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Contact Stress Analysis of Roller Conveyor as a part of Real time application using FEA

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Abstract — *A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. 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.*

Many kinds of conveying systems are available and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free, and hand pushed trolleys. The modeling is done in Creo Parametric 2.0 and contact stress analysis is done in Ansys 15.0(Workbench 15.0). The analysis is performed to check for the base model validation and better material which can be used to the Roller Conveyer system.

Keywords- *Contact Stress, Conveyer System, Material handling and Packaging.*

I. INTRODUCTION

Contact mechanics is the study of the deformation of solids that touch each other at one or more points. The physical and mathematical formulation of the subject is built upon the mechanics of materials and continuum mechanics and focuses on computations involving elastic, viscoelastic, and plastic bodies in static or dynamic contact. Central aspects in contact mechanics are the pressures and adhesion acting perpendicular to the contacting bodies' surfaces (known as the normal direction) and the frictional stresses acting tangentially between the surfaces. This page focuses mainly on the normal direction, i.e. on frictionless contact mechanics. Frictional contact mechanics is discussed separately.

Contact mechanics is part of mechanical engineering; it provides necessary information for the safe and energy efficient design of technical systems and for the study of tribology, contact stiffness, electrical contact resistance and indentation hardness. Principles of contacts mechanics are implemented towards applications such as locomotive wheel-rail contact, coupling devices, braking systems, tires, bearings, combustion engines, mechanical linkages, gasket seals, metalworking, metal forming, ultrasonic welding, electrical contacts, and many others. Current challenges faced in the field may include stress analysis of contact and coupling members and the influence of lubrication and material design on friction and wear. Applications of contact mechanics further extend into the micro- and Nano technological realm.

The contact between two spheres is as shown in the Fig 1.

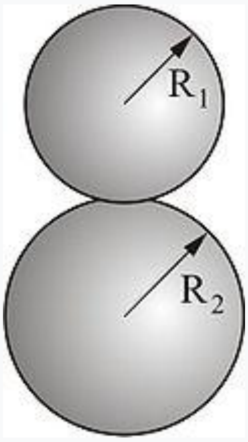

Fig. 1 Contact between two spheres.

The contact between two crossed cylinders of equal radius.is as shown in the Fig 2.

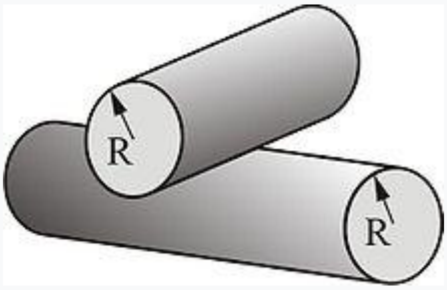

Fig. 2 Contact between two crossed cylinders of equal radius.

II. REVIEW OF LITERATURE

Prayag. R. Shirolkar[1] in his paper stated that In general, Roller Conveyors are designed with a set of elements to reduce cost, ease of assembly and manufacturability etc. In context to this, one also needs to address stress issues at the contact regions between any two elements; stress is induced when a load is applied to two elastic solids in contact. If not considered and addressed adequately, these stresses can cause serious flaws within the mechanical design and the end product may fail to qualify. The application of Hertizian contact stress equations can estimate maximum stress produced and ways to ease the stresses can be sought.

Sunil Kumar Sharma [2] in his paper described that a rail wheel contact mechanism has been a keen interest area for railway engineers. The present study focuses on the influence of interacting wheel and rail profile topology. A standard rail UIC 60 and standard wheel profile, as per the standards of Indian railways, were taken for different rail profile radii, wheel profile radii and wheel profile tapers.

Smith [3] in his paper described that the characteristics of an involute gear system including contact stresses analysis of gears in mesh. Gearing is one of the most critical components in mechanical power transmission systems. Transmission error is considered to be one of the main contributors to noise and vibration in a gear set. Transmission error measurement has become popular as an area of research on gears and is possible method for quality control.

