As per UGC guidelines an electronic bar code is provided to seure your paper

International Journal for Modern Trends in Science and Technology, 7(09): 54-59, 2021

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0709010
Available online at: http://www.ijmtst.com/vol7issue09.html

Modeling and Finite Element Analysis of Chain Drive using Different Materials

G.Prasad[1] | Dr.K.Vasantha Kumar[2]

[1] PG Scholar, Dept. of Mechanical Engineering, JNTUH College of Engineering, Kondagattu, Jagtial, Telangana India
[2] Assistant Professor and HOD, Department of Mechanical Engineering, Jawaharlal Nehru Technological University Hyderabad College of Engineering, Jagtial, Telangana state, India

To Cite this Article
G.Prasad and Dr.K.Vasantha Kumar. Modeling and Finite Element Analysis of Chain Drive using Different Materials. *International Journal for Modern Trends in Science and Technology* 2021, 7, pp. 54-59. https://doi.org/10.46501/IJMTST0709010

Article Info
Received: 15 August 2021; Accepted: 07 September 2021; Published: 10 September 2021

ABSTRACT

In any automobile the power is transmitted from one shaft to another by using chain drive. Chain drive 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 design and material selection of this chain drive plays a vital role in efficient running of the automobile. Present the material used for chain drive is mild steel.

This paper involves increases the strength of the Pulsar 180cc chain drive by selecting the different materials (AISI 1050 steel, EN 8 steel, EN 32 steel, EN 19 steel and C45 steel).

In this the Pulsar 180cc chain drive designed through reverse engineering approach and detailed finite element analysis is carried out to calculate stresses and deflections on the chain drive. Later the analysis is extended to fatigue analysis to estimate the life of the chain drive and the dynamic analysis is carried out to calculate stresses and deflections on the chain drive when it is in motion. SOLID WORKS software is used for doing 3D model of chain drive and ANSYS is used for doing finite element analysis.

KEYWORDS: Chain drive, Reverse Engineering, ANSYS, SOLIDWORKS.

1.INTRODUCTION

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.

Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. Another type of drive chain is the Morse chain, invented by the Morse Chain Company of Ithaca, New York, United States. This has inverted teeth.

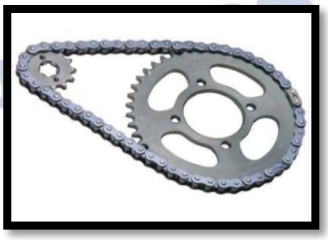


Fig 1: Chain Drive

MATERIALS USED

A chain drive can be made of different materials based on required strength and service conditions. In this an examination is established on materials of iron family element, an alloy and a carbon element. This gives a better choice of chain drive based on application. As materials reduce in weight, noise, cost and will improve efficiency of chain drive.

A.AISI 1050 STEEL

Carbon steels contain carbon as the main alloying element. They are designated by AISI four-digit numbers, and contain 0.4% of silicon and 1.2% of manganese. Molybdenum, chromium, nickel, copper, and aluminum are present in small quantities.

B.EN 8 STEEL

EN8 steel material is suitable for the all general engineering applications requiring a higher strength than mild steel such as:

- General-purpose axles
- Shafts,
- Gears,
- Bolts and studs.

C.EN 32 STEEL

EN32 is a case hardening steel with low tensile strength and is used in general engineering for the production of lightly stressed components.

The material displays good weld ability and mach inability characteristics in the supplied condition and has a hard wearing surface. EN32 is classed as an unalloyed low carbon grade.

D. EN 19 STEEL

EN19 is a high quality, high tensile steel usually supplied readily machine able in 'T' condition, giving good ductility and shock resisting properties combined with resistance to wear.

