Scientific Journal of Impact Factor (SJIF): 5.71
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 04, April -2018

FATIGUE ANALYSIS OF CHAIN SPROCKET USING FINITE ELEMENT ANALYSIS

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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 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. From the analysis principle stresses are calculated and are used as fatigue inputs for making Goodman diagram. NX-CAD software is used for doing 3D model and Ansys is used for doing finite element analysis.

Keywords*-Sprocket, Fatigue Analysis, Design, NX-CAD, 3D model.*

I. INTRODUCTION

A chain is a reliable machine component, which transmits power by means of tensile forces, and it used primarily for power transmission. The function and uses of chain are similar to a belt, Roller chain or bush roller chain is the type of chain drive most commonly used for transmission of mechanical power on many kinds of domestic, industrial and agricultural machinery, including conveyors, cars, motorcycles, and bicycles. It consists of a series of short cylindrical rollers held together by side links. It is driven by a toothed wheel called a sprocket. In this paper it is proposed to substitute the metallic sprocket of motorcycle with composite material to reduce the weight and noise. For the purpose composite material were considered namely carbon fibre and the irritability are checked with their counterpart metallic gear (Mild steel). Based on the static analysis, the best composite material is recommended for the purpose**.** A virtual model of sprocket was created in NX-CAD. Model is imported in Hyper mesh 12. 0f or pre-processing and analysis is carried in ANSYS 13 After analysis a comparison is made among existing mild steel sprocket. Based on the deflections and stresses from the analysis, we choose carbon fibre as a substitute of metal.

No researcher has applied effort for designing of sprocket with carbon fibre. Therefore, there is stern need to work on sprocket with composite material. In this work, we introduced the carbon fibre as replacement for conventional mild steel. Also we done the CAD through reverse engineering and analysis is carried out using Hyper mesh and ANSYS This paper, concentrating on the typical working condition of mobile crushing station, conducts an array of theoretical analyses and contrasts analytical results with simulation ones. These works strive to provide support in the design of chain drive system in a heavy duty apron feeder of mobile crushing station.

II. PROBLEM DEFINITION & METHODOLOGY

In this paper a two wheeler automobile (PULSAR BIKE) chain sprocket is designed BY REVERSE ENGINEERING using NX-CAD software.3d model and 2D engineering data and has been developed using NX-CAD.

Structural static analysis is carried out to calculate stresses and deflections on the sprocket by applying boundary conditions and loading. From the analysis principle stresses are calculated and are used as fatigue inputs for making Goodman diagram.

- Dimensions of pulsar bike sprocket are taken by reverse engineering using measuring instruments like vernier and scale.
- 3d model and 2D engineering data and has been developed using NX-CAD.3D model is converted into parasolid to import into Ansys.
- Structural static analysis is carried out to calculate stresses and deflections on the sprocket by applying boundary conditions and loading.
- From the analysis principle stresses are calculated and are used as fatigue inputs for making Goodman diagram

2.1. 3D MODEL

Specifications of the sprocket used for the design of the model are taken by reverse engineering from pulsar 180 and are shown below

- Number of the teeth: 42
- Roller diameter : 8.51mm
- Sprocket thickness: 7.2 mm
- Chain pitch:12.7mm
- Sprocket diameter: 170 mm

Fig1: 3D Model of Sprocket

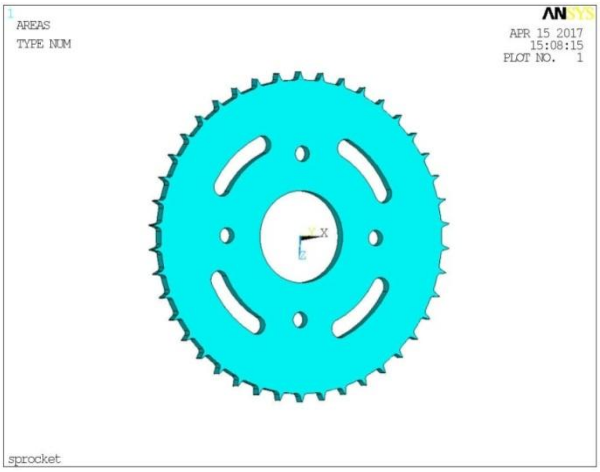


Fig.2: 3D model in the Ansys environment

Table 1: Properties of Mild Steel.

