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Finite Element Analysis of Conveyor Systems

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***Abstract*—This project discusses about the different components of the conveyor pulley worked at different angles. It will provide an approximate analysis of the different testing conditions under which the conveyor pulley system will be run. The project aims to find an optimum position of the conveyor pulley system at a specified angle under which the conveyor pulley system will be most efficiently run. The project also aims to rectify the decreased service life which is caused by variable loads, pretention, weather conditions and material.**

***Index Term*—Conveyor Pulley, Conveyor Belt, Belt Materials, FEA, Stress Analysis**

I. INTRODUCTION

A conveyor belt system includes drive pulley, driven pulley, idlers, snub pulleys, conveyor belt, scraper, take up pulleys. Belt conveyors are widely used in industrial applications such as agriculture, mining, steel, cement, food and have gained increased importance in the past century. To transport manufactured goods from one place to another by human efforts takes time and conveyors are provided as a solution to eradicate this time constraint and make the system more efficient by faster means of transport. They also provide higher capacity and bulk loads can be transported over greater distances.

This project uses ANSYS software to analyze and calculate the optimum angles at which the system will operate and what materials should be used to obtain the lowest possible cost for the designing of the conveyor pulley system. The reader will also learn about the methods through which the pulleys are designed to function at the optimum angle and this is done by using the SOLIDWORKS software. [1]

II. MATERIALS

The belt material must be durable, long lasting and resistant to a wide range of temperatures, moisture and chemicals. There are 5 main materials that the conveyor belts are made out of: Thermoplastics, Metals, Rubbers, Fabric and Leather. Plastics include polyester, polyvinyl chloride, silicone and polyethylene. The metals are stainless steel and carbon steel. Fabric materials are canvas and cotton. The most popular material is a rubber composite because it is flexible, resistant, smooth and seamless.

ALLOY	YIELD STRENGTH (0.2% OFFSET) 1000 PSI (N/mm^2)	TENSILE STRENGTH 1000 PSI (N/mm^2)	ELONGATION IN 51mm %	HARDNESS	TENSILE MODULUS OF ELASTICITY IN 10^6 PSI (in 10^5 n/mm^2)	POISSON'S RATIO (g/cm^3)	DENSITY #/IN^3 $cal/cm^2/sec/°C/cm$	THERMAL CONDUCTIVITY (32° TO 212° F) $BTU/FT^2/HR/°F/IN$ $cm/cm/°C \times 10^{-6}$ (0° to 100° C)	THERMAL EXPANSION COEFFICIENT (32° TO 212° F) $cm/cm/°C \times 10^{-6}$ (0° to 100° C) in/in/° F	MAGNETIC PERMEABILITY	CORROSION RESISTANCE
301 FULL HARD	160 (1100)	180 (1240)	5-15	RC40-45	28 (1.93)	.285	0.29 (7.9)	113 (.039)	9.4 16.9	L-M	M
301 HIGH YIELD	260 (1790)	280 (1930)	1	N/A	26 (1.79)	.285	0.29 (7.9)	113 (.039)	9.4 16.9	M-H	M
302 FULL HARD	160 (1100)	180 (1240)	1-5	RC40-45	26 (1.93)	.285	0.29 (7.9)	113 (.039)	9.6 17.3	L-M	M-H
304 FULL HARD	160 (1100)	180 (1240)	1-5	RC40-45	26 (1.93)	.285	0.29 (7.9)	113 (.039)	9.6 17.3	L-M	M-H
316 FULL HARD	175 (1200)	190 (1310)	1-2	RC35-45	28 (1.93)	.285	0.28 (7.9)	97 (.036)	8.9 16.0	L	H
716 FULL HARD	210 (1450)	260 (1790)	5-10	RC52	32 (2.20)	.285	0.28 (7.9)	170 (.059)	5.9 10.6	H	L-M
17-7 CONDITION C	185 (1275)	215 (1480)	5	RC43	28 (1.93)	.305	0.28 (7.8)	114 (.037)	8.5 15.3	M-H	M-H
17-7 CH-900	240 (1655)	250 (1720)	2	RC49	29 (2.00)	.305	0.28 (7.8)	114 (.037)	6.1 10.9	M-H	M-H
INCONEL® 718 CARBON STEEL	175 (1200)	210 (1450)	17	RC41	29 (2.00)	.284	0.29 (7.9)	86 (.030)	6.6 11.9	L	H
CARBON STEEL SAE 1095	240 (1650)	260 (1790)	7-10	RC50-55	30 (2.07)	.287	0.29 (7.9)	360 (.124)	5.8 10.5	H	L
TITANIUM 15V-3CR-3AI-3SN	150 (1030)	165 (1140)	11	RC35	15 (1.03)	.300	0.17 (4.7)	56 (.019)	5.5 9.7	L	H
INVAR 36	50 (340)	75 (520)	30	RB80	20 (1.38)	.317	0.30 (7.9)	120	2.1 1.2	L	M-H

Fig. 1 Material Properties

Choosing the right belting material is the most important specification involved with conveyor system because the wrong material could compromise productivity or worker safety.

Desirable Qualities of Materials:

[1] It should possess high flexibility and low rigidity.
[2] It should withstand high tensile stress.
[3] Resistance to wear and fatigue.
[4] Low weight per unit length. [2]

III. PROCEDURE

The procedure involving the below analysis shown in pictorial demonstration includes, selecting the designed belt. Following this, we apply forces on the selected contour points on the belt, at the specified angles (15deg and 23.61deg taken as specimen here) having forces 167223kg and 157004kg respectively.

Following this, surface extrudes at the given points are carried and bonded contacts were given between the external strip defining the placement of the selected angle and the actual belt. Then a body sizing mesh of 150mm was given to the model.