E. C45 GRADE STEEL

C45 grade steel is defined as a medium carbon steel offering tensile strengths in the modest range. The material can be maneuvered with hardening by means of quenching and tempering on focused and restricted areas. C45 can also be instigated with induction hardening up to the hardness level of HRC 55

Table: 1 mechanical properties of materials:

Materials	Young's modulus(Mpa)	Tensile strength(Mpa)	Poisson's ratio	Density (kg/mm3)
AISI 1050 carbon steel	200000	690	0.29	0.00000785
EN 8 steel	190000	465	0.3	0.00000078
EN32 steel	206000	430	0.29	0.00000070
EN 19 steel	205000	1230	0.3	0.000008
C45 steel	210000	700	0.3	0.0000078

2.LITERATURE REVIEW

Based on Literature Review, different design optimization processes and techniques was used by different researchers. Some of them re-designed the chain sprocket, analysis using FEA and using the results from FEA they optimized the weight of sprocket. Some has given heat treatment and other types of chemical treatment to the sprocket to enhance its mechanical properties. For this review, many international and national papers were helpful. Worldwide researchers have applied the efforts to design and tried to optimize the weight of chain sprocket as,

[1] Tushar D. Bhoite et al studied into various application aspects and manufacturing aspects to formulate an idea of the system. Finally Finite Element Analysis (FEA) has been used to conduct shape optimization. Since lot of work has already been done in other components, in this work the focus has been narrowed down to specific component of outer link. Within the outer link, most dimensions in the industry are parametrically defined, however one dimension, the radius that is in between the inter connecting holes is left to manufacturer convenience. In this paper we assess the impact of this radius on the stress in the system and see if material saving and consequently efficiency increment is possible.1

[2] M. Koray KESİKÇİ widely investigated in literature the theoretical differences and the superiorities of the techniques over each other. In the study, roller chains which are used as pulling and driving members of materials handling mechanisms are inspected. Stress analysis of a standard roller chain link is performed using both boundary and finite element methods. The mechanical behaviors of a standard roller chain which is loaded by the maximum allowed load are considered. Comparing the results of the both techniques with each other and the results of literature, the appropriate method for the roller chain problem is proposed

[3] Shoji NOGUCHI et al suggests some approaches for reducing stresses and weight saving in the link plate of roller chain. Stresses are 3% higher in proposed design, but the weight reduced in 10%. Tensile tests are performed on link plates made of resin and the effectiveness of proposed model is confirmed.

[4] Sagar N. Vasoya, P. L. Koradiya and B. J. Patel, "Development of Sprocket to Improvement the Torque for Off Road Bike", In this paper, the process of development in sprocket was studied and gear ratio between them was investigated. They discussed four types of materials which will be best suited for sprocket namely Mild Steel, Chromoly Steel, Carbon Fiber and Aviation Grade Aluminium Alloy. They developed the Sprocket using 15/41 Teeth into the 13/39 Teeth and found that torque has increased by 9.91% by using the developed sprocket ratio.

[5] **Parag Nikam and Rahul Tanpure,** "Design Optimization of Chain Sprocket Using Finite Element Analysis", In this research, the chain sprocket was designed and analyzed using Finite Element Analysis for safety and reliability. ANSYS software was used for static and fatigue analysis of sprocket design. Using these results optimization of sprocket for weight reduction have been done. As sprocket undergo vibration, modal analysis was also performed. The design of sprocket has been successfully optimized with weight reduction of 15.67%. Also von-mises stress of modified design was lesser than preliminary design with little increase in deformation, which ultimately results in the safety and reliability of design.

3.MODELING AND ANALYSIS

Solid Works (stylized as SOLIDWORKS) is a strong modeling computer-aided layout (CAD) and laptop-aided engineering (CAE) computer application that runs on Microsoft Windows. Solid Works is published with the aid of Dassault Systems. According to the writer, over million engineers and architects at extra than 165,000 corporations were the use of Solid Works as of 2013. Also in line with the organization, financial year 2011–12 revenue for Solid Works totaled $483 million. DS Solid works Corp. Has sold over 1.5 million licenses of SolidWorks global. This consists of a massive proportion of tutorial licenses. The Sheffield Telegraph feedback that Solidworks is the world's most famous CAD software program.

