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Design & Analysis of Spring used in Dual Mass Flywheel

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***Abstract*— All engines have flywheels that balance out compression and power strokes, maintain idle speed, aid starting and reduce parts wear. Dual mass flywheel is a multi-clutch device which is used to dampen vibration that occurs due to the slight twist in the crankshaft during the power stroke. When the operating speed of the engine is low, vibration occurs due to the torsional resonance and this can be avoided using dual mass flywheel Spring. This work is carried out to study the effect material changing of springs on the dual mass flywheel. The main aim is to increase the vibration absorbing capacity and to increase durability of the spring and to elimination of gear rattle. First design steel, aluminum, copper and brass material springs as per our load. Then modeling in Creo 2.0 A three dimensional model of a single spring are optimized by modal analysis and static structural deformation using ANSYS13.00. Manufacture, Compare with Ansys 13.00 and FFT analyzer, Validation of result.**

Keywords*— Design springs for steel, aluminum, copper and brass material, Modeling of springs in Creo 2.0 , Manufacture, Compare with Ansys 13.00 and FFT analyzer, Validation of result.

INTRODUCTION

A spring is defined as an elastic body, whose function is to distort when loaded and to recover its original shape when the load is removed. Spring act as a flexible joint in between two parts which provides cushioning effect for this system a spring is an elastic object used to store mechanical energy. Springs are usually made out of spring steel. There are a large number of spring designs; in everyday usage the term often refers to springs. Small springs can be wound from pre-hardened stock, while larger ones are made from annealed steel and hardened after fabrication. Some non-ferrous metals are also used including phosphor bronze and titanium for parts requiring corrosion resistance and beryllium for springs carrying electrical current (because of its low electrical resistance).

When a coil spring is compressed or stretched slightly from rest, the force it exerts is approximately proportional to its change in length (this approximation breaks down for larger deflections). The rate or spring constant of a spring is the change in the force it exerts, divided by the change in deflection of the spring. it is the gradient of the force versus deflection curve An extension or compression spring has units of force divided by distance, for example N/m. The inverse of spring rate is compliance, the stiffness (or rate) of springs in parallel is additive, as is the compliance of springs in series. Depending on the design and required operating environment, any material can be used to construct a spring, so long as the material has the required combination of rigidity and elasticity: technically, a wooden bow is a form of spring. [13]

Functions of Spring

Following are the objectives of a spring when used as a machine member:

1. Cushioning, absorbing, or controlling of energy due to shock and vibration. Car springs or railway buffers to control energy, springs-supports and vibration dampers.

2. Control of motion maintaining contact between two elements (cam and its follower) in a cam and a follower arrangement, widely used in numerous applications, a spring maintains contact between the two elements. It primarily controls the motion.

Creation of the necessary pressure in a friction device (a brake or a clutch) A person driving a car uses a brake or a clutch for controlling the car motion. A spring system keep the brake in disengaged position until applied to stop the car. The clutch has also got a spring system (single springs or multiple springs) which engages and disengages the engine with the transmission system. Restoration of a machine part to its normal position when the applied force is withdrawn (a governor or valve) A typical example is a governor for turbine speed control. A governor system uses a spring controlled valve to regulate flow of fluid through the turbine, thereby controlling the turbine speed.

3. Measuring forces

Spring balances, gauges like no. of equipment which used to measure the force which act on that body

4. Storing of energy

In clocks or starters The clock has spiral type of spring which is wound to coil and then the stored energy helps gradual recoil of the spring when in operation. Nowadays we do not find much use of the winding clocks. Before considering the design aspects of springs we will have a quick look at the spring materials and manufacturing methods. [15]

1.1.2Terminology of Helical Coil Spring

Helical springs.

The helical springs are made up of a wire coiled in the form of a helix and are primarily intended for compressive or tensile loads. The cross-section of the wire from which the spring is made may be circular, square or rectangular. Helical compression springs have applications to resist applied compression forces or in the push mode, store energy to provide the "push". Different forms of compression springs are produced.

