FEA ANALYSIS OF CHAIN LINK FOR FINDING OPTIMIZATION PARAMETERS

[1] Prashant S. Mulmule, [2] Prof. Tushar Y. Badgujar, [3]Prof. Akshay G. Tajne

[1] PG Student in Mechanical (Design) Engineering, Late G. N. Sapkal College Engineering, Nashik, Maharashtra, India

[2]Associate Professor, in Mechanical (Design) Engineering Department, Late G. N. Sapkal College Engineering, Nashik, Maharashtra, India

[2]Assistant Professor, in Mechanical (Design) Engineering Department, Late G. N. Sapkal College Engineering, Nashik, Maharashtra, India

ABSTRACT

The present study simulates a practical system such as a conveyor. Chain Link assembly is extensively used in the industry, the scope of this work is to review the applications in the industry and explore the design considerations that go into the design of the assembly. Roller conveyor chains are common used to transport goods in production lines or assembly lines, such as pallets, cars or steel coils. They are sometimes used in severe environments, soiled with water, foreign particles, chemicals or other contaminants. The work deals into various application aspects and manufacturing aspects to formulate an idea of the system. CAD model of chain using CATIA and further structural analysis is done with the help of ANSYS 16.0.

Keywords: - *Chain link, optimization, FEA analysis, Structural analysis.*

Economy of state is dominated by agricultural as well as industrial sector. Sugar factories play important role in economy of state. About 60 percent processes in these factories are based on roller chain conveyers. Apart from that, other industries also use these chains frequently for process atomization. However, failure of this chain is perennial problem in these industries which causes huge losses to these industries along with its dependants and in turn economical growth of the state. So, roller chain is the most important element of the industrial processes. Fig. 1: Shows the typical roller chain link assembly

Most of the time chain is under tension which causes failure of chain assembly which is the major problem for industrial sector. Causes of this failure are improper design. It is important to study the influence of these parameters. All these parameters can be considered simultaneously and chain link design optimally. Optimization is the process of obtaining the best result under given circumstances in design of system. In optimization process we can find the conditions that give the maximum and minimum value of function.

1.1 Basic structure of roller conveyor chain:

Chains are used in a variety of applications in engineering practice. In general, there are three basic types of system; hoisting and securing chains, conveying and elevating chains and power transmission chains. Conveyors chains are used when material are to be moved frequently between specific points. Depending on the materials to be handled and the move to be performed, a variety of conveyors can be used. All roller chains are constructed so that the rollers are evenly spaced throughout the chain. Several types of roller chains are used in conveyors, many of single-pitch or double-pitch conveyors chain but here below Fig.1 shows the basic structure of roller conveyor chain. Main components of roller conveyor chain are pin, link plate (strip), bushing and roller. The pin link plate i.e. strip is the assemblies of two pins that are press fitted into the holes of two pin link plates. The press fit between pin and the pin link plate prevents the pin from rotating. Usually there is a repeated loading, sometimes accompanied by shock.

The pin is subject to shearing and bending forces transmitted by the plate. There is slip fit between bushing and pin. The bushing is subject to shearing and bending stresses transmitted by theplate and roller, and also gets shock loads when the chain engages the sprocket. In addition, when the chain articulates, the inner surface forms a load-bearing part together with the pin. The outer surface also forms a load-bearing part with the roller's inner surface when the roller rotates on the rail or engages the sprocket. There is slip fit between the bushing and the roller. The roller is subject to impact load as it strikes the sprocket teeth during the chain engagement with the sprocket. After engagement, the roller changes its point of contact and balance. It is held between the sprocket teeth and bushing, and moves on the tooth face while receiving a compression load. A major advantages of roller chian is that the rollers rotate when contacting the teeth of the sprocket.

