DESIGN AND ANALYSIS OF CONICAL SPRING

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ABSTRACT

Despite occasionally having to drastically shorten their axial length, springs are frequently used in mechanical systems to store energy. Conical springs are used as a result because of their ability to telescope. Mechanical system designers have access to a wide range of tools, however the majority of these are essentially validation tools that necessitate concurrent trial and error techniques. The designer should just specify the tools he needs, and optimisation algorithms can be used to deliver them. As a result, the tool immediately identifies the spring that meets standards and needs. Constant pitch conical spring behavior can now be analytically expressed, even in the non-linear phase, thanks to recent developments in the field. In light of this, we have developed a synthesis tool for conical spring design using optimization techniques. The presentation of an application sample. Thus, the tool shown here is a synthesis aid that might be of great benefit to designers that need to include a conical spring into their design

Keyword : *conical spring, Designing, Analyzing using Ansys workbench, analytical calculation, comparing the analytical and experimental results, essential application*

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1. INTRODUCTION

To store energy, springs are frequently utilized in mechanical systems. Compression, traction, and torsion springs are just a few examples of the various spring types that have been created to address a variety of purposes. Because cylinder springs behave linearly, it is feasible to create analytical formulas that may be used to optimization techniques. Recently, optimization techniques have been used to create design support tools. The programmed "Advanced Spring Design 7" from the Spring Manufacturers Institute and Universal Technical Systems is an illustration of this. It was created in a full visual environment and has straightforward and automated unit conversion in addition to quick access to dynamic charts and reports. ASD uses the TK Solver collaborative math engine to solve a range of combinations of input and output variables using the back-solving technique. It is therefore helpful for design verification. To offer better support, synthesis tools have been presented for cylindrical compression, traction, and torsion springs. These technologies employ optimization techniques to suggest a spring that precisely fits the requirements of the designer. The Institute of Spring Technology’s' 'Spring CAD software packages' now contain the research done on the best compression spring design. Cylindrical compression springs are the most dependable springs and are used the most frequently. However, conical compression springs might be used in their place when the axial length has to be reduced. Conical springs can, in fact, telescope, resulting in an axial length near to the wire diameter, depending on their three geometrical designs. Electrical appliances like contactors frequently employ this kind of spring.

1.1 Objective

• Design of Conical spring.
• FEA analysis of conical spring.
• The main objective is to design & develop spring for this performance enhancement

2. METHODOLOGY

• The fundamental idea behind FEA is that a body or structure may be broken down into smaller, so called "finite elements," which have finite dimensions.
• The original body or structure is then viewed as an amalgamation of these parts joined at a limited number of "Nodes" or "Nodal Points," which are joints in the structure.
• This section presents the conical spring-based isolator's thorough design. The isolator is designed for a minimum frequency range of a tolerable mass for the reasons listed in section I.
• The maximum length, L, and pitch, S, of the spring influence the isolator's n rotations. The number of rotations for a spring with a constant length is inversely related to the pitch. The designed isolator that is being suggested is meant to be installed in an existing system that supports lengths up to 70mm. Consequently, L is taken to be 70mm in the following design equations.
• The wire diameter, denoted by d in Equation, affects pitch. If pitch doesn't rise in step with wire diameter, there will be surging in the spring. The 4mm minimum wire diameter is feasible. The degree of stiffness rises to the fourth power with increasing diameter. The frequency rises with increasing stiffness, and the time delay falls. Time delays are minimized, which slows the rate of absorption

