Research Paper Engineering

A study on Drag Conveyor Chain: How to Prevent Corrective Maintenance in Drag Conveyors Due to Tensile Loading.

Vishal Wankhade	Student of Master of Engineering in Production Engineering & Engineering Design from Truba College of Engineering and Technology, Indore
Suman Sharma	Prof. and Head of the Mechanical Engineering Department in Truba College of Engineering and Technology, Indore

ABSTRACT

Drag conveyor consist a drive head and non drive tail end in between head and tail number of trough or casting are attach. In the trough of drag conveyor a heavy duty endless chain with wide links carrying projections drags a bed of bulk material from feeding end to discharge end. Roller conveyor chains are the critical component of conveyors in sugar mills, paper mill, food processing, fertilizer industry, pharmaceutical industry, cement industry, foundry industry, heat treatment units, coal mines etc. In the drag conveyors a roller chain is wound around at least two sprockets, with the sprocket teeth engaging rollers or bushings between the links of the chain. Rotation of a driving sprocket causes power transmission through the chain and consequent rotation of at least one driven sprocket. This process is applied tensile load on the chain and most of times chain gets fail in the tensile loading. In this paper the research is done to prevent tensile failure of drag conveyor chain.

KEYWORDS drag conveyor, trough, roller conveyor chains, tensile loading

INTRODUCTION

Chain is one of the most widely used moving medium in material handling systems, being robust and very adaptable, but it is also one of the most neglected component with in such equipments when general or routine maintenance is carried out. In many cases this product is attended to when problem is occur, normally when the chain is already damaged or need corrective maintenance and required replacement. This research is based on how to improve the tensile loading capacity of the chain to prevent tensile failure.

M. D. Jagtap states Chain strips are machine elements that are subjected to extreme service

conditions, such as high tensile loads, friction, and sometimes aggressive operating environment. The chain strips are primarily tension members, and they also are subjected to substantial bending and stress concentrations around the holes. The chain strips must have enough strength to withstand the tensile forces without deforming or breaking, and they must have enough ductility to withstand substantial bending and to resist fatigue

Ravishankar Rai's literature presents that failure of chain link and stress analysis is widely done by Finite Element Method (FEA & FEM) and design optimization tool. The chain links are considered different loading condition, different behavior of failure and design parameter. FEA apply in mechanical element and link, we find in which the parameter are effect to its failure.

Patil R.A are focused on die designing parameters because the chain links are made through the sheet metal operation on the meal plates. From the experimental result in this paper it is found that when fine piercing process is used for link plate then there is 22% increment in the shear zone length. Thus an alternative process of stamping i.e. fine piercing process can be used for roller chain link plates for reducing the share zone.

CONSTRUCTION OF DRAG CONVEYOR CHAIN

A typical roller chain consists of alternate inner links and outer links. The outer links, which are sometimes known as "pin links," consist of spaced link plates each having a pair of openings or apertures. Pins are tightly received in the apertures of the outer links. The inner links, which are sometimes known as "bushing links," consist of spaced link plates each having a pair of openings or apertures. Bushings are tightly received in the apertures. The bushings freely rotate about the pins, so that the inner links are pivotally connected to the outer links or able to articulate with respect to the outer links.