Nicholas LeCain [4] in his paper discussed that his research interests include Analysis of structure, Computer Aided Designing, Computer Aided Engineering. In this research, topology optimization has been applied on various components of 5Ton hydraulic press and scrap baling press using ANSYS software. Proper loads and constraints are applied on the initial design of the components. By using ANSYS software, an integrated approach has been developed to verify the performance of the structure. At the last part, actual part that is being manufactured for the press is compared with the shape optimized design model. It is seen that topology optimization results in an enhanced and innovative product design.

III. MODELING OF AN ASSEMBLY OF ROLLER CONVEYOR SYSTEM

The modeling of Assembly of Roller Conveyor System is done in Creo Parametric 2.0 modeling software. The model of a Assembly Of Roller Conveyor System is as shown in the Fig. 3.

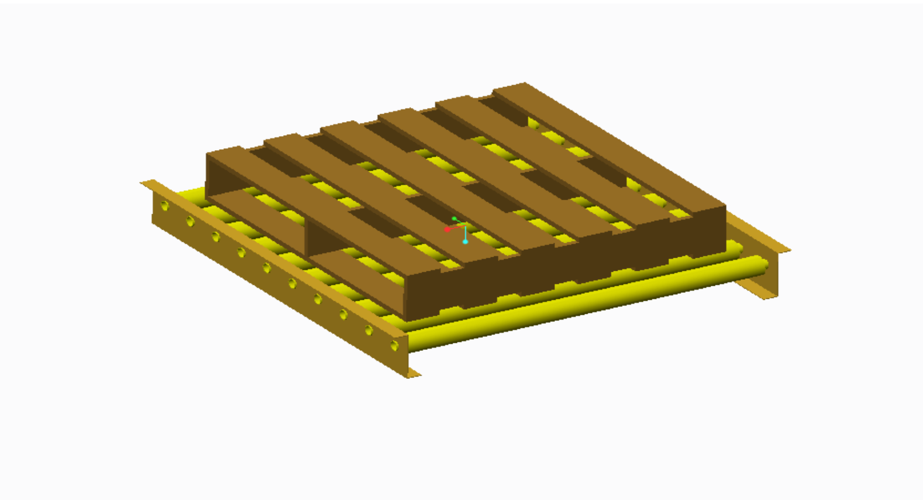

Fig. 3 Model of Assembly Of Roller Conveyor System

The drawing specifications of Assembly of Roller Conveyor System are as shown in the Fig. 4.

