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DESIGN AND ANALYSIS OF A CAMSHAFT USED IN MULTI CYLINDER ENGINE

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Abstract:

The cam shaft and its associated motives control the hole and best of the two valves. The related components are push rods, rocker arms, valve springs and tappets. It involves a cylindrical rod running over the interval of the cylinder financial team with a quantity of rectangular lobes protruding from it, one for every valve. The cam lobes stress the valves open by way of urgent at the valve, or on some intermediate mechanism as they rotate. This shaft furthermore offers the force to the ignition device. The camshaft is driven via utilizing the crankshaft by way of timing gears cams are made as valuable additives of the camshaft and are designed in the style of method to open and almost the valves at the appropriate timing and to preserve them open for the valuable length. A normal instance is the camshaft of an auto, which takes the rotary motion of the engine and interprets it in to the reciprocating action main to hold out the consumption and exhaust valves of the cylinders. On this artwork, a camshaft is designed for multi cylinder engine and 3-D-mannequin of the camshaft is created the usage of modeling program software CREO. The modeled in CREO is imported in to ANSYS. After finishing the aspect residences, meshing and constraints the hundreds are done on camshaft for three surely one among a sort supplies mainly aluminum alloy, solid steel and cast iron to make a decision the displacement, similar pressure of the cam shaft. On this thesis, static, modal, fatigue and fracture evaluation finished in ANSYS.

INTRODUCTION TO CAMSHAFT:

A camshaft is a rod which rotates and slides against a piece of machinery in order to turn rotational motion into linear motion. This change of motion is accomplished by the camshaft moving further and closer from the axis of rotation as the camshaft is pushed by the machinery. These moving pieces of the shaft are the cams. The linear distance moved is called the 'throw'

A camshaft on an internal combustion heat engine is a device that controls both the input of fuel and the expulsion of exhaust fumes. It consists of several radial cams, each displacing intake or exhaust valves. This camshaft is connected to the crankshaft via belt, chain or gears. This ensures consistent timing of the valves in relation to the motion of the pistons.

Figure 1. A diagram of a 4-stroke internal combustion engine. The cams are at the top of figure 2, notice how they turn their spinning motion into a linear motion for the valves.

The function of a camshaft is dependent on how a valve works and the function of the cam itself. A valve on a cylinder head consists of two basic parts, a stem and a head. The head plugs the nozzle that allows fuel intake or exhaust flow and requires linear motion. A cam, in its simplest definition, is a mechanical link that converts rotational motion into linear motion, or vice versa.The cams on a camshaft achieve this displacement by the rotation of a radial pattern, and a follower which moves perpendicular to the rotational axis. The cam pattern on a camshaft is non-circular with a single lobe. The follower matches the displacement of the cam as it rotates. This displacement is then translated to the stem of the valve, allowing head to rise as the lobes of the cam pass through the follower.

Camshaft Configurations:

Single Overhead Cam:

This association denotes an engine with one cam steady with head. So if it's far an inline four-cylinder or inline 6-cylinder engine, it's going to have one cam; if it is a V-6 or V-8, it's going to have cams (one for every head).

Double Overhead Cam:

A double overhead cam engine has two cams in step with head. So inline engines have two cams, and V engines have four. Usually, double overhead cams are used on engines with four or extra valves in keeping with cylinder -- a single camshaft certainly cannot fit enough cam lobes to actuate all of those valves.

Double Overhead Cam:

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Pushrod Engines:

Like SOHC and DOHC engines, the valves in a pushrod engine are positioned in the head, above the cylinder. The key distinction is that the camshaft on a pushrod engine is in the engine block, in preference to in the head.

LITERATURE REVIEW:

The following are the literature reviews drawn from the conclusions of many authors.

V Swamulu, N Siva Nagaraju [et al] In this paper the cam shaft and its associated parts control the opening and closing of the two valves. The associated parts are push rods, rocker arms, valve springs and tappets. It consists of a cylindrical rod running over the length of the cylinder bank with a number of oblong lobes protruding from it, one for each valve. The cam lobes force the valves open by pressing on the valve, or on some intermediate mechanism as they rotate. This shaft also provides the drive to the ignition system. The camshaft is driven by the crankshaft through timing gears cams are made as integral parts of the camshaft and are designed in such a way to open and close the valves at the correct timing and to keep them open for the necessary duration. A common example is the camshaft of an automobile, which takes the rotary motion of the engine and translates it in to the reciprocating motion necessary to operate the intake and exhaust valves of the cylinders. In this work, a camshaft is designed for multi cylinder engine and 3D-model of the camshaft is created using modeling software pro/Engineer. The model created in pro/E is imported in to ANSYS. After completing the element properties, meshing and constraints the loads are applied on camshaft for three different materials namely aluminum alloy 360, forged steel and cast iron. For that condition the results have been taken has displacement values and von misses stresses for the static state of the camshaft. After taking the results of static analysis, the model analysis and harmonic analysis are done one by one. Finally, comparing the three different materials the best suitable material is selected for the construction of camshaft.

