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A CATIA and ANSYS-based analysis of mechanical power transmission

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Abstract

The principles of chain drive modelling using a reverse engineering technique are covered in this study. As part of this investigation, a chain drive is subjected to a finite element analysis to determine its level of safety and dependability. The CATIA V5 part module is used to construct a cad model of the chain drive. The ANSYS workbench is utilised for both the pre-processing and post-processing activities. Material properties of AISI 1050 steel, EN 8 steel, EN 32 steel, EN 19 steel and C45 steel were used at varied vehicle speeds (40, 60 and 80 kilometres per hour) for Von-Missies in this project. ' There has been a comparison of total deformation, equivalent strains, and stresses. A more secure design is possible because the stress values of EN 32 steel and C 45 steel, as determined by the aforementioned finite element material analysis. Because of its low density, availability, and low initial investment, EN 32 steel is the ideal choice for chain drive when comparing the properties of the other materials. It was also found that C45 steel had better results than EN 32 steel in tests.

Keywords: EN 32 steel, mechanical power transmission, speed, CATIA, ANSYS, steel alloys

1. INTRODUCTION

The transmission of mechanical force from one position to the next, starting with the initial site, is the purpose of a chain drive. It is a technique that is used rather frequently to transfer the capacity of a vehicle to the wheels of the vehicle, especially bicycles and cruisers. In addition to its use in automobiles, this technology is also put to work in a wide range of other machines and gadgets [1-3]. The force is typically conveyed by a roller chain, which is also known as the drive chain or transmission chain. This procedure does away with the need for a sprocket gear because the teeth of the device are able to fit into the gaps that are present in the chain's connections [4-5]. The rigging is spun, and as a result, the chain is pulled, which supplies the framework with mechanical power. The Morse chain is a type of drive chain that was developed by the Morse Chain Company, which is located in Ithaca, New York, in the United States. Teeth have been changed as a result [6].

According to a Literature Review, researchers employed many design optimization methods. In certain situations, they redesigned the Chain sprocket using FEA, then used the results to improve its weight [7]. Heat medication is partially met. Chemicals can improve the sprocket's mechanical properties. Many national and international articles backed this review. Industry specialists are working to reduce chain sprocket weight. [8] and others discuss requisition. By providing multiple viewpoints on plan A. Streamlining behaviour state requires constrained component research (FEA). Because so much work had been put into other areas of the system, this fill-in was needed. The span between buried vivos trust interfacing gaps is the most pleasant measurement for producers, but most oak measurements parametrically define it. This article evaluates anxiety levels in the framework as well as material savings and efficiency improvements. His study centred on theoretical contrasts and system supremacy. Roller chains used to pull and shatter materials-care components are studied. A roller chain connection stress test uses both limit-by-limited-component approaches. Heavy loads are stored with a roller chain. After analysing both systems' effects on each other and on literature, the right roller chain solution is presented. Shoji Noguchi et al. offer three approaches for minimising roller chain stress and weight. The design would increase anxiety by 3% but cut weight by 10%. The recommended model's feasibility will be tested using tar-coated connection plates [9-13]

Sprocket improvement may have been judged by the rigging ratio. Four materials for sprockets were studied. Chrome steel, carbon fibre, and metal alloys Aeronautics uses aluminium compound. Torque requirements rose by 9.91 percent when using a 15/41-tooth sprocket instead of 13/39 teeth. Using the gear ratio. Chain sprocket design streamlining using few components" limited component investigation for safety and dependability. ANSYS can analyse the sprocket plan's static and wear. After considering these factors, the sprocket must be streamlined to save weight. Modal testing can also use sprocket vibration. Sprocket design must be optimised to cut weight by 15.67%. With greater time and effort, von-mises might not have worried about design stability and uniformity [14-18].

Fig:1 chain sprocket

2. Materials Used

Different materials can be used to make a chain sprocket depending on the strength and service conditions required. The iron family element, an alloy, and a carbon element are all examined in this study. Because of this, it is possible to select the best chain sprocket for the job at hand. Chain sprocket efficiency will increase as materials become lighter and less noisy [8].

Table: 1 mechanical properties of materials

Materials	Young's modulus (Mpa)	Tensile strength (Mpa)	Poisson's ratio	Density (kg/mm3)
AISI	200000	690	0.29	0.000007
EN19 steel	205000	1230	0.3	0.000008
EN32 steel	206000	430	0.29	0.00000070
EN 8 steel	190000	465	0.3	0.00000078

3. DESIGN AND ANALYSIS

CATIA stands for computer-aided three-dimensional intelligent provision, or CATIA. As a leading 3D product, it will be used by a wide range of commercial organisations across a variety of industries, including aerospace, automotive, and consumer items. In addition to CAD, Cam, and CAE, Dassault Systems has developed CATIA, which is an all-in-one 3D programming solution. An aviation, 3D design and advanced mockups, and item lifecycle management (PLM) software company based out of France may be referred to as Dassault.

