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Simulation of Helical Spring Used In Tractor Seat Application

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Abstract- Over the year a lot of work has been done and is still continuing with great effort to reduce the cost and improving the performance of compression spring and also study the analysis of failure in spring. The aim of this project is to study existing design of helical spring and manufacturing the spring and carry out the vibration analysis of helical spring for Tractor seat .To reduced vibration at the time of dynamic loading condition, applied on helical spring.. At different load condition and vibration we have check the failure analysis of spring. In general we have studied vibration analysis of spring and also study the effect of varying the number of turns of the spring. In tractor seat vibration take place so we have to reduce this vibration by using suitable design and material. . The suspension of spring has to be modified in order to reduce the vibration and journey should be comfortable i.e. jerk free journey. Due to damping the helical spring gets break up and which causes the serious accident. so effective design of helical spring needed for tractor seat to get comfort and to withstand vibration. Our aim is to find the natural frequency of helical spring by using Finite element method (Modal Analysis) for tractor seat which ultimately gives strength characteristics , safety ,comfort and durability of spring and also to reduce the weight of spring for purpose of seat.

General Terms- Helical spring, suspension systems.

Keywords- Finite element analysis, modal vibration, strength analysis

INTRODUCTION

Helical springs are widely used in many engineering applications due to their importance. Helical compression springs are used widely all over the world. It has different type of applications in different area Springs are used in mechanical equipment with moving parts, to absorb loads, which may be continuously, or abrupt varying. The absorption of the loads takes place in the form of elastic energy. Coil springs are manufactured from rods which are coiled in the form of a helix. The design parameters of a coil spring are the rod diameter, spring diameter and the number of coil turns per unit length. Compression springs may be cylindrical, conical, tapered, concave or convex in shape. Vehicle suspension system is made out of springs that have basic role in power transfer, vehicle motion and driving.

There has been a lot research has been carried out to find optimized solution for helical spring depending on the application. The jinhee Lee has proposed a Pseudo spectral method which was applied to the free vibration analysis of cylindrical helical springs. The displacements and the rotations are approximated by the series expansions of Chebyshev polynomials and the governing equation was collocated [1]. A.M. Yu, Y. Hao has done analytical study on the free vibration analysis of cylindrical helical springs with noncircular cross-sections. They have formulated explicit analytical expressions of the vibrating mode shapes of cylindrical helical springs with noncircular cross-sections and the end conditions clamped–clamped and clamped–free, using the symbolic computing package MATHEMATICA [2]. L.E. Becker et al. linearized disturbance equations governing the resonant frequencies of a helical spring subjected to a static axial compressive load are solved numerically using the transfer matrix method for clamped ends and circular cross-section to produce frequency design charts [3]. The scope of K.MIchalczyk work includes the determination of the stress amplitudes in the spring for the given parameters of elastomeric coating, at the consecutive resonance frequencies [4]. Mohamed Taktak has proposed a numerical method to model the dynamic behavior of an isotropic helical spring [5]. The analytical and numerical models describing wave propagation, of gradual excitations in time has been investigated by Aimin Yu, et al[6]. Suraj Kumar et al have purposed air spring which is to restrict the vibration at a desirable level as per requirements [7]. Anis Hamza et al has studied the vibrations of a coil, excited axially, in helical compression springs such as tamping rammers are discussed. He has developed a mathematical formulation which was comprised of a system of four partial differential equations of first-order hyperbolic type, as the unknown variables are angular and axial deformations and velocities. The numerical resolution was performed by the conservative finite difference scheme of Lax–Wendroff. [8]. Youl Zhu et al have Shown that a variety of factors may cause fatigue failure of helical compression springs in engineering applications.

In this paper, we studied different types of helical springs which are used for tractor seats to reduce the vibration. The Detailed research has been carried out to find modal vibration for helical spring. The finite element results obtained from ANSYS software for helical spring. The good agreement has been found between analysis and literature values.

MATERIAL

Springs are resilient structures designed to undergo large deflections within their elastic range. It follows that the materials used in springs must have an extensive elastic range.

Some materials are well known as spring materials. Although they are not specifically designed alloys, they do have the elastic range required. In steels, the medium-and high-carbon grades are suitable for springs. Beryllium copper and phosphor bronze are used when a copper-base alloy is required. The high-nickel alloys are used when high strength must be maintained in an elevated-temperature environment.

The selection of material is always a cost-benefit decision. Some factors to be considered are costs, availability, formability, fatigue strength, corrosion resistance, stress relaxation, and electric conductivity. The right selection is usually a compromise among these factors.

2.1Commonly used spring materials.

One of the important considerations in spring design is the choice of the spring material. Some of the common spring materials are given below.

Hard-drawn wire.

This is cold drawn, cheapest spring steel. Normally used for low stress and static load. The material is not suitable at subzero temperatures or at temperatures above 1200C.

Oil-tempered wire.

