Review of Compression Helical Spring for Two Wheeler Suspension Systems

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Abstract— Present paper reviews the general study on configuration of helical springs. Fundamental of stress distribution and characteristics of helical coil spring has been reviewed. Discussion on parameters influencing the helical spring quality has also been explained. From the study it has been found that weight of the automobile helical spring should be reduced. So the springs are to be designed for higher stress and small dimensions. Finite element modelling brings improvement to the suspension spring analysis. A lot of study has been conducted on the Finite element analysis using ANSYS

Key words: Helical Spring, ANSYS

I. INTRODUCTION

A spring may be defined as an elastic body, whose expand in size when load applied and regain its original shape when removed. A spring performs many operations taking from exerting a force or torque to store energy. Force applied by a spring can be linear or radial, this force be termed as pull or push. Helical spring also called as closely coiled helical spring when wire of the springs are attached so close that each turn is nearly orthogonal to the axis of helix angle. We can also say that in helical spring helix angle is very small and is less that 10°. The major stresses developed in the helical spring are shear stresses due to twisting. The applied torque can cause a rotation or twist.

Helical springs are flexible components and are regularly utilized as a part of machines. Normally helical springs are delivered by curling steel wire of round or rectangular segment. Wires with little diameter (d ≤ 8-10 mm) are basically cold-coiled after heat treatment. Springs are generally tempered with a specific end goal to reduce residual stresses. Springs with greater areas and additionally springs with obligated applications are hot-curled and in this manner heat treated so as to increment in mechanical properties. In view of distinctive applications and took after by them diverse necessities identified with trademark, proportion between greatest burden and transversal measurements, mounting arrangement and so forth an extensive variety of advancements of helical springs are utilized. The development that is moderately new among others is spring machined from cylindrical sleeve. Springs of such types are made with high precision without exhibiting extra stress, separate themselves with high accuracy of characteristics and probability of distinctive mounting courses with co-working segments.

Fig. 1: Closely coiled helical spring

These springs can be applied in systems where because of certain reasons very small tolerance of positioning is demanded like e.g. in elastic seat of deflecting segments in slide thrust bearings of high overall dimensions. Important advantage of such springs is also possibility of gaining very high stiffness, not possible in case of springs coiled from wire. Besides the advantages presented above, helical springs similar to the ones shown at Figure 1 have also some disadvantages. The main disadvantage of such springs is high (comparing to helical spring coiled from wire with circular section, having the same stiffness and loaded with the same force) level of stresses during work. Also there is a stress fixation in the area of spot where the coils start.

II. STABILITY OF THE SPRING (BUCKLING)

Clasping of segment is a natural phenomenon. Clasping of section is a recognizable phenomenon. We have noted before that a slim part or segment subjected to compressive loading will clasp when the load surpasses a difficult value. Correspondingly pressure coil springs will clasp when the free length of the spring is bigger and the end conditions are improper to uniformly divide the load up and down the coil perimeter. The coil pressure springs will tend to clasp when the redirection (for a given free length) turns out to be too substantial. Limiting so as to clasp can be anticipated the spring's avoidance or the free length of the spring. The conduct can be described by utilizing two dimensionless parameters, basic length and basic diversion. Basic redirection can be characterized as the proportion of diversion (y) to the free length (Lf) of the spring. The basic length is the proportion of free length (Lf) to mean coil measurement (D). The basic redirection is an element of basic length and must be underneath a sure utmost. As could be saw from the figure total strength can be guaranteed if the basic length can be constrained underneath a farthest point. For lessening the clasping impact taking after condition must be fulfilled

$L_f < 4D$, the crippling load can be given by $W_{cr} = K \times K_B \times L_f$

Where, K = spring rate K_B = clasping element

III. SPRING SURGE AND CRITICAL FREQUENCY

On the off chance that one end of a stress spring is held against a level surface and the flip side is aggravated, a pressure wave is made that goes forward and backward from one end to the next precisely like the swimming pool wave. Under specific conditions, a reverberation may happen bringing about an exceptionally fierce movement, with the spring really hopping out of contact with the end plates, regularly bringing about harming burdens. This is entirely genuine if the inner damping of the spring material is very low. This marvel is called spring surge or just surging. At the point when helical springs are utilized as a part of uses requiring a quick responding movement, the creator must be sure that the physical measurements of the spring are not, for example, to make a characteristic vibratory recurrence near the recurrence of the applied power.