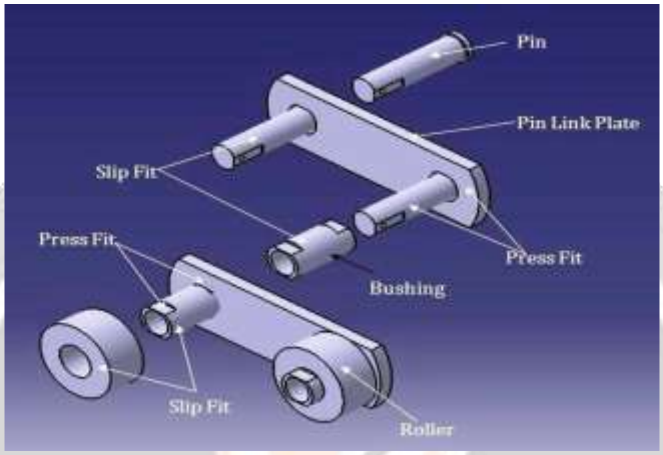

Fig-1: Basic components of chain link

2. LITERATURE REVIEW

2.1Review papers

Tushar D. Bhoite (2012) 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]

M. Koray KESİKÇİ (2014) 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.[2]

Shoji NOGUCHI (2009) 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.[3]

XU Lixin (2010) developed a mathematical model to calculate the dynamic response of a roller chain drive working at constant or variable speed condition. In the model, the complete chain transmission with two sprockets and the necessary tight and slack spans is used. The effect of the flexibility of input shaft on dynamic response of the chain system is taken into account, as well as the elastic deformation in the chain, the inertial forces, the gravity and the torque on driven shaft. The nonlinear equations of movement are derived from using Lagrange equations and solved numerically. Given the center distance and the two initial position angles of teeth on driving and driven sprockets corresponding to the first seating roller on each side of the tight span, dynamics of any roller chain drive with two sprockets and two spans can be analyzed by the procedure. Finally, a numerical example is given and the validity of the procedure developed is demonstrated by analyzing the dynamic behavior of a typical roller chain drive. The model can well simulate the transverse and longitudinal vibration of the chain spans and the tensional vibration of the sprockets. This study can provide an effective method for the analysis of the dynamic characteristics of all the chain drive systems.[4]

V. Kerremans (2011) studied various wear related things for chain conveyor, reasons as they are sometimes used in severe environments, soiled with water, foreign particles, chemicals or other contaminants. Normal use will result in wear of the components of the chain which can lead to unexpected failure and costly production downtime. Today, few literatures on the wear of conveyor chain are available and there are almost no reliable test-rigs to generate and measure chain wear in a reproducible manner. In this research the different components of conveyor chains and the loading conditions are described. Additionally, the applications and disadvantages of chains with polymer rollers are discussed. The chain wear mechanisms found in literature are listed. Abrasive and adhesive wear between pin, bushing, roller and track are discussed. From the contact mechanics of the chain and pressure-velocity limit of the roller materials, the design constraints for the laboratory test-rig were derived. The capabilities and working principles of the developed test-rig are explained in this work.[5]

2.3 Objectives

The objective of the present study is to investigate existing chain link of conveyor system

1. CAD modeling of existing chain link.
2. Structural Analysis of link using FEA software.

3. DESIGN OF CHAIN CONVEYOR

To enable the most suitable chain to be selected for a particular application it is necessary to know full application details such as the following:

- Type of conveyor.
- Conveyor centre distance and inclination from the horizontal.
- Type of chain attachment, spacing and method of fixing to the chain.
- Number of chains and chain speed.
- Details of conveying attachments, e.g. weight of slats, buckets, etc.
- Description of material carried, i.e. weight, size and quantity.
- Method of feed and rate of delivery.

Chain manufacturers specify the chain in their product range by breaking load. Some have quoted average breaking loads; some have quoted minimum breaking loads depending upon their level of confidence in their product. To obtain a design working load it is necessary to apply a “factor of safety” to the breaking load and this is an area where confusion has arisen. As a general rule, for most applications a factor of safety of 8 is used.
Working Load = Breaking Load/8