Following this procedure, the below images define the detailed outputs and the stress values evaluated after carrying out the analysis by the methods specified above. [2][3]

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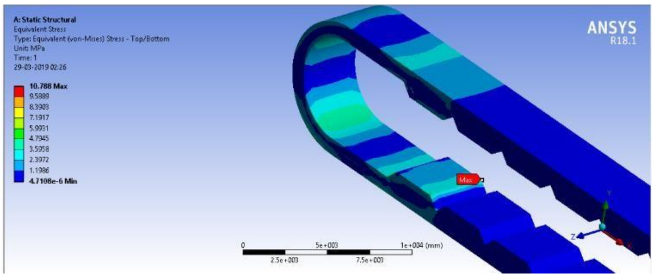

Fig 2(a) Belt Material Titanium Alloy at 23.61deg

The stress value for this analysis was 10.708 MPa.

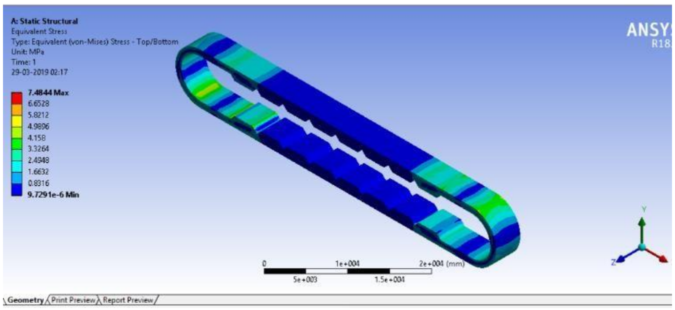

Fig. 2(b) Belt Material Stainless Steel at 23.61deg

The stress value for this analysis was 5.44 MPa.

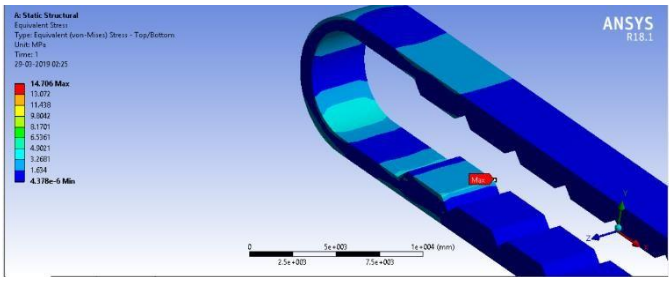

Fig. 2(c) Belt Material Aluminum alloy at 23.61deg

The stress value for this analysis was 14.706 MPa.

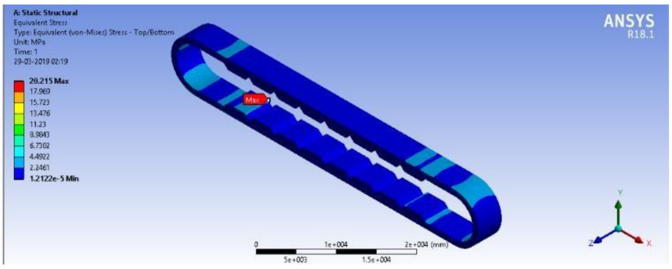

Fig. 3(b) Belt Material Stainless Steel at 15deg

The stress value for this analysis was 7.48 MPa

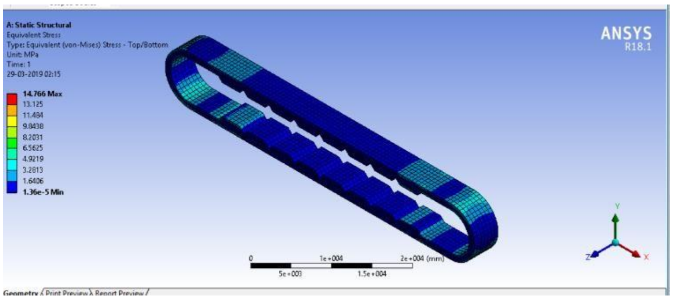

Fig. 3(a) Belt Material Titanium at 15deg

The stress value for this analysis was 14.76 MPa.

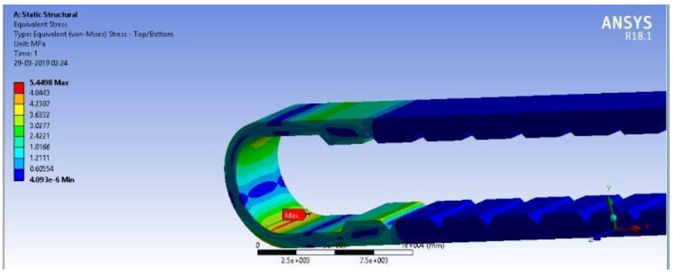

Fig. 3(c) Material Aluminum Alloy at 15deg

The stress value for this analysis was 20.215 MPa.

IV. CONCLUSION

Looking at the above trends, for both tested angles aluminum alloy gives the highest stress value, followed by titanium and stainless steel. Therefore, stainless steel can be used for the lowest amount of stress induction on the system for its most efficient functioning. This will also ensure a very low amount of material usage and hence cost reduction in the manufacturing and usage of the system will be evident. The final aim of this analysis can be obtained by witnessing the cost reduction through the above analytical methods. [3]

V. FUTURE SCOPE

As three metals are used in this experiment, as specimens, a wide variety of materials can be used like Polyethylene, Grey Cast Iron, Fibre, Polyplastics. These materials are bound to show different characteristics and have a high possibility of proving to be beneficial for such conveyor pulley systems achieving the aims. They can be very cost effective but their longevity is usually criticized in comparison to the metals. Such factors can provide a detailed overview of the best possible outcomes for conveyor pulley systems in order to make all its industrial applications as effective and efficient as possible. [4][5]

VI. REFERENCES

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