IV. FATIGUE LOADING

The springs need to manage a great many cycles of operation without disappointment, so it must be intended for limitless life. Helical springs are never utilized as both pressure and augmentation springs. They are generally collected with a preload so that the working burden is extra. Consequently, their anxiety time chart is of fluctuating nature. Presently, for configuration we characterize,

$$F_a = (F_{max} - F_{min}) / 2, F_a = (F_{max} + F_{min}) / 2$$

Certain applications like the valve spring of a car motor, the springs need to manage a large number of cycles of operation without disappointment, so it must be intended for unbounded life. Not at all like different components like shafts, helical springs are never utilized as both pressure and augmentation springs. Actually they are normally collected with a preload so that the working burden is extra. In this way, their anxiety time outline is of fluctuating nature.

While designing the helical spring, at first length of spring, diameter of wire, spring mean diameter, pitch of spring considered according to application. When subjected to load spring get twisted or stresses. What is the maximum deflection and developed when subjected to load is very imperative to know. Some different qualities are additionally considered. To ascertain diversion and most extreme shear stress recipes are below.

$$\delta = \frac{\theta x D}{2}$$

$$\frac{T}{J} = \frac{\tau}{\frac{D}{2}} = \frac{G\theta}{l}$$

Using above equation, we can get,

$$\delta = \frac{8WD^3n}{Gd^4} = \frac{8WC^3n}{Gd}$$

From above equation we get, C=D/d which is also known as spring index,

Stress in the helical spring of circular wire can be calculated as,

$$T = \frac{\pi}{16}\tau d^3$$

$$\tau = \frac{8WC}{\pi d^2}$$

If we consider the Wahl's stress factor (KW) then,

$$K_W = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

$$\tau = \frac{8WCK_W}{\pi d^2}$$

V. STRAIN ENERGY

Generally the springs are made up of materials. The fundamental variable is to be considered in configuration of spring is the strain vitality of material utilized. Strain vitality in materials can be defined as.

$$U = \frac{1}{2}T\theta$$

Where T is torque applied and θ is angular deformation

VI. SPRING RELAXATION

Springs of all types are required to operate over drawn out stretches of time without noteworthy changes in measurement, removal, or spring rates, regularly under fluctuating burdens. In the event that a spring is avoided under full load and the hassles instigated surpass the yield quality of the material, the subsequent perpetual misshaping may keep the spring from giving the required power or to convey put away vitality for ensuing operations. Most springs are liable to some measure of relaxation amid their life compass even under favourable conditions. The measure of spring relaxation is a spring's element material and the measure of time the spring is presented to the higher burdens and/or temperatures. Static springs can be used as a part of steady diversion or constant load applications. A constant diversion spring is rounded through a predefined avoidance range, the pressure on the spring defect about some set or relaxation which thus turns brings down the applied pressure. The spring may unwind with time and diminish the applied load. Raised temperatures can bring about heat relaxation, abundance changes in spring measurement or decreased pressure supporting capacity. Under steady load conditions, the load applied to the spring does not change amid operation. Constant burden springs may set or crawl, however the applied anxiety is steady. The steady pressure may bring about exhaustion lives shorter than those found in constant redirection applications. In so many applications, stress and strain springs are subjected to hoisted temperatures at high stresses which can bring about relaxation or loss of burden. This condition is regularly alluded to as "set". After the operating conditions are explanation, set can be anticipated and remittances made in the spring design. At the point when no set is permitted in the application, the spring maker may have the capacity to pre-set the spring at temperatures and pressure higher than those to be experienced in the operating environment. A much focused on spring will set the initial a several times it is squeezed. Relaxation is an element of a genuinely high stress (however generally lower than that required to cause set) over a time. Creep in the spring may prompt unsuitable dimensional changes even under static loading (set). A spring held at a sure stress will really unwind more in a given time than a spring cycled between that stretch and a lower anxiety on the grounds that it invests more energy at the higher anxiety. The measure of spring relaxation over a time of period is evaluated by first deciding the working temperature, the most extreme amount of stress the spring sees and how.