PROPERTY	VALUE
Young's Modulus	2.1e5 M. Pa
Poisson's ratio	0.3
Density	7850 kg/m^3
Yield stress	250 M. Pa
Ultimate tensile tress	390 M. Pa

Fig.3: Meshed 3D Model

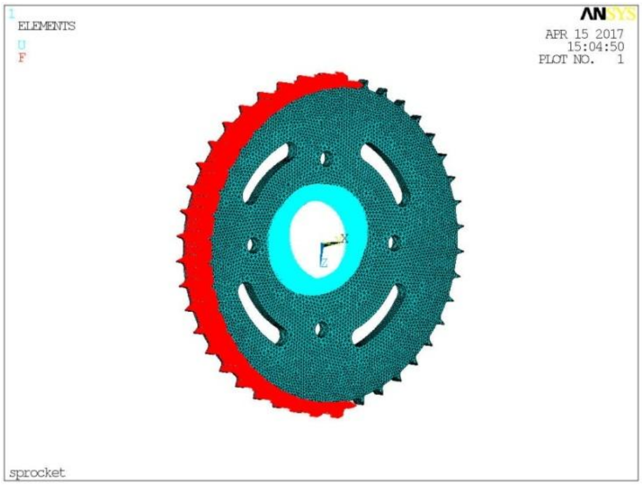


Fig.4: Meshed 3D Model with Boundary Conditions

III. RESULTS

3.1. Static Analysis-Deflection & Stress

