Proceedings of "National Conference on Emerging Trends in Science and Advances in Engineering"
Organized by Phaltan Education Society's College of Engineering Phaltan, www.coephaltan.edu.in
International Journal of Innovations in Engineering Research and Technology [IJIERT]
ISSN: 2394-3696, Website: www.ijiert.org, July, 2023

Design and Development of Bagasse Carrier Chain by using Ansys

Bhaskar D. Gaikwad#, Rushikesh A. Bichitkar*, Ajay P. Gavali#, Ashitosh R. Sathe*, Prathmesh D. Yadav

Mechanical Department
bdgaikwad@coe.sveri.ac.in#, rushikeshabichitkar@coep.sveri.ac.in, ajaypgavali@coep.sveri.ac.in#, ashitoshrsathe@coep.sveri.ac.in*, prathmeshdyadav@coep.sveri.ac.in*
Sveri College of Engineering, Pandharpur
P.B. No. 54, Gopalpur, Pandharpur,, Ranjani Road, Gopalpur, Maharashtra 413304
bdgaikwad@coe.sveri.ac.in

Abstract— ***In the sugar industry, bagasse carrier chains are extensively used for various purposes related to the handling and processing of bagasse, the fibrous residue left over after sugarcane is crushed. Here are some common uses of bagasse carrier chains in the sugar industry. The main purpose of the bagasse carrier chain in the sugar industry is to transport bagasse efficiently and effectively within the sugar mill. Bagasse, the fibrous residue left after sugarcane is crushed, needs to be moved from one area to another for various purposes such as drying, storage, or further processing. The bagasse carrier chain is designed to handle the heavy load of bagasse and ensure smooth and continuous movement throughout the sugar production process. By facilitating the transportation of bagasse, the carrier chain helps optimize the overall efficiency and productivity of the sugar industry. Bagasse carrier chains are subjected to continuous use and are exposed to high loads and harsh operating conditions. Over time, the chain links can experience wear and tear, leading to weakening of the chain structure and potential breakage. Bagasse carrier chains are designed to carry a certain amount of weight. If they are overloaded, they can break. This work is focused on part of the bagasse carrier chain to understand the chain strength using theoretical, experimental and Ansys analysis method. To study the basic part of bagasse carrier chain in loading condition and comparing the result with Ansys analysis.***

Keywords— **Bagasse carrier chain, Outer link, Inner link Pin, Ansys Software, Catia Software, UTM Machine**

INTRODUCTION

The economy of the state is dominated by the agricultural as well as industrial sector. Sugar factories play an important role in the economy of the state. About 60 percent of the processes in these factories are based on Bagasse chain conveyors. Aside from that, different enterprises likewise use these chains regularly for process atomization. However, failure of this chain is a perennial problem in these industries which causes huge losses to these industries along with its dependents and in turn economic growth of the state. So, the Bagasse carrier chain is the most important element of the industrial processes. bagasse carrier chains find extensive use in the sugar industry for the transportation, storage, drying, combustion, handling, and processing of bagasse. Bagasse carrier chains play a vital role in the sugar industry, specifically in the handling and transportation of bagasse—the fibrous residue left over after sugarcane is crushed to extract juice. Bagasse is a valuable by product with various applications, such as energy generation.

The bagasse carrier chain system consists of interconnected chain links that form a continuous loop, driven by motorized systems or manual operation. These chains are installed on conveyors, drag chains, elevators, and other equipment used to transport bagasse within the sugar mill. By utilizing the bagasse carrier chain, sugar mills can effectively manage the movement of bagasse, contributing to the smooth operation of the sugar production line. This essential component helps maintain a continuous workflow, reducing downtime and optimizing the overall productivity of the sugar industry.

OBJECTIVE

1) To Decide Bagasse chain nomenclature and specification as per expected capacity.
2) To test chain design theoretical and at actual as well as by using Ansys software.
3) To decide particular requirement of heat treatment for required breaking load.
4) To reduce cost of manufacturing and increase capacity for given data.
5) Justify design analysis by theoretical analysis and at actual on basis of breaking load.

