ICEST-2K24 [International Conference on Engineering, Science and Technology]
In Association with
International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN - 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)

Methodology of Life Estimation of Bagasse Carrier Chain

B. D. Gaikwad[1], A. B. Chounde[2]
*[1]Department of Mechanical Engineering, SVERI'S College of Engineering, Gopalpur - Pandharpur, Maharashtra, India
[2]Department of Electronics and Telecommunication Engineering, SVERI'S College of Engineering, Gopalpur - Pandharpur, Maharashtra, India

ABSTRACT

Bagasse carrier chains play a crucial role in transporting goods within production and assembly lines, enduring harsh environments and diverse loads. However, the inevitability of wear in chain components poses a significant challenge, leading to potential failures and costly downtimes. Despite its critical importance, literature on conveyor chain wear is scarce, and reliable test-rigs for reproducible wear measurement are lacking. This paper addresses these gaps by designing the components of bagasse carrier chains tailored for sugar bucket elevators in the sugar industry, considering a capacity of 25 tonnes per hour and detailing the loading conditions. Additionally, we explore the advantages of chain drives over alternative systems and catalog prevalent chain wear mechanisms documented in literature. Special emphasis is placed on abrasive and adhesive wear between pins, bushings, and rollers, shedding light on potential mitigation strategies.

Keywords: Bagasse carrier chain, Bucket Elevator, Material Properties, Chain Wear Mechanisms, Adhesive Wear

I. INTRODUCTION

The purpose of the bagasse carrier conveyor chain is to efficiently and reliably transport bagasse within the sugar mill contributing to one overall productivity and profitability of the sugar production process. Sugar mills typically operate continuously during the crossing season requiring conveyor bagasse carrier chain that can handle heavy loads and frequent use without downtime. Failure of some conveyor chain there is huge loss of sugar industry. To avoid this there is need of estimate life of chain. This is broadly discussed in this paper.

The failure of conveyor chains can result from various factors, but a significant proportion can be attributed to defects occurring throughout the manufacturing process of the conveyor chain component. These defects may emerge during material acquisition, casting, shaping, heat treatment, or assembly stages. Issues like material impurities, insufficient heat treatment, subpar machining, or incorrect assembly techniques can all foster the formation of weaknesses or flaws within the chain, ultimately culminating in failure during operation. It's crucial to identify and address these defects through rigorous quality control measures and meticulous manufacturing processes to uphold the reliability and durability of conveyor chain systems [1].

In their study, G. Pantazopoulos and A. Vazdirvanidis conducted a metallurgical investigation into the fatigue failure of stainless steel chains in a continuous casting machine [2]. These chains play a crucial role in connecting dam blocks in belt casting machines, enduring thermal cycling and repetitive stress from tension and bending during production. To prevent similar fatigue damage in the future, the authors recommend reviewing the service history, including operating conditions and loads, and considering a substitution of the material with one more resistant to heat and fatigue.

In their research, Suhas M. Shinde and R. B. Patil focused on the design and analysis of a roller conveyor system with the goal of optimizing its weight and saving materials [3]. The paper aimed to investigate the current conveyor system and identify key components such as rollers, shafts, and support structures like C-channels for the chassis. By optimizing these critical parts, the researchers aimed to reduce the overall weight of the assembly while also conserving materials. This study likely contributes valuable insights into the efficiency and sustainability of conveyor systems in various industries.

In their paper, Tushar D. Bhoite, Prashant M. Pawar, and Bhaskar D. Gaikwad present a Finite Element Analysis (FEA) study on the effect of radial variation of the outer link in a typical roller chain link assembly [4]. The ultimate goal is to explore the potential for material savings and subsequent efficiency improvements in roller chain assemblies.

In their study, M. Sujata, M.A. Venkataswamy, M.A. Parameswara, and S.K. Bhaumik conducted a failure analysis of conveyor chain links [5]. This research underscores the importance of quality control and defect prevention in engineering components to ensure reliability and performance in industrial applications.

Previous studies on roller conveyor chains have predominantly concentrated on enhancing efficiency and performance, with a notable emphasis on load estimation. However, there is a scarcity of research exploring fatigue life estimation for chain assemblies. Analysis of chain failure cases reveals that defective material processing, improper material selection, and inadequate heat treatment are common root causes of failure. Although literature addressing uncertainty analysis stemming from faulty material processing, heat treatment, and material selection exists, it remains limited. Additionally, failure case studies suggest that certain failure modes are initiated during the design stage itself, underscoring the importance of meticulous design considerations in preventing future failures.

II. EXPERIMENT SETUP

Estimation of life or a bagasse carrier chain involves several steps and considerations:

A. Material Analysis

Bagasse carrier chain has link plate made from 55C8 material. Pin of the same made from 16mmcr5 material. Bosh made from 15cr3 material and roller is made from C40 material. In this link plate is having through Harding mechanical properties like tensile up to 75 Kg/m2 other element i.e. pin, bush, and roller having case harden get good wear resistance.

B. Load analysis

As per converge capacity 25 ton/hr. broadly load of chain 40 ton and wear load 10tons and measuring load 40 to 50 tons as per I.S.

C. Operation conditions

Need to consider environmental factors such as temperature, humidity which significantly affects the chain's wear and corrosion resistance.

D. Maintenance practices

Maintenance schedule and procedure proper lubricants alignment and tensioning can extend the life of the chain.

E. Failure Analysis

Conduct failure analysis to identify common failure mode and their causes. This can help in predicting potential failure and implementing preventive measures.

F. Modelling and simulation

Use mathematical models or simulation software to predict the chains. Fatigue life on its design material properties and operating conditions.

