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MODELING AND ANALYSIS OF INDUSTRIAL BELT CONVEYOR SYSTEM USING CREO PARAMETRIC AND ANSYS SOFTWARE

Rohini N. Sangolkar, Vidhyadhar P. Kshirsagar
Department of Mechanical Engineering
Rashtrasant Tukdoji Maharaj Nagpur University
Nagpur, India
rohinisangolkar542@gmail.com, vidhyadharkshirsagar@gmail.com

***Abstract*—Belt conveyor is the transportation of material from one location to another. Belt conveyor is a commonly used equipment of continuous transport; it has a high efficiency and large conveying capacity, it can be achieved at different distances, different materials transportation. An attempt is made in this paper to study the Structural analysis on a belt conveyor system. The modeling of the belt conveyor system is created using Creo Parametric Software. Finite element analysis (FEA) is performed to obtain the variation of stress at critical locations of the system using the ANSYS software and applying the boundary conditions to evaluate the total deformation, equivalent (von-misses) stress and shear stress. Further it can be extended for the different materials and dynamic analysis, optimization of belt conveyor system.**

***Keywords*—Conveyor belt, Finite Element Analysis (FEA), Creo parametric, ANSYS Software, Structural analysis**

I. INTRODUCTION

Now a day's Belt conveyor system not only used in mining industries but also applied in cement industries, power plant, food industries, production industries etc. So it is essential equipment for in house material transportation today. It has high load carrying capacity, large length of conveying path, simple design, easy maintenance and high reliability of operation. Belt conveyor system is also used various industries such as the material transport in foundry shop like supply and distribution of moulding sand, moulds and removal of waste, coal and mining industry, sugar industry, agricultural industry, bagasse industry, fuel industry etc. In any industrial process, the product being manufactured passes through various phases and it needs to be transported from place to place. This could involve processes such as transporting of raw material to the machines and then shifting the machines from one station to another station and finally to the store or warehouse. This involves the use of material handling equipment. Simplest form of material handling is to take material from one place to another place manually or with the help of worker. In large production setups, where the production rates are high and the product to be handled is such that manual transportation is not possible, sophisticated material handling systems would be required.

It is widely used in coal handling system in thermal power plant and other projects. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries They can move loads of all shapes, sizes and weights. Also, many have advanced safety features that help prevent accidents. Belt-conveyors are more acceptable than other means of transporting bulk materials; they neither pollute the air nor deafen the ears. They operate quietly, often in their own enclosures, which when desirable can be located above the confusion and safety hazards of surface traffic or in small tunnels out of sight and hearing. Belt conveyor is one of the main transport equipment in coal mine, driving drum and belt is its key part. Belt conveyor is a commonly used equipment of continuous transport; it has a high efficiency and large conveying capacity, simpler construction, small amount of maintenance. It can be achieved at different distances, different materials transportation. It is widely used in coal handling system in thermal power plant and other projects.

A conveyor belt is the carrying medium of a belt conveyor system. A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium - the conveyor belt - that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley. The belt consists of one or more layers of material. Many belts in general material handling have two layers. An under layer of material to provide linear strength and shape called a carcass and an over layer called the cover. The carcass is often a woven fabric having a warp & weft. The most common carcass materials are polyester, nylon and cotton. The cover is often various rubber or plastic compounds specified by use of the belt. Covers can be made from more exotic materials for unusual applications such as silicone for heat or gum rubber when traction is essential.

II. OBJECTIVE

- An attempt in this paper, the conveyor belt system is modeled by using Creo Parametric software, and analysis is done by using ANSYS Workbench software to evaluate the total deformation, von-misses stress and shear stress.
- Utilizing the software ANSYS to analyzing the modification of conveyor belt for better result.

III. SPECIFICATIONS OF CONVEYOR BELT SYSTEM

Total length of belt = 34m
Centre to centre distance = 17m
Belt width = 1600mm
Troughing angle = 35°
Number of snub pulleys = 02
Number of idlers pulleys = 03

Number of carrying pulleys = 10
Dimensions of drive pulley: Diameter = 630mm, Length = 2730mm
Dimensions of tail end pulley: Diameter = 500mm, Length = 2370mm
Dimensions of snub pulley: Diameter = 500mm, Length = 2370mm
Dimensions of carrying idlers: Diameter = 300mm, Length = 2340mm
Dimensions of return idlers: Diameter = 300mm, Length = 2340mm
Bulk density = 1.1 tonne/ m^3 = 1100 kg/ m^3 = 1100 * 9.81 = 10791 N
Maximum lump size = 250mm
Feeding = 1500 tp/ hr
Height of fall = 5m
Material handled = coal (from wagon tippler to crusher)
Belt material = Nylon belt M24 5+2ply

IV. MATERIAL PROPERTIES NYLON 66 FOR CONVEYOR BELT

High strength, high elongation, good resistance to abrasion, fatigue and impact. While moisture absorption not as high as cotton, it will absorb up to 10% of its own weight in moisture. Consequently, poor dimensional stability. High resistance to mildew. At one time, nylon represented 40% of the raw material input into belt manufacturing. Today, it is something less than 20%.