INTRODUCTION TO CAD:

Pc-aided design (CAD) is making use of computer buildings (or workstations) to useful resource within the appearance, amendment, analysis, or optimization of a structure. CAD application software is used to increase the productiveness of the trend dressmaker, give a boost to the nice of structure, fortify communications by way of documentation, and to create a database for manufacturing.

INTRODUCTION TO CREO:

Present CREO, earlier known as professional/ENGINEER, is 3-D modeling program software applied in mechanical engineering, design, manufacturing, and in CAD drafting provider companies. It grew to become one of the vital first 3-d CAD modeling packages that used a rule-headquartered parametric gadget. Using parameters, dimensions and capabilities to grab the habits of the product, it might optimize the advance product furthermore to the design itself.

3-D MODEL OF CAM SHAFT:

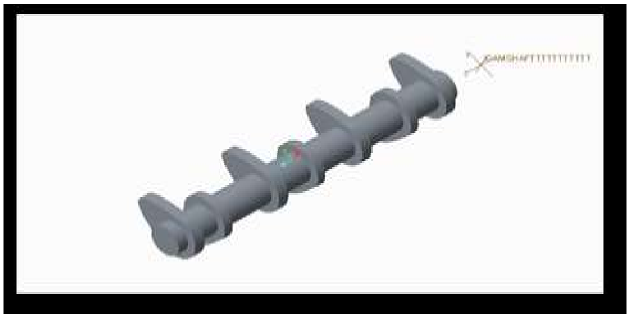


Figure: 3.1 3D MODEL CAM SHAFT

2D MODEL OF CAM SHAFT:

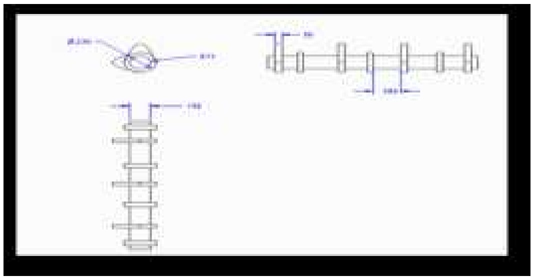


Figure: 3.2 2D MODEL CAM SHAFT

INTRODUCTION TO FEA:

Finite element evaluation is a method of fixing, ordinarily approximately, nice disorders in engineering and science. It's used specifically for troubles for which no actual resolution, expressible in just a few mathematical forms, is available. As such, it is miles a numerical as an alternative of an analytical procedure. Approaches of this variety are wanted because analytical techniques cannot care for the real, complex disorders which might be met with in engineering.

STATIC AND MODAL ANALYSIS OF CAM SHAFT

5.1 STATIC ANALYSIS OF CAM SHAFT

5.1.1 Materials – forged steel

Young's modulus = 205000mpa

Poisson's ratio = 0.3

Density = 7850kg/mm3

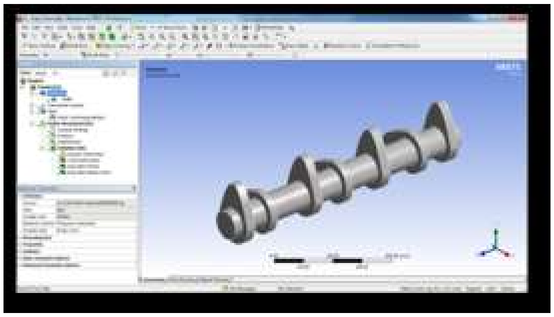


Figure 5.1: Static structural geometry

Select mesh on left side part tree → right click → generate mesh →

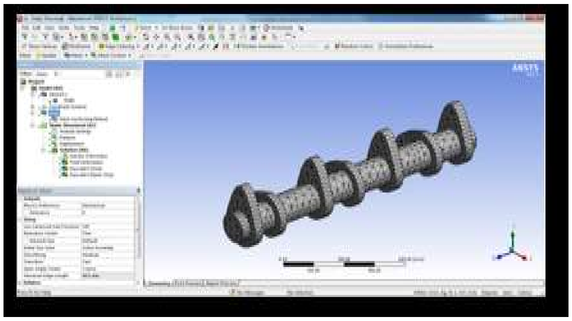


Figure 5.2: Static structural of mesh generation

Pick static structural right click on → insert → pick rotational velocity and caught aid → choose displacement → pick required area → click on on practice → placed X,Y,Z factor 0 →