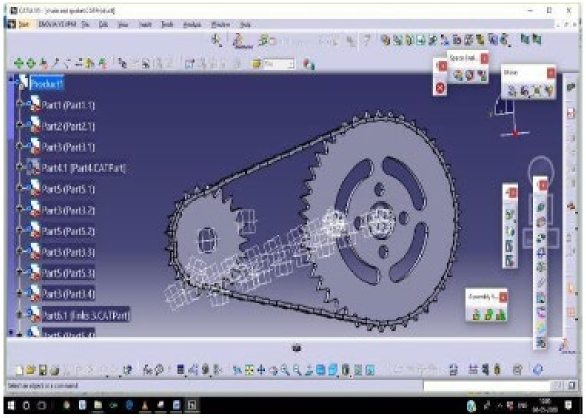


Fig: A chain sprocket in 3 D.

Limited component analysis (FEA) programming is universally beneficial with ANSYS. In a limited component investigation, a numerical system is used to decompose a complex framework into a series of discrete pieces known as components. All of these equations are solved by the programming, providing a comprehensive explanation of how the framework works.

3.1 Force Calculations

Given this, we can arrive to the following conclusions about

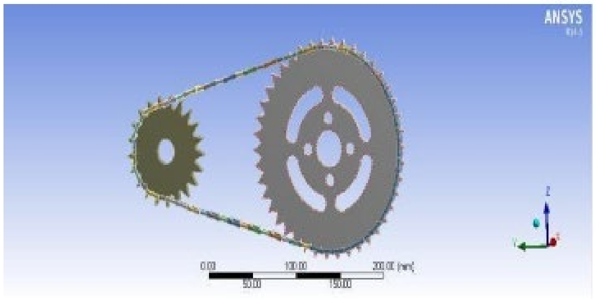
2g force acts, Approximated bike weight = 110 kg+160 (the weight of the bike + 2 persons) Force = 9.81*270

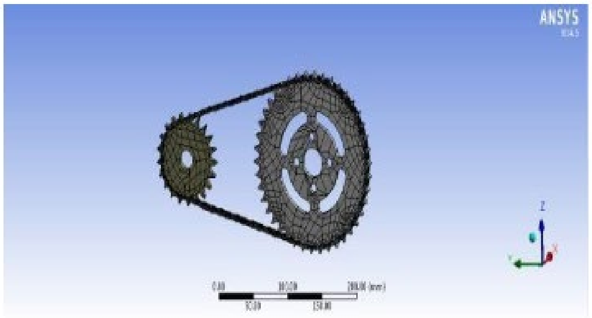
= 2648.7 N

3.2 Rotational velocity Calculations

To alter km/hr to rad/s, multiply by 0.278 to get m/s, and after that divide by t~~he~~ radius of the wheel to get rad/s. (v = rω so ω = v/r = v Rotational speed (**ω**) r