TABLE 1

Material Properties	**Value**	**Unit**
Density	1180	Kg/m^3
Young's Modulus	1999.5	Mpa
Poisson's ratio	0.39	
Bulk Modulus	3.0295×10^9	Pa
Shear Modulus	7.0924×10^8	Pa
Tensile Yield Strength	527	Mpa
Compressive Yield Strength	527	Mpa
Tensile Ultimate Strength	604	Mpa
Compressive Ultimate Strength	0	Mpa

V. MATERIAL PROPERTIES ASTM A36 HOT ROLLED STEEL FOR STRUCTURES

A-36 steel bar is one of the most widely used carbon steel bars for construction and manufacturing. A36 bar is a hot rolled steel bar that is weldable, formable and machinable. Intermediate tensile strength carbon steel for use in riveted, bolted or welded construction of bridges and buildings, manufactured parts and equipment.

TABLE 2

Material Properties	**Value**	**Unit**
Density	7800	Kg/m^3
Young's Modulus	2×10^5	Mpa
Poisson's ratio	0.26	
Bulk Modulus	1.3889×10^{11}	Pa
Shear Modulus	7.9365×10^{10}	Pa
Tensile Yield Strength	250	Mpa
Compressive Yield Strength	250	Mpa
Tensile Ultimate Strength	400	Mpa
Compressive Ultimate Strength	0	Mpa

VI. MODELING OF CONVEYOR BELT SYSTEM

Creo Parametric is the standard in 3D CAD, featuring state of the art productivity tools that promote best practices in design while simultaneously ensuring compliance with industrial and company standards. This 3D CAD software is powerful, easy to use, flexible and also fully scalable. It features the industry's broadest range of 3D solid modeling and design capabilities for creating high quality designs in minimum time.

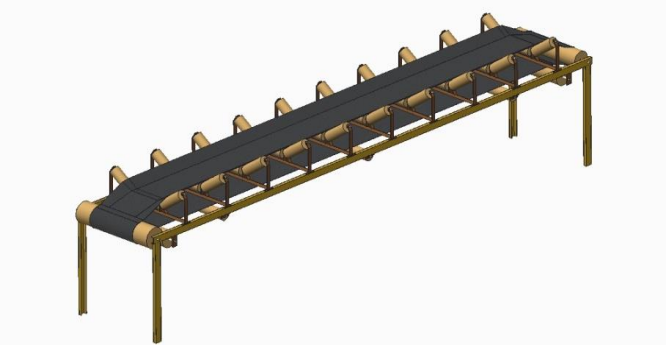

Fig. 1. CAD model image of conveyor belt system

VII. ANALYSIS OF CONVEYOR BELT SYSTEM

A. Introduction to Finite Element Analysis

The basis of FEA relies on the decomposition of the domain into a finite number of sub-domains (elements) for which the systematic approximate solution is constructed by applying the variation or weighted residual methods. In effect, FEA reduces problem to that of a finite number of unknowns by dividing the domain into elements and by expressing the unknown field variable in terms of the assumed approximating functions within each element. These functions (also called interpolation functions) are defined in terms of the values of the field variables at specific points, referred to as nodes. The finite element method is a numerical procedure that can be used to obtain solutions to a large class of engineering problems involving stress analysis, heat transfer, electro-magnetism, and fluid flow.

B. Introduction to ANSYS software

ANSYS is general-purpose Finite Element Analysis (FEA) software package. The ANSYS computer program is a large-scale multipurpose finite element program. It is used for solving several engineering analyses. The analysis capabilities of ANSYS include the ability to solve static and dynamic structural analyses, steady-state and transient heat transfer problems, mode frequency and buckling Eigen value problems, static or time varying magnetic analyses and various types of field and couple field application. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user designed 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. The ANSYS Workbench environment is an intuitive up-front finite element analysis tool that is used in conjunction with CAD systems and/or Design Model. ANSYS Workbench is a software environment for performing structural, thermal, and electromagnetic analyses. The Workbench focuses on attaching existing geometry, setting up the finite element model, solving, and reviewing results. After geometric

modeling of the conveyor belt system with given specifications it is subjected to analysis. The Analysis involves the following discretization called meshing, boundary conditions and loading.