WORKING STEPS

1) Survey of nearby sugar factory to find out the failure modes of Bagasse conveyor chain.
2) Design of required breaking load as per conveying capacity of Bagasse conveyor chain.
3) Theoretical analysis of the stresses in chain link and pin.
4) Modelling of chain link plate, pin and chain assembly in CATIA and analysis using ANSYS.
5) Experimental testing of chain link plate, pin and chain assembly using on Computerized Universal Testing Machine.
6) Comparison of theoretical, Ansys and experimental results.

LITERATURE REVIEW

The literature review has been conducted on failure analysis of bagasse carrier conveyor chains and is continuing. This chapter reviews the relevant literature of failure analysis of bagasse conveyor and can be divided into three types of analysis.

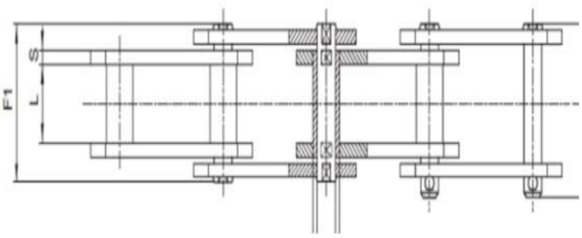
The first type is the calculate theoretical breaking load of bagasse carrier chain. The second type is the calculate experimental breaking load and third type is the calculation on Ansys software analysis.

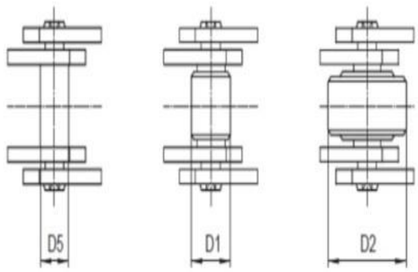
Software Required-

1) CATIA V5
2) ANSYS

Different material in chain:

1) Inner link material as per IS standard 55 C8 and Rockwell hardness 30-35 HRC.
2) Outer link material as per IS standard 55 C8 and Rockwell hardness 30-35 HRC.
3) Roller material B.S.EN8 and Hardness 35-40 HRC
4) Bush material DIN Standard 15 CR3
5) Pin Material DIN Standard 16MNCR5





Specification:

- Pitch of the chain = 150mm
- Length of pin (F1) = 100mm
- Thickness of plate(S) = 10mm
- Diameter of Bush(D1) = 32mm
- Diameter of Roller(D2) = 76mm
- Diameter of Pin(D5) = 23mm

Problem related to B. C. C. used in sugar industry for capacity of 30 tons/hrs.

i. Motor RPM = 1000
ii. Gear box reduction = 40:1
iii. Sprocket PCD = 600 mm
iv. Centre distance between drive and drive end = 300mm
v. Angle of inclination = 45°

Solution –

a. Sprocket Speed
 = Motor speed / Reductions
 = 1000 / 40
 = 25 Rpm
b. Displacement of the conveyor
 = $\pi d / 2$
 = $\pi \times 600 / 2$
 = 942 mm
c. for 1-minute displacement = conveyor displacement × Sprocket speed
 = 0.942 × 25
 =23.55 m

Let, us consider load on chain 23 kg, so for 1 minute per meter load.
= 23.55 × 23
= 541.65 kg & for 60 minutes (1 hour)
= 541.65 × 60
= 32499 kg.
32499 / 1000 = 32.49 Tons
So, Minimum breaking load = 32.49 Tons & Maximum breaking load = 48.58 Tons.

Normally breaking load of the chain is directly Proportional to the capacity of Conveyor in between 1 to 1.5 So, minimum breaking load 32.49 tons and maximum breaking load 48.58 tons.