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The helical springs are said to be closely coiled when the spring wire is coiled so close that the plane containing each turn is nearly at right angles to the axis of the helix and the wire is subjected to torsion. in other words, in a closely coiled helical spring, the helix angle is very small, it is usually less than 10 degree. The major stresses produced in helical springs are shear stresses due to twisting. The load applied is parallel to or along the axis of the spring. In open coiled helical springs, the spring wire is coiled in such a way that there is a gap between the two consecutive turns, as a result of which the helix angle is large.

Literature review

The recent development in the automotive sector is diminishing due to the demand by the automotive industry for saving cost during the increase in the research and development phase. When taking survey then following revives obtained

Dr. K .Annamalai & A .Govinda (2014)studied the theoretical and experimental dynamic behavior of different materials for dual mass flywheel spring Dual mass flywheel is a multi-clutch device which is used to dampen vibration that occurs due to the slight twist in the crankshaft during the power stroke. The torsional frequency is defined as the rate at which the torsional vibration occurs. When the torsional frequency of the crankshaft is equal to the transaxles torsional frequency an effect known as the torsional resonance occurs. When the operating speed of the engine is low, vibration occurs due to the torsional resonance and this can be avoided using dual mass flywheel. This work is carried out to study the effect of arc springs on the dual mass flywheel. The main aim is to increase durability of the arc spring and to elimination of gear rattle. A three dimensional model of a single arc spring, hard-soft spring combination and single mass with arc springs are optimized by modal analysis and fatigue analysis using ANSYSThe torsional frequency is defined as the rate at which the torsional vibration occurs. When the torsional frequency of the crankshaft is equal to the transaxles torsional frequency an effect known as the torsional resonance occurs. The vibration caused by the torsional resonance when the operating speed of the engine is low can be avoided using dual mass flywheel. This work is carried out to study the effect of arc springs on the dual mass flywheel, a three dimensional model of a single arc spring, two arc springs with different stiffness and single mass with arc springs are optimized using ANSYS. The simulation of fatigue analysis is also performed using ANSYS. [01]

D. G. Dighole, Prof. R.S. Shelke, Prof. Dr. S.N. Shelke (2015)studied about the rapid developments of vehicle technology over the last few decades, flywheels have been used to achieve smooth operation of machines. The early models where purely mechanical consisting of only a stone wheel attached to an axle. Nowadays, flywheels are complex constructions where energy is stored mechanically and transferred to an integrated motor/generator. The stone wheel has been replaced by a steel or composite rotor and magnetic bearings have been introduced. Today flywheels are used as supplementary UPS storage at several industries world over. Flywheels serve as kinetic energy storage and retrieval devices with the ability to deliver high output power at high rotational speeds as being one of the emerging energy storage technologies available today in various stages of development, especially in advanced technological areas, that is spacecraft's. Today, most of the research efforts are being spent on improving energy storage capability of flywheels to deliver high power transfer, lasting longer than conventional battery powered technologies. This study solely focuses on exploring the effects of dual mass flywheel geometry for improving energy storage capability to deliver high power transfer per unit mass, as compared to conventional flywheel. Dual mass flywheel also reduces the weight of the flywheel using composite materials. In this study using the two spring two mass system to produce useful vibrations which will be employed to increase the inertia of the system and thereby enable to reduce the weight of existing flywheel or increase power output using existing weight of flywheel. They concluded that there is approximately 7 to 8 % increase in power output by using the Dual mass flywheel and also observed that the Dual mass flywheel is 5 to 6 % efficient than the conventional flywheel which will also result in increasing fuel economy of the engine. [02].

Park, Dong hon Suwon- si ,Kyunggi do (2000) [6]invented about a dual mass flywheel for a vehicle includes us a primary flywheel connected to a crank shaft of an engine a dumper housing integrally formed in a circumfertially direction of the primary flywheel .A secondary flywheel connected to an input shaft of a transmission and rotating mounted on a hub of primary flywheel. Driven fingers integrally formed the second flywheel and insert the vertically in to the dumper housing to be forced by the dumper spring .The dumper springs compresses two spring sets symmetrically disposed within the dumper housing .one end of each dumper springs being driven by the stoppers which are integrally formed on primary flywheel. While the other end of springs drives the driven finger of the secondary fly wheel. The primary and secondary flywheels are integrally provided which projections for preventing the dumper spring from excessively compressed & damaged. The dumper spring compressed a plurality of springs .Each having difference springs coefficients and the dumper springs are supported by a plurality of a sliding guide or blocks in that way torsional vibrations of cranck shaft get reduced with the help of Dual Mass Flywheel [03].