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

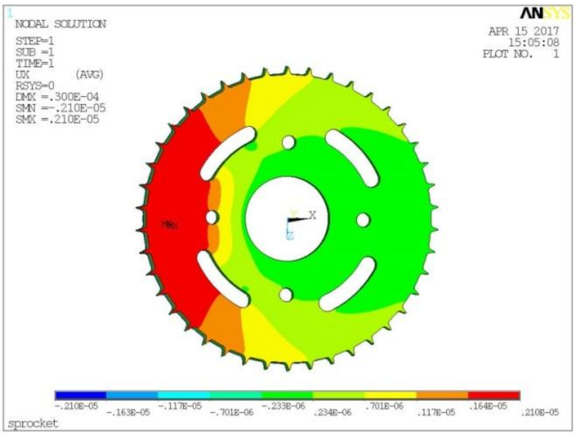


Fig.4: Deflection in X direction

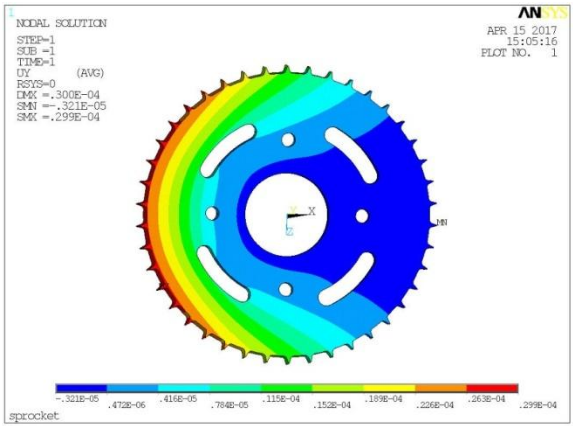


Fig.5: Deflection in Y direction

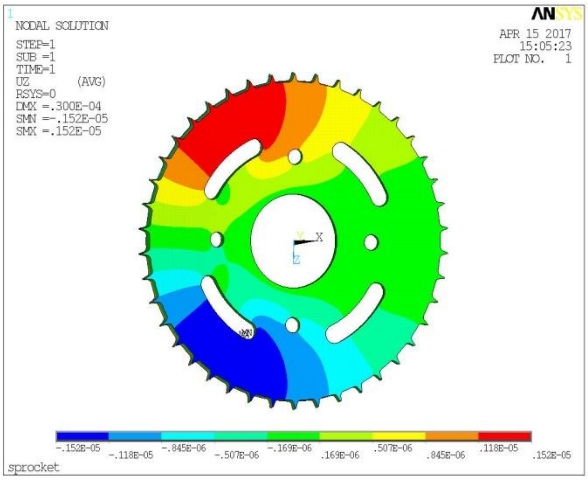


Fig.6: Deflection in Z direction

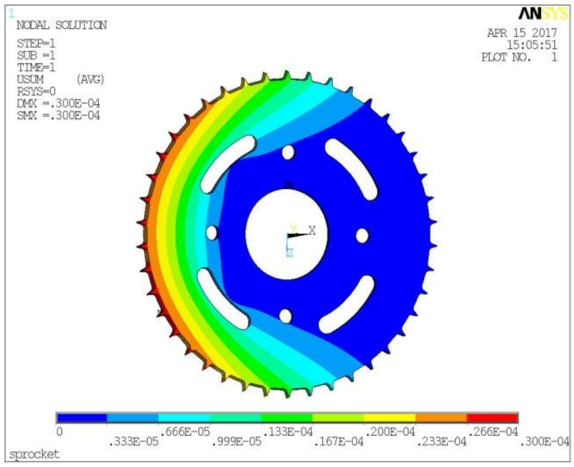


