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MODELLING AND STRUCTURAL ANALYSIS OF CAMSHAFT

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Abstract

The idea of harnessing combustion to perform mechanical work is by no means a new one. The internal combustion engine, as we know it today, has its origins in the last century, however the idea for controlling combustion to perform mechanical work dates back to the Renaissance. Even with the advent of alternative sources of power for commerce and personal applications, the internal combustion engine represents a large portion of the power generation available in this country.There are numerous types of internal combustion engines, each with a variety of subsystems. While all of these types and corresponding subsystems are equally important, this investigation is focused on the valve train dynamics of a pushrod type internal combustion engine. Operating this type of engine at too high of an engine speed usually causes dynamic malfunctions such as spring surge, lifter/cam pair separation, valve bounce, etc. in the valve train. Although the interaction of each of the valve train components contributes to the limit speed, the shape of the cam plays a critical role. This cam shaft along with cams are designed in CATIA V5 and we analysed the cam shaft in ANSYS using various materials and determined which material is best for cam shaft.

Key Words: Design; Analysis; Cam Shaft; Cam; Internal combustion

INTORDUCTION

Since the origination of the automobile, the internal combustion engine has evolved considerably. However, one constant has remained throughout the decades of ICE development. The camshaft has been the primary means of controlling the valve actuation and timing, and therefore, influencing the overall performance of the vehicle. The camshaft is attached to the crankshaft of an ICE and rotates relative to the rotation of the crankshaft. Therefore, as the vehicle increases is velocity, the crankshaft must turn more quickly, and ultimately the camshaft rotates faster. This dependence on the rotational velocity of the crankshaft provides the primary limitation on the use of camshafts. As the camshaft rotates, cam lobes, attached to the camshaft, interface with the engine's valves. This interface may take place via a mechanical linkage, but the result is, as the cam rotates it forces the valve open. The spring return closes the valve when the cam is no longer supplying the opening force. Since the timing of the engine is dependent on the shape of the cam lobes and the rotational velocity of the camshaft, engineers must make decisions early in the automobile development process that affect the engine's performance. The resulting design represents a compromise between fuel efficiency and engine power. Since maximum efficiency and maximum power require unique timing characteristics, the cam design must compromise between the two extremesThis compromise is a prime consideration when consumers purchase automobiles. Some individuals value power and lean toward the purchase of a high-performance sports car or towing capable trucks, while others value fuel economy and vehicles that will provide more miles per gallon. Recognizing this compromise, automobile manufacturers have been attempting to provide vehicles capable of cylinder deactivation, variable valve timing (VVT), or variable camshaft timing (VCT). These new designs are mostly mechanical in nature. Although they do provide an increased level of sophistication, most are still limited to discrete valve timing changes over a limited range.Trip hammers are one of the early uses of a form of cam to convert rotating motion, e.g. from a waterwheel, into the reciprocating motion of a hammer used in forging or to pound grain. Evidence for these exists back to the Han Dynasty in China, and they were widespread by the medieval period.The camshaft was described in 1206 by engineer Al-Jazari. He employed it as part of his automata, water-raising machines, and water clocks such as the castle clock.Once the rotative version of the steam engine was developed in the late 18th century, the operation of the valve gear was usually by an eccentric, which turned the rotation of the crankshaft into reciprocating motion of the valve gear, normally a slide valve. Camshafts more like those seen later in internal combustion engines were used in some steam engines, most commonly where high-pressure steam (such as that generated from a flash steam boiler), required the use of poppet valves, or piston valves. For examples see the Uniflow steam engine, and the Gardner-Serpollet steam cars, which also included axially sliding the camshaft to achieve variable valve timing. Among the first cars to utilize engines with single overhead camshafts were the Maudslay designed by Alexander Craig and introduced in 1902 and the Marr Auto Car designed by Michigan native Walter Lorenzo Marr in 1903. The camshaft is a mechanical component used in internal combustion engines to operate the valves and dates back to ancient Greece, where it was used in water clocks and automata.In the 16th century, Leonardo da Vinci designed camshafts for his inventions.The first practical use of a camshaft in an engine was in 1820 by the French engineer Philippe LeBon. In the early 20th century, the camshaft became a standard feature in most internal combustion engines. It is typically made of hardened steel and is precision machined to exact specifications.The shape of the cam lobes on the camshaft determines the timing and duration of the valve openings. Overhead camshafts, where the camshaft is located above the cylinder head, were first used in racing engines in the 1920s. In the 1930s, the overhead camshaft design became more widespread in production cars.

PROBLEM FORMATION AND GAP

Failure of its parts are sudden and total due to which engine parts might get damaged so that we need use different materials and need to check for different loads to overcome this problem. The overheating problems are often more in camshaft which increases the internal thermal stresses which may cause damage to the cam shaft which in turn cause damage to whole system.