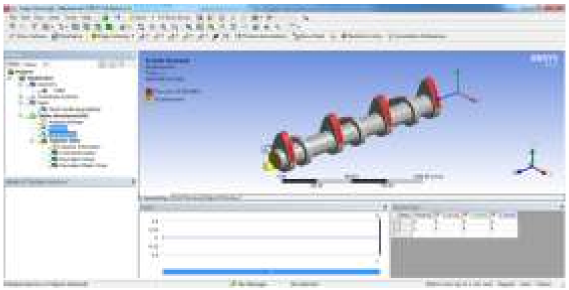


Figure 5.3: Static structural displacement

TOTAL DEFORMATION:

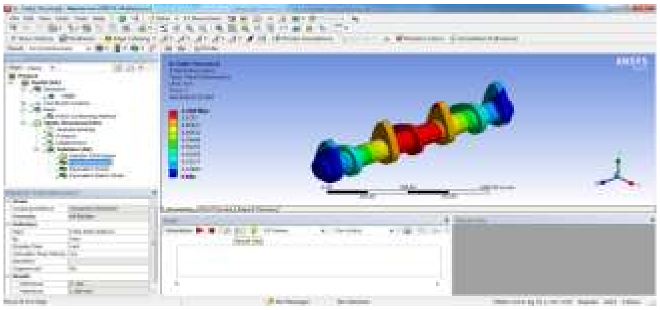


Figure 5.4: Static structural total deformation of forged steel

VON-MISES STRESS:

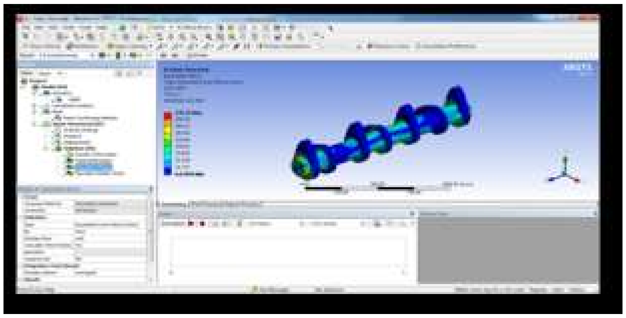


Figure 5.5: Static structural stress of forged steel

VON-MISES STRAIN:

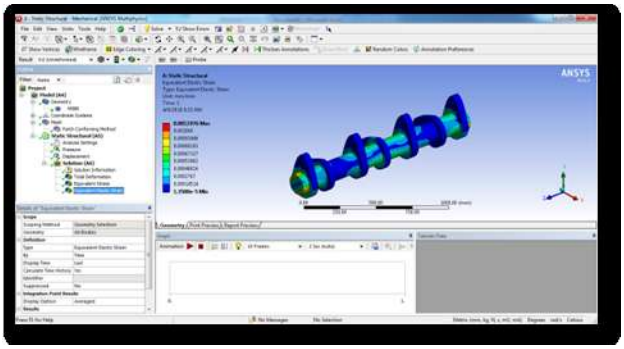


Figure 5.6: Static structural strain of forged steel

5.1.2 Materials – cast iron:

TOTAL DEFORMATION:

Figure5.7: Static structural deformation of cast iron

VON MISES STRESS:

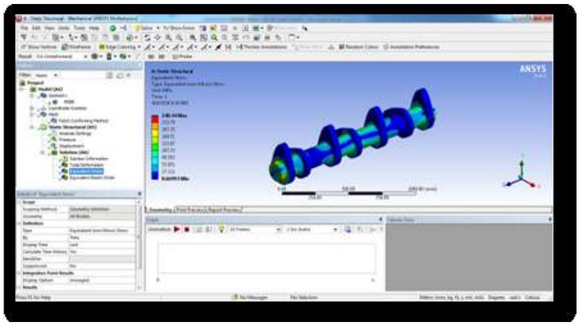


Figure5.8: Static structural stress of cast iron

VON MISES STRAIN:

