

“Design and analysis of shock absorber using FEA tool”

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Abstract:- A suspension system or 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 or dissipate energy. In this project a shock absorber is designed and a 3D model is created using Pro/Engineer. Structural analysis and modal analysis are done on the shock absorber by varying material for spring, Spring Steel and Phosphor Bronze . 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 two materials to verify best material for spring in Shock absorber. Modeling is done in Pro/ENGINEER and analysis is done in ANSYS.

I. INTRODUCTION

A shock absorber or damper is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. Pneumatic and hydraulic shock absorbers commonly take the form of a cylinder with a sliding piston inside. The cylinder is filled with a fluid (such as hydraulic fluid) or air. This fluid-filled piston/cylinder combination is a dashpot.

The shock absorbers duty is to absorb or dissipate energy. One design consideration, when designing or choosing a shock absorber, is where that energy will go. In most dashpots, energy is converted to heat inside the viscous fluid. In hydraulic cylinders, the hydraulic fluid will heat up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of dashpots, such as electromagnetic ones, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion cars on uneven roads.

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.

II. DESIGN CALCULATIONS FOR HELICAL SPRINGS FOR SHOCK ABSORBERS

Material: Steel

Modulus of rigidity $G = 80000 \text{ Pa}$, Average shear stress $= 364 \text{ MPa}^{[3]}$

$C = \text{spring index} = 8$, Wahl's stress factor $= 1.184$

Mean diameter of a coil $D = 82.81 \text{ mm}$

Diameter of wire $d = 10.35 \text{ mm}$

Total no of coils $n_1 = 16$

Outer diameter of spring coil $D_0 = D + d = 93.16 \text{ mm}$

No of active turns $n = 14$

Weight of bike $= 125 \text{ kgs}$

Let weight of 1 person $= 75 \text{ Kgs}$

Weight of 2 persons $= 75 \times 2 = 150 \text{ Kgs}$ Weight of bike + persons $= 275 \text{ Kgs}$

Rear suspension $= 60\%^{[1]}$ Hence 60% of $275 = 165 \text{ Kgs}$

Considering dynamic loads it will be double $W = 330 \text{ Kgs} = 3234 \text{ N}$

For single shock absorber weight $= w/2 = 1617 \text{ N} = W$

Compression of spring $(\delta) = 111.98 \text{ mm}$

Solid length, $L_s = n \times d = 16 \times 10.3 = 165.6 \text{ mm}$

Free length of spring, $L_f = \text{solid length} + \text{maximum compression} + \text{clearance between adjustable coils} = 165.6 + 111.98 + 0.15 \times 111.98 = 295.3 \text{ mm}$

Spring rate, $K = 14.44$

Pitch of coil, $P = 22.64$

III. INTRODUCTION TO PRO-E

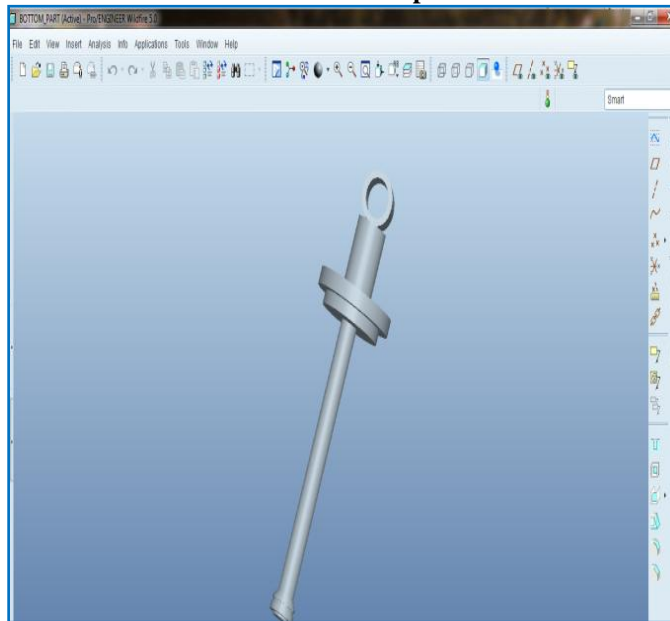
Pro/ENGINEER is a feature based, parametric solid modeling program. As such, it's use is significantly different from conventional drafting programs. In conventional drafting (either manual or computer assisted), various views of a part are created in an attempt to describe the geometry. Each view incorporates 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 Pro/ENGINEER 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 Pro/E, complete drawings are never created. A typical design cycle for a molded plastic part might consist of the creation of a solid model, export of an SLA file to a rapid prototyping system (stereo lithography, etc.), use of the SLA part in hands-on verification of fit, form, and function, and then export of an IGES file to the molder or toolmaker. A toolmaker will then use the IGES file to program the NC machines which will directly create the mold for the parts. In many such design cycles, the only print created will be an inspection drawing with critical and envelope dimensions shown.

