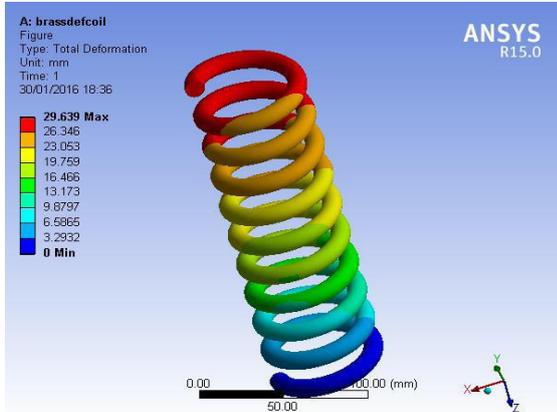

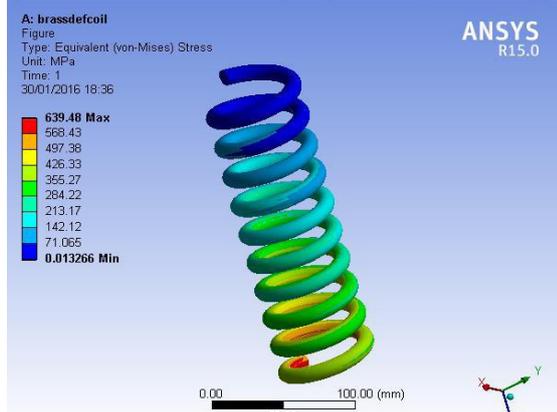Fig.2 Deformation of coil spring for Beryllium Copper

Fig.3 Equivalent stress of coil spring for Beryllium Copper

For Brass coil spring the deformation and stress 33.501mm and 639MPa as shown in fig 4 and fig 5
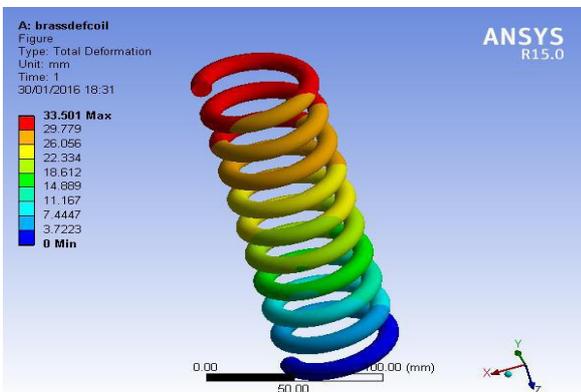
Fig. 4   Deformation of coil spring for Brass
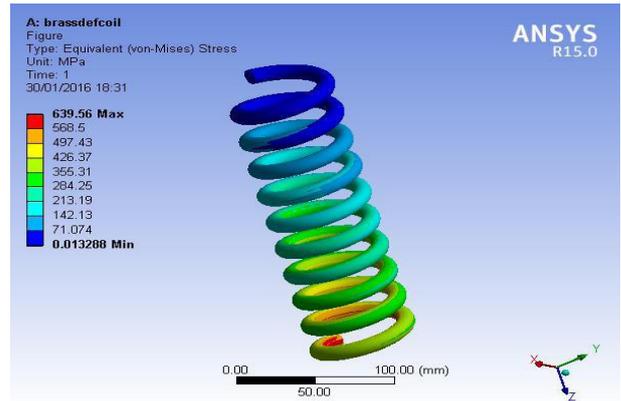
Fig. 5 Equivalent stress of coil spring for Brass

For Structural Steel coil spring material the deformation and stress 19.582 mm and 639.5MPa as shown in fig 6 and fig 7.
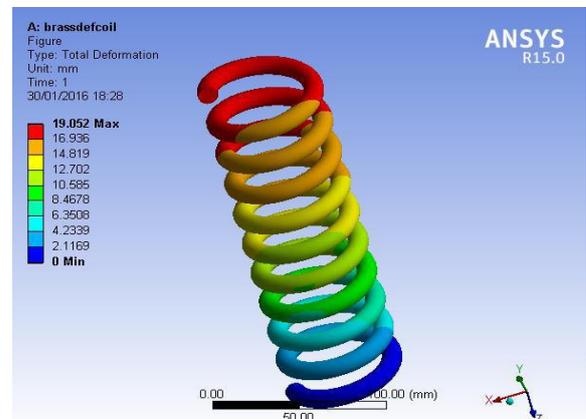

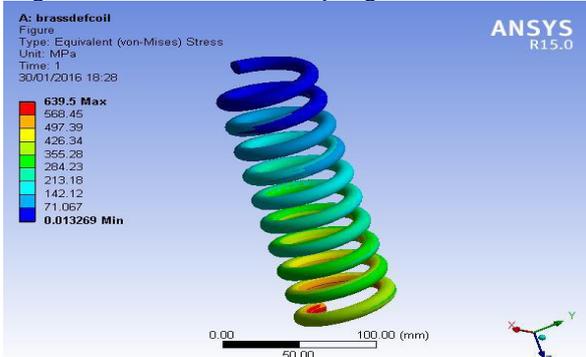Fig. 6   Deformation of coil spring for Structural Steel