4. CHAIN LINK MODEL AND ANALYSIS

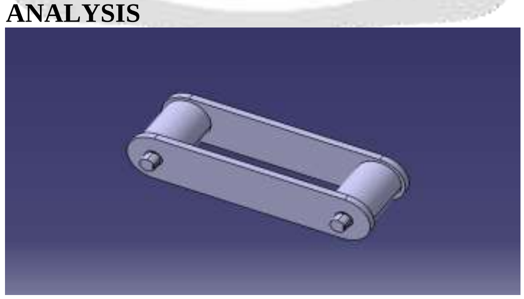

Fig-2: 3D cad model of chain link

4.1 Structural Analysis of link

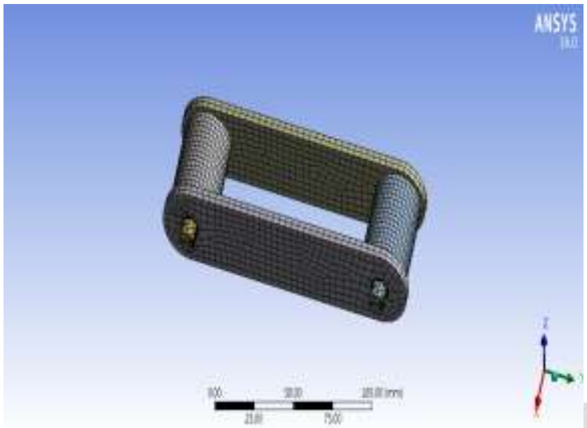

Fig 3-: Meshing of chain link using Tetrahedral And hexahedral elements

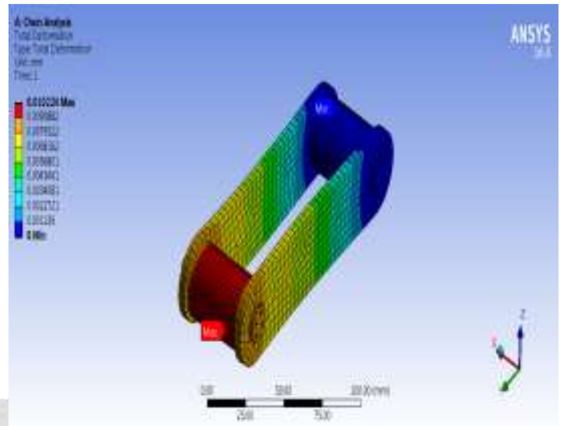

Fig 4-: Deformation of chain after application of force

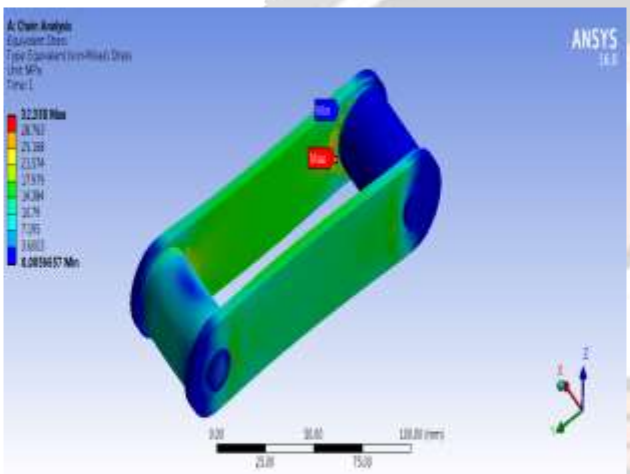

Fig5-: Stress in the chain after application of force

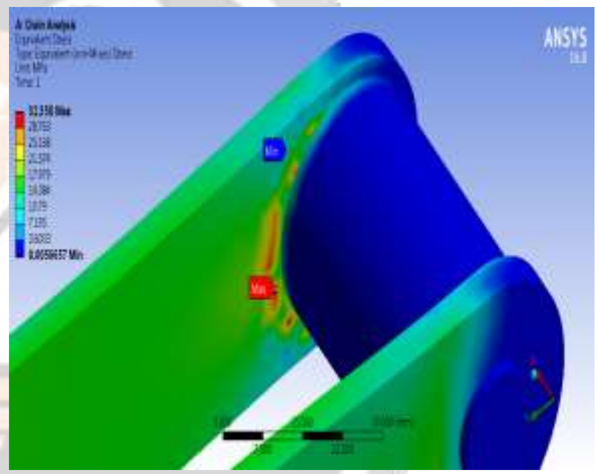

Fig6-: Stress in the chain after application of force (Zoomed view at high stress region)

