Design and Fatigue Analysis of Chain Sprocket Using FEA

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Abstract- *In any automobile the power is transmitted from one shaft to another by using chain sprocket assembly. Chain assembly consists of chain, driving sprocket and driven sprocket. The driving sprocket is connected to engine output shaft, which transfer power to driven sprocket by chain. Further this driven sprocket transfer power to drive shaft. The material used for driving sprocket is mild steel. The design of this sprocket plays a vital role in efficient running of the automobile. Because of this reason careful efforts are required in design of chain sprocket.*

In this paper a two wheeler automobile chain sprocket is designed and detailed finite element analysis is carried out to calculate stresses and deflections on the sprocket. Later the analysis is extended to fatigue analysis to estimate the life of the chain sprocket. Initially, the 3D model of the chain sprocket is done from design obtained from previous literatures. Finite element analysis is carried out by applying the forces evaluated from the calculations.

I. INTRODUCTION

The name 'sprocket' applies by and large to any wheel whereupon are spiral paperions that connect with a chain ignoring it. It is recognized from a rigging in that sprockets are never fit together straightforwardly, and contrasts from a pulley in that sprockets have teeth and pulleys are smooth.

Sprockets can be provided in different materials and styles, contingent on the application and seriousness of administration necessities. The choice of material utilized for the assembling of sprocket relies on the quality and administration conditions like wear and clamor and so on includes the cost and also the material execution required. The sprockets possibly produced from metallic non-metallic materials. The steel is broadly utilized for the assembling of sprocket because of its go wearing properties, incredible mach powerlessness and instance of delivering confused shapes by machining. Sprockets can likewise be provided in different given materials a role as Standard Carbon Steel (with or without solidified teeth), Stainless Steel, Special materials, for example, combination steel, bronze and so forth The nonmetallic materials like wood, compacted paper and plastics like Nylon, Acrylic and Polycarbonate and so on are utilized for gears, particularly to reduce weight and clamor.

1 METHODOLOGY:

All the motorbikes in the recent times are equipped with conventional chain drive which transmits the power from engine to rear wheel. The two main parts of the chain drive are as follows:

1. Chain
2. Sprocket

The material used for making the chain and sprocket is mild steel.

The main objective of this paper is to do static and fatigue analysis of the sprocket, and to find out the deflections, stresses and total life cycles of the sprocket under working conditions.

- The 3d model which is used to perform structural analysis is designed by using NX-cad software.
- After the design is completed, the model format is formatted to Ansys format which will helpful in importing the model into Ansys very easily.
- Structural analysis is performed on the designed sprocket using material mild steel and getting know the stresses and deflections.
- The results are tabulated after completing structural analysis for mild steel material.

After getting the results at best the sprocket is moved to the next step to find out the life cycles that can the sprocket withstand by conducting fatigue analysis.

2. MODELING PART:

The conventional sprocket model of Bajaj Pulsar 180is used. Input for design of sprocket is taken from rear wheel sprocket of Bajaj pulsar 180. CAD model then is made by the commands in CATIAV5 R19 of pad, pocket, fillet, and geometrical selections in part design module.

Standard procedure for designing and drawing the sprocket**:**

- Input → Bajaj Pulsar 180 rear wheel sprocket-reverse engineering.

1. Number of teeth= 42
2. Roller diameter = 8.51mm
3. Sprocket thickness = 7.2
4. Chain pitch =12.7mm
5. Sprocket diameter = 170mm

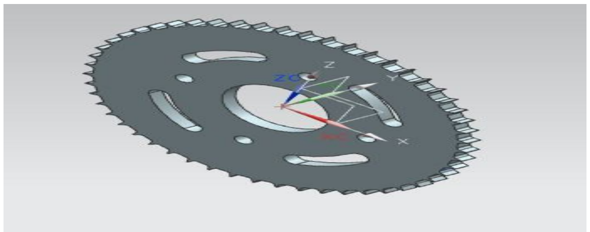


Figure1. Shows the 3d model of sprocket

II. ANALYSIS OF THE SPROCKET IN ANSYS SOFTWARE

The 3d model of sprocket is made in the NX-7.5 and then it is converted in the parasolid file. The parasolid file is imported in the Ansys to perform the static analysis with mild steel material.

Figure2. 3D model in the Ansys environment

The properties of the mild steel material used in this analysis are shown below:

PROPERTY	VALUE
Young's Modulus	2.1e5 MPa
Poisson's ratio	0.3
Density	7850 kg/m³
Yield stress	250 MPa
Ultimate tensile stress	390 MPa

1. BOUNDARY CONDITIONS:

The boundary conditions applied on the body i.e. constrains and the forces applied are shown in below figures. After meshing, sprocket is constrained in the center and the force is applied on the select part of the circumference.