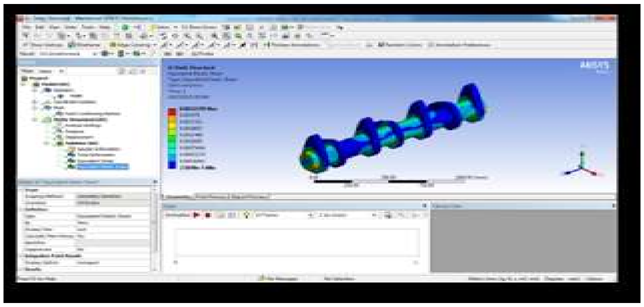


Figure 5.9: Static structural strain of cast iron

5.1.3 MATERIALS – ALUMINUM ALLOY:

TOTAL DEFORMATION:

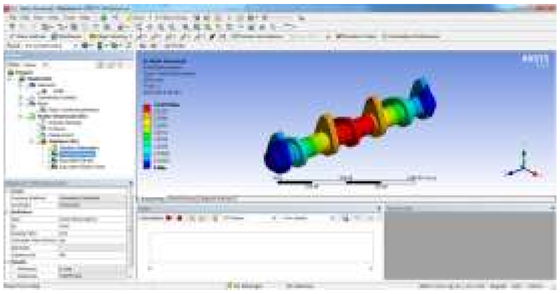


Figure 5.10:Static structural deformation of aluminum alloy

VON-MISES STRESS:

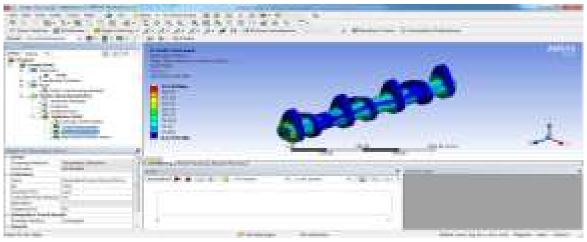


Figure 5.11: Static structural stress of aluminum alloy

VON-MISES STRAIN:

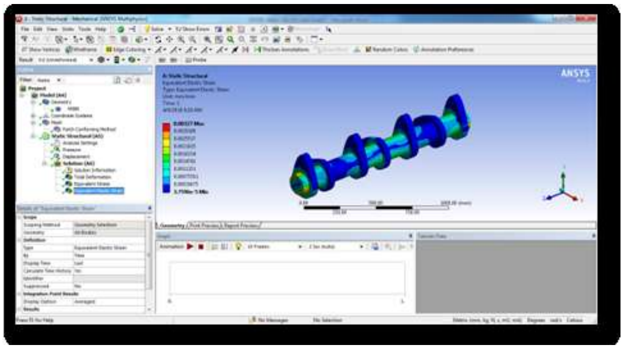


Figure 5.12: Static structural strain aluminum alloy

3MODAL ANALYSIS OF CAMSHAFT

5.3.1 Materials – forged steel:

MODE 1

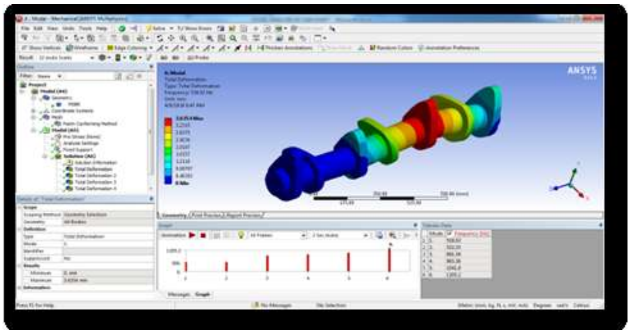


Figure 5.22: Modal analysis deformation 1 of forged steel

MODE 2

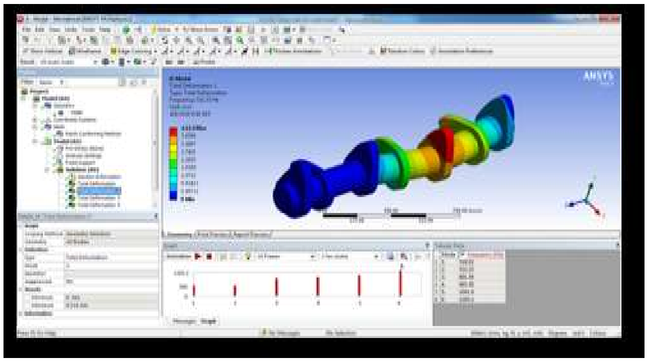


Figure 5.23: Modal analysis deformation 2 of forged steel

MODE3

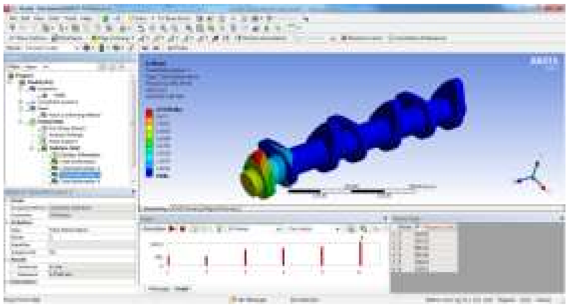
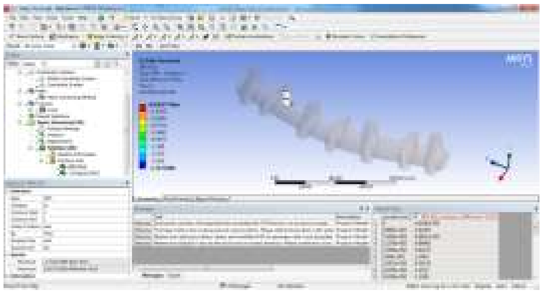


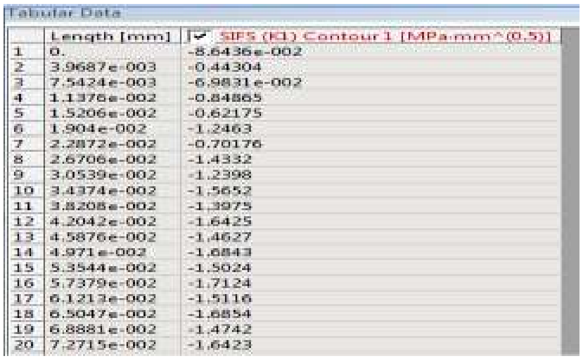
Figure 5.24: Modal analysis deformation 3 of forged steel

FRACTURE ANALYSIS OF CAM SHAFT:

5.4.1 Materials – forged steel:

SIFS (STRESS INTENSITY FACTOR)



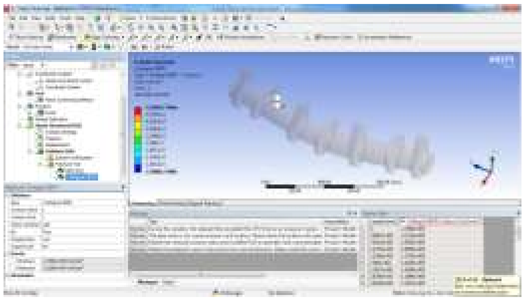


Tabular Data

	Length [mm]	☑ SIFS (K1) Contour 1 [MPa.mm^(0.5)]
1	0.	-8.6436e-002
2	3.9687e-003	-0.44304
3	7.5424e-003	-6.9831e-002
4	1.1376e-002	-0.84865
5	1.5206e-002	-0.62175
6	1.904e-002	-1.2463
7	2.2872e-002	-0.70176
8	2.6706e-002	-1.4332
9	3.0539e-002	-1.2398
10	3.4374e-002	-1.5652
11	3.8208e-002	-1.3975
12	4.2042e-002	-1.6425
13	4.5876e-002	-1.4627
14	4.971e-002	-1.6843
15	5.3544e-002	-1.5024
16	5.7379e-002	-1.7124
17	6.1213e-002	-1.5116
18	6.5047e-002	-1.6854
19	6.8881e-002	-1.4742
20	7.2715e-002	-1.6423