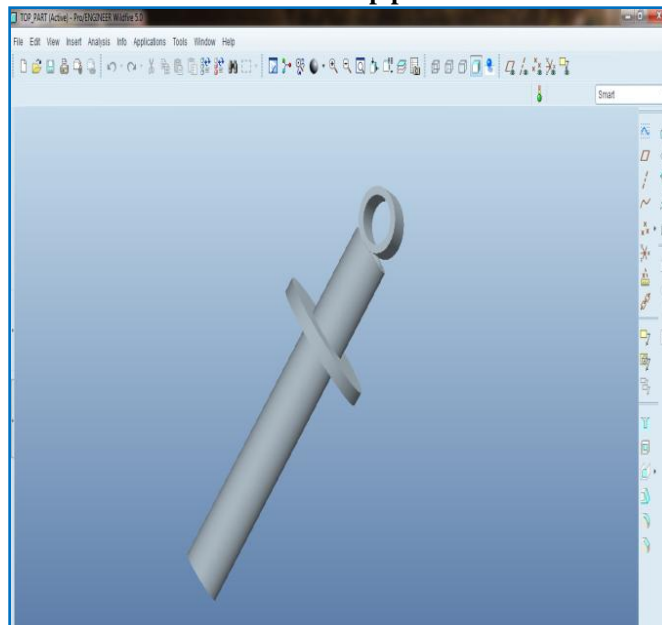
Model of Shock Absorber

1. Parts of shock absorber

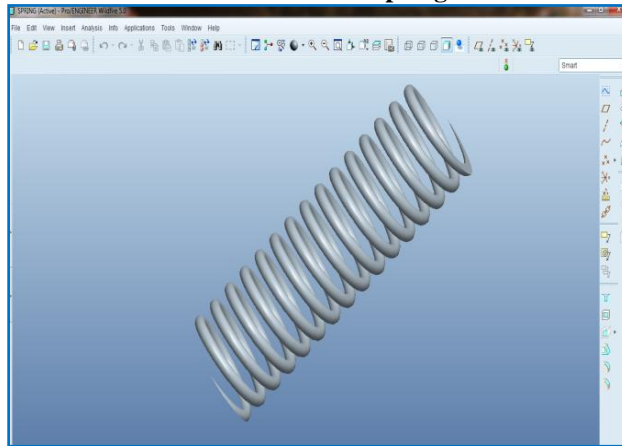
i. Bottom part



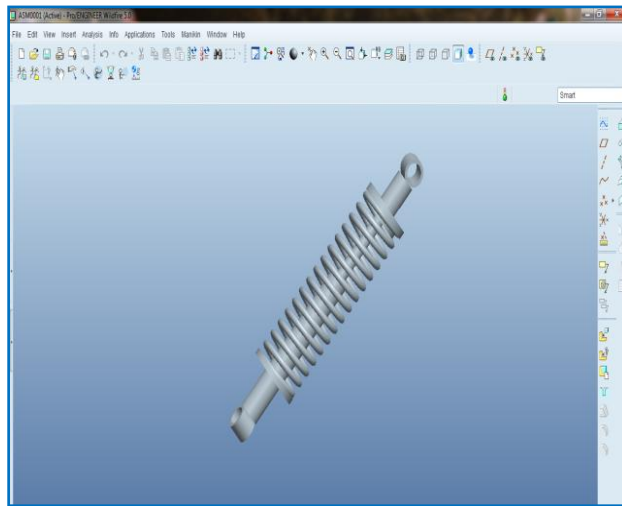
ii. Top part



iii. Helical spring



2. Total assembly



Analysis Structural Analysis using Spring Steel as spring material

Material: Spring Steel

Material Properties:

Young's Modulus (EX): 202000N/mm²

Poisson's Ratio (PRXY): 0.292

Density: 0.000007820kg/mm³

i. Imported Model from Pro/Engineer

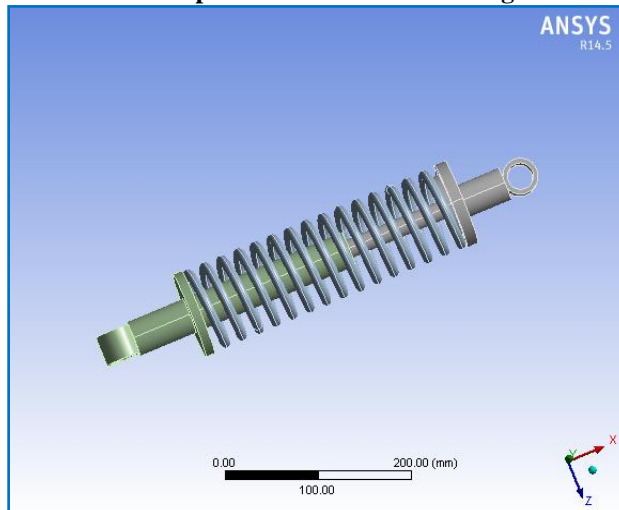


Fig 8.1:- Imported model from Pro/Engineer

ii. **Meshed Model**

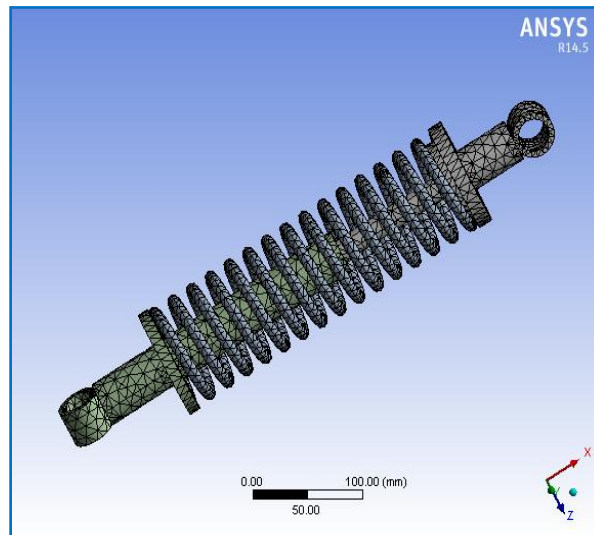


Fig 8.2:- Meshed model

iii. **Load applied on model**

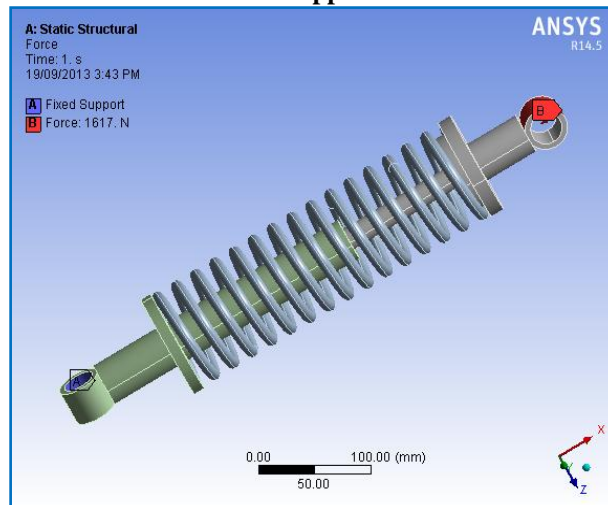


Fig 8.3:- Load applied on model

iv. **Results after applying load:**

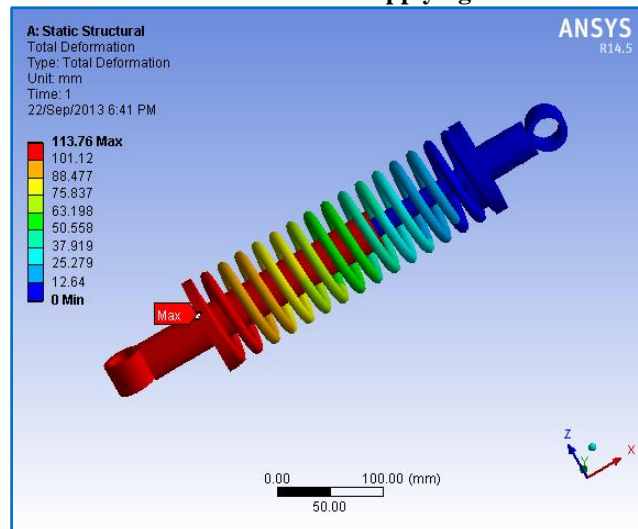


Fig 8.4:- Total Deformation

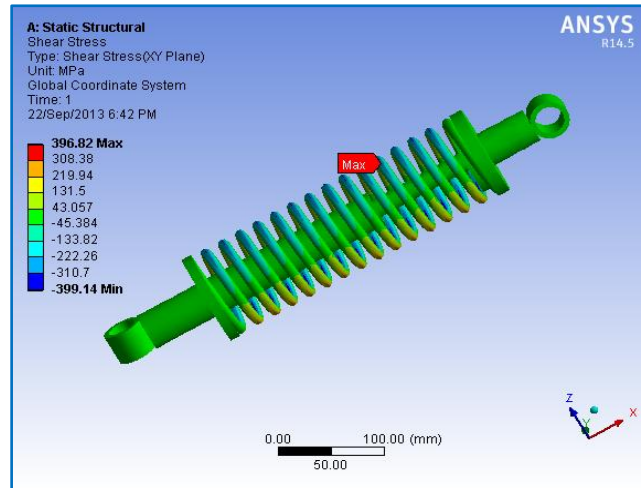


Fig 8.5:- shear stress

Structural Analysis using Phosphor Bronze as spring material

Material:Phosphor Bronze

Material Properties:

Young's Modulus (EX) : 103000N/mm²

Poisson's Ratio (PRXY): 0.34

Density: 0.000008160kg/mm³

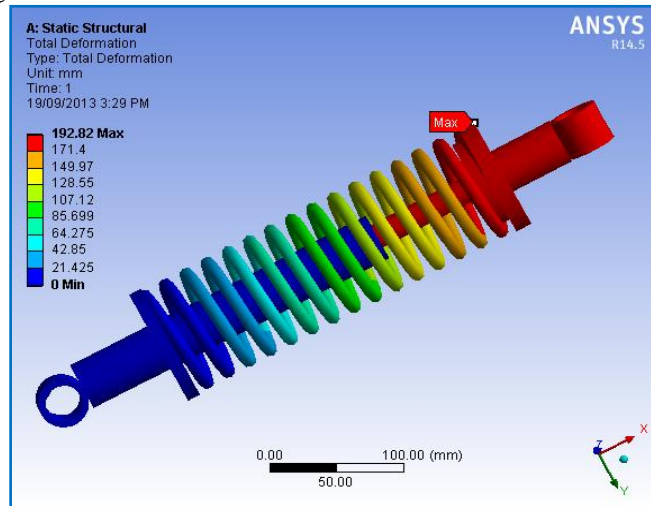


Fig 8.6:- Total Deformation

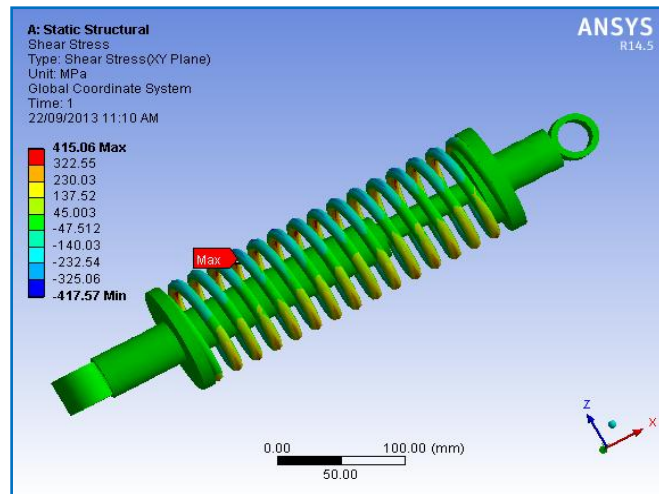


Fig 8.7:-shear stress

Mode Shapes for Spring Steel

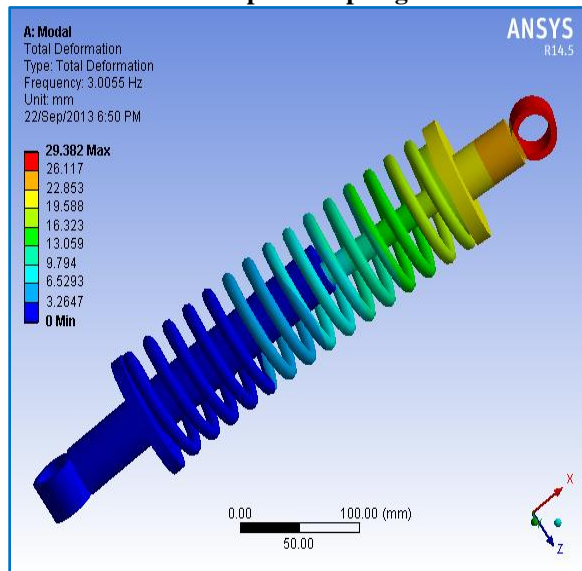


Fig 8.8 :- first mode shape

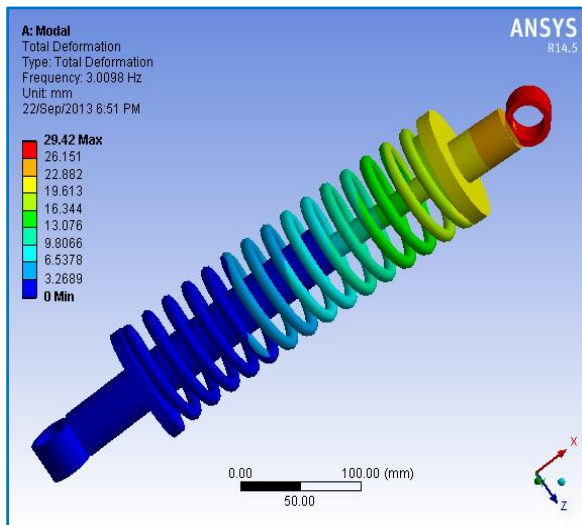


Fig 8.9 :- second mode shape

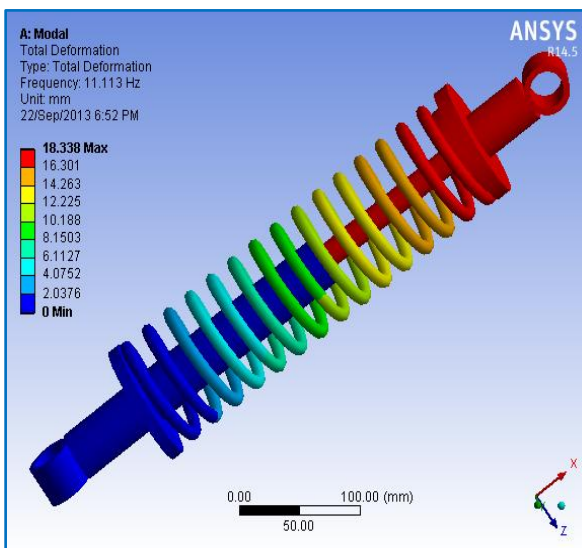


Fig 8.10 :- third mode shape

Result table

	Analytical	Spring Steel	Phosphor Bronze
Total Deformation(mm)	111.98	113.76	192.82
Shear Stress (N/mm²)	364	396.82	415.06
Natural Frequency		3.0055	2.1185
		3.0098	2.1237
		11.113	7.7306
		12.873	9.0925
		12.896	9.1118
		17.200	12.163

IV. CONCLUSION

1. In this project we have designed a shock absorber. We have modeled the shock absorber by using 3D parametric software Pro/Engineer.
2. To validate the strength of our design, we have done structural analysis and modal analysis on the shock absorber. We have done analysis by varying spring material Spring Steel and Phosphor Bronze.
3. By observing the analysis results, the analyzed stress values are less than their respective yield stress values. So our design is safe.
4. By comparing the results for both materials, the total deformation value is less for Spring Steel than Phosphor Bronze. So stiffness is more for Spring Steel.
5. By comparing the results for both materials, the Natural Frequency is more for Spring Steel than Phosphor Bronze.
6. So we can conclude that as per our analysis using material spring steel for spring is best.

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