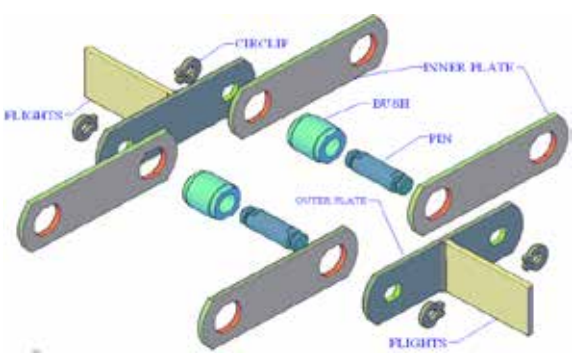

Figure 1: Drag conveyor chain components

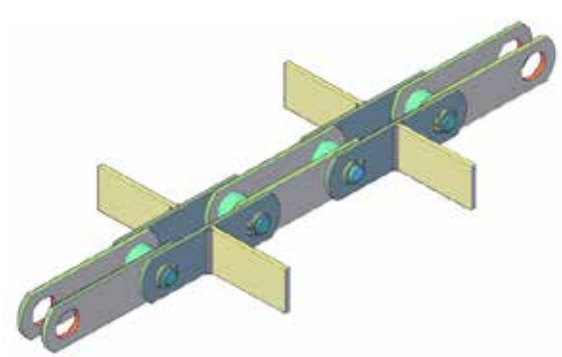

Figure 2: Drag conveyor chain

FAILURE OF CHAIN DUE TO TENSILE OVERLOADING

Due to the overloading the pin at the head and the inner plate at their oblong hole are failed. In the case of inner plate the chain has been severely overloaded in tension causing plastic elongation and failed at the oblong hole made for the fitment of the bush. Similarly the outer plates are also get failed on their oblong hole.

TABLE – 1
INNER LINK FAILURE

Mode of Failure : Tensile Overloading		
Failure Mode	Diagnosis	Solution
Inner plate have failed around the bush hole with cracks initiating from the corner caused by the flatted pin.	The chain has been severely overloaded in tension causing plastic elongation of the bush hole.	Replace the chain and determine the cause of the overload. IF it is not possible to remove the source of the overload then the chain should be reselected and a larger chain installed.



Figure 3: Failure of inner link

TABLE – 2
OUTER LINK FAILURE

Mode of Failure : Tensile Overloading		
Failure Mode	Diagnosis	Solution
The chain outer link has failed in tensile mode.	The outer link has been crudely modified which was thinner than the normal inner link.	This problem will solve by proper designing of outer plate.



Figure 4: Failure of outer link

CASE STUDY

The present case study is being done for preventing the drag conveyor chain from tensile failures. In this case study we analyze the inner chain link 102 mm. pitch and the width of 40mm. during the study we change the thickness of chains link from 4 mm to 10 mm and check its effect at 30kN and 50kN tensile force.

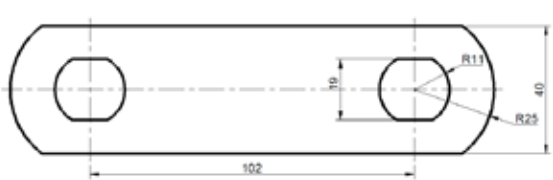

Figure 5: Inner Chain Link Plate

METHODOLOGY

CAD models of the chain link are prepared in the Solidworks and than FEA analyses is being performed in Hypermesh using Optistruct solver. The results of analysis are viewed in the Hyperview.

Input Parameters	
Young's Modulus	2.05e + 005 2 N/mm^2
Poisson's Ratio	0.3
Material Density	7.9 e -09 t/mm^3
Force Applied	+ ve X Direction

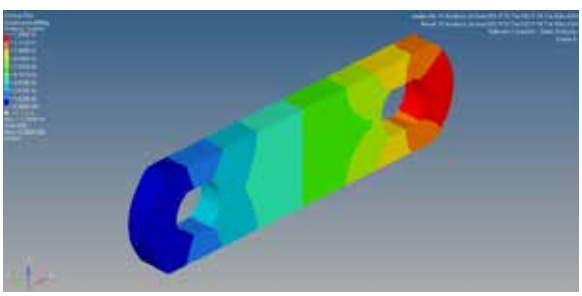

Figure 6: Displacement at 50 kN Tensile force for 10 mm thk. Inner Link.

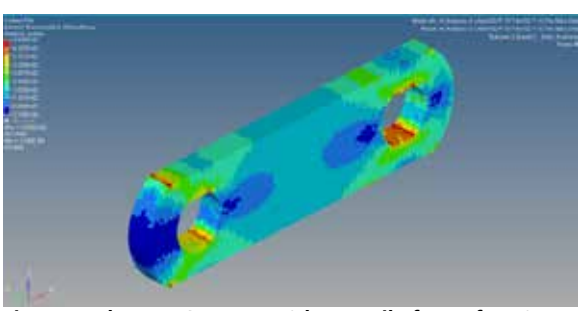

Figure 7: Element Stress at 50 kN Tensile force for 10 mm thk. Inner Link.