It is a cold drawn, quenched, tempered, and general purpose spring steel. It is not suitable for fatigue or sudden loads, at subzero temperatures and at temperatures above 1800C.

Chrome Vanadium.

This alloy spring steel is used for high stress conditions and at high temperature up to 2200C. It is good for fatigue resistance and long endurance for shock and impact loads.

Chrome Silicon.

This material can be used for highly stressed springs. It offers excellent service for long life, shock loading and for temperature up to 2500C.

Music wire.

This spring material is most widely used for small springs. It is the toughest and has highest tensile strength and can withstand repeated loading at high stresses. It cannot be used at subzero temperatures or at temperatures above 1200C.

Stainless steel.

Widely used alloy spring materials.

Phosphor Bronze / Spring Brass.

It has good corrosion resistance and electrical conductivity. It is commonly used for contacts in electrical switches. Spring brass can be used at subzero temperatures.

On the basis of this particular study we have selected material as 55 Si 2 Mn 90

Table 1. Material Configuartion

% C	**% Si**	**% Mn**% Si
0.5-0.6	1.5-2	0.8-1.0

% Mn

I. FINITE ELEMENT ANALYSIS
II.

CAD model has been prepared for helical spring for the tractor seat .Material properties has been taken for the selected 55 Si 2 Mn 90 as follows

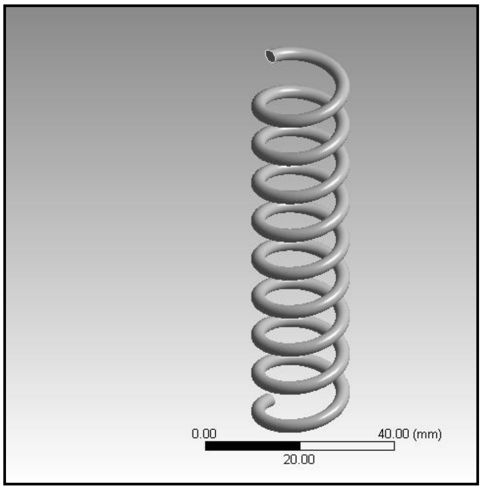

Table 2. Material Properties

Tensile strength (σsut)	**Yield strengt h (σsyt)**	**BHN**
1600-2000	1500	440-510

Fig 1: CAD drawing of helical spring

Dimension for this helical spring has been taken according to the literature and tractor seat application. The coil diameter is 18 mm, wire diameter is 3 mm and pitch is 7.5 .
Modal analysis has been done the basis of free vibration analysis, the natural circular frequencies wi and mode shapes fi are calculated from: $\left([K]-\omega_i^2[M]\right)\{\phi_i\}=0$
For the modal analysis in ANSYS this following assumption has been taken in to account
K] and [M] are constant
Linear elastic material behavior is assumed
Small deflection theory is used, and no nonlinearities included
[C] is not present, so damping is not included
{F} is not present, so no excitation of the structure is assumed
The structure can be constrained or unconstrained
Mode shapes {f} are relative values, not absolute
The Meshing model for Finite element analysis i.e modal analysis has been carried out using tetrahydron element so that it will cover all mathematical formulation .for this specific spring we have got 3690 elements and above 16000 nodes to cover total geometry.

RESULTS AND DISCUSSION

Modal analysis for free-free condition of helical spring for getting 10 mode shape and 10 natural frequencies has been done. The results shows first 6 natural frequencies to be approximately equal to zero as there is no restriction on the or constrained being a free-free condition. For first 6 modes shape gives the 3 translation and 3 rotations in respective direction.

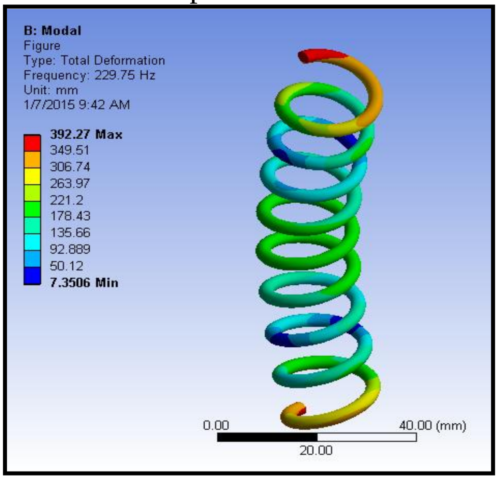

Fig 1: Mode shape (7) and its Deformation

The natural frequencies for the particular problem is as shown in a table

Table 3. Natural Frequencies

Modes	Natural Frequency(Hz)
1	0
2	0
3	0

4	0
5	0
6	0
7	229.75
8	230.26
9	351.94
10	403.21

III. CONCLUSION

It has been found that the natural frequency obtained after analysis of this helical spring shows good agreement with the experimental analysis readings which are observed in literature. It is also been suggested that to verify those natural frequency by using FFT analyzer.

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