So, by considering frictions alignment of the Conveyors, lubrications, and environment effect need to design conveyor for maximum breaking load that is 48.58 tons.

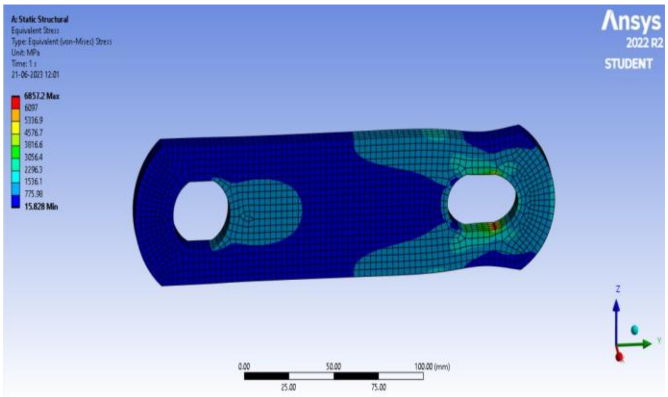
In order to design B.C.C. chain following assumptions need to be consider,

i. select standard Pitch (IS-Std) to 150 mm IS Std No. – IS2403
ii. select material for outer & inner link at Per Indian Std that is 55C8.
iii. select all dimension as per IS that means size of link plate, Pin, Bush, rollers & Cotter pin.

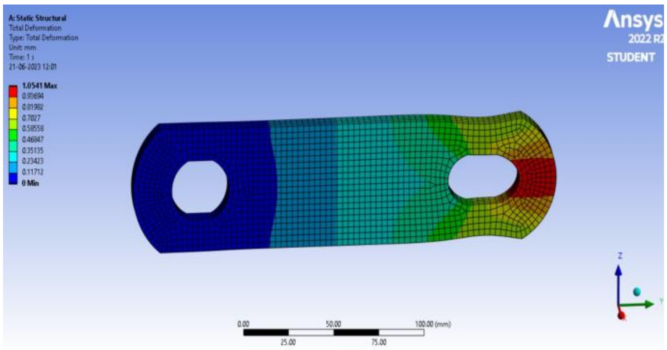
Calculate Initially Breaking load of the Conveyor at a joint of link Plate & select minimum Cross section area. As Per above assumptions there is need to design inner link Plate on the basis of minimum Cross section area under tensile loading & design the connecting Pin Under shear load.