Ulf Shaper, Oliver Sawodny, Tobias Mahl and UtiBlessing(2009) [5]those research about -The Dual Mass Flywheel (DMF) is primarily used for dampening of oscillations in automotive power trains and to prevent gearbox rattling. TWs paper explains the DMF mechanics along with its application and components. Afterwards detailed abs-initio model of the DMF dynamics is presented. This mainly includes a model for the two arc springs in the DMF and their friction behavior. Both centrifugal effects and redirection forces act racially on the arc spring which induces friction. A numerical simulation of the DMF model is compared to measurements for model validation. Finally the observe ability of the engine torque using the DMF is discussed. For this purpose a linear torque observer is proposed and evaluated. In today's world power train control sits acclimates torque information to perform various tasks.

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These tasks include for example the clutch acnl3tion in automated manual transmissions and dual-clutch transmissions as well as the control of electric motors in hybrid power trains. Indirect torque estimation is needed because the direct measurement of the transmuted torque using strain gages cannot be done in volume production cars for economic reasons. One source for power train torque estimation is the engine itself. However, the torque estimation provided by the internal combustion engine is based on complex thermodynamic models. These engine models tend not to be reliable in all situations .Critical a picture indeed the accuracy of the lobo charger models and the influence of exhaust gas recirculation on combustion calculation. [4].

Rudolf Glassner(2013) [6]studied about Dual Mass flywheel of driver train of vehicle includes a primary flywheel mass, Secondary flywheel mass & coupling device. The coupling device include at least two pivot levers associated with secondary flywheel mass with inter act with a control profile formed on primary flywheel mass. The pivot levers are pre tensional against control profile in a radial direction by the elastic element. a control segment of elastic element is disposed radially inside control profile. An object of the present invention is to provide a dual mass flywheel having coupling device which has fewer speed dependent coupling characteristics .In the Dual mass flywheel in accordance with the invention the centrifugal force acting on elastic elements in operation is minimized in that elastic elements are more closely to axis of rotation of dual mass flywheel than previously usual If the flywheel is too light the motorcycle requires more effort to start, idles badly, and is prone to stalling. Weight is not the important factor here, but inertia. Inertia is stored energy, and is not directly proportional to flywheel weight. It's possible to have a light flywheel with much more. Any power the motor develops must accelerate the flywheels before leaving the sprocket shaft, and any used in bringing the flywheel up to speed is not available at the rear wheel [05].

Li Quan Song , Li Ping Zeng,Shu Ping Zhang ,Jian Dong Zhou Hong En Niu(2014) was develops new structure of new structure of dual mass flywheel (DMF) with continuously variable stiffness is proposed based on compensation principle in order to release the impact produced by the step changes of stiffness. By theoretical calculation and experiments, the proposed structure and design theory involved are proved to be feasible for reducing the torsional vibration of the power transmission system for automobiles with large-power and high-torque engines. The natural characteristics of the vehicle power transmission system carrying the DMF are analyzed to investigate the influence of torsional stiffness on the first-order and the second-order resonance speeds. The results show that this new DMF can lower the idle speed of the engine, realize high counter torque at a large torsional angle, and avoid the impact due to the abrupt changes of stiffness. An inertia balance mechanism is proposed to eliminate the inertia forces produced by moving parts of the compensation device, which can successfully put the torque compensation theory into engineering practice. By adding a compensation device, a new DMF with continuously variable stiffness is presented to release the impact produced by the step changes of stiffness. This new DMF can avoid impact and noise more effectively. By adding a compensation device, a new DMF with continuously variable stiffness is presented to release the impact produced by the step changes of stiffness. [06].