Information – Bajaj Pulsar 180
Driver Sprocket
Diameter - 70 mm
Number of Teeth – 14
Driven sprocket
Diameter - 182 mm
Number of teeth – 39
Sprocket Width – 7.5 mm
Chain
Chain pitch – 12.8 mm
Number of links - 104
Roller diameter –7mm

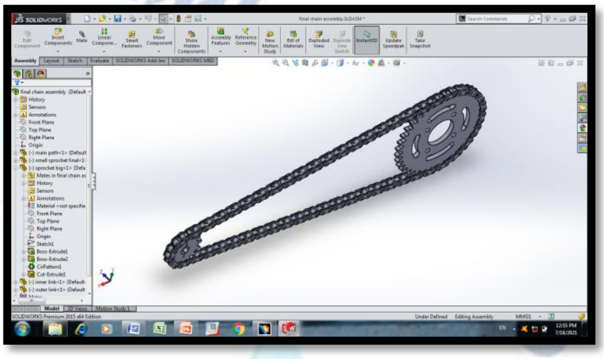


Fig 2: 3D Model of the chain drive

ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software implements equations that govern the behavior of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyze by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

ANSYS is the standard FEA teaching tool within the Mechanical Engineering Department at many colleges. ANSYS is also used in Civil and Electrical Engineering, as well as the Physics and Chemistry departments.

ANALYSIS OF CHAIN DRIVE

A. Static Analysis - Used to determine displacements, stresses, etc. under static loading conditions. ANSYS can compute both linear and nonlinear static analyses. Nonlinearities can include plasticity, stress stiffening, large deflection, large strain, hyper elasticity, contact surfaces, and creep.

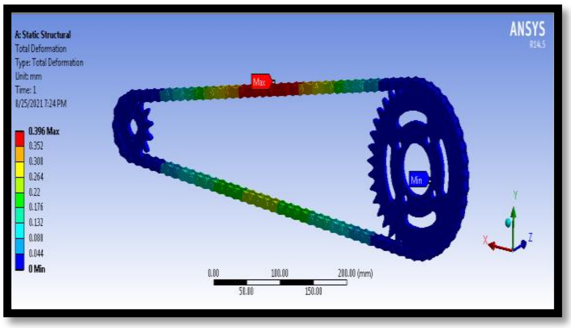


Fig 3: Total deformation of chain Drive

Above figure represent the total deformation of chain drive in static analysis.

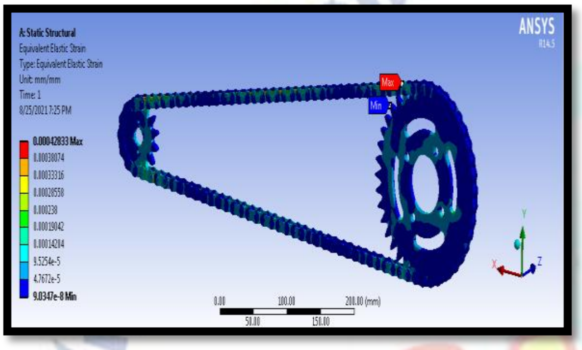


Fig 4: Stress of chain Drive

Above figure represent the stress of chain drive in static analysis.

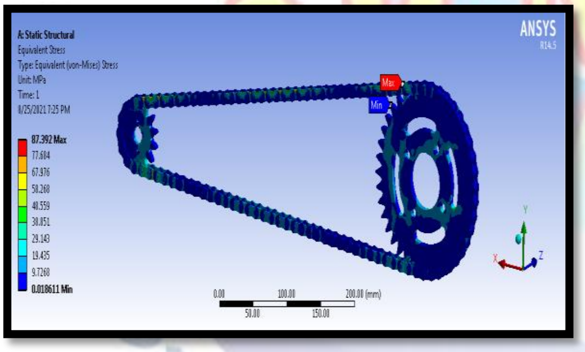


Fig 5: Strain of chain Drive

Above figure represent the strain of chain drive in static analysis.

B. Fatigue Analysis

Fatigue analysis used for estimate life, damage and safety factor of a component under static loading conditions.