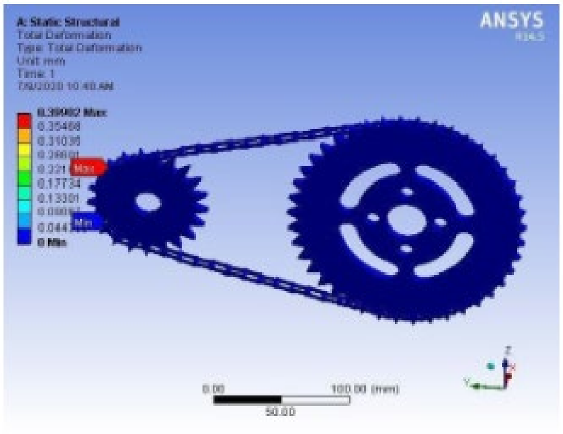
3.3 Chain Drive Static Analysis



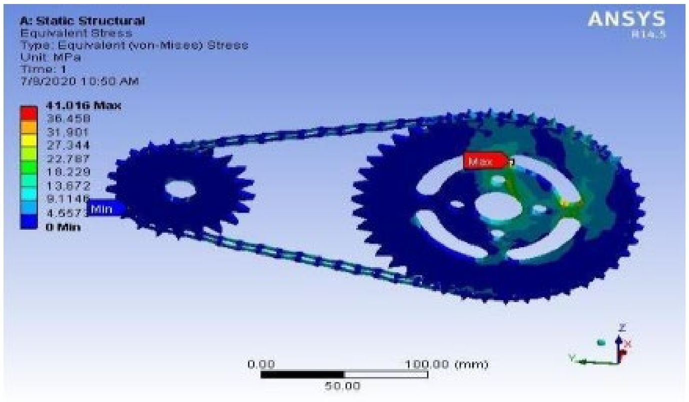


3.4 Existing material –stainless steel At -40 km/hr

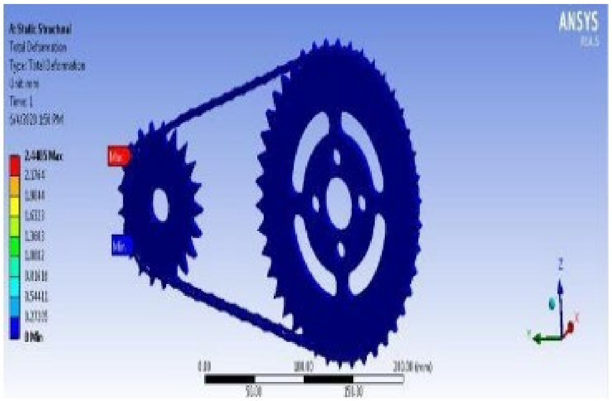
Total deformation



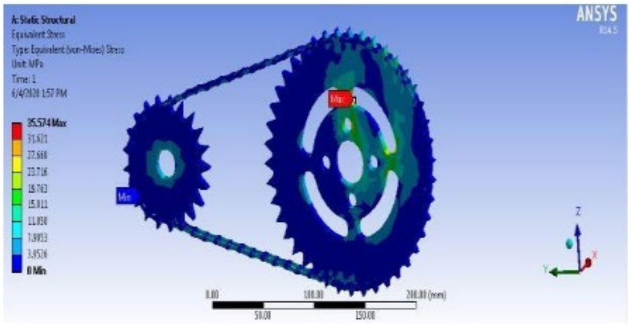
3.5 Equivalent Von Mises Stress



3.6 Material: EN 32 Steel At speed -40 km/hr Total deformation



3.7 Equivalent Von Mises Stress



4. Results and Discussions

Table: stainless steel material results

Speed (km/hr)	Deformation (mm)	Stress (N/mm2)	Strain
40	0.39902	41.016	0.0021315

60	1.0417	45.711	0.00023751
80	4.244	63.802	0.00033879

Table: 2 AISI 1050 steel results

Speed (km/hr)	Deformation (mm)	Stress (N/mm^2)	Strain
40	2.3598	36.076	0.0001809
60	3.7463	41.26	0.0002068
80	4.0859	48.467	0.0002417

Table: 3 EN8 steel results

Speed (km/hr)	Deformation (mm)	Stress (N/mm^2)	Strain
40	0.42236	35.919	0.00018959
60	0.95329	41.095	0.00021689
80	1.4668	48.213	0.00025609

Table: 4 results of material EN32 steel

Speed(km/hr)	Deformation (mm)	Stress(N/mm^2)	Strain
40	1.824	35.574	0.00017318
60	2.4458	40.16	0.00019549
80	8.2948	46.607	0.0022686

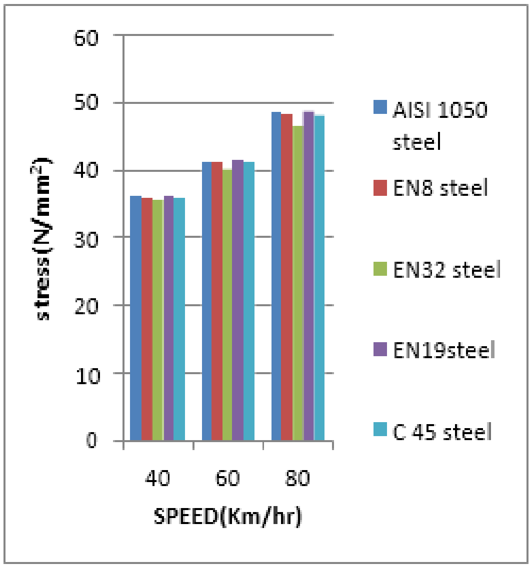
Table: 5 results of material EN19steel

Speed(km/h)	Deformation (mm)	Stress (N/mm^2)	Strain
40	4.0518	36.087	0.00017654
60	9.8737	41.36	0.00020219
80	11.252	48.77	0.00024375

Table:6 C 45 steel results

Speed (km/hr)	Deformation (mm)	Stress (N/mm2)	Strain
40	0.5662	35.951	0.00017169
60	0.88231	41.101	0.00019626
80	1.6205	48.163	0.0002309

- The following results are based on the comparison of the five materials and three speeds shown above.
- When compared to other materials, EN 8 steel has a total deformation value of 0.4226 mm at a speed of 40 km/h.
- When compared to other materials, EN 32 steel has a lower equivalent elastic strain of 0.00017167 mm/mm.
- 35.574 MPa is the von Misses stress equivalent for EN 32 steel. Which means that the design is safer because of the material's ductility.



5. CONCLUSIONS

Plot 1 compares the deformation of various materials and speeds.

Plot 2: Materials and speed are compared against stress in this simulation. Comparative stress analysis of existing and proposed materials is depicted in plot 3.

To compare the Von-Missies, total deformation, equivalent strains, and stresses of various steels, we used the material properties of AISI 1050, EN 8 steel, EN 32 steel, EN 19 steel, and C45 steel in this article.

The stress levels of EN 32 Steel and C 45 Steel are within acceptable ranges for safe design based on finite element analysis. Because of its low density, availability, and inexpensive investment, EN 32 steel is ideally suited for chain drives. Also, C45 steel alloy performed better than EN 32steel in comparison.

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