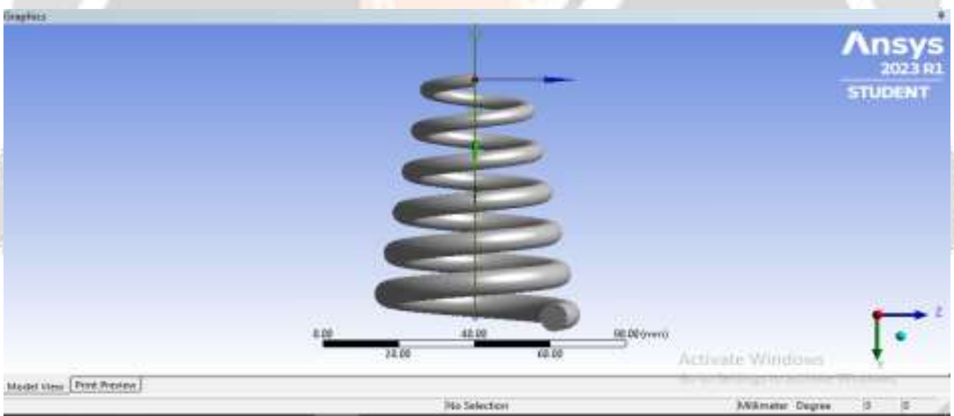

Fig-1 Desgign of conical spring

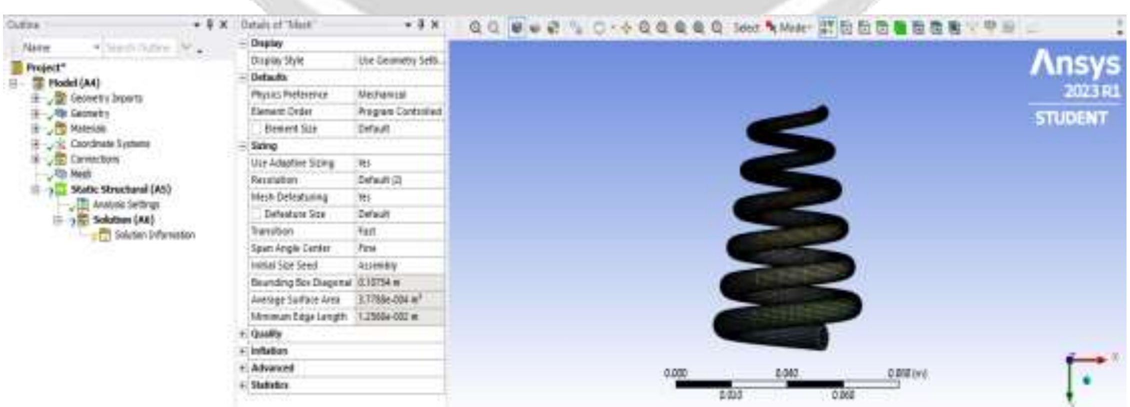

Fig -2 Meshing of conical spring

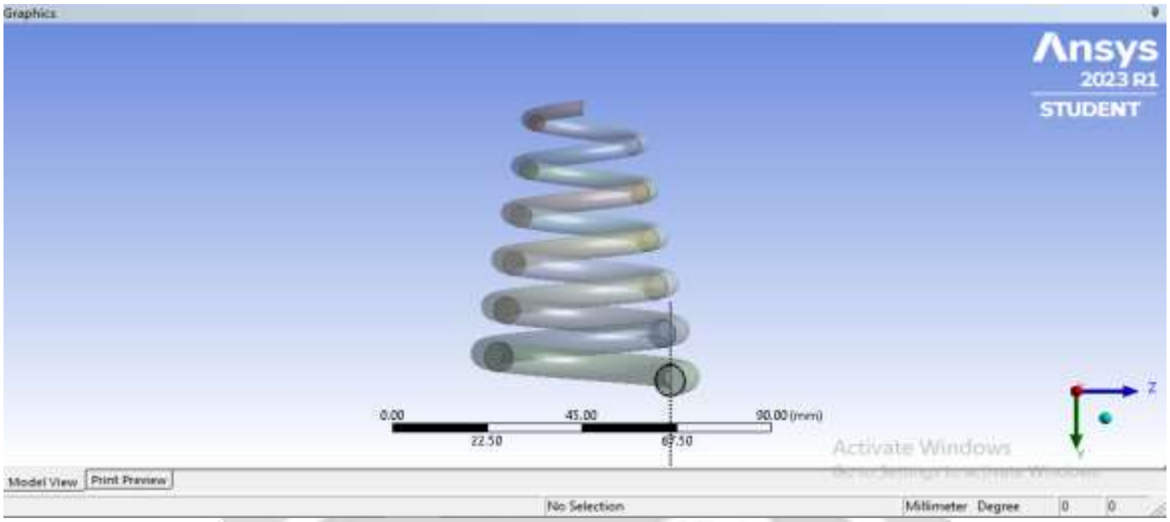

Fig-3 Slicing of conical Spring

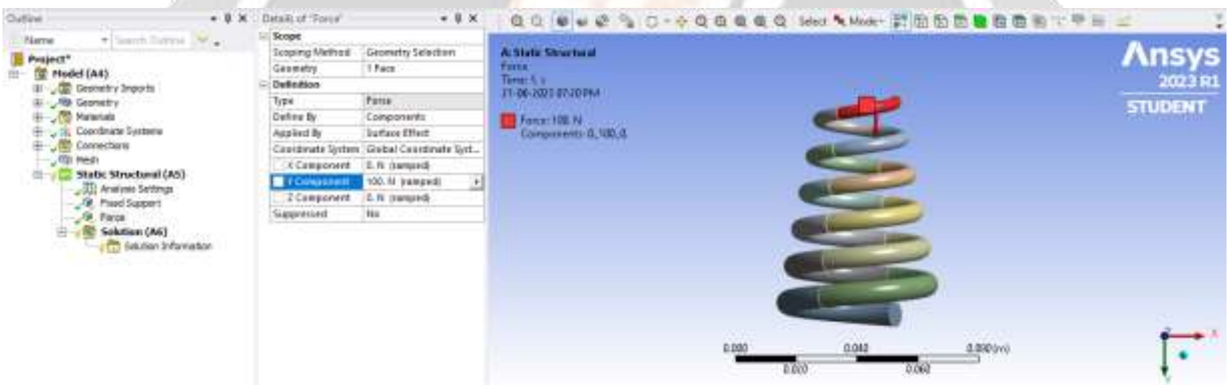

Fig-4 Applying of boundary conditions (Force of 100N and Fixed support at bottom)

3. RESULTS AND DISCUSSION

3.1 Design Parameters

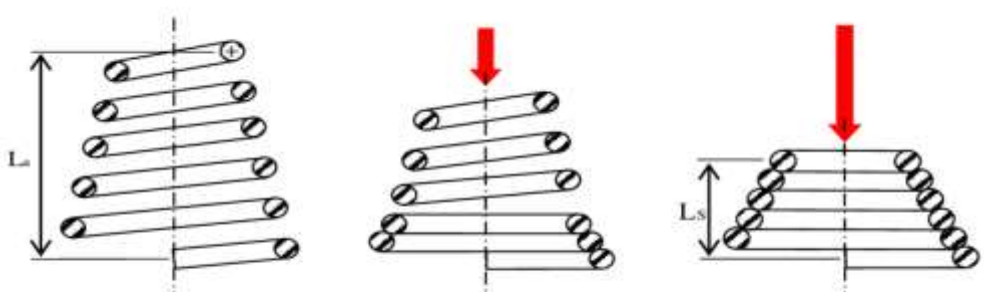

Fig-5 Schematic representation of conical spring with applied load

d = Diameter of wire
D1 = Mean Spring diameter of largest coil
D2 = Mean Spring diameter of smallest coil
n = Number of coils
H=L = Initial height of Spring
F = Axial External Load

3.2 Data's for designing of conical spring and analytical soltion

Sl.No	Force "F" in (N)	Radius "R" in (mm)	Free length "L" in (mm)	No of Turns "i"	Pitch "P" in (mm)	Coil diameter "d" in (mm)
1	100	$R_1 = 10$ $R_2 = 24$	70	6	12	4