Figure 5.40: fracture analysis stress intensity factor of forged steel

J-INTEGREAL



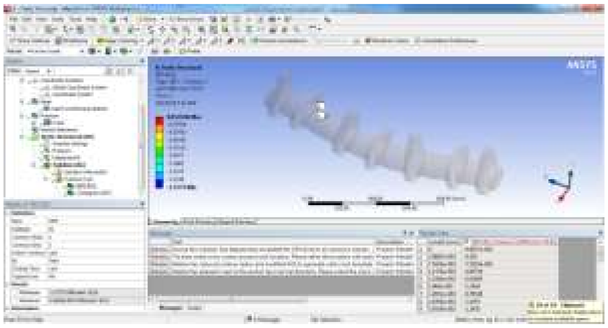
Tabular Data

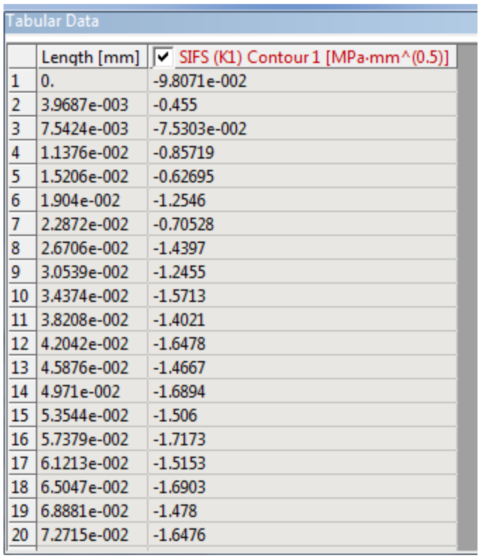
	Length [mm]	☑ J-Integral (JINT) Contour 1 [mJ/mm^2]
1	0.	-2.7606e-005
2	3.9687e-003	-2.1726e-005
3	7.5424e-003	-1.9382e-005
4	1.1376e-002	-1.8958e-005
5	1.5206e-002	-1.7376e-005
6	1.904e-002	-1.6028e-005
7	2.2872e-002	-1.4288e-005
8	2.6706e-002	-1.2696e-005
9	3.0539e-002	-1.1031e-005
10	3.4374e-002	-9.5416e-006
11	3.8208e-002	-7.9678e-006
12	4.2042e-002	-6.3875e-006
13	4.5876e-002	-4.7252e-006
14	4.971e-002	-3.0766e-006
15	5.3544e-002	-1.3355e-006
16	5.7379e-002	-3.2204e-007
17	6.1213e-002	-1.6973e-006
18	6.5047e-002	-3.092e-006
19	6.8881e-002	-4.7666e-006
20	7.2715e-002	-6.5425e-006

Figure 5.41: fracture analysis J integral of forged steel

5.4.2 Materials – CAST IRON:

SIFS (STRESS INTENSITY FACTOR)



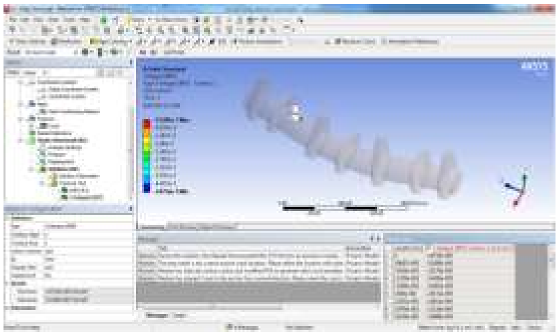


Tabular Data

	Length [mm]	☑ SIFS (K1) Contour 1 [MPa·mm^(0.5)]
1	0.	-9.8071e-002
2	3.9687e-003	-0.455
3	7.5424e-003	-7.5303e-002
4	1.1376e-002	-0.85719
5	1.5206e-002	-0.62695
6	1.904e-002	-1.2546
7	2.2872e-002	-0.70528
8	2.6706e-002	-1.4397
9	3.0539e-002	-1.2455
10	3.4374e-002	-1.5713
11	3.8208e-002	-1.4021
12	4.2042e-002	-1.6478
13	4.5876e-002	-1.4667
14	4.971e-002	-1.6894
15	5.3544e-002	-1.506
16	5.7379e-002	-1.7173
17	6.1213e-002	-1.5153
18	6.5047e-002	-1.6903
19	6.8881e-002	-1.478
20	7.2715e-002	-1.6476

Figure 5.42: fracture analysis stress intensity factor of cast iron

J-INTEGRAL



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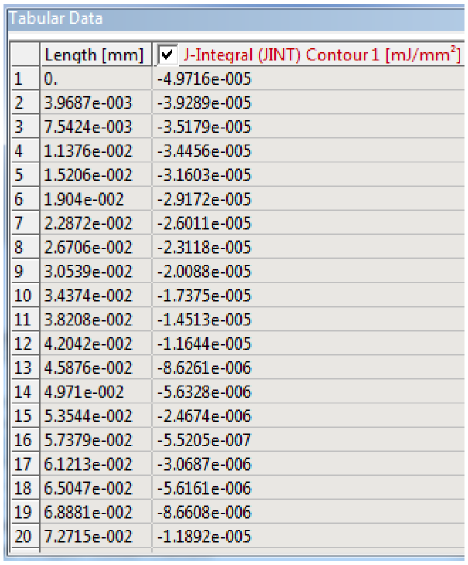