OBJECTIVES:

• The main aim of the project is to focus on the mechanical design and structural analysis of cam shaft of two-wheeler auto-mobiles when they transmit power at different speeds.

• Analysis is also conducted by varying the structures of the cams and cam shaft

• The analysis is conducted to verify the best material, structure for the cam shaft in the engines at higher speeds by analysing stress, displacement, deformation.

• Design calculations are done on the cam shafts by varying materials

METHODOLOGY

The methodology followed in this project is as follows:

Perform outline computations of camshaft demonstrate.

Create 3D model of the cams and shaft from the 2D illustrations

CATIA V5 is utilized to do the 3D displaying.

Convert the 3D show into IGES/STEP configuration and import into ANSYS to do Finite component examination.

Perform Static investigation of the camshaft by applying different loads on different materials and record the values.

Perform Modal investigation of the camshaft and ascertain the normal frequencies in the working reach.

Record the Total Deformation and Equivalent stress values from the figures that are displayed during the analysis of camshaft.

Record the values in a table.

Now Draw the comparison graph between two materials.

WORKING

A camshaft is a rotating shaft with a series of lobes or cams that control the opening and closing of the engine's valves. The camshaft is typically located in the engine block or cylinder head and is driven by the engine's crankshaft. As the camshaft rotates, the lobes or cams push against the engine's valve lifters, causing the valves to open and close at precise intervals. This allows air and fuel to enter the engine's cylinders and exhaust gases to be expelled. The shape and size of the camshaft's lobes or cams determine the engine's valve timing, which can affect the engine's performance characteristics, such as power, torque, and fuel efficiency. Camshafts can be designed to optimize performance at different RPM ranges. Some engines may have multiple camshafts, such as DOHC or quad cam engines, which can further increase the precision and control over the valve timing and engine performance. The camshaft is a critical component in the proper operation of an internal combustion engine. It is responsible for the timing and control of the engine's valves. Proper timing of the valves is essential for the engine to operate efficiently and generate power. The camshaft is typically made from high-strength steel or other materials that can withstand the stresses of high-speed rotation. The camshaft must be precisely

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machined to ensure the proper shape and size of the lobes or cams. The lobes or cams can wear over time and may need to be replaced or re-machined to maintain proper valve timing. The camshaft is typically lubricated by engine oil to reduce friction and wear. Lack of proper lubrication can cause premature wear and damage to the camshaft and other engine components. The camshaft is a vital component of the engine and must be properly maintained to ensure long-term reliability and performance. The operation of the camshaft is controlled by the engine's computer or by mechanical systems, depending on the engine's design. Advances in camshaft technology, such as variable valve timing, can improve engine performance and efficiency. The design of the camshaft is optimized for specific engine applications, such as high-performance racing engines or fuel-efficient economy engines. Overall, the camshaft plays a critical role in the proper operation of an internal combustion engine, and is a key factor in determining the engine's power and efficiency.

FLOW CHART

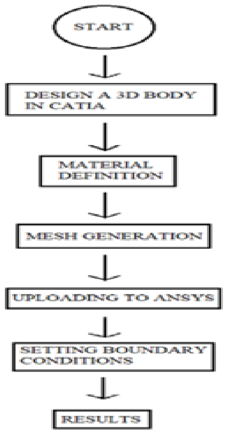

Figure 1 Flow chart: It describes the step-by-step process of the modelling and analysis of camshaft