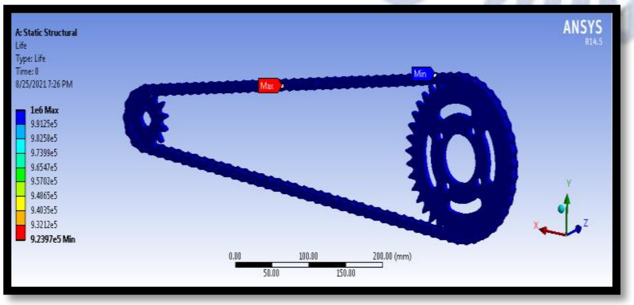


Fig 6: Life of chain Drive

Above figure represent the Life of chain drive in Fatigue analysis.

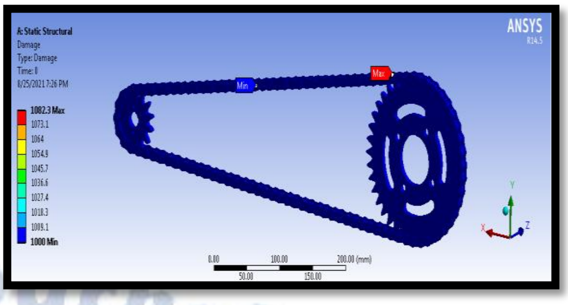


Fig 7: Damage of chain Drive

Above figure represent the Damage of chain drive in Fatigue analysis.

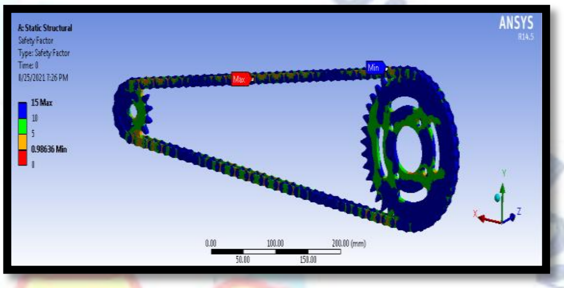


Fig 8: Safety Factor of chain Drive

Above figure represent the Safety Factor of chain drive in Fatigue analysis.

C. Dynamic Analysis

Transient analysis is one of the main branch of dynamic analysis to estimate the problems in which load is a function of a time.

At time -5sec

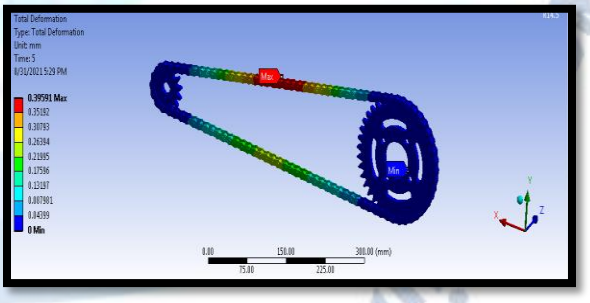


Fig 9: Total deformation of chain Drive

Above figure represent the total deformation of chain drive in Dynamic analysis.

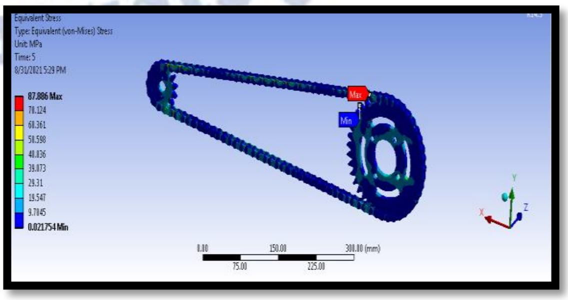


Fig 10: Stress of chain Drive

Above figure represent the Stress of chain drive in Dynamic analysis.

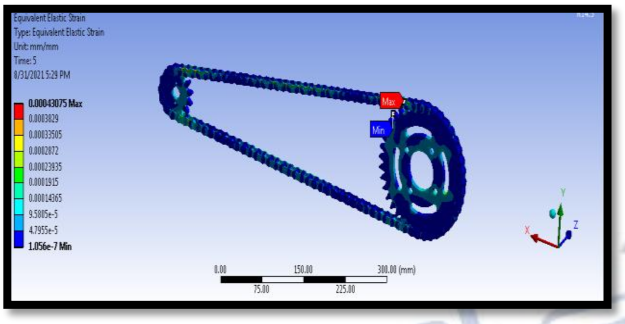


Fig 11: Strain of chain Drive

4.RESULTS AND DISCUSSIONS

All the results are carried out of static, fatigue and dynamic analysis. Indicated the all results in tabular format.