VIII. STEPS INVOLVED IN ANALYSIS

A. Import the geometry

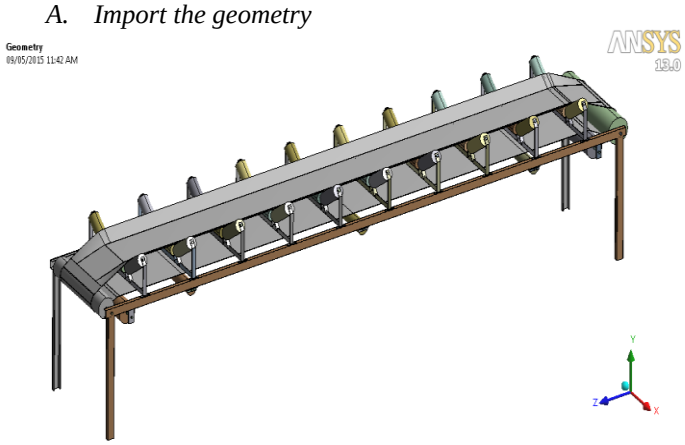

Fig. 2. Geometry model of conveyor belt system

B. Meshing

Mesh Statics:
Type of Element : Tetrahedrons
Number of nodes : 215156
Number of Elements: 58948

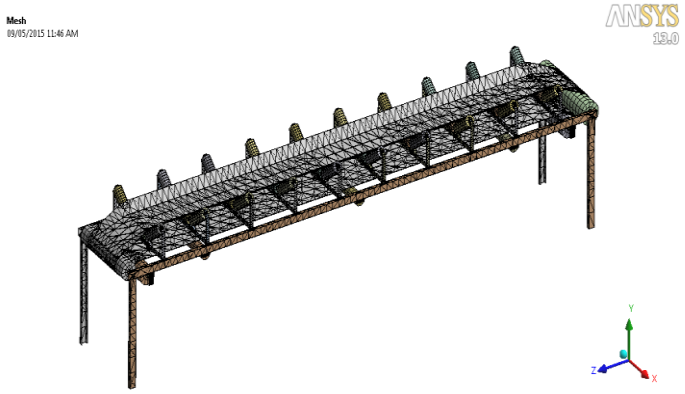

Fig. 3. Meshed model of conveyor belt system

C. Apply Boundary conditions

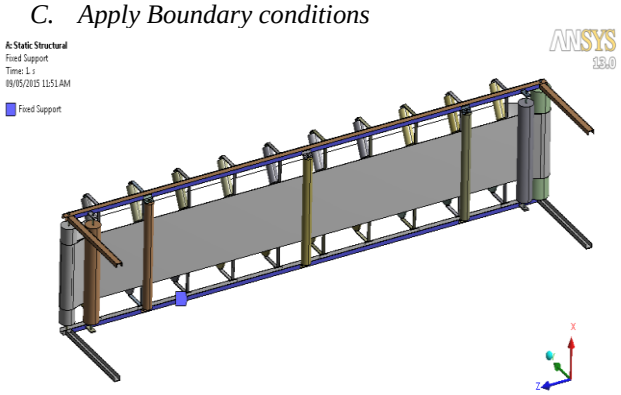

Fig. 4. Fixed support
The base structure is to be fixed.

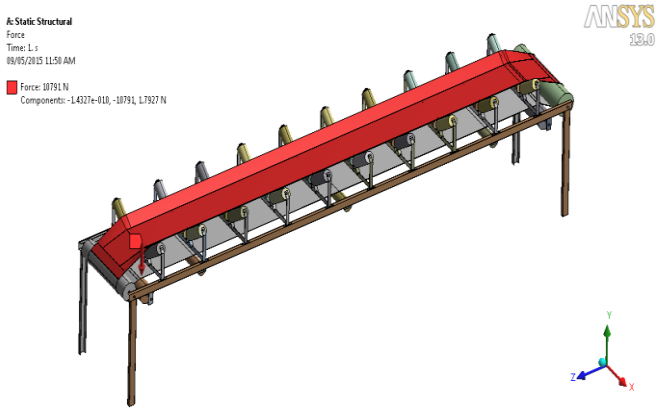

Fig. 5. Force
Force(load) 10791 N is applied on the top of the belt surface. The load is Uniformly Distributed Load.