Figure3. The meshed model is shown in the above figure.

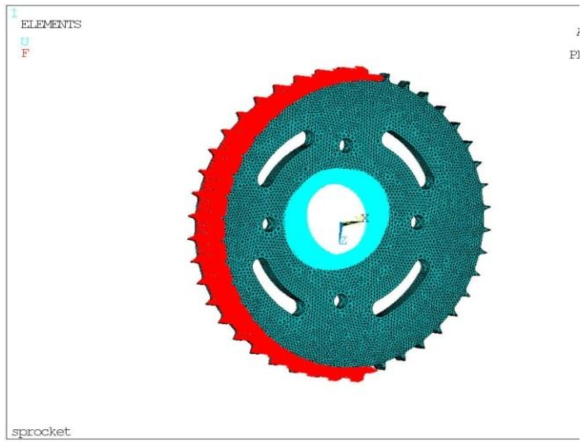


Figure4. Shows the applied boundary conditions.

III. RESULTS

STATIC ANALYSIS:

The results obtained for the static analysis of the sprocket in Ansys are shown below by plotting deflections and stresses.

DEFLECTIONS:

- The deflections obtained in the different directions are plotted below
- The maximum deflections obtained in the x direction are plotted in the below figure.

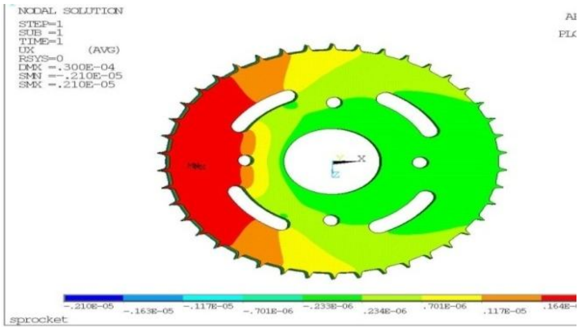


Figure5. Shows the deflection in x direction

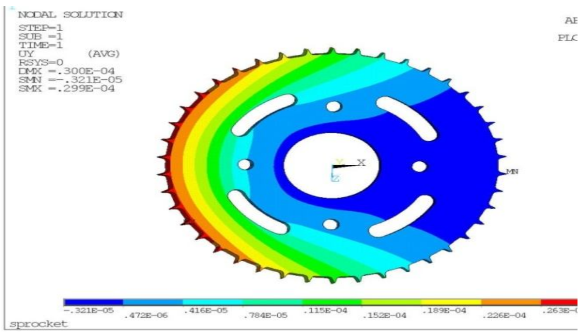


Figure6. Shows the deflection in y direction

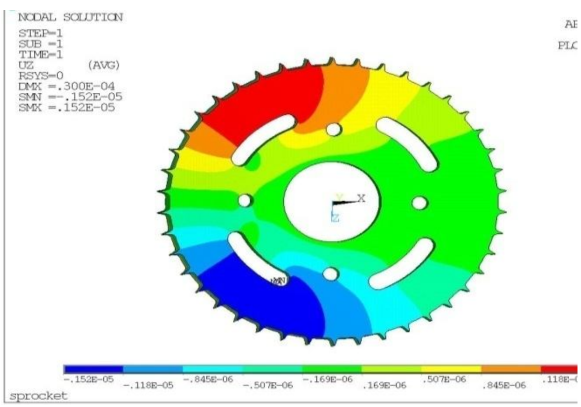


Figure7. Shows the deflection in z direction

STRESSES:

The stresses developed in the static analysis are plotted below.

