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Performance Analysis of IC Engine Inlet and Exhaust Valve Spring - A Review

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ABSTRACT

A valve train is a system that controls the operation of an internal combustion engine, such as inlet and exhaust, and the valve spring can maintain the required amount of force to hold the valve in the closed position until the cam opens the valve for pressure release, so it plays an important role in engine performance, but it can fail due to high rotational speed and high temperature, which can reach 150o C. Valve springs must be lighter and smaller in order to enhance fuel efficiency, lower the inertia weight of the valve train, and aid to minimise engine size. So, in this study, we use the finite element approach to design the valve spring for high-speed engines.

Keywords: Valve spring, High speed engines, Fatigue life, Heat Treatment.

1.INTRODUCTION

An internal combustion engine is a type of heat engine in which the combustion of fuel occurs in combustion chamber and produces high temperature and pressurized gasses and converts this fuel energy into mechanical power which is transferred to the wheels to run the vehicle through power train system. The valve train is an assembly of valves, valve spring, rocker arm, retainer, push road, tappet and cam etc. The intake valve controls the flow of fuel inside the combustion chamber while the exhaust valve controls the out flow of exhaust gasses and the timing of opening and closing controlled by cam shaft. Valve Spring Play an important role in engine performance, but it can fail due to high rotational speed and high temperature, which can reach 150^{o} C.

LITERATURE REVIEW

The Following research papers are used in this research work

Youlong Chen et.al [1] These work are verified by systematic FEM simulations and parallel experiments. Effective compressive strain in substrate increases, the buckling profile from a vertical ellipse to a lateral ellipse, and then approaches to a circle when the effective compressive strain is larger than 30%. The useful for the design and optimization of high-performance stretchable structures.

Gowtham. et.al[2] In this paper, the suitable material for the valve spring of 2956 cc engine is selected. The valve spring is designed for high fluctuated load on the working engine. The specifications obtained from the design are used to create the 3D model of the spring and analysis is carried out using finite element methods. Deformation and shear stress are obtained from static structural analysis of valve spring. The results obtained from the finite element analysis are compared with the analytical calculations. The load deflection behavior of the spring is studied. This analysis allowing one to determine, whether the valve springs

Jie Guo , Wenping Zhang, Dequan Zou et.al [3] A valve train dynamics model of internal combustion engine has been developed using thekineto-elastodynamics method. The dynamics behavior for flexible components such as thevalve springs in the valve train system was described by the wave equation. The contact force atthe cam/tappet interface was estimated by the elasto-hydrodynamic lubrication theory of finiteline conjunction. The predicted results agree well with experiments at difference camshaft speeds. The effects of the bending deflection and torsional vibration of camshaft on performance of the valve train system were also studied.

Del Llano-Vizcayaet.al[4] conducted a failure analysis in order to determine the fatigue crack initiation point and a comparison of that location with the most damaged zone predicted by the numerical analysis is made. Critical plane approach gives good solutions of fatigue life. Criterion overestimates spring fatigue life, the Coffin–Mason model gives conservative results.

Husselman et.al [5] The spring model was developed systematically from a solid model, into a finite element model and finally into dynamic model . all development steps were continuously checked with experimental and calculation. The primary concept used in the spring modeling lends itself to model analysis theory in conjunction with the superimposing of non – linearity onto linear model.

Moorthy et.al [6] The main objective of the project is Analyzing the failure of spring in the cylinder head valve spring in the locomotive. Study of failure of suspension coil spring of a locomotive, which failed within few months after being put into service, has been carried out analytically and using ANSYS software.

P.N.L.Pavaniaet.al [7] In this paper, a three dimensional finite element (FE) model for shock absorber spring is proposed. In this study we perform the structural analysis for modeling and the structural behavior of springs. It is very important I the design of spring in this study the researcher design the spring using proe software , it's basically a 3D design software. Structural analysis has been performed with changing the material properties.

R. Champion, W.L. Champion et.al [8] A Taylor expansion of the elasticity equations governing theaxial extension of the spring is used to determine the relative magnitudes of linear and(quadratic and cubic) nonlinear terms in the force–extension relationship. This study basically focused on the relation of static load and the variable loads.

