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Design and analysis of inlet & exhaust Valve springs for high speed engines using finite element method

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A B S T R A C T

Valvetrain is a system that controls the operation of an internal combustion engine like 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 essential role in respect to the engine performance but sometimes it may fail due to high rotational speed and high temperature around 150º C. Valve spring are required to be lighter and smaller to improve the fuel efficiency, reduce the inertia weight of valve train and it also help to reduce the size of the engine. So in this research work, we design the valve spring for high-speed engines using the finite element method.

Keywords:Valvetrain, 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 pressurised gasses which is controlled by valve train mechanical system in most of engine types. The valve train is an assembly of valves, valve spring, rocker arm, retainer, push road, tappet and cam etc. The intake valve control the flow of fuel inside the combustion chamber while the exhaust valve control the out flow of exhaust gasses and the timing of opening and closing controlled by cam shaft.

A valve spring is a compression type of helical spring, it is behave like elastic component Store a mechanical energy and get deformed in shape and when the load is removed is gain its original shape again. A valve helical spring is working with very high working stress and it is working in very high fluctuating load. A simple type of helical spring cannot sustain this type of loading, for that purpose we designed a special type of helical spring with some advanced techniques.

2. Methodology

We followed the methodology as shown in figure first off all we find the design and operational requirement of existing engine valve train or specifically valve spring then design valve spring on creo parametric design software using existing spring dimensions and use material property which is easily available then perform stiffness analysis using finite element method and find out the approximate value of E (Elasticity of modules). After that we have to perform the specific heat treatment process to maintain mechanical and chemical properties.

The design of valve spring is as important as cam design because is operate in extremely violent environment so our design is based on dimensional requirement of engine as shown in below tables.

Spring length	55mm
Coil diameter	37mm
Wire diameter	4.2mm
no. of coils	7
coil pitch	8mm

Fig. 1–Cad Modeling

3. Boundary Condition

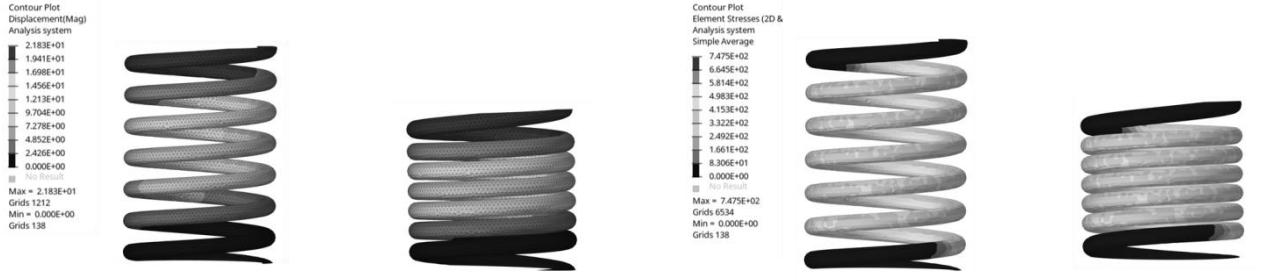
The valve spring in internal combustion engine are subjected to dynamic loading to control the operation of valves, resulting high stress and premature failure. As per engine valve train requirement this valve spring subjected to two different loads.

A spring load when the valve is closed – 250 N

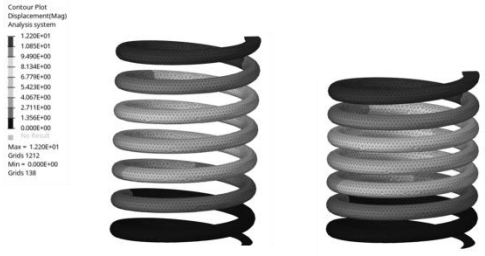
A spring load when the valve is open – 360 N

4. Results

In this static analysis we considered Chromium-Vanadium Steel as a material for valve spring and apply 250N load when valve is closed condition. As shown in results the maximum displacement is 21.83mm and maximum stress are 747 Mpa



In the direction to meet the max displacement of valve spring upto 12mm me need to consider some other material, in that case we improved elasticity of modulus value 3.4E+05 from 1.9E+05.



The same updated material properties applied in second load case where the maximum load is 360N when valve is in open condition and got the maximum displacement 17.57mm and stress 1076Mpa.

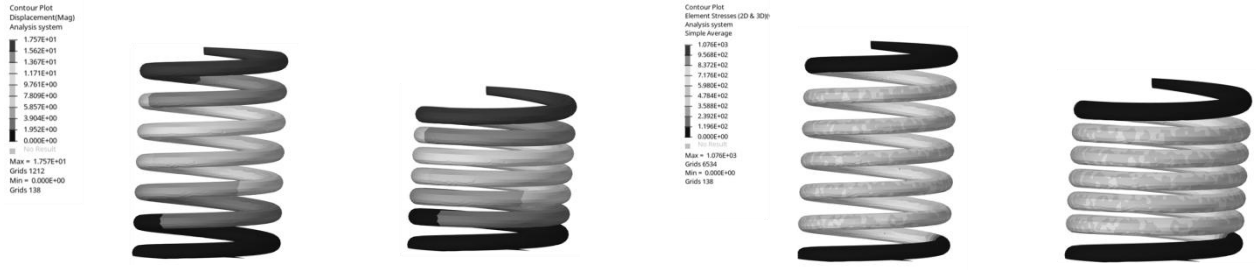


Fig. 2–Results

5. Conclusion

Valve springs are one of the most important part of the engine may be its cost is very less as compared with any other engine part but any failure in valve spring structure can reduce the performance of the engine. 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.

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