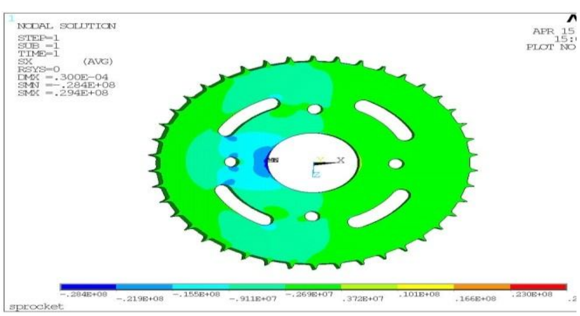


Figure8. Shows the x component of the stress

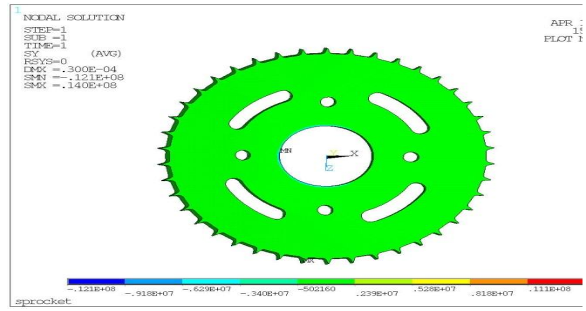


Figure9. Shows the z component of the stress

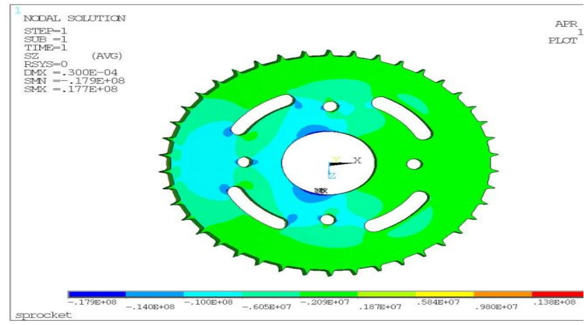


Figure10. Shows the y component of the stress

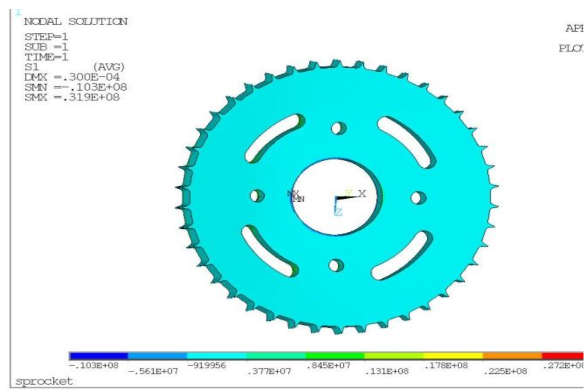


Figure11. The 1st principal stress developed

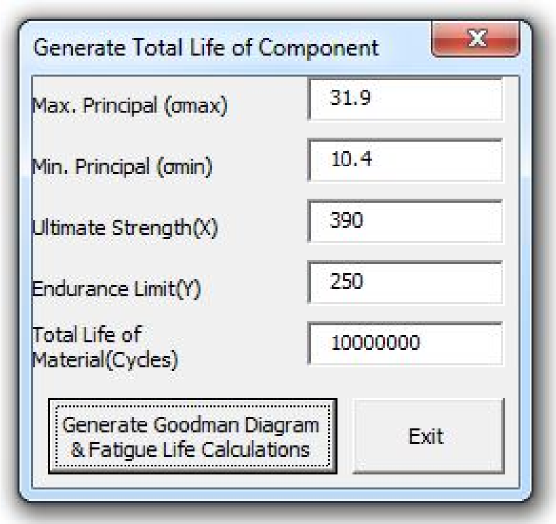
OBTAINED RESULTS:

Total deflection: 0.03mm
Von mises stress: 27.8 N/mm^2
1st principal stress: 31.9 N/mm^2
2nd principal stress: 12.6 N/mm^2
3rd principal stress: 10.4 N/mm^2

FATIGUE ANALYSIS:

The steps involved in the fatigue analysis by using fatigue calculations tool are shown below.

The below figure shows the input data for the fataigue life calculations



GOODMAN DIAGRAM:

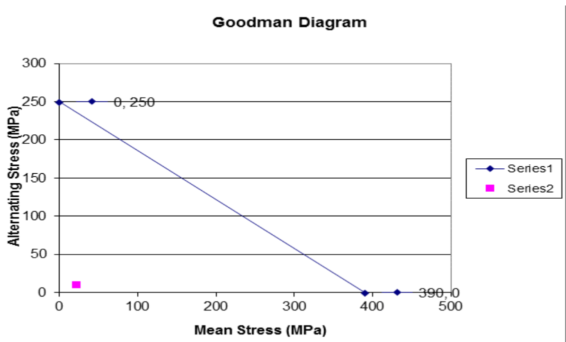


Figure11. Goodman diagram

IV. CONCLUSION

After the static analysis of the model that is made in NX-7.5 and imported into Ansys, the deflections obtained and stresses developed are very well below the critical value and the design is found to be safe.

Total deflection: 0.03mm
Von misses stress: 27.8 N/mm^2

After fatigue analysis to find life cycles, it is clear that the design is having infinite number of life cycles with very less mean stress.

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