SOFTWARE ANALYSIS

i. Inner link-



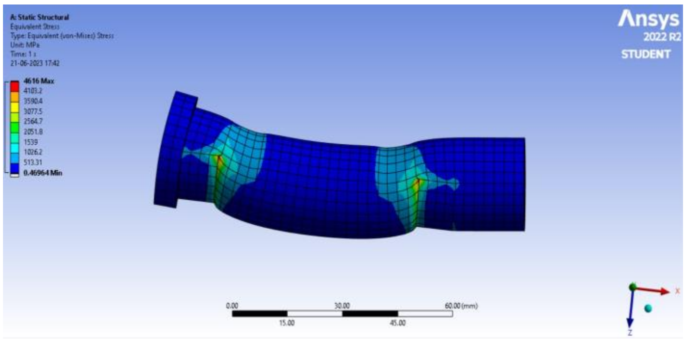
Equivalent Von-misses stress



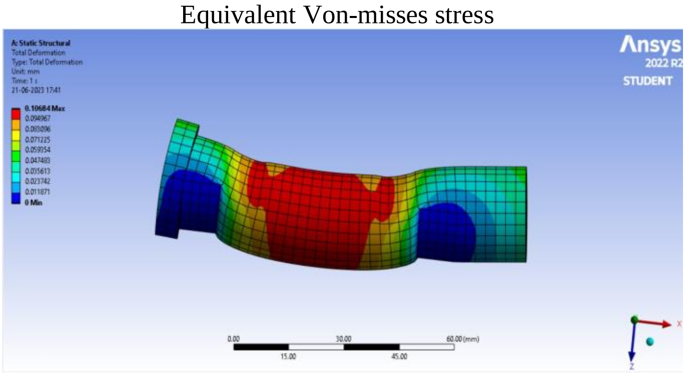
Dicplacement

F= 441450 N

ii. Pin-



Equivalent Von-misses stress



Dicplacement

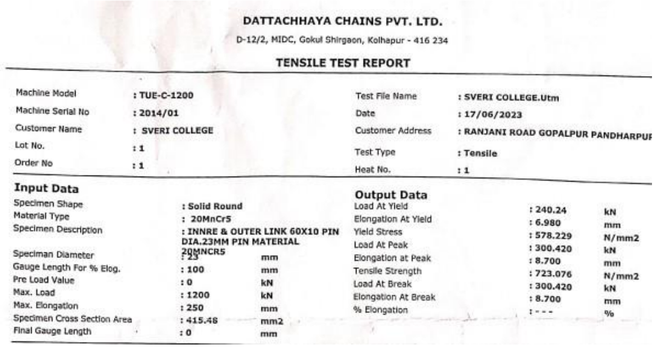
F= 343350 N

EXPERIMENTAL ANALYSIS

Experimental testing of chain is carried out to study the effect of material. The experimental test set up for this experiment is shown in fig for this testing we are using a universal testing machine of 120 tonne capacity.

Breaking Pin

Actual chain on Universal Testing Machine Experimental testing of chain assembly of 20MnCr5 material has been performed on UTM. The dimensions of chain assembly plate was 60 x 10 x 225mm.



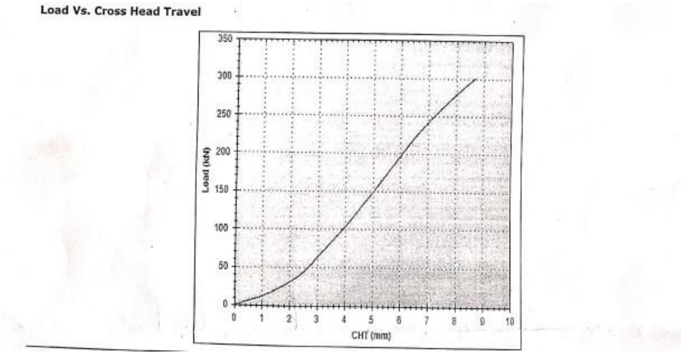
DATTACHHAYA CHAINS PVT. LTD.

D-12/2, MIDC, Gokul Shirgaon, Kolhapur - 416 234

TENSILE TEST REPORT

Machine Model	: TUE-C-1200	Test File Name	: SVERI COLLEGE.Utm
Machine Serial No	: 2014/01	Date	: 17/06/2023
Customer Name	: SVERI COLLEGE	Customer Address	: RANJANI ROAD GOPALPUR PANDHARPUR
Lot No.	: 1	Test Type	: Tensile
Order No	: 1	Heat No.	: 1

Input Data			Output Data		
Specimen Shape	: Solid Round		Load At Yield	: 240.24	kN
Material Type	: 20MnCr5		Elongation At Yield	: 6.980	mm
Specimen Description	: INNRE & OUTER LINK 60X10 PIN DIA.23MM PIN MATERIAL 20MNCR5		Yield Stress	: 578.229	N/mm2
Speciman Diameter	: 23	mm	Load At Peak	: 300.420	kN
Gauge Length For % Elog.	: 100	mm	Elongation at Peak	: 8.700	mm
Pre Load Value	: 0	kN	Tensile Strength	: 723.076	N/mm2
Max. Load	: 1200	kN	Load At Break	: 300.420	kN
Max. Elongation	: 250	mm	Elongation At Break	: 8.700	mm
Specimen Cross Section Area	: 415.48	mm2	% Elongation	: - - -	%
Final Gauge Length	: 0	mm			



RESULTS AND DISCUSSION

Analysis has been carried for chain link plate, pin and the assembly. Von-misses stress and Displacement has been obtained for different force magnitudes. Below table gives the comparison results for Von mises stress and displacement for chain link plate, pin and chain assembly under different forces.