Fig. 7 Equivalent stress of coil spring for Structural Steel

V.MODAL ANALYSIS

A modal analysis is typically used to determine the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component while it is being designed. It can also serve as a starting point for another, more detailed, dynamic analysis, such as a harmonic response or full transient dynamic analysis. Modal analyses, while being one of the most basic dynamic analysis types available in ANSYS, can also be more computationally time consuming than a typical

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99

static analysis. A reduced solver, utilizing automatically or manually selected master degrees of freedom is used to drastically reduce the problem size and solution time.
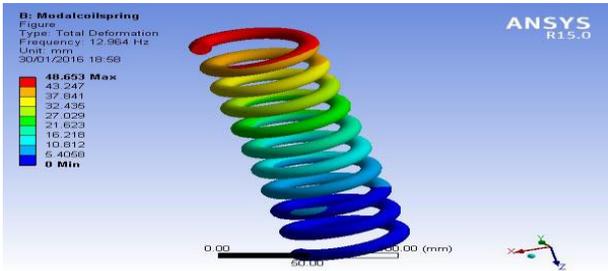
Modal analysis for Beryllium Copper

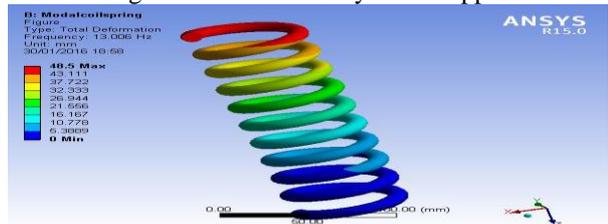Fig8 first mode for Beryllium Copper

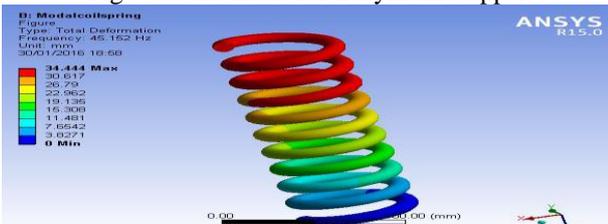

Fig 9 second mode for Beryllium Copper
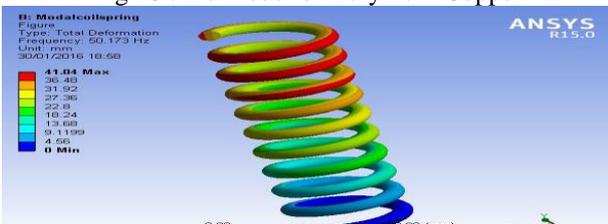

Fig 10 third mode for Beryllium Copper

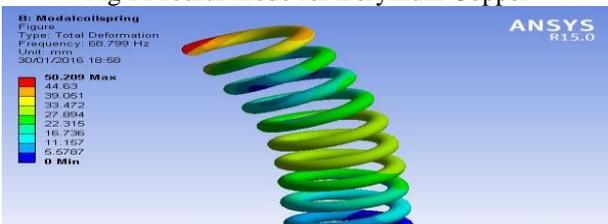Fig 11 fourth mode for Beryllium Copper

Fig 11 fifth mode for Beryllium Copper Modal analysis for Brass
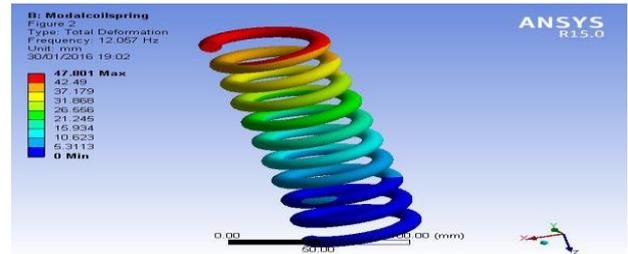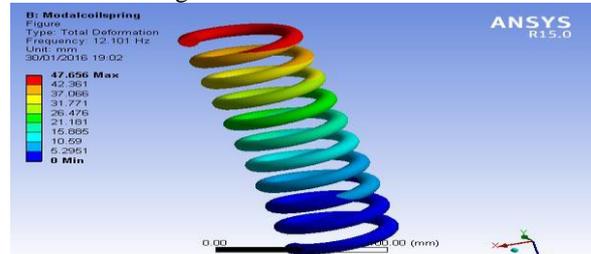