D. Solution

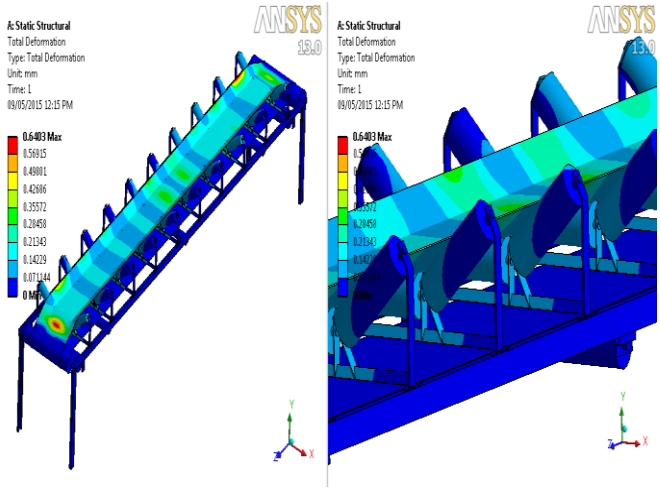

Fig. 6. Total Deformation
The maximum deformation induced in belt conveyor system is 0.6403mm at near the tail pulley side belt surface.

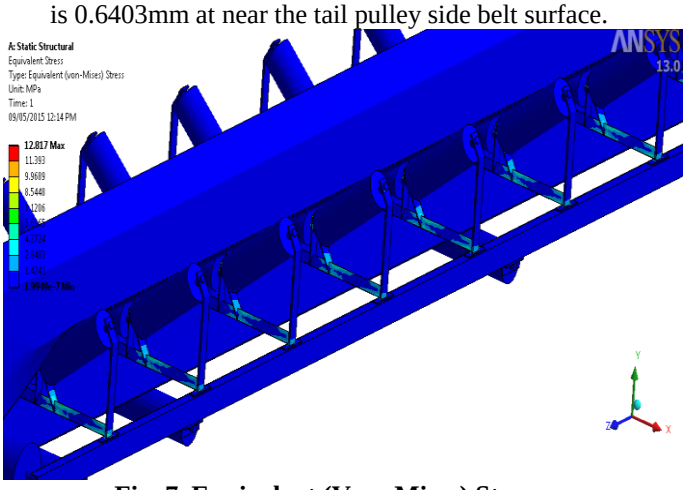

Fig. 7. Equivalent (Von- Mises) Stress
The maximum equivalent stress induced is 12.817mpa and minimum equivalent stress induced is 1.9949 x 10^{-7} mpa

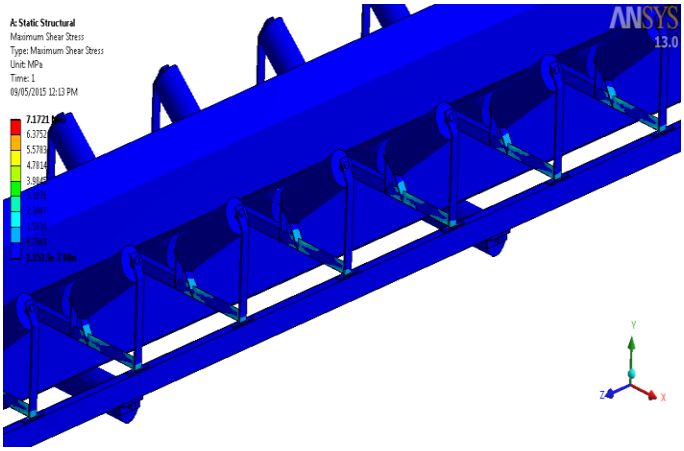

Fig. 8. Maximum Shear Stress

The maximum shear stress induced is 7.1721mpa and minimum shear stress induced is 1.151 x 10 $^{-7}$ mpa

IX. CONCLUSION

CAD model of the belt conveyor system is generated in Creo Parametric and this model is imported to ANSYS for processing work. An amount of force 10.791 KN is applied along the upper belt surface and base structure is fixed.

Following are the conclusions from the results obtained:

- The maximum deformation induced in belt conveyor system is 0.6403mm near the tail pulley side belt surface.
- From the FEA output the maximum design strength is 12.817mpa from the material property the ultimate tensile strength of the material is 400mpa, then the factor of safety becomes within that safety limit.
- The value of equivalent (von-misses) stress that comes out from the analysis is far less than material yield stress so our design is safe.

X. SCOPE FOR FUTURE WORK

In the above work, the maximum deformation induced at near the tail pulley side belt surface which cause to wear problem on pulleys. In the belt conveyor, as the conveyor belt is traction components, transmit power and motion, and also is carrying components, support material load. Working more complex, so at work often happen belt and pulley slippage. As the conveyor belt slippage and wear may cause between the belt surface and pulley or drum, cause belt premature damage, ranging impact the life of conveyor, affect the throughput of material, weight is caused by withdrawal material, even happen stop occurrence, direct impact on production. So, to reduce and eliminate belt slippage over pulley during operation, this can be extended to modified the outer surface of pulley and inner surface of conveyor belt and structural analysis is carried out, also this can be extended to dynamic analysis.

XI. ACKNOWLEDGMENT

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