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A Review on the comparison of Helical and Wave springs

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Abstract – Helical springs are mechanical parts used as shock Absorbers in various Engineering Designs. The design of Coil springs are fairly simple and they provide good suspension in mechanical machines. Various springs are used in Automobiles and other day to day devices. From clock to Aeroplanes, a spring is being used in almost every machine. The design of coil spring is slightly changed in order to obtain a Wave spring, which is also helically twisted and of same size and Material. In the present work a review is made on the the types of springs that have been used in the Engineering applications along the history. A thorough comparsion is made to find out different modes of failure of helical springs and how the design of helical coil spring evolved with time to fight against those modes of failures. The objective is to identify the best way to design a helical spring and to counter the modes of failure that the spring faces during its term of service.

Keywords – Helical Spring, Coil Spring, Wave Springs, Static Analysis, Dynamic Analysis.

1. Introduction –

Among the many types of springs, wave springs have attracted considerable attention this kind of long and reliable source of long lasting durability and considerable effectiveness than rest of the springs (David Clarke, 2002). An analytical model for stamped ring wave springs is proposed, Because of the particular shape of the spring in the un-deformed configuration, the load— deflection curve is found to be appreciably bilinear in character. A similar but less pronounced behavior is displayed also by the relationship between load and internal stresses. The analytical results are compared to earlier theoretical findings and are shown to correlate well with experimental measurements. A wave spring, also known as coiled wave spring or scro-wave spring, is a spring made up of pre-hardened flat wire in a process called on-edge coiling (also known as edge-winding). During this process, waves are added to give it a spring effect. The number of turns and waves can be easily adjusted to accommodate stronger force.

- Same force and deflection as ordinary helical / compression springs
- Wave springs fit tight radial and axial spaces
- Over 4,000 standard springs in carbon and stainless steel (¼" to 16", 6 mm to 400 mm diameters)
- No Tooling Charges on custom designs (.165" to 120", 4 mm to 3000 mm diameters)
- Exotic alloys available

Smalley Wave Springs (Flat Wire Compression Springs) offer the unique advantage of material savings when used to replace helical springs. With a less material used in the manufacturing process, a cost savings is realized.

2. Literature Survey

P.N.L.Pavania, et al. [1] has analysis on wave springs has been done by structural mechanics approach and results were validated compared with the coil spring of the shock absorber. By performing static analysis comparison of wave spring with coil spring is done. Results shows that Wave springs possess less deformation and more stresses when compared with coil springs.

Chandrakant Chavan, et al. [2] has carried out work on the Fatigue life analysis of the suspension coil spring using a FEA technique interface would offer credible design inputs which can be used concurrently while designing the spring. The modified design based upon the analysis should further be subjected to analysis to check the new outcome. This process of iteration yields an optimized design which fits the function and helps the Design Engineer to validation his design over the virtual interface followed by physical test further to validation for improvement of fatigue life.

Dr P. Ravinder Reddy, et al. [3] has analysis on wave spring has been done by structural mechanics approach and results were validated and compared with the coil spring of the shock absorber. The deflection induced in the wave spring is average 25.88% less than the coil spring. The equivalent stress of wave spring is an average 58.32% less than coil spring. The strain energy of wave spring is an average 21.3% greater than coil spring.

C.Madan Mohan Reddy et al. [4] has carried out work on modeling, analysis and testing of suspension spring is to replace the existed steel helical spring used in popular two wheeler vehicle. The stress and deflections of the helical spring is going to be reduced by using the new material. The comparative study is carried out between existed spring and new material spring. In this the finite element analysis values are compared to the experimental values. A typical two wheeler suspension spring is chosen for study. The modeling of spring is developed on pro/E 5.0 analysis is carried out on ANSYS 14.

Dr P. Ravinder Reddy et al. [5] has present work on the structural analysis of wave and coil spring by modeling the structural behavior of these springs using three dimensional finite elements (FE) software. The design of spring in suspension system is very important. In this work a wave type of spring is designed and a 3D model is created using CREO software. The model is also varied by changing the length of the spring. Structural analysis has been conducted on the wave spring by varying thickness and number of turns. For the analysis, loads are bike weight with single and two persons. The buckling load is then estimated for both Wave spring and coil spring with the same parameters. Analysis on wave spring has been done by structural mechanics approach and results were validated and compared with the coil spring of the shock absorber.