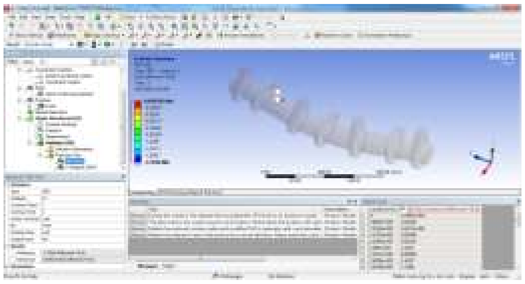
Tabular Data

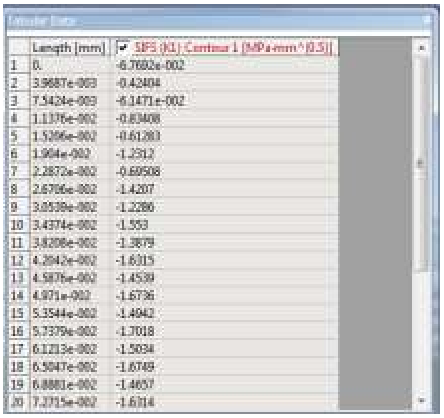
	Length [mm]	☑ J-Integral (JINT) Contour 1 [mJ/mm²]
1	0.	-4.9716e-005
2	3.9687e-003	-3.9289e-005
3	7.5424e-003	-3.5179e-005
4	1.1376e-002	-3.4456e-005
5	1.5206e-002	-3.1603e-005
6	1.904e-002	-2.9172e-005
7	2.2872e-002	-2.6011e-005
8	2.6706e-002	-2.3118e-005
9	3.0539e-002	-2.0088e-005
10	3.4374e-002	-1.7375e-005
11	3.8208e-002	-1.4513e-005
12	4.2042e-002	-1.1644e-005
13	4.5876e-002	-8.6261e-006
14	4.971e-002	-5.6328e-006
15	5.3544e-002	-2.4674e-006
16	5.7379e-002	-5.5205e-007
17	6.1213e-002	-3.0687e-006
18	6.5047e-002	-5.6161e-006
19	6.8881e-002	-8.6608e-006
20	7.2715e-002	-1.1892e-005

Figure 5.43: fracture analysis J integral of cast iron

5.4.3 Materials – ALUMINUM ALLOY:

SIFS (STRESS INTENSITY FACTOR)



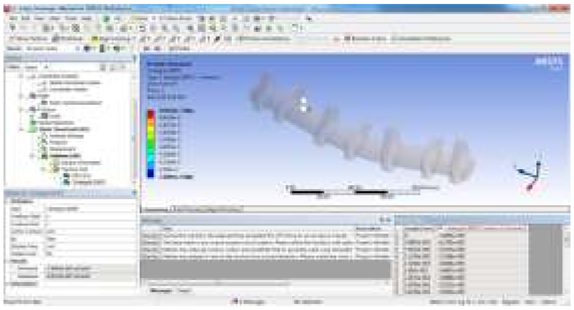


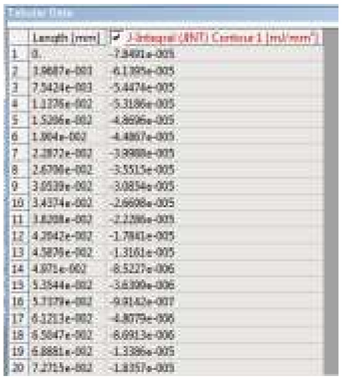
Tabular Data

	Length [mm]	☑ SIFS (K1) Contour 1 [MPa·mm^(0.5)]
1	0.	-6.7692e-002
2	3.9687e-003	-0.42404
3	7.5424e-003	-6.1471e-002
4	1.1376e-002	-0.83408
5	1.5206e-002	-0.61283
6	1.904e-002	-1.2312
7	2.2872e-002	-0.69508
8	2.6706e-002	-1.4207
9	3.0539e-002	-1.2280
10	3.4374e-002	-1.553
11	3.8208e-002	-1.3879
12	4.2042e-002	-1.6315
13	4.5876e-002	-1.4539
14	4.971e-002	-1.6736
15	5.3544e-002	-1.4942
16	5.7379e-002	-1.7018
17	6.1213e-002	-1.5034
18	6.5047e-002	-1.6749
19	6.8881e-002	-1.4657
20	7.2715e-002	-1.6314

