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# Design and Analysis of Chain Strip in Roller Conveyor under Tensile Load

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**Abstract.** The chain drives are the primary systems used in order to transmit power, and act as the effective means of material handling. Chain conveyors ultimately experience tension due to wear. The tension generated on this conveyor setup needs to be supplanted, consequently would affect the efficiency and increases to perform such an important activity of an industry. Roller and chain transports are predominantly used in the mills where sugar, paper, fertilizer and cements are produced in large quantities. Such material handling systems are more reliable and appropriate in the metal casting industries in which the foundry practices and heat treatment processes are inevitable. This report discusses on the physical responses of the chain drive upon elastic loading and also contemplates on the internal resistances. Analysis on such experimentations brings in fruitful results and suggestions so as to minimize the constraints related to time and cost, to the aforesaid industries.

## INTRODUCTION

The theories on chain drive given as a perception that it is a ceaseless rack, connects with the teeth on a couple of gears, which is adaptable. Absolutely, a toothed wheel resembles a gear, termed as sprocket works in association with the chain to accomplish the power transmission. In considering the history of its usefulness over the years and the advancements happened in this drive system, this drive system commands its suitability as a mechanical belt running in synchronization with the sprocket in contact, to handle materials all over the plant with utmost control. The machine components like the chain strips are put into extreme load conditions and exposed to heating ambience where they are of great use., for example, high load burdens, friction, and now and then forceful working condition (for example nearness of stickiness, seawater, synthetic compounds). A side from tensile over-load break, twofold shear is likewise a significant disappointment system which happens under lower applied loads. Chain is the most significant component of the mechanical procedures required for transmitting power and passing on of materials. As these chains work under different conditions, chain assembly is the serious issue. Reasons for this failure are inappropriate material choice, vulnerabilities in assembling, flawed assembling forms. It is imperative to ponder the impact of these parameters on the quality of the chain which oversees the failure methods of the chain. Roller Conveyors are a practical answer for material taking care of circumstances when a non-powered transport isn't required. Gravity transports enable materials and items to move effectively and uninhibitedly up to a point of around 7 degrees. You regularly discover a roller gravity transport being utilized in assembling to move boxes, containers,

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totes, and request picking and arranging. You will likewise observe roller gravity transports being utilized in delivery and dispersion, when stacking and emptying shipping holders and trucks.

## CONCEPT USED

Two sided casings accommodating a progression of rollers which are made to associate with a pair of chain and sprocket, driver by an engine placed at the side of the transport system. Heavier materials are being transported through the pulleys (made of steel) that guide the chains precisely, unlike the plastic based transports such as table tops and timing belts. This transport method faces adversity, generally because of presence of enormous holes in between the rollers. The varying sides of materials that could be viably carried through such a conveyor system become a constraint. Palletized Goods bundled cases or boxes of items are usually conveyed through such a chain and roller conveyor arrangements. Utility of chain and roller conveyors are enormous only as the bulk transport systems. The engine transmitted by a roller chain, which acts as the drive chain to the gear shaped sprocket, the holes in between the two links of chain takes in the teeth of the sprocket. The mechanical effort thus produced in between the mating chain and the sprocket is being utilized to drag the materials or to lift the objects. There is a possibility to grab the power developed in the rotating gear, by meshing in with another gear which rotates on a separate shaft. Power is recovered from the wheel through a typical shaft, gear and hub assembly (Oval). The usual loops formed by these flexible transmission systems can also overcome the corners edges of the loop pattern by incorporating more number of gears normally referred as idler gears, along the chain. These gears have no role in transmitting the power and they simply behave as a support component in the drive structure.With the variations in the diameter ratios between the input and output gears in relation to each other, the needed speed and torque required could be obtained. The suitable example being, first one revolution of pedal in the bicycle brings in several rotations of the wheels.

**FIGURE 1.** Roller conveyor under Chain Driven

A series of rollers being placed parallel in a supporting frame over which the objects glide and advance either with manual effort or electrical source, is the roller conveyor system. Manufacturing units and warehouses utilizes the roller conveyors. The two terminals at the opposite ends of conveyor systems have a sprocket and a bearing housing, one respectively at each end.

## OBJECTIVE

The main aim of our project is to analyses and Study the Roller conveyor under chain drive which gets strip failure under tensile loadings. Thus, we have chosen the company named ESHWA ENGINEERINGS COMPANY, which is well versed in manufacturing all types of conveyors. They have approved us to do our project in their company and we have done analysis of roller conveyor from the beginning of manufacturing. The main part of manufacturing is the chain drive arrangement and roller plate. And our main objective is to get clear idea about how the strip end gets break under load in roller conveyor. To provide safety, a protective covering was given to the chain conveyors. A conveyor wherein the rollers have appended sprockets driven by means of a duplex chain roller to roller. A determined length of belt transport, used to move item on a level plane onto a slope/decrease transport. The chain driven roller transport frameworks are utilized for the controlled handling of an incredible assortment of

loads with regular or irregular shapes, with heavy or light unit weights, rugged or fragile, either horizontally or with a light slope. They are used to synchronize automatic transport systems, as slave systems for assembly stations and operating machines, with continuous, step-by-step or accumulating advancing, and for all those applications where idle roller gravity conveying systems are not recommended.