Table: 2 fatigue analysis results

Materials	Damage	Safety factor
AISI 1050 Carbon Steel	1110	0.98204
EN 8 Steel	1105	0.98279
EN 32 Steel	1082	0.98636
EN 19 Steel	1111.8	0.98176
C45 Steel	1104	0.98283

From Observing above table it is easy to conclude that EN 32 Steel has less damage i.e. High life of chain drive.

Table: 3 static analysis results

Materials	Speed (Km/hr)	Deformation (mm)	Stress (N/mm²)	Strain
AISI 1050 Carbon Steel	40	0.40781	87.777	0.00044312
	60	0.40693	117.89	0.00059908
	80	0.4043	322.79	0.0016403
EN 8 Steel	40	0.42896	87.709	0.00042202
	60	0.42803	117.32	0.00062764
	80	0.42524	321.15	0.0017181
EN 32 Steel	40	0.396	87.392	0.00042833
	60	0.3952	105.42	0.00052007
	80	0.3924	288.12	0.0014215
EN 19 Steel	40	0.3975	87.801	0.00043237
	60	0.39668	120.26	0.0005962
	80	0.39403	329.32	0.0016329
`C45 Steel	40	0.38811	87.706	0.0004216
	60	0.38277	117.33	0.00056787
	80	0.38474	321.15	0.0015545

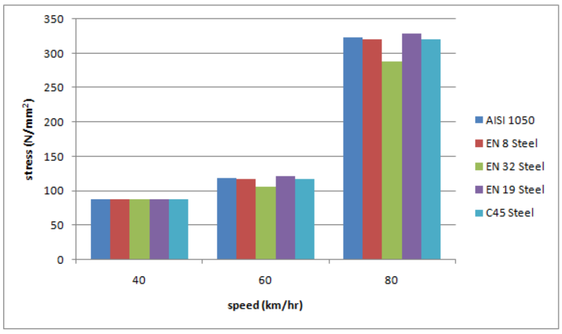
From Observing static analysis results it is easy to conclude that EN 32 Steel has less stress and strain.

Table: 4 Dynamic analysis results

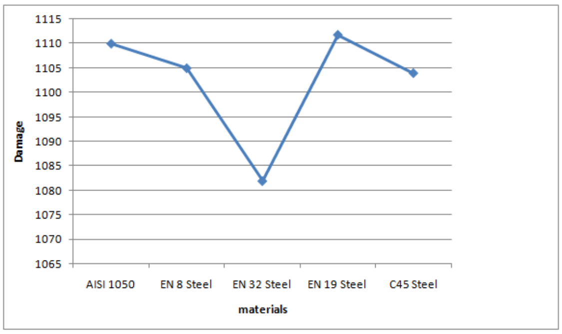
Materials	Time(sec)	Deformation (mm)	Stress (N/mm²)	Strain
AISI 1050 Carbon Steel	5	0.38801	88.262	0.0004243
	10	0.38749	100.67	0.00048728
	15	0.38474	317.95	0.0015389
EN 8 Steel	5	0.42886	88.235	0.00046881
	10	0.42829	100.05	0.00053521
	15	0.42525	317.51	0.0016986
EN 32 Steel	5	0.39591	87.886	0.00043075
	10	0.39544	90.492	0.00044644
	15	0.3928	285.26	0.001407
EN 19 Steel	5	0.39745	88.372	0.00043519
	10	0.3969	102.73	0.00050934
	15	0.39407	326.04	0.001616
`C45 Steel	5	0.388	88.246	0.00042422
	10	0.3874	100.23	0.00048511
	15	0.38478	317.96	0.001539

From Observing Dynamic analysis results it is easy to conclude that EN 32 Steel has less stress and strain.