Table 1. Result for chain link plate

Sr. No	Force (N)	Equivalent Stress (MPa)	Displacement (mm)	Load (Tonne)
1	196200	2637.7	0.06105	26
2	245250	3297.2	0.07631	33
3	294300	3956.6	0.09157	40
4	343350	4666.3	0.10684	47

Table 2. Result for Pin

Sr. No		Force (N)	Equivalent Stress (MPa)	Displacement (mm)	Load (Tonne)
1		294300	4751.5	0.7027	48
2		433500	5333.4	0.8198	54
3		392400	6095.3	0.9369	62
4		441450	6857.2	1.0541	69

Above all forces we applied in (Newton) unit in Ansys software.

Conversion:
Tonne→Kg/mm^2→ Newton.... (1 kg/mm^2→ 9.81 N)
(1 tonne→1000 kg/mm^2→9810 Newton)
Ansys is showing results in Stress (MPa) unit so we conversion MPa to Tonne unit.
MPa→Kg/mm^2→ Tonne
(1 MPa→ 10.197 kg/mm^2) (1000 kg/mm^2→1 tonne)

CONCLUSION

As per above result theoretical calculation bagasse chain parameter of tensile stress of the inner link is 46 tonne and shear stress of pin is 36 tonne and by using Ansys software test tensile load is 48 tonnes, share load is 40 tonne and at actual load test on Universal testing machine break the pin on 30 tonne load that time pin HRC is 50- 55. out at above three analysis loads necessary to almost equivalent to at actual load hence chain can work at breaking load 30 tonne. The main conclusion is the when the increase the HRC of pin 55-60 in that range then shear strength increases.

REFERENCES

M. Sujata, M. V. (2006). Failure analysis of conveyor chain links. Engineering Failure Analysis, 914–924. 2] Jagtap M.D., Gaikwad B.D., Pawar P.M., “Study of roller conveyor chain strip under tensile loading”, IJMER, ISSN: 2249-6645, Vol. 4, Issue 5, May 20143] Bhoite Tushar, Prashant M. Pawar & Bhaskar D. Gaikwad “Fea Based Study of Effect of Radial Variation of Outer Link in A Typical Roller Chain Link Assembly”, Ijmie,2012.

1. Payet P., Combuston., Reunion.,"Process and Conveyor Device for Feeding Sugar Cane in a Mill Train", U. S. Patent, (1964), 3,120,173.
2. Ledvina T., Hummel J., "Randomized Sprocket for Roller Chain", European Patent, (2002), EP0907041.
3. White D., Fraboni H., "Roller Chain Sprockets Oriented to Minimize Strand Length Variation", United States Patent, (2001), 6213905.
4. Moster A., Ledvina T.,"Roller Chain Link Plate Profile", European Patent, (2003), EP0833078.
5. Noguchi S, Nagasaki K., Nakayama S., Kanada T., Nishino T., Ohtani T.,"Static Stress Analysis of Link Plate of Roller Chain Using Finite Element Method and Some Design Proposals for Weight Saving", Journal of Advanced Mechanical Design, Systems, and Manufacturing. (2009), Vol. 3, No. 2.
6. Sujata M.,Venkataswamy M.,Parameswara M.,Bhaumik S.,"Failure Analysis of Conveyor Chain Links", Engineering Failure Analysis, (2006), 13(6), 914-924
7. Bhoite T., Pawar P., Gaikwad B., "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.
8.DATTACHHAYA CHAINS PVT LTD. , "Bagasse carrier Chain Assembly Testing", D-12/2, MIDC , Gokul Shirgaon, Kolhapur, (2023), 416234