Sagar N Khurd, Prasad P Kulkarni, Samir D Katekar(2015)study represents new approach to design helical coil spring by using workbench. Response surface modeling and analysis of helical spring by considering Translational invariance have been carried out. In previous paper we had considered longitudinal invariance. Design parameters are wire diameter, coil diameter, height, number of turns elastic modulus in X and Y direction, force. Simple equation is proposed which gives value of compressive stress of helical coil spring by carrying out regression analysis done by M S excels, It is observed that force and material property are significant parameters which affect compressive stress because their P value is 1. Relationship among design parameters and compressive stress has been obtained. In this analysis it is observed that coil diameter increases stress on the spring decreases. It is observed that force and material property are significant parameters which affect compressive stress. [07]

C.Madan Mohan Reddy ,D.RavindraNaikDrM.LakshmiKantha Reddy (2014) studied about present work is carried out 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. Static analysis determines the stress and deflections of the helical compression spring in finite element analysis. The testing proto type is used to test the spring under different loading conditions. Finite element analysis methods (FEA) are the methods of finding approximate solutions to a physical problem defined in a finite region or domain. FEA is a mathematical tool for solving engineering problems. 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. They conclude that the comparative study has been carried out in between the theoretical values to the experimental values and the and the analytical values. The maximum shear stress of chrome vanadium steel spring has 13-17% less with compare to hard drawn steel spring. [08]

` Prince Jerome Christopher J, Pavendhan R.(2010) studied about vehicles problem happens while driving on bumping road condition. The objective of this project is to design and analyze the performance of Shock absorber by varying the wire diameter of the coil spring. The Shock absorber which is one of the Suspension systems is designed mechanically to handle shock impulse and dissipate kinetic energy. It reduces the amplitude of disturbances leading to increase in comfort and improved ride quality. The spring is compressed quickly when the wheel strikes the bump. The compressed spring rebound to its normal dimension or normal loaded length which causes the body to be lifted. The

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spring goes down below its normal height when the weight of the vehicle pushes the spring down. This, in turn, causes the spring to rebound again. The spring bouncing process occurs over and over every less each time, until the up-and-down movement finally stops. The vehicle handling becomes very difficult and leads to uncomfortable ride when bouncing is allowed uncontrolled. Hence, the designing of spring in a suspension system is very crucial. The analysis is done by considering bike mass, loads, and no of persons seated on bike. Comparison is done by varying the wire diameter of the coil spring to verify the best dimension for the spring in shock absorber. Modeling and Analysis is done using Pro/ENGINEER and ANSYS respectively. They have designed a Shock Absorber used in 160 cc bike and we have modeled it using 3D parametric software called Pro/Engineer. The shock absorber design is modified by reducing the diameter and stress analysis is performed. The stress value is lesser in our designed spring than in original which adds an advantage to our design. By comparing the results in the table we could analyses that our modified spring has reduced in weight and it is safe. [09]

Mehdi Bakhshesh, and MajidBakhshesh (2012) both studied about springs that can reserve high level of potential energy, have undeniable role in industries. Helical spring is the most common element that has been used in car suspension system. In this research, steel helical spring related to light vehicle suspension system under the effect of a uniform loading has been studied and finite element analysis has been compared with analytical solution. Afterwards, steel spring has been replaced by three different composite helical springs including E-glass/Epoxy, Carbon/Epoxy and Kevlar/Epoxy. Spring weight, maximum stress and deflection have been compared with steel helical spring and factors of safety under the effect of applied loads have been calculated. It has been shown that spring optimization by material spring changing causes reduction of spring weight and maximum stress considerably. In any case, with changing fiber angle relative to spring axial, composite spring properties have been investigated & concluded that a helical steel spring has been replaced by three different composite helical springs. Numerical results have been compared with theoretical results and found to be in good agreement. Compared to steel spring, the composite helical spring has been found to have lesser stress and has the most value when fiber position has been considered to be in direction of loading. Weight of spring has been reduced and has been shown that changing percentage of fiber, especially at Carbon/Epoxy composite, does not affect spring weight. Longitudinal displacement in composite helical spring is more than that of steel helical spring and has the least value when fiber position has been considered to be in direction of loading. The most safety factor is related to case that fiber position has been considered to be perpendicular to loading and it is for Carbon/Epoxy composite helical spring. [10].