Output Of Second Cam

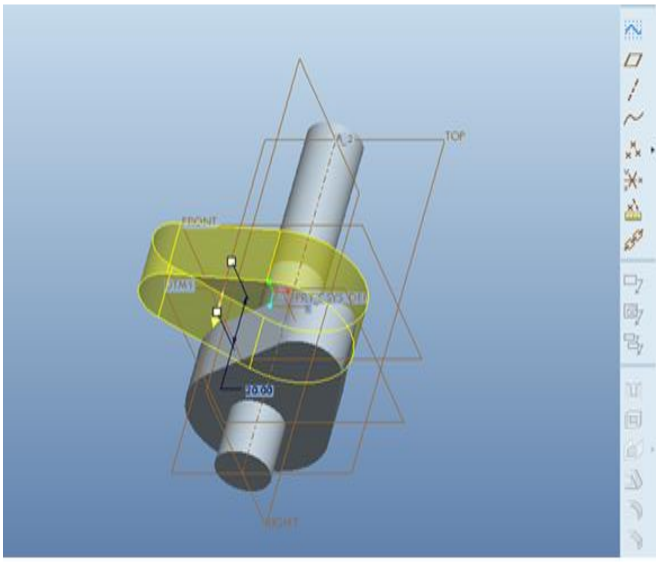

Figure 2 : The output of the second cam

Final Output

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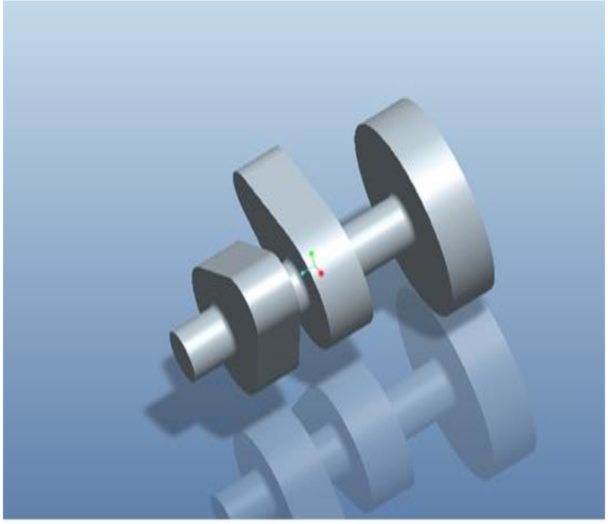

Figure 3Final output

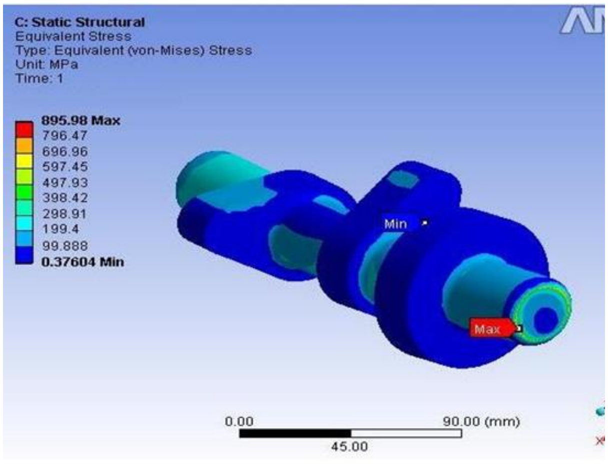

Figure4Equivalent Stressat load500

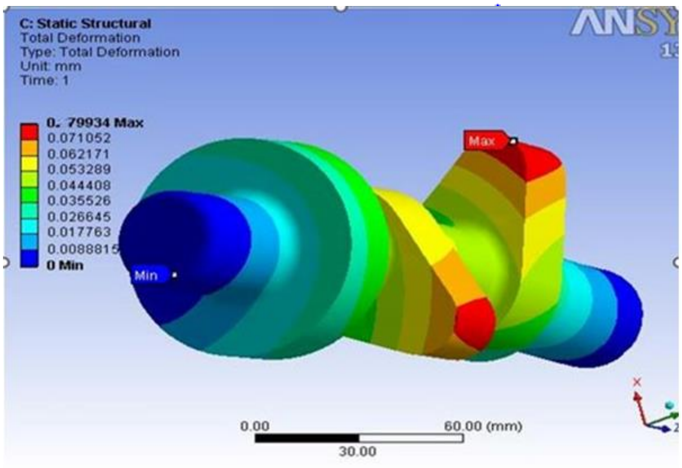

Figure5 TotalDeformationat load 500

RESULTS

TOTAL DEFROMATION RESULTS

Table1TotalDeformation valuesofat differentloads

LOAD (N)	Nickel Chromium Molybdenum Steel Total Deformation (mm)	Gray Cast Iron Total Deformation (mm)
100	0.039967	0.2398
200	0.042991	0.27977
300	0.1199	0.31974
400	0.15987	0.3597
500	0.19983	0.79934

CONCLUSION

IhereconcludetheMajorProjectReporton“ ModellingandAnalysisofCamshaft”. InthistaskIhereconsideraCamshaftwhichis madewiththeproperexistingCamshaft.Inthisprojectwehavecombined the specifically designed Camshaft which is made by using CATIA V5 and combinedit with various materials like in this report we have chosen 2 materials 1. Nickel ChromiumMolybdenumSteel,2.GrayCastIron.Consequently,findingoutthestressesinducedonaCamshaftatanormalloadandathigherloadscanbehelpfultofindoutanddeterminethemaximumdeformationand concludethesuitablematerialwhichcanbeusedtomanufacturethe turbineblade.Initially the Camshaft is designed in CATIA V5 and later the designed Camshaft istransferred to ANSYS for the further process, Static Structural Analysis is done on the Camshaftat various loads where the blade is made of various materials. The total deformation and Stress iscalculated so that the behavior of the Camshaft is found out, finally comparison graphs of totaldeformationandequivalentstressareplottedforthetwomaterialstoshowthedeformationoftheCamshaftFrom the results we can analyze that nickel chromium molybdenum steel has less stress anddeformation values for various loads than gray cast iron so nickel chromium molybdenum steelcanbeusedformanufacturingcamshaft.

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