Fig.7: Total (USUM) Deflection

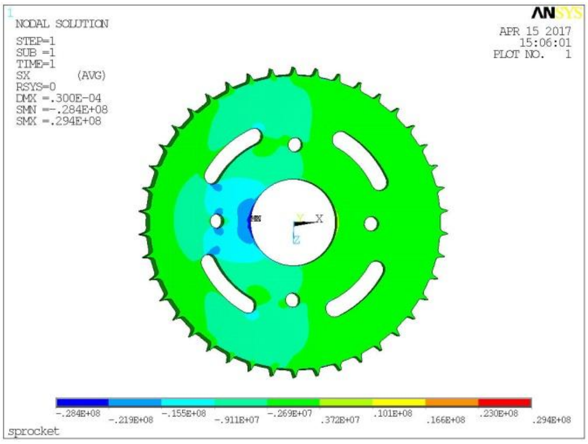


Fig.8: X component of Stress

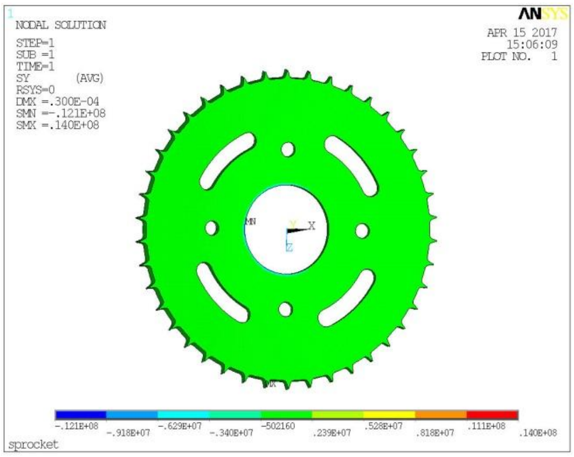


Fig.9: Y component of Stress

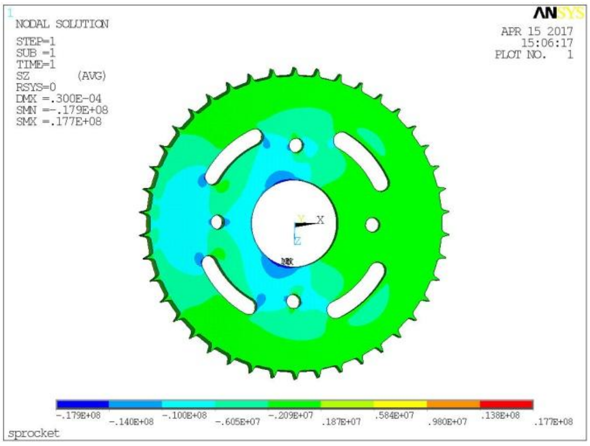


Fig.10: Z component of Stress

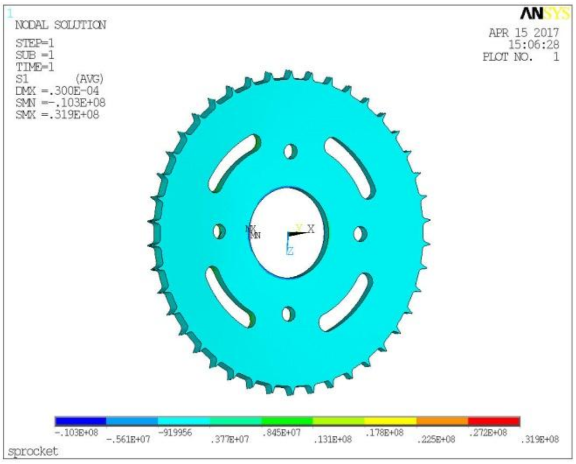
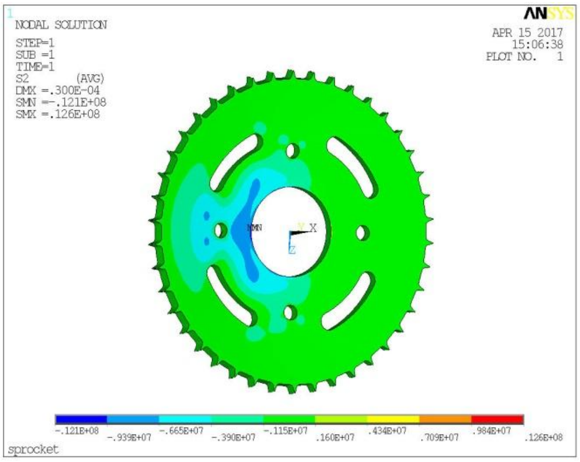