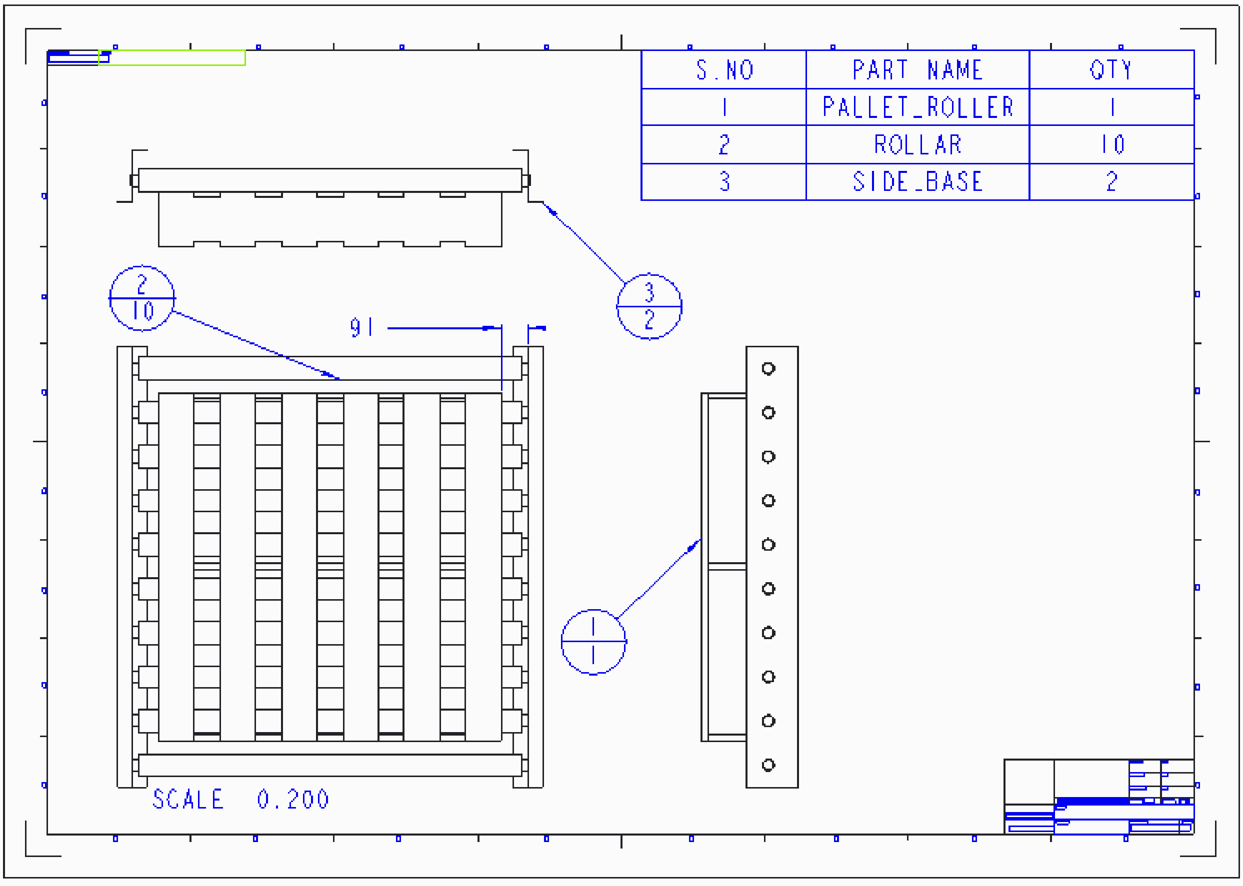

Fig. 4 Drawing Specifications of Assembly of Roller Conveyor System

IV. COMPUTATION ANALYSIS

The finite element method has become a powerful tool for the numerical solutions of a wide range of engineering problems. It has developed simultaneously with the increasing use of the high-speed electronic digital computers and with the growing emphasis on numerical methods for engineering analysis. This method started as a generalization of the structural idea to some problems of elastic continuum problem, started in terms of different equations or as an extrinum problem.

F.E.A is a way to deal with structures that are more complex than dealt with analytically using the partial differential equations. F.E.A deals with complex boundaries better than finite difference equations and gives answers to the 'real world' structural problems. It has been substantially extended scope during the roughly forty years of its use.

F.E.A makes it possible it evaluate a detail and complex structure, in a computer during the planning of the structure. The demonstration in the computer about the adequate strength of the structure and possibility of improving design during planning can justify the cost of this analysis work. F.E.A has also been known to increase the rating of the structures that were significantly over design and build many decades ago.

A numerical analysis is carried out to study efficiency and temperature distribution of annular fins of different fin profiles (constant and variable cross-sectional area) when subjected to simultaneous heat and mass transfer mechanisms. The temperature and humidity ratio differences are driving forces for heat and mass transfer, respectively. Actual psychometric relations are used in the present work instead of a linear model between humidity ratio and temperature that has been used in the literature. A non-linear model representing heat and mass transfer mechanisms was solved using a finite difference successive over-relaxation method.

Fins improve heat transfer in two ways. One way is by creating turbulent flow through fin geometry, which reduces the thermal resistance (the inverse of the heat transfer coefficient) through the nearly stagnant film that forms when a fluid flows parallel to a solid surface. A second way is by increasing the fin density, which increases the heat transfer area that comes in contact with the fluid. Fin geometries and densities that create turbulent flow and improve performance also increase pressure drop, which is a critical requirement in most high performance applications. The optimum fin geometry and fin density combination is then a compromise of performance, pressure drop, weight, and size.