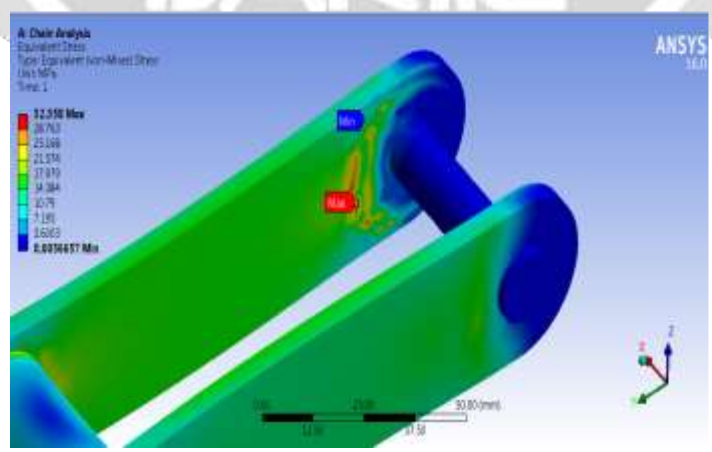

Fig 7-: Stress in the chain after application of force (Zoomed view at high stress region with hiding the bush)

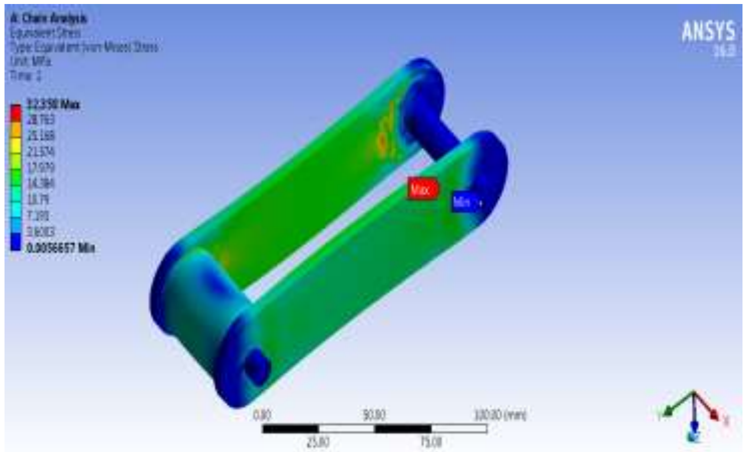

Fig 8-: Stress in the chain after application of force
(Zoomed view at high stress region with hiding the bush)

5. SUMMARY

1. 3D CAD model is drawn based on drawing.
2. Analysis results for existing chain link are 32.358 Map stress, 0.010224 mm deformation.

6. REFERENCES

[1]“ 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.

[2] “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.

[3] “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.

[4] “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, No.3, 2010.

[5] “Wear of Conveyor Chains with Polymer Rollers” by Ch. V. Kerremans, T. Rolly1, P. De Baets, J. De Pauw, J. Sukumaran and Y. Perez Delgado at Ghent University, Laboratory 2011.

[6] "Corrosion of working chains continuously immersed in seawater," by R. E. Melchers, T. Moan, and Z. Gao, at Journal of Marine Science and Technology, vol. 12, pp. 102-110, Jun 2007.

[7] "Contact Mechanics in A Roller Chain Drive using A Multibody Approach," by Cândida Pereira, Jorge Ambrósio, and Amilcar Ramalho, at American Congress of Applied Mechanics, January 04-08, 2010.

BIOGRAPHIES

Mr. Prashant S.Mulmule is completed Bachelor of Engineering in Mechanical Engineering Department from Late. G. N. Sapkal college of engineering (Pune University).Now doing the Master of Engineering in Late. G. N. Sapkal college of engineering (Pune University) Nashik. Maharashtra, India. Also Working as Lecturer in Sandip institute, Sandip foundation’s,Nashik,422213.Maharashtra India