Figure 5.44: fracture analysis stress intensity factor of aluminum alloy

J-INTEGREAL





Tabular Data

	Length [mm]	☑ J-Integral (JINT) Contour 1 [mJ/mm²]
1	0.	-7.8491e-005
2	3.9687e-003	-6.1395e-005
3	7.5424e-003	-5.4474e-005
4	1.1376e-002	-5.3186e-005
5	1.5206e-002	-4.8696e-005
6	1.904e-002	-4.4867e-005
7	2.2872e-002	-3.9988e-005
8	2.6706e-002	-3.5515e-005
9	3.0539e-002	-3.0834e-005
10	3.4374e-002	-2.6608e-005
11	3.8208e-002	-2.2286e-005
12	4.2042e-002	-1.7841e-005
13	4.5876e-002	-1.3161e-005
14	4.971e-002	-8.5227e-006
15	5.3544e-002	-3.6399e-006
16	5.7379e-002	-9.9142e-007
17	6.1213e-002	-4.8079e-006
18	6.5047e-002	-8.6913e-006
19	6.8881e-002	-1.3386e-005
20	7.2715e-002	-1.8357e-005

Figure 5.45: fracture analysis J integral of aluminum alloy

CALCULATIONS

DESIGN CALCULATIONS

PRESSURE CALCULATIONS

Bore ×stroke(mm)=fifty seven×fifty eight.6

Displacement =149.5CC

Maximum energy = 13.8bhp @8500rpm

Maximum torque = 13.4Nm @ 6000 rpm

Compression ratio =9.35/1

Density of petrol C_8 H_18=737.22 kg/m^three at 60F

= zero.00073722 kg/cm3

= 0.00000073722 kg/mm3

T = 60F =288.855K =15.550C

Mass = density ×quantity

m = zero.00000073722×149500

m = 0.11kg

Molecular cut for petrol 144.2285 g/mole

PV = mRT

P mRT/V=(zero.11×eight.3143×288.555)/(0.11422 ×0.0001495)=263.9/0.00001707

P = 15454538.533 j/m3 = n/m2

P =15.454 N/mm2

DESIGN OF CAMSHAFT

The cam is forged as one piece with the camshaft

The diameter of camshaft D1 = 0.16 cylinder bore+12.7

D1 = 0.16 fifty seven+12.7=21.82mm

The base circle diameter is set 4mm greater than camshaft diameter

Base circle diameter = 21.82+3 = 24.82mm = 25mm

Width of camshaft w1 = zero.09 cylinder bore+6

W1 = zero.09 fifty seven+6 = eleven.13mm

OA = minimum radius of camshaft + (1/2 diameter of roller)

= 12.5+ (1/2 41) = 33mm

RESULT TABLES

STATIC ANALYSIS RESULTS TABLE

Material	Deformation (mm)	Stress (N/mm^2)	Strain
Forged steel	1.268	235.25	0.0011976
Cast iron	2.3145	240.44	0.002219
Aluminum alloy	3.5479	227.69	0.00327

modal analysis

Material	Deformation1 (mm)	Frequency (Hz)	Deformation 2 (mm)	Frequency (Hz)	Deformation 3 (mm)	Frequency (Hz)
Forged steel	3.0247	255.78	2.9848	256.27	6.8222	648.98
Cast iron	3.1567	197.66	3.1099	198.02	7.123	506.41
Aluminum alloy	5.0966	257.35	5.037	257.91	11.486	643.67

CONCLUSION

The camshaft is driven via using using the crankshaft through timing gears cams are made as valuable components of the camshaft and are designed in this type of approach to open and virtually the valves on the excellent timing and to preserve them open for the predominant length. A not distinctive instance is the camshaft of an car, which takes the rotary motion of the engine and interprets it in to the reciprocating movement principal to characteristic the consumption and exhaust valves of the cylinders.

Through looking on the static analysis the strain values are a lot less for aluminum alloy overview with cast steel and forged iron.

By watching on the modal evaluation the deformation and frequency values are higher for aluminum alloy.

So it may be finish the aluminum alloy is healthier cloth for cam shaft

FUTURE SCOPE

As has been found in this study that certain geometrical features have significant impact in improving the SCF in cyclically loaded components, other standard geometric features used in machine components like threaded holes, threaded flanges, knuckles, locking pins etc. can be studied and their impact can be seen on the SCF for guiding the design engineers while development of new designs Similarly many other components manufactured out of rolled bars and prone to failures like axles, shafts, lead screws, ball screws etc. can be examined for their failures during service and carefully designed forgings can be developed for better grain flow at the plane of failures. These studies will find lot of potential for field application in improving the service life of the cyclically loaded components and may also reduce their cost of manufacturing.

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