FEA can be used in new product design, or to refine an existing product, to ensure that the design will be able to perform to specifications prior to manufacturing. With FEA you can:

- Predict and improve product performance and reliability
- Reduce physical prototyping and testing
- Evaluate different designs and materials
- Optimize designs and reduce material usage

Solutions are obtained for temperature distribution over the fin surface in addition to fin efficiency for both fully wet and partially wet fin surfaces. The numerical results are compared with those of previous studies. It was found that one of the linear models for the relation between the humidity ratio and temperature is a reasonable approximation.

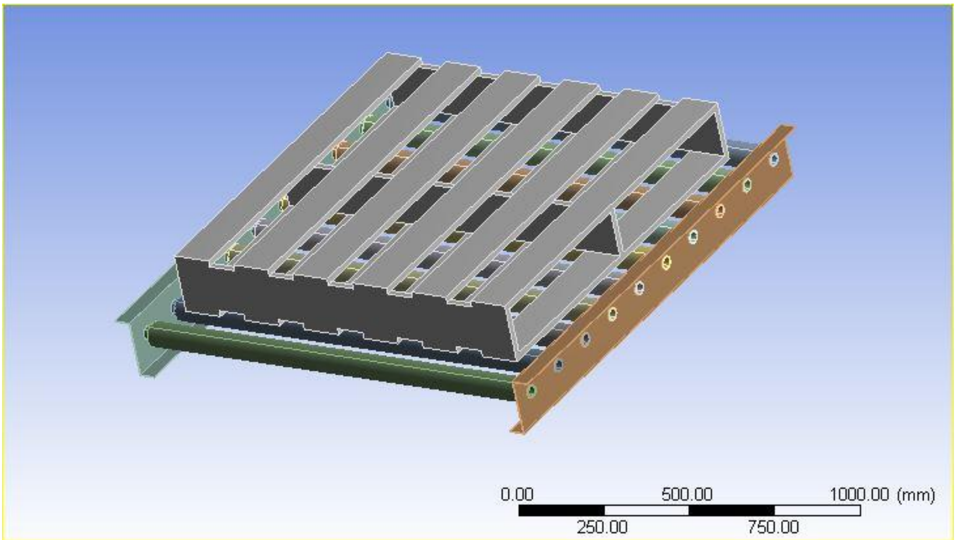

Fig. 5 Geometric model of the Assembly of Roller Conveyor System

The meshed model for the Assembly of Roller Conveyor System is as shown in the Fig. 6

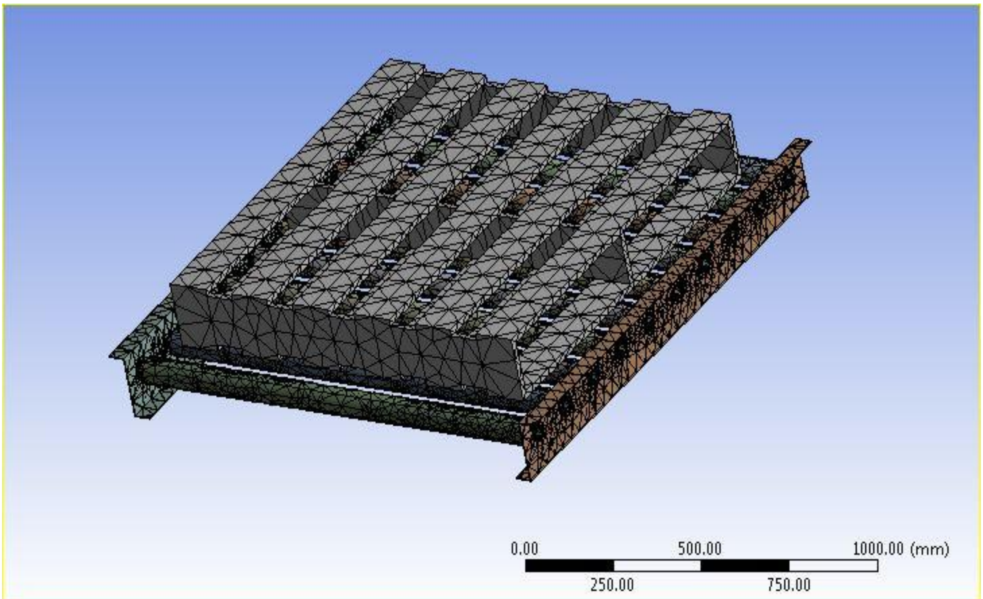

Fig. 6 Meshed model of the Assembly of Roller Conveyor System

The Deformation for the Real time application model- Structural steel position is as shown in the Fig. 7