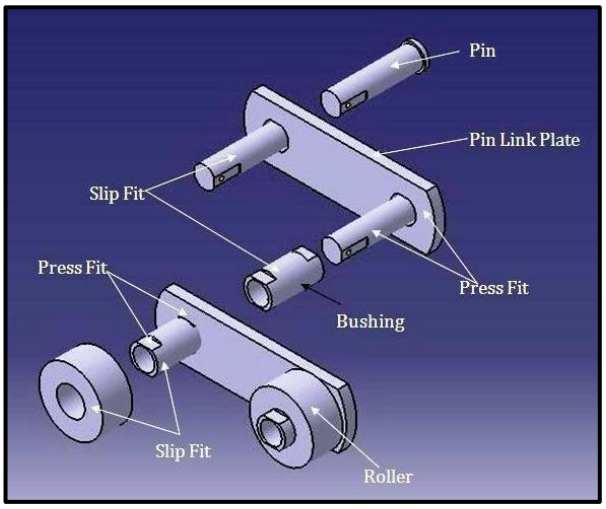


**FIGURE 2.** Basic structure of roller conveyor chain

Chain drives prove their mettle in applications that are so wide in range, from hoisting to elevating, from securing to conveying and most importantly to transmit the need power required for the process to come to finish. When materials 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. Conveyers are so handy to the manufacturing industries to collect the materials at a given point and to deliver the same at various specified points. The gaps that prevail between the rollers are more useful to transfer the goods and materials to various places, the rollers are more often uniformly placed. Several such chains are used in conveyors; many are of single pitch or double pitch conveyors. The Figure 2 shows the basic structure of roller conveyor chain. Variety of fits are assembled to suit the unique working conditions, Fig 2 depicts the important components of the chain drive and its basic structure. Main components of roller conveyor chain are pin, link plate (strip), bushing and roller. The pin interface plate for example strip is the assemblies of two pins that are press fitted into the gaps of two pin interface plates. The press fit among pin and the pin connect plate keeps the pin from pivoting. Ordinarily there is a continued stacking, at times joined by shock. The pin is liable to shearing and twisting powers transmitted by the plate. There is slip fit among bushing and pin. The bushing is subject to shearing and bending stresses transmitted by the plate and roller, and gets shock loads when the chaining ages 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 advantage of roller chain is that the rollers rotate when contacting the teeth of the sprocket.

## OPTIMIZED DESIGN OF DOUBLE CHAINSTRIP

The optimized design we have done is DOUBLE ROW CHAIN STRIP.When layers of single strand chains are stranded in a roller chain placed side by side, with pins extending through the entire width, a multiple stand roller chain would be formed. Even with smaller pitches maximum power could be transferred from the stand point of industries. The chains that are being used are, roller chains to pull or drag materials packed, or bundled or boxed, the leaf chains for shorter distances, flat top chains, silent chains and engineering steel chains for heavy loads at challenging environments. Each application has an individual form of roller chain requirement. All the roller chains have equi-spaced rollers, they are single and multi-stranded. More chains are consecutively joined by their sides and aligned to bring in the variety called as multi stranded chains.

The optimized design of the double chain strip is given below in Fig 3;

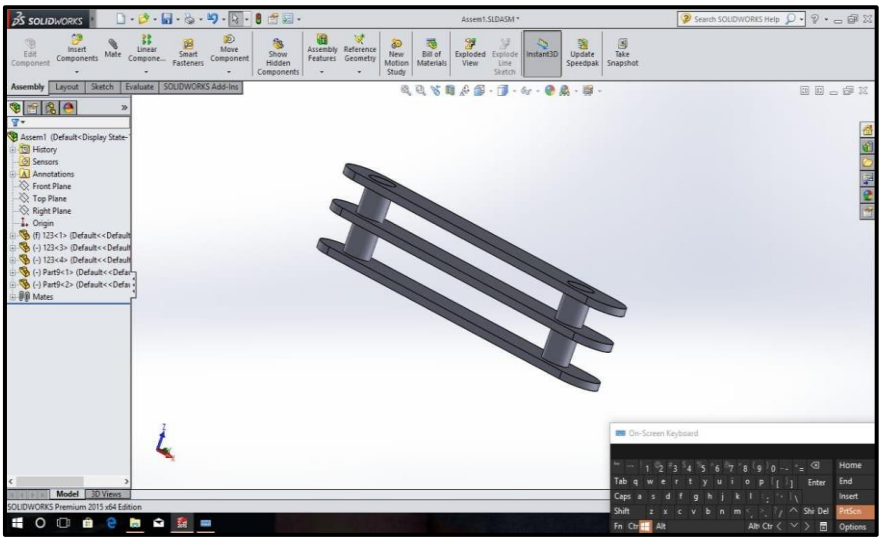

**FIGURE 3.** Design of double row chain strip

Analytical study of double chain strip is calculated through the datebook. Values from design data book