As shown in figure 6 , 7 FEA analysis is being done for the chain inner link of 4mm, 5mm, 8mm and 10 mm thickness on 50 kN and 30 kN tensile force.The following are the result of analysis.

RESULTS

By the FEA analysis of inner chain link the following results are found.

TABLE – 3
Stress and Displacement at 30kN and 50kN Tensile Force

Link thk. (in mm)	Stress (In MPa)		Displacement (in mm)	
	30 kN	50 kN	30 kN	50 kN
4	691.8	1093	0.193	0.305
5	575.1	958.7	0.155	0.258
6	467.3	778.8	0.129	0.215
8	357.1	595.1	0.097	0.161
10	289.5	482.5	0.077	0.129

We make a graph shown in figure 8 for displacement and stress of inner chain link at 30 kN and 50 kN tensile force.

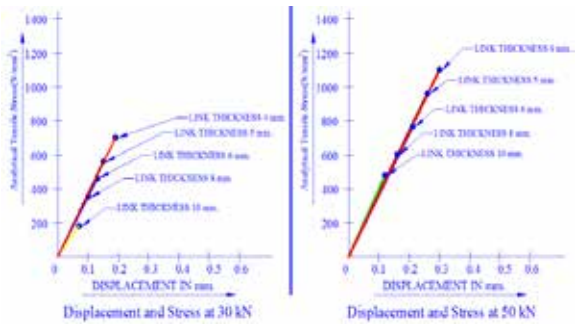

Figure 8: Graph for Stress and Displacement at 30 kN and 50 kN Tensile Force.

CONCLUSIONS

We studied the analytical behavior of the chain link under the tensile loading condition and observed that there is stress concentration near to elliptical hole in the chain link, so the chain will fail in that region. The fatigue initially nucleated at the external cracks of the link, and later propagated to the inside of the links until sudden fracture occurred. Another reason of chain link failure is wrong calculation of tensile load and this will be avoided by doing proper FEA study of chain at different load condition. During the FEA study we have to also keep in mind the sudden impact loading conditions. The failure of chain link cause corrective maintenance and loss of productivity. Failure of links may be avoided by using the chain links of proper thickness because by FEA analysis we see at the higher thickness value of plate can reduce displacement and stress. So we can say we can prevent the tensile failure of chain by increasing the thickness of plate.

REFERENCES

[1]Jagtap M. D. and Gaikwad B. D.(2014), "Study of Roller Conveyor Chain Strip under Tensile Loading" International Journal of Modern Engineering Research (IJMER),4,61-66. | [2]Ravishankar Rai and A.K. Jain (2013), "Fea and Double Shear Stress Analysis of Shackles Chain Link: A Review" International Journal of Engineering Technology & Management,1, 27-31. | [3]Patil R.A and Gaikwad B.D (2014), "Application of Fine Piercing Process for Roller Chain Link Plate to Increase Breaking Load of Roller Chain", International Journal of Advanced Engineering Research and Studies, III,106-110. | [4]D. Van Steenkiste and S. Plasschaert (2011), "Abrasive Wear of Link Chains" Ghent University, Laboratory Soete, Belgium, Sustainable Construction and Design, 388-396. | [5]Tushar D. Bhoite and Prashant M. Pawar (2012), "Fea Based Study of Effect of Radial Variation of Outer Link in A Typical Roller Chain Link Assembly", International Journal of Mechanical and Industrial Engineering (IJMIE), 4,65-70. | [6] M. D. Jagtap and B. D. Gaikwad (2014) "Use of Strain Gages to Analyze the Behavior of Roller Conveyor Chain Strip" International Conference on Computer Science and Mechanical Engineering. |