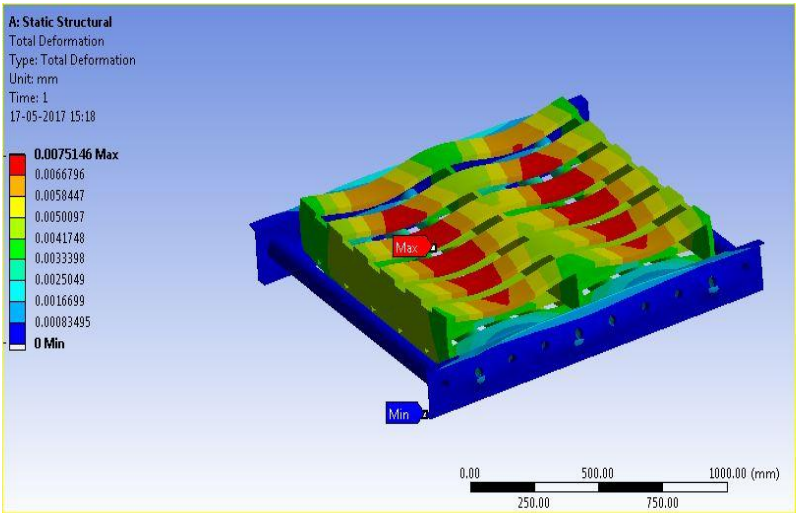

Fig. 7 Deformation of the Real time application model- Structural steel position

The Maximum Frictional Stress for the Real time application model- Structural steel position is as shown in the Fig. 8

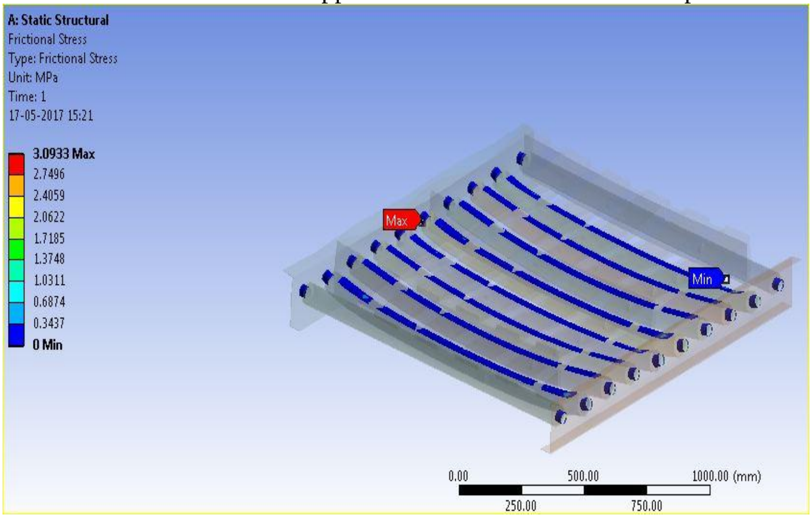

Fig. 8 Maximum Frictional Stress for the Real time application model- Structural steel position

The Contact Pressure for the Real time application model- Structural steel position is as shown in the Fig. 9