Table-1 Data's for analytical solution

3.3 Analytical Solution

Shear Stress

$$\tau_{max} = \frac{16\ R2\ P}{\pi d^3}$$

$$= \frac{16\times10\times100}{\pi 4^3}$$

$$\tau_{max} = 79.57\ N/mm^2$$

Deformation

$$\delta_{max} = d\sqrt{1\left[\frac{R1-R2}{nd}\right]}$$

$$= 4\sqrt{1\left[\frac{24-10}{6\times4}\right]}$$

$$\delta_{max} = 2.33mm$$

<u>Shear Strain</u>

$$\gamma = \frac{F}{G \times A}$$

$$= \frac{100}{210 \times 10^3 \times \frac{\pi \times 4^2}{4}}$$

$$\gamma = 3.78 \times 10^{-5}$$

3.4 Experimental solution

- Deformation

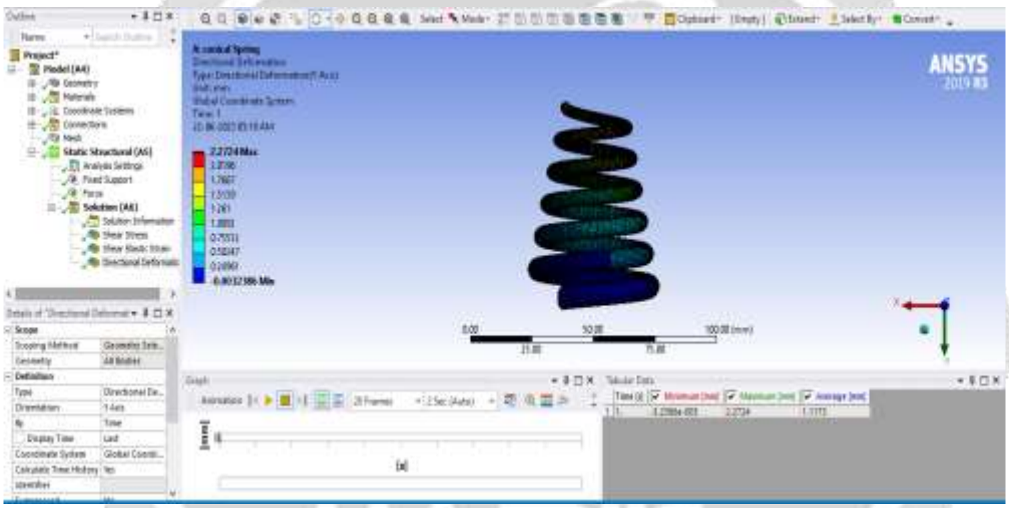

Fig-6 Exprimental result of deformation

- Shear Stress

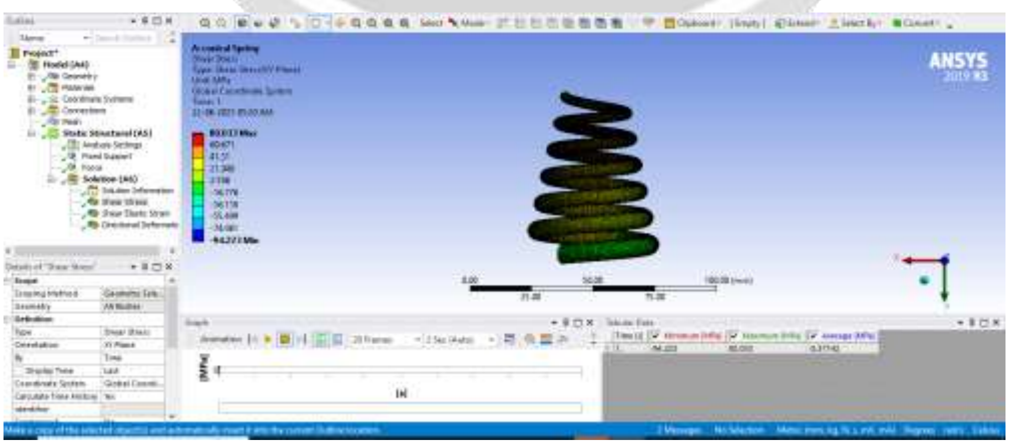

Fig-7 Experimental result of shear stress

- Shear strain

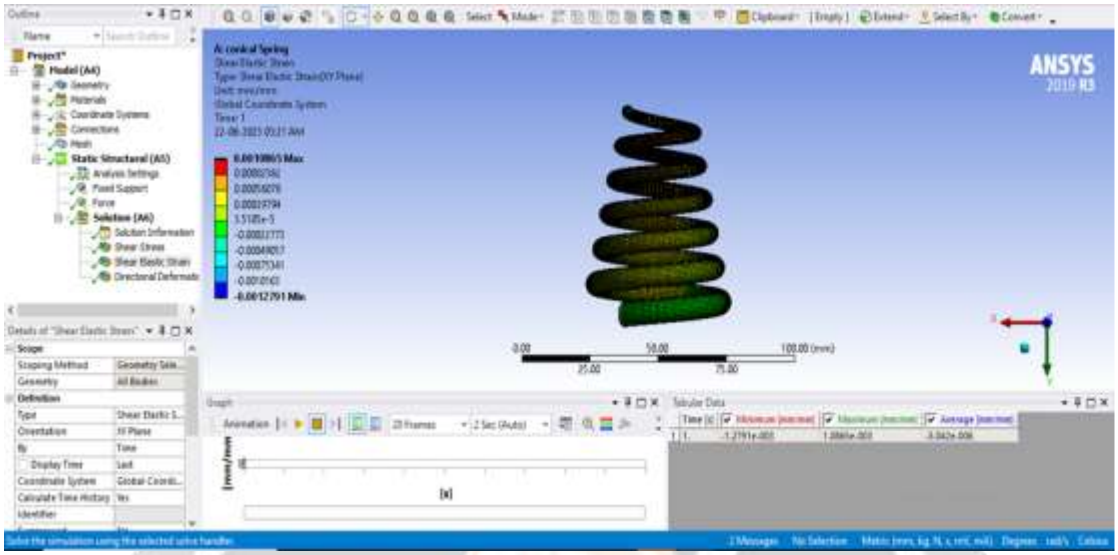

Fig-8 Experimental result of shear strain

3.5 Comparison Table

Table-2 Comparison between Analytical and Experimental results

Sl.No	Particulars	Analytical results	Experimental results	% of Error
1	Deformation (mm)	2.33	2.2724	2.47%
2	Shear Stress (N/mm^2)	79.57	80.033	0.57%
3	Shear Elastic Strain	3.78×10^{-5}	3.5105×10^{-5}	5.54%

4. CONCLUSION

The presentation of an extensive procedure for ideal conical spring design. Its primary benefit is the integration of mathematical and industrial knowledge to suggest an ideal design that operates directly from global standards.

Moreover, information regarding tolerances might be included in the specification sheet of the proposed tool during the first design phases. The quick computation time attained enables the designer to try many setups and decide which is most effective. As the designer can easily change the criteria or the goal function to evaluate various design alternatives, this is a helpful exploratory tool.

The obtained Analytical results are approximately close to the Experimental results and these results are tabulated in **Table-2**with minimum percentage of error.

5. SCOPE FOR FUTURE WORK