Tensile strength = 134-142kgf = 1260 N/mm$^2$ to 2840 N/mm$^2$

Modulus of elasticity = 2.05*10$^5$ N/mm$^2$

Poisson's ratio = 0.3

Working stress = Maximum stress / Factor of safety Working stress = 2840 / 1.5

Working stress = 1893.33 N/mm$^2$

So as per the above analytical calculations we got working stress of 1893.33 N/mm$^2$, now by using that working stress value we calculate the working load the strip can carry by using the following formulae.

Working stress = Working load / Resisting area 1893.33 = Working load / 27x10

Working load = 1893.33 x 270 Working load = 5,11,199.1 N

So as per the above analytical calculations we got working load of 5,11,199.1 N. Now we can check these values with experimental and numerical results.

## EXPERIMENTAL STUDY OF DOUBLE CHAIN STRIP

For Experimental testing of double chain strip of dimensions each 55mm x 150mm x 10mm of EN353 material were taken to study the working stress of the strip. For this testing we are using a Universal Testing Machine of 40 tonne capacity. Thus, from the graphical analysis the maximum load of 527.25kN is taken by the double strip and then it fails elliptical hole. The maximum tensile strength of 1962.5 N/mm2 was gained by the double strip. Table 4.1 shows the comparison of results of double strip chain.

Tensile Strength = 1962.5 N/mm$^2$ Maximum load = 527.25 kN.

**FIGURE 4.** Assemble of double chain strip

**Table 1.** Comparison of results of double strip chain

| Tests | Analytical Results | Experimental Results |
|---|---|---|
| Tensile Stress($N/mm^2$) | 1893.33 | 1962.5 |

As above table shows all the results are within +/-10% of the calculated working stress, so the double stripis safe under the maximum working load of 5, 27,000N. A roller chain drives may be subjected to all of the tensile loads thus the roller chain must have several tensile strength properties to with stand the wide range of tensile loads that may be imposed onit.

The benefits that could be reaped out of installing the roller conveyors in the industry are:

i. They are so economical
ii. They provide immense ease in installation and maintenance
iii. Smooth rolling action of conveyance reduces the noise considerably.
iv. Such conveyors are more reliable and would exist for a longer period of time.
v. The conveyor limits or reach could be stretched, so they offer the flexibility to increase the length.

Some of the conveyors effectively utilize the gravitational force for their operation, if they especially carry unit loads. The conveyors could be used at various levels, the operators have the chance to push the semi-finished goods to the final stage after passing through multiple workstations.

Moreover roller and chain conveyors have been in utility to convey the loads of materials in bulk. The unit handling operations are made easy through containers which have flat bottoms. The rollers simple slide those heavy structures through safety and without any noise. The bottoms of cartons, poles, cardboards and pallets loads are perpendicular to the rollers, so the simplicity of conveyance is possible in comparison with wheeled conveyors. Heavy leads and load accumulations are possible with these types of conveyors. The material cost incurred in fabricating such a material handling system is huge, when compared to belt conveyors.

## CONCLUSION

The study reveals the nucleation of a particle and its propagation. The cracks initiate externally and propagate into the portions that are interior to the links, until the links fail or which develops into a fracture. The origin of the failure is the application of tensile loading. The fatigue emerged due to the subsequent loadings leads to a catastrophic failure.. By analysis both single strip and double strip, double strip withstands the heavy load than

single strip and works for more time in accordance with double strip. But the double strip costs more than the single strip. Single strip needs only single sprocket, by the way double strip need two sprockets, which can withstand heavy loads for longer time and transfers the work sooner and easier.

## REFERENCES


1. Ledvina T. J. and Hummel J. A. Randomized Sprocket for Roller Chain, European Patent #EP0907041(2002).
2. Payet P. R. Process and Conveyor Device for Feeding Sugar Cane in a Mill Train, U. S. Patent #3,120,173(1964).
3. White D. C. and FraboniH. J. Roller Chain Sprockets Oriented to Minimize Strand Length Variation, United States Patent #6213905(2001).
4. Moster A. and Ledvina T. J. Roller Chain Link Plate Profile, European Patent #EP0833078(2003).
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, Vol. 3, No.2.(2009).
6. Sujata M., Venkataswamy M., Parameswara M., Bhaumik S., "Failure Analysis of Conveyor Chain Links", Engineering FailureAnalysis,13(6), 914-924(2006).
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), ISSN No. 2231–6477,Vol-1,Issue-4(2012).
8. Sapate S., Didolkar V., "Metallurgical Investigation of Failure of Coal Mill Drag Chain Pin", Materials and Design, 30(7)2623-2629 (2009).