G. Testing

As per the figure 1 driving shaft connected to electric motor. One it keyed sprocket having rotational movement driven shaft also having keyed sprocket. But it has two movement one is rotational second one is transverse. In between two shaft two idler to adjust slackness or conveyor. The transvers movement of driven shaft is done by hydraulic power pack unit and its movement is measure by calibrated dial gauge. Following graph is developed

Figure1:Experimental set up to find elongation of chain on preloading and length measuring machine

Figure2:Dial gauge location for measuring elongation of chain

III.RESULT AND ANALYSIS

Experimental and analytical study of roller conveyor chain links has been carried out and the results of work done are given below.

TABLE I

Sr. No.	Number of revolutions for 26 links chain	Chain Elongation measured in mm
1.	1000	0.2
2.	1500	0.4
3.	2000	0.6
4.	2500	0.8
5.	3000	0.9
6.	3500	0.7
7.	4000	0.4
8.	4500	0.2

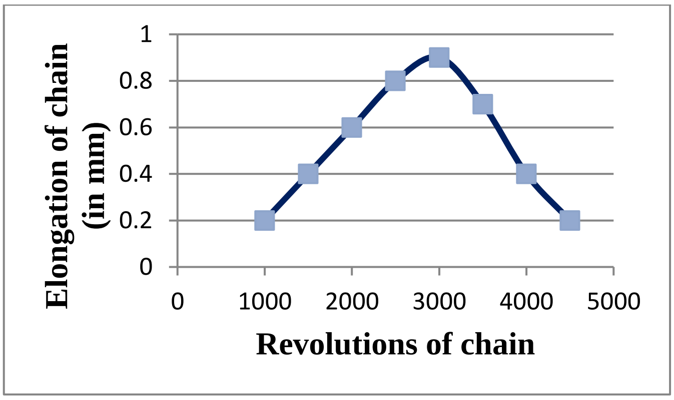

Figure3:

The results are plotted in the graph for 1000, 1500, 2000, 2500, 3000, 3500 4000 and 4500 respectively. The graph shows a linear increase in elongation of chain up to the certain limit and again gradually it decreases. There are significant changes after every revolution of chain.

From the graph i.e. figure no. it can be seen that there is a linear rise in elongation with the increasing number of revolutions. Materials have a fatigue limit or endurance limit which represents a stress level below which the material does not fail and can be cycled infinitely. If the applied stress level is below the endurance limit of the material, the structure is said to have an infinite life.

IV. CONCLUSION

The major failure modes of Bagasse carrier chains are fatigue, excessive loads and excessive chain elongation due to wear of parts. Following conclusions can be drawn from the theoretical, experimental and analytical work done:

- The experimental testing of 26 links of a Bagasse carrier chains demonstrated that as the number of revolutions increases the chain elongation increases. The graph shows the linear nature and afterwards a gradual decrease in elongation.
- The fatigue initially nucleated at the external cracks of the chain link, and later propagated to the inside of the links until sudden fracture occurred. As the Finite element analysis results are within the calculated working stress, so the chain link plate assembly were safe under the maximum working load of 25 tonne.
- Maximum life cycles available for the chain link assembly are 1e6 and minimum 746 cycles as studied from analytical analysis.

V. REFERENCES

[1]. Khaled Al-Fadhala, Ahmed Elkholy, Majed Majeed, “Failure Analysis of Grade -80 Alloy Steel Towing Chain Links”, Engineering Failure Analysis 17 (2010) 1542-1550.

[2]. G. Pantazopoulos, A. Vazdirvanidis, “Metallurgical Investigation on Fatigue Failure of Stainless Steel Chain in a Continuous Casting Machine”, Engineering Failure Analysis 16 (2009) 1623-1630.

[3]. Suhas M. Shinde and R.B. Patil, “Design and Analysis of a Roller conveyor system for weight optimization and material saving”, International journal on Emerging Technologies, (2012), 3(1), p.p. 168-173.

[4]. T. D. Bhoite, P.M. Pawar and B. D. Gaikwad, “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), (2012), ISSN No. 2231 –6477, Vol-1, Issue-4.

[5]. Sujata M., Venkataswamy M., Parameswara M., Bhaumik S., “Failure Analysis of Conveyor Chain Links”, Engineering Failure Analysis, (2006), 13(6), p.p. 914-924.

[6]. Snehal Patel, Sumant Patel, Jigar Patel Douglas and D. Kuhlmann, “A Review on Design and Analysis of Bucket Elevator”, International Journal of Engineering Research and Applications, Vol. 2, Issue 5, September- October 2012, pp.018-022.

[7]. Jagtap M.D., Gaikwad B.D. and Pawar P.M., “Study of Roller Conveyor Chain Strip under Tensile Loading”, International Journal of Modern Engineering Research, Vol. 4, Issue 5, May 2014, p.p. 61-66.

[8]. M. D. Jagtap, B. D. Gaikwad, P. M. Pawar, B. P. Ronge, “ Use of Strain Gages to Analyze the Behavior of Roller Conveyor Chain Strip”, International Conference on Computer Science and Mechanical Engineering, 10thAugust 2014, Jaipur, India, ISBN: 978-93-84209-42-1.

[9]. V. Kerremans, T. Rolly, P. De Baets, J. De Pauw, J. Sukumaran and Y. Perez Delgado, “Wear of conveyor chains with polymer rollers”, Sustainable Construction and Design 2011.

[10]. Mahesh L. Raotole, Prof. D. B. Sadaphale, and Prof. J. R.Chaudhari, “Prediction of Fatigue Life of Crank Shaft using S-N Approach,” International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 2, February 2013.