R. Lewis et.al [9] described an experimental approach to solving valve and seat wear problems. The procedure involves two levels of test abstraction; firstly a bench test-rig, designed to fit in a hydraulic test machine, using real valve and seat insert specimens simulating combustion loading, and secondly a motorized cylinder-head, to study the effect of impact on valve closure without the application of combustion loading. The design of the rigs is described as well as test methodologies developed for their operation. Bench test work carried out using the rigs is detailed and wear features and valve recession observed are analyzed and compared with those observed during engine testing in order to establish the validity of the test methodologies. Use of this approach will enable potential valve and seat insert materials to be screened and the effect of alterations in design and engine operating parameters to be assessed in a more cost effective and less time consuming manner than the commonly used engine testing.

R.P.B. dos Reis et.al [10] This work presents an experimental methodology to estimate the material damping of superelastic helical minispringsfabricated with superelastic shape memory alloys (SMA-SE).Moreover, themethodology provides a relativelyinexpensive means for investigating the dynamic thermomechanical behavior of the NiTi SMA-SE minispringstested.

Reza Mirzaeifar et.al [11] In this paper, both analytically andnumerically the pseudo elastic response of shape memory alloy. The studied of Helical springs under axial force in this paper. In this paper considered of analytical solution from two different approximations.Both the curvature and pitch effectsare assumed to be negligible In the firstapproximation.

Saleh Khorasani et.al [12] As like to straight tubes, experts try to use heat transfer enhancement techniques to improve the thermal performance of helical tubes. Present study provides an experimental investigation on the effect of geometrical properties of spiral wire tabulators on thermal performance of helical tube. Also it was revealed that increment in wire diameter increases the heat transfer coefficient whereas the effect of increment of spring pitch on heat transfer coefficient is vice versa.

H. J. C. Voorwaldaet.al [13] the study will focus on axial fatigue strength of the microstructure afterheat treatment at the marten sitic steel, it will combined with different heat treatments as hard chrome-plating. It was verified a significant increase on the fatigue strength of the marten sitic steel after nitrating, compared with results from the chrome- plating specimens. The increase in the strength was alsonoted on parts as a consequence of a resistance .

Salim El Bouzidi et.al[14] Experimentally investigated the self-excitation mechanism of a model spring-loaded valve with an emphasis on the interaction between the system flow and sound fields, and the valve structure. Tests are performed for various values of valve stiffness and maximum allowable valve lift. In each case, the pressure drop across the valve is increased gradually until the valve becomes fully open. The valve was found that it is working on fatigue loading. The oscillation amplitude was found to be positively correlated to both the pipe length and spring stiffness value. Furthermore, initial spring compression was found to have only moderate effects on the range of static pressures that would cause instability.

Satbeer Singh Bhatia* , Ajeet Bergaley et.al [15] In this work the stresses developed in composite material helicalcompression spring is lower as compared to the stresses developed in conventional steel (IS 4454 Grade 3)helicalcompression spring. Theresults indicate that composite materials are feasible option at normal loading conditions which will also reduce themanufacturing and maintenance costs.

Sid Ali Kaoua et al. [16] have done a 3 Dimensional geometric modelling of a helical spring and its FEA results are used to study the mechanical behaviour of spring under tensile axial loading. The spiralled shape of graphic design is gain through the use of CAD tools, of which a finite element model is generated.

Souvik Dasa et.al [17] We have study in this paper, wire samples broken during manufacturing were collected from wiredrawing plants for understanding their quality aspect and potential causes of breakage while drawing. The quality of well-meant preparation needs to be paid attention because the two ends of the wires arenot fused properly when subjected to welding.

CONCLUSION

Dimensional parameters cannot be improved due to engine space constraints, and engine manufacturers also provide the load v/s deflection curve for different operations, such as when the valve is in close position, the load value is 250N, and the displacement should not be more than 12mm, and the second operation, when the valve is in open position, the load value is 360N, and the deflection should not be more than 17mm, so in this research work we performed static structural analysis using element method which is a good approach to predict the failure in high performance valve spring design then we finds out the suitable material property to meet the engine requirement and avoid failure and it also increased the fatigue life.

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