Fig 12. first mode for Brass
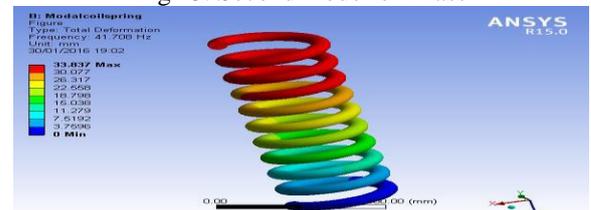

Fig 13. Second mode for Brass
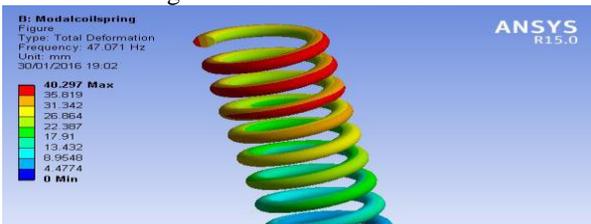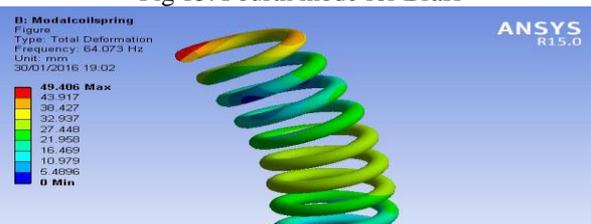

Fig 14. Third mode for Brass

Fig 15. Fourth mode for Brass

Fig 16. Fifth mode for Brass Modal analysis for structural steel

Fig 17. First mode for structural steel

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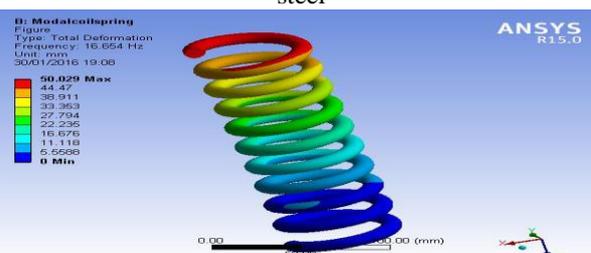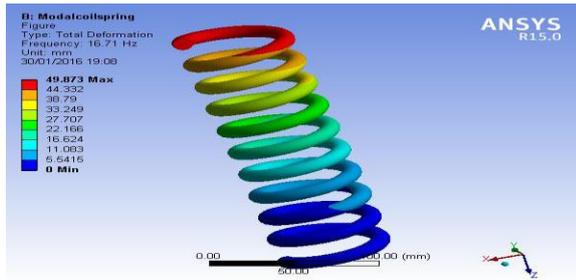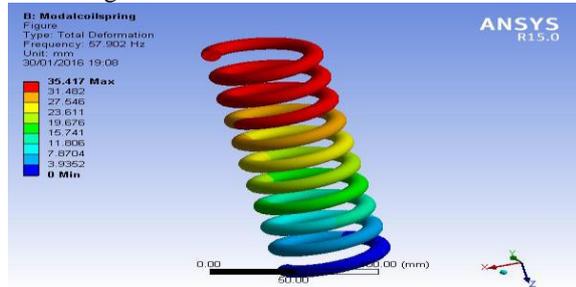100

Fig 18. second mode for structural steel

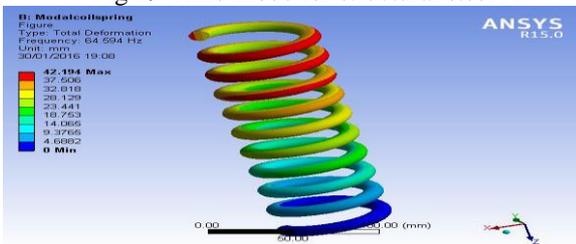Fig 19 Third mode for structural steel

Fig 20 Fourth mode for structural steel

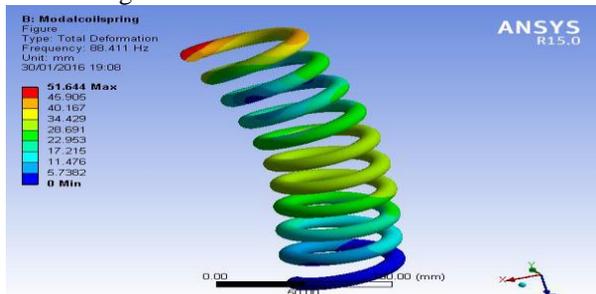Fig 21 Fifth mode for structural steel

VI. RESULTS

Table 2 RESULT TABLE

Materials	Beryllium Copper	Brass	structural steel
Total Deformation (mm)	29.63	33.50	19.58
Equivalent stress (MPa)	639.48	639	639.5

Natural frequency(Hz)			
Mode 1	12.96	12.05	16.65
Mode 2	13.00	12.10	16.71
Mode 3	45.15	41.70	57.902
Mode 4	50.17	47.07	64.59
Mode 5	68.79	64.07	88.41

V.CONCLUSON

By comparing the results for all three materials, the total deformation value is less for structural steel than Beryllium Copper and Brass. So stiffness is more for structural steel.

Natural frequency is more for structural steel.

Hence we can conclude that for high stiffness and dynamic characteristics structural steel is more suitable for spring.

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101