VII. LITERATURE SURVEY

Helical pressure springs, as one of the essential versatile individuals from the suspension arrangement of vehicles, are generally utilized as a part of automobile industry. They connect the wheel to the body flexibly and store the vitality to ingest and smooth out stuns that are gotten by the wheel from street abnormalities and transmitted to the body. This dynamic administration stacking condition regularly brings about weariness disappointment of the suspension spring in an assortment of ways.

Raw materials deformity, surface defects, improper heat treatment, consumption and decarburization are for the most part perceived reasons for weariness disappointment of suspension spring. In administration, the stress on the internal surface of a dynamic coil of the helical spring is the position of most extreme anxiety and the coil surface itself is defenceless against defects in materials and surface respectability that serve as anxiety focus focuses realizing weakness split start.

Moreover, it is perceived that stress springs regularly broken at the move position from the bearing coil to the first dynamic coil. The accompanying perspectives, for example, poor shot pining as a result of no hole or little crevice between the bearing coil and the first dynamic coil, bending pressure because of rotating of the first dynamic coil about the end tip, bigger erratic ism of the stacking power affected bigger most extreme net-elastic anxiety, and consumption because of gathering of destructive liquid in the littler hole between the bearing coil and the first dynamic coil.

Prawoto Y. et al. [1] discusses about automotive suspension coil springs. They studied about stress distribution, common failures, manufacturing, factors affecting coil spring quality and material characteristics. They discuss about the different failures occurs at the suspension spring. They also studied about the materials used for higher level stresses and weight reduction capabilities. The failures studied they conduct vary from insufficient capacity of carrying loads, defects due to raw materials like high stress level, manufacturing defects to complex stress distribution.

Todinov M. T. [2] studied about maximum principal tensile stress and fatigue crack origin for compression springs. They proposed an equation for helical spring for maximum tensile stress loading. They also suggested a model for fatigue crack opening calculation. They concluded that for high stress helical springs should be designed on the basis of maximum principal tensile stresses. They also studied the shot opening effect on crack opening location.

Michalczyk K. [3] studied analysis of helical compression spring support Influence on its deformation. In their study they suggested a new method for change in angle twist calculation of helical springs. They also verified their results with the experiments. They concluded that model developed by them shown below for calculation of angle of twist in presence of high lead angle, mutual rotation of springs end-coil's gives better results compared to models available in the literature.

$$\vartheta = 2\pi n_{0cz} - \frac{L^2}{\sqrt{L^2 - H_{1cz}^2}} \left(\frac{R_0}{\left(\frac{H_{0cz}}{2\pi \cdot n_{0cz}}\right)^2 + R_0^2} + \frac{(H_{0cz} - H_{1cz})}{2\pi R_0^2 \cdot n_{0cz} \cdot (1+\nu)} \cdot \frac{H_{1cz}}{L} \right)$$

The above summary demonstrates that an assortment of elements may bring about weariness disappointment of helical pressure springs in designing applications. Truth be told, it is regularly the simultaneous demonstrations of an above few causes that outcomes in spring exhaustion. Our currently works about disappointment analysis of a helical pressure springs of an overwhelming vehicle uncovered that push peculiarity because of non-Hertzian contact between the bearing coil and the first dynamic coil assumed basic part in the weariness break start. An over weighted vehicle's suspension helical pressure spring cracked in administration exactly at the move position from the bearing coil to the first active coil. The spring, having shut closures plan, with aggregate length of 532 mm, coil span of 82.5 mm, seven dynamic coils and two bearing coils, was icy snaked from a wire of 36 mm in breadth.

VIII. CONCLUSION

- Major factors that influence the quality of springs are design parameters, material determination, Raw material deformity, spring geometry and surface defect.
- Design factors like working modes, working temperature and flaws inside the spring influence specifically on fatigue life of spring, modulus and torsional yield quality of spring material decreases as temperature increases.
- If the internal side of the spring is shot peened than the stresses developed inside loop surface lessens and fatigue life of spring increases.
- Strength of the spring reduces if there is any impurity in the materials.
- Shot opening affect the crack opening location.
- High stress helical springs should be designed on the basis of maximum principal tensile stresses.

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