Mr. J. J. Pharne et al. [6] has proposed a finite element model for helical compression springs subjected to cyclic loads is developed for fatigue stress analysis. In the design modification of this kind of spring both the elastic characteristics and the fatigue strength have to be considered as significant aspects. A typical helical compression spring used for two wheeler horn is chosen for study under fatigue loading condition. Fatigue analysis is done in ANSYS 14.0 software. The results developed have been compared with the experimental observations.

S. Abdullah et al. [7] has carried out on the study of a fatigue damage and relationship with I-kaz coefficient. The data collected from the coil spring of an automobile which was driven over highway, country road and damage road surface were used as the subject of this study. This comparative study shows that fatigue damage was proportionally related to the I-kaz coefficient. The reason behind this statement is fatigue damage has relationship with kurtosis and I-kaz coefficient was obviously based on kurtosis and standard deviation. This result shows that, fatigue damage determination can be evaluated either using strain-life approach or I-kaz method.

Krzyszto Michalczyk [8] has carried out analyzes the effectiveness of damping resonance vibrations of a spring using a new method of local coatings made of highly-damping material covering its last coils, as well as the infl uence of these coatings on the maximum values of dynamic stresses and the values of natural vibration frequencies of springs. It is shown that while an elastomeric coating applied on the whole length of spring wire always causes a decrease in the First natural frequency of the spring, application of the same amount of damping material only on its end-coils may lead to an increase in this frequency. The mathematical model derived in the paper allows users to calculate the effectiveness of dynamic stress reduction both in the spring and the coating itself, for arbitrary geometrical and material properties of coatings.

Rajkumar V. Patil [9] has proposed an analytical buckling equation with its experimental verification and used it along with the existing theories to locate the phase of compression of conical spring at which buckling occurs. Subsequently, a comparison between cylindrical and conical springs has been made at the point of buckling of cylindrical spring in respect of their load and deflection. This helps to decide the suitability of conical springs against buckling failure of cylindrical springs under the given operating conditions.

P.R. Jadhav et,al [10] has carried out work study presents the stress analysis of mono suspension spring. Here, stresses and deflections are calculated with changing speed and validated with FEA. From the finite element analyses, the following findings are reported. Though, the results are elaborated in earlier chapter, the brief discussion and conclusion is presented as follows.

Pinjarla.Poornamohan[1], et al. [11] has carried out work on a suspension system or shock absorber is a mechanical device. In this project a shock absorber is designed and a 3D model is created using Pro/Engineer. The model is also changed by changing the thickness of the spring. Structural analysis and modal analysis are done on the shock absorber by varying material for spring, Spring Steel and Beryllium

Copper. The analysis is done by considering loads, bike weight, single person and 2 persons. Structural analysis is done to validate the strength and modal analysis is done to determine the displacements for different frequencies for number of modes. Modeling is done in Pro/ENGINEER and analysis is done in ANSYS.

M.Venkatesan et al. [12] has describes design and experimental analysis of composite leaf spring made of glass fiber reinforced polymer. The objective was to compare the load carrying capacity, stiffness and weight savings of composite leaf spring with that of steel leaf spring. The dimensions of an existing conventional steel leaf spring of a light commercial vehicle are taken. Same dimensions of conventional leaf spring are used to fabricate a composite multi leaf spring using E- Glass/Epoxy unidirectional laminates.

Lei Lei, Zuo Shuguang, et al. [13] has carried out work on improve the stability of the vehicle by using non-linear spring, such as barrel-shaped helical spring, in vehicle suspension. The barrel-shaped helical spring on the rear suspension of P ASSAT B5 was analyzed is this paper. Firstly, the accurate physical model of the spring is built by 3D scanning and post-process. Then the stiffness of the spring was calculated by finite element analysis, and the influences of the major structural parameters on the spring's stiffness were obtained. Finally, the FE model of the barrel-shaped helical spring was validated with experiment results.

3. CONCLUSION

After comparing all the above literature and more, it is a clear indication that a wave spring of helical nature is much more efficient in many aspects than coil spring. But there is only static analysis, which is performed over these springs as the comparison in all the literature. A vibrational or dynamic analysis can be done to compare the natural frequencies of such springs and then we can be able to purely compare the performance of these types.

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