Fig.11: 1st Principal Stress



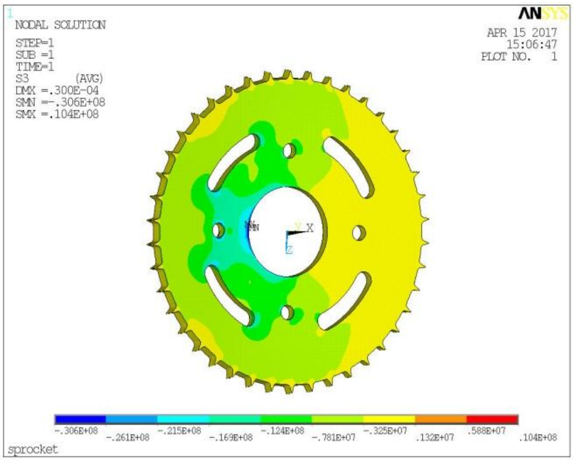


Fig.12: 2nd Principal Stress

Fig.12:3rd Principal Stress

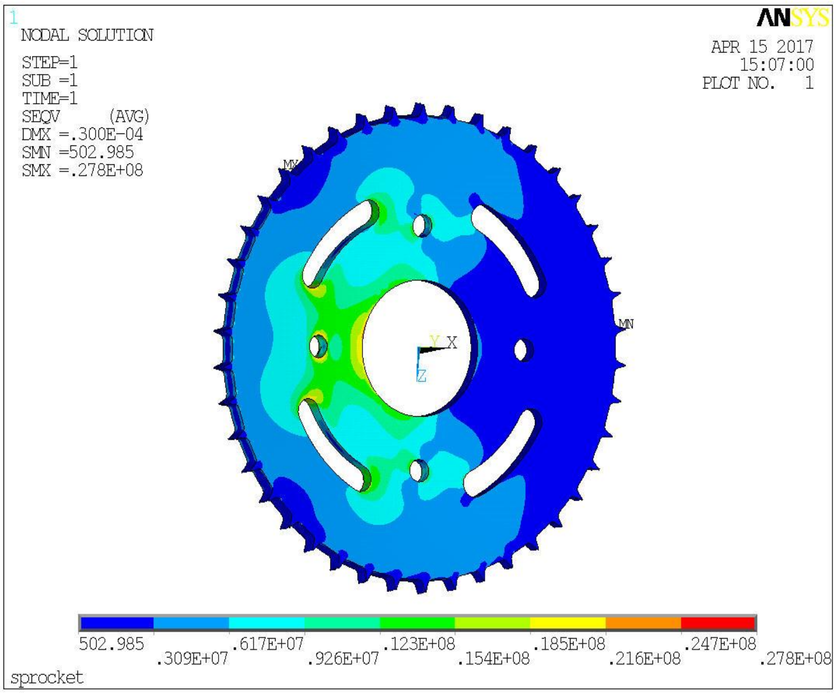


Fig 13: Von Mises Stress

3.2. Fatigue analysis:

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

Steps involved:

- •Identifying the critical locations in the component.
- •Maximum Principal stress extraction for the entire cycle
- •Obtaining the max (σ_{max}) and min (σ_{min}) values of maximum principal stress from entire cycle.
- •Stress range(σ_{range}) = σ_{max} - σ_{min}
- •Stress amplitude (σ_{amp}) = (σ_{max} - σ_{min})/2
- •Mean Stress(σ_{mean})= (σ_{max} + σ_{min})/2
- •Ultimate Strength of material=σ_{ut}
- •Endurance limit=σ_e
- •Locating the point in Goodman's diagram using the coordinate ($x = \sigma_{mean}$, $y = \sigma_{amp}$).
- •If the point is within the Goodman's line then component has infinite life. If it is on or above the line then component will fail.
- •Margin of Safety for alternating stress (MS) = y^1/y

Assume that total life of material = 10^7 cycles

Total Life of Component in cycles = 10^7 X (1-(1/MS))

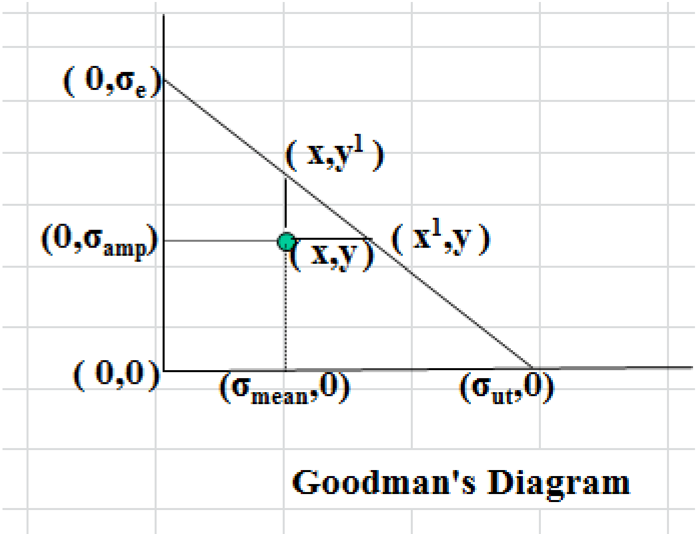


Fig.14: Goodman's Diagram

- ➢ The **x** axis in the above figure represents the **Mean stress(MPa)**
- ➢ The **y** axis represents the **Alternating stress(MPa)**.