Pavan Kumar AV, Vinayaka N, Dr P B Shetty, DrKiranAithal S, Gowtham V studied about that the Helical Compression spring has been designed in such a way that when the vehicle travels over the spring, the spring takes the maximum load of 200 kg and the rest is taken by the ground. For this purpose, the spring is analyzed for the fatigue loads and has been optimized for the selection of material, wire diameter, carbon percentage and other governing parameters & concluded that as the diameter of spring increases, Ultimate Tensile Strength increases. As the carbon percentage increases, the Ultimate Tensile Strength increases, but flexibility decreases. As the diameter increases, factor of safety increases. As the carbon percentage increases, the factor of safety graph shifts up with respect to the previous grades. As the carbon spring is oil hardened, the strength increases and the factor of safety curve shifts up. [11]

N. N. Suryawanshi1, Prof. D. P. Bhaskar (2015) studied about Dual Mass Flywheel (DMF) is primarily used for dampening of oscillations in automotive power trains and to prevent gearbox rattling. We explained detailed initial model of the DMF dynamics is presented. This mainly includes the two arc springs and two masses in the DMF and their behavior. An experimental the DMF model is compared to convention flywheel. Finally the observation of the engine torque using the DMF is discussed. For this purpose the DMF is manufactured and done experiment or testing to see the results. And then results are comparing with the conventional flywheel &both concluded that there is approximately 10 % increase in power output by using the Dual mass flywheel. [12].

Saurabh Singh(2012) studied about demonstrates the feasibility of adopting composite material for design of helical coil suspension system. In this paper the combination of steel and composite material is used in place of conventional steel only. The composite material used in this analysis is Glass Fiber/Epoxy. The cause of implementing combination of steel and composite material was because of the low stiffness of single composite spring, which limits its application to light weight vehicle only. And conclude that that combination of conventional steel and composite material can increase the stiffness; which is the major requirement however the ever demanding need of weight reduction of vehicles will be satisfied by employing this method. The weight reduction in this combination of material [13]

Demin Chena, Yueyin Ma, Wei Sun, XiaolinGuo, Xaofei Shi (2011) studied about In order to reduce torsion vibration of automotive powertrain, angular stiffness formula of arc helix spring was built according to the performance parameter of a C-grade car. Based on the expression, a method of optimization design about arc helix spring is proposed with the variable radian. A new Dual Mass Flywheel (DMF) with 6 arc helix springs is designed. The torsion vibration simulation model of automotive power train is established by MSc. Easy and the system is analyzed. Further, the experiment is made and proves that the design of DMF can satisfy the use of the car & they concluded that angular stiffness formula of arch helix spring are calculated; a new design optimization method of DMF is proposed with radian as the main variables. The DMF of six arch helix springs is designed. The torsion vibration model of a C-Class car is built by Msc.Easy5, and the vibration reduction effect of DMF designed is simulated. Finally, the experiment on the DMF is carried out and results show that it meets design requirements. This method given in the paper can be used to

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select the appropriate arc helix springs for DMF to avoid resonance between the transmission and engine. It makes the DMF better match with the vehicle's transmission system and access to the best effect of reducing vibration and noise. Therefore, it is quite important to improve vehicle comfort, the transmission efficiency and prolong the transmission life. [14]

By Alaster John Young (2000) [6]explained about a twin flywheel comprising first and second co axially arranged flywheel masses which are mounted for limited angular rotation relative to the each other .The flywheel masses are inter connected at least one linkage arrangement comprising a multi-link linkage having two or more circumfetially spaced main links pivotally mounted on second flywheel masses with the circumfertially adjust pair of main links inter connected by extending connected linkage and anchor link which connect to the multi linkage with first flywheel mass .Relative rotation of flywheel mass causes multi-link linkage which connect to the second flywheel mass by anchor link , so that when twin mass is rotating ,relative rotation of flywheel masses resisted by centrifugal forces acting on linkage . Any particular link may in the form of unitary link in the form of parallel pair's plates. Associated with one or more links or pivots acting between flywheel masses there may be controlling means to control the relative rotation of flywheel masses[15].

CONCLUSION

With respect to above all Paper work following conclusion are drawn:

- There is number of problems due to less deflection in previously used springs Which can be overcome by used of newly used material spring by increasing deflection of spring
- For our research we select Brass, Aluminum, Copper material springs for overcome above mention problem.

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