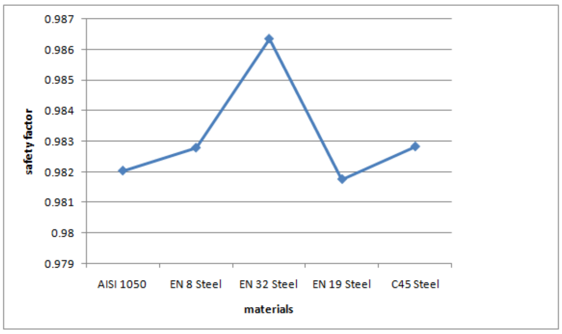
Graph: 1 Materials and speeds Vs stress



Graph: 2 Materials and speeds Vs Damage



Graph: 3 Materials and speeds Vs Safety factor



5. CONCLUSION

In this paper, Applied material properties of AISI 1050 steel, EN 8 steel, EN 32 steel, EN 19 steel and C45 steel at different vehicle speeds(40,60 and 80 km/hr) values for Von-Missies, total deformation, equivalent strains and stresses has been compared.

From finite element analysis of above materials, stress values of EN 32 Steel and C 45 Steel are in permissible limits for safer design. As compared to material properties, EN 32 steel is best suited for chain drive due to its low density, availability and less investment. Also C45 steel alloy shown better results adjacent to EN 32 steel.

REFERENCES

[1] M.Lohith srikrishna varma,I.Rama Pavan Kumar Varma,M.Hari Krishnam Raju Modelling and Analysis of chain drive sprocket using Different materials, IJRTE. 2019;ISSN:2277-3878.

[2] Aman Sharma ,Rishabh Chaturvedi,Rajat Yadav. An analytical study of mechanical power transmitting by utilizing CATIA and ANSYS techniques,European journal of Molecular& Clinical Medicine.2020;ISSN :2515-8260.

[3] Y Madhu Maheswara Reddy,Dr.P Ravi Chander, Fatigue analysis of chain sprocket using finite element analysis Scientific journal of impact factor.2018;ISSN:2348-4470.

[4] " Fea Based Study of Effect of Radial Variation of Outer Link in A Typical Roller Chain Link Assembly" by Tushar D. Bhoite, Prashant M. Pawar & Bhaskar D. Gaikwad at International Journal of Mechanical and Industrial Engineering (IJMIE), ISSN No. 2231 –6477, Vol-1, Issue-4, 2012.

[5] "Stress Distribution of The Chain Link By Means Of Boundary Element and Finite Element Methods" by M. Koray KESİKÇİ, M. Cüneyt FETVACI, C. Erdem İMRAK at Journal of Engineering and Natural Sciences, Received: 30.06.2004 Accepted: 04.11.2004.

[6] "Static Stress analysis of link plate of roller chain using Finite element method and some design proposals 4for weight saving" by Shoji NOGUCHI, Kohta NAGASAKI, Satoshi NAGAKAYAMA at Journal of Advanced Mechanical Design, Systems and Manufacturing, Volume 2, No-2 2009.

[7] "Dynamic Modeling of a Roller Chain Drive System Considering the Flexibility of Input Shaft" by XU Lixin, YANG Yuhu, CHANG Zongyu, and LIU Jianping at CHINESE JOURNAL OF MECHANICAL ENGINEERING Vol. 23,aNo.3, 2010.

[8] Tushar S. Hingve, Y. A. Kharche and N.A. Kharche, "Diagnosis for the Failure of Sprockets and Chain Drive", International Journal of Research in Science & Engineering, e-ISSN: 2394-8299, Volume: 3, Issue: 3, May-June 2017, p-ISSN: 2394-8280

[9] Sagar N. Vasoya, P. L. Koradiya and B. J. Patel, "Development of Sprocket to Improvement the Torque for Off Road Bike", IJRSI, Volume IV, Issue I, December 2016, ISSN 2321-2705

[10] Nikhil P. Ambole and Prof. P. R. Kale, "Design and Analysis Carbon Fiber Sprocket", International Engineering Research Journal Page No 218-225