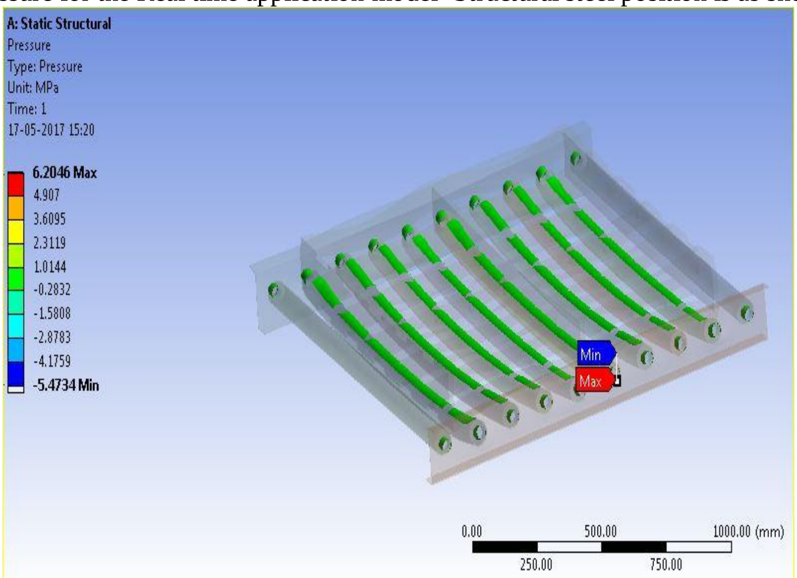

Fig. 9 Contact Pressure for the Real time application model- Structural steel position

The Contact Status for the Real time application model- Structural steel position is as shown in the Fig. 10

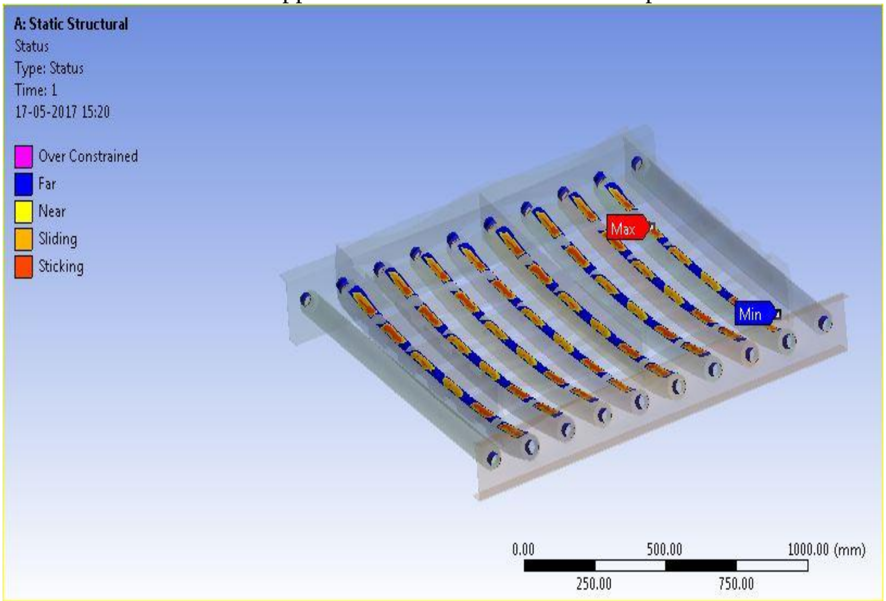

Fig. 10 Contact Status for the Real time application model- Structural steel position

The results obtained for Frictional Stress are as shown in the below Table. 1

Table 1 Results obtained for Frictional Stress

Material	Deformation, mm	Frictional Stress, MPa
Structural steel	0.0075	3.0933
Aluminum	0.0210	3.2930
Gray Cast Iron	0.0137	2.9776

The results obtained for Contact Pressure are as shown in the below Table. 2

Table 2 Results obtained for Contact Pressure

Material	Contact Pressure, MPa
Structural steel	6.2046
Aluminum	6.2727
Gray Cast Iron	6.1678

V. CONCLUSIONS

The following conclusions can be outlined by considering the analysis on Assembly of Roller Conveyor System. The modeling is done in Creo Parametric 2.0 modeling software. The contact stress analysis is performed in Ansys 15.0 workbench. The solutions obtained were then converted to plots and contours using the post processing interface. Computational analysis was performed on various materials on the whole layup of roller conveyor system. The frictional stress, deformation and the Contact stress are solved for the system and analyzed. Taking deformation into account, for the Real time application model- Structural steel position is yielding better results. Taking Frictional Stress and Contact Pressure into account, Real time application model- Gray Cast-iron position is yielding better results. Further, composites can be done for material optimization.

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