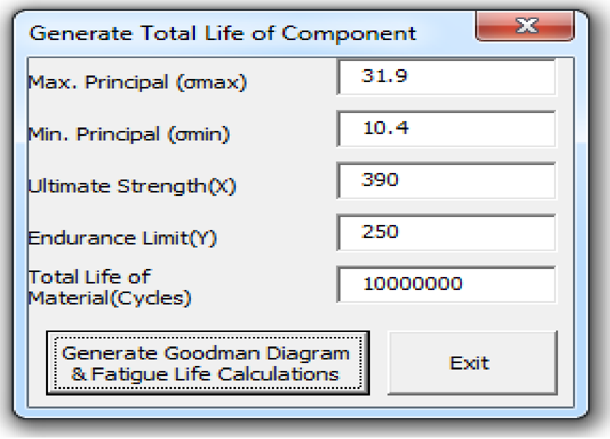


Fig.15: Input data for the Fataigue Life calculations

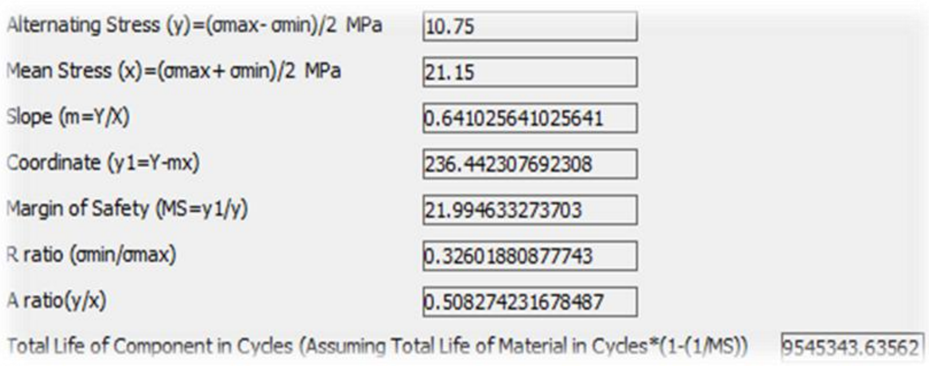


Fig.16: Life of Component in Cycles

IV. CONCLUSIONS

After the static analysis of the model that is made in NX CAD-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: 0.03 mm Von mises 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.

REFERENCES

[1] Ebhota Williams S, Ademola Emmanuel, Oghenekaro Peter, (2014), Fundamentals of Sprocket Design and Reverse Engineering of Rear Sprocket of a Yamaha CY80 Motorcycle, *International Journal of Engineering and Technology*, 4, pp. 170- 179.
[2] Swapnil Ghodake, Prashant Deshpande, Shrikant Phadatare, (2014), Optimization of Excavator Sprocket and its Validation by Test Rig Concept, *Conference on Advances in Engineering and Technology,* pp. 253-256.
[3] Chandraraj Singh Baghel, Abhishek Jain, Dr. A.K. Nema and Anil Mahapatra, (2013), Software ANSYS Based Analysis on Replacement of Material of Sprocket Metal to Plastic Material PEEK, *International Research Journal of Engineering and Applied Science*, 1 (4).
[4] Chaitanya G Rothe, A. S. Bombatkar , (2015), Design and Analysis of Composite Material Drive Shaft, *International Journal of Innovative and Emerging Research in Engineering*, 2 (1), pp. 72-84.
[5] R. V. Mulik, Prof. M. M. Joshi, Dr. S. Y. Gajjal, S. S. Ramdasi and N. V. Marathe, (2014), Dynamic Analysis of Timing Chain System of a High Speed Three Cylinder Diesel Engine, *International Journal of Engineering and Science*, 4 (5), pp. 21-25.
[6] Candida Pereira, Jorge Ambrosia, Amilcar Ramalho, (2010), Contact Mechanics In A Roller Chain Drive Using A Multibody Approach, *11th Pan-American Congress of Applied Mechanics Copyright © 2009 by ABCM* January 04-08.
[7] Sine Leergaard Pedersen, (2014), Simulation and Analysis of Roller Chain Drive Systems, *PHD Dissertation, technical university of Denmark*.
[8] C Conwell, (1989), An Examination of Transient Forces in Roller Chain Drives, *Ph.D. Dissertation: Vanderbilt University, Nashville, TN.*