- With the advancement of technology, it is possible to develop advanced simulation software that can accurately predict the behavior of conical springs under different loads and conditions. This software can be used to optimize the design of conical springs for specific applications.
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- 3D printing technology has the potential to revolutionize the manufacturing of conical springs. Future research can focus on developing new techniques for 3D printing conical springs with improved performance and durability

6. REFERENCES

1. Design of Machine elements text book by “V B Bhandari”.

2. Rivin, E. I ,1999, “ Stiffness and Damping in Mechanical Design”, Marckel Dekker Inc.NY

3. T. Gotoh and T. Imaizumi, “Optimization of Force Action Line Spring Design on the Macpherson Strut Suspension for Riding comfort,” SAE Technical Paper 2000-01-0101, 2000

4. Krishna S., Vignesh S., " Hybrid Springs for Power Generation", journal of Mechanical and Civil Engineering, Volume 12, Issue 3 Ver. III,2015,pp. 1-6.

5. S. Pattar, S. J. Sanjay, and V. B. Math, “Static Analysis of Helical compression Spring,” Int. J. Res. Eng. Technol., vol. 3, no. 3, pp. 835–838, 2014

6. K. Hasega a and T. Imaizumi, “Curved Helical Compression spring ,” US 6375174 B2, 2002.

7. Pavani P., Prafulla B. K., Rao R. Pola, "Design, Modeling and Structural Analysis of Wave Springs", Procedia Materials Science Elesvier, Vol.6, 2014, pp. 988-995.

8. A. R. Klembczyk., “Introduction to Shock and Vibration Isolation and Damping Systems”. website:http://taylordevices.com/Tech-Paper-archives/literature-pdf/74- Introduction_ShockandVibration.pdf.

9. R.A. Ibrahim ,“Recent advances in nonlinear passive vibration isolators”, Journal of Sound and Vibration 314 (2008) 371–452.

10. G. Popov, S. Sankar, Modeling and analysis of nonlinear orifice type damping in vibration isolators, Journal of Sound and Vibration 183 (1995) 751–764.

11 Manuel Paredes , Emmanuel Rodriguez, “Optimal design of conical springs”, Engineering with Computers (2009) 25:147–154.

BIOGRAPHIES

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