"STUDY OF THE OPTIMUM DESIGN PARAMETERS OF CHAIN OF CHAIN CONVEYOR SYSTEM USING FEA"

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ABSTRACT

As far as the Indian scenario is considered economic growth is dependent on industrialization. Current picture states that 63% of development of industry is dependent on efficient use of machinery. In case of industry there is continuous requirement of transportation of material and this requirement is fulfilled by Conveyor system, Jib crane, Pallet jack, Automatic Guided Vehicles etc. Taking example of sugar mills there is requirement of transportation of materials like coal, bagasse, sugar etc. These materials are in granular form and it is necessary to develop a proper transport system which is long lasting, having less maintenance, which can sustain heavy loading and shocks in rusty and dusty environment. Apart from that, other industries also use these chains frequently for process atomization. However, failure of this chain is challenging problem in these industries which causes huge losses to these industries and in turn economic growth of the state Chain conveyor has the advantage of high transmission efficiency for short distance transportation of materials over belt conveyors. Adding to it chain conveyor has disadvantage of deformation of chain link due to tension force and jerk. Frequent maintenance and timely lubrication is required to avoid corrosion of roller chain. Basically Solid Bearing Roller Chain is used in sugar industry for transportation of coal. Vital components of roller chain are outer and inner link which is also called as strip. The other important components are roller, pin and bushing. Constructional features of roller chain shows that inner and outer links are connected to each other by using pin which is press fitted between holes located on link plates. Press fit constrains a rotary motion of pin. Further pin and bush are assembled together with slip fit between them. Bushing is basically applied with bending, shock as well as shearing loads which is transmitted by inner and outer links to it. Bushing and roller are assembled using slip fit. Roller is subjected to impact loading when tooth of sprocket comes in contact with roller.

Keywords:- *Roller chain conveyor, material selection, slat conveyor*

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1 LITERATURE REVIEW

1. Huanyu Zhao et.al. studied the tension of crawler chain link of excavator is measured by experimenting in horizontal straight, pivot steering, and differential steering conditions. The fracture surface morphology of chain link crack is analyzed by scanning electron microscopy. Finite element analysis result indicates that the maximum stress of chain link is lower than the yield strength of material. The stress of key points in the cracked area and the fatigue life of chain link are obtained from the simulation. A virtual prototype model of excavator is established and its accuracy is verified on the basis of comparing the simulated and experimental tension of chain link in the abovementioned three conditions and adjusting the parameters of the model. The comparison between the simulation and experimental data confirms the accuracy of the established virtual prototype model of excavator. Accordingly, the fatigue life of chain link is analyzed, which is usually difficult to achieve by experiment.

2. Debashis Ghosh et.al. This investigation is primarily aimed to examine the probable causes of in-service failure of cage suspension gear chain used in coal mines. Optical microscopic analysis along with scanning electron microscopy examinations are carried out to understand the metallurgical reasons for failure. Detailed stress analyses are also carried out to evaluate the stress generated along the chain periphery. The macro and micro structural examinations of the samples prepared from both failed and un-failed specimens depict presence of continuous as well as aligned linear inclusions randomly distributed along with decarburized layer at weld interface zone.

2. DESIGN OF CONVEYOR CHAIN LINK

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,

A suitable type of chain has to be selected for horizontal slat conveyor-

Transported material: Anthracite coal, Conveyor length: 19.0 m, Flow: 28 T/h, Conveyor conduit width: 320 mm
Conveyor conduit height: 280 mm, Roller Diameter: 210 mm, Number of chains: 1, Load distribution: even

1. Material flow Q

Q = 28 T/h

2. Chain velocity v

We use the formula: Q = H. B .β. γ. v. 3600 (T/h)

v= QH.B .β.γ. 3600, v= 280.32 x 0.28 x 0.5.x 0.7 x 3600 = 0.25 m/sec.

Where,

H= Conduit Height (m), B= Conduit width (m), β = conveyor repletion coefficient = 0.5 to 0.6

3. Weight of transported material P1

$P1=a.\ Q3.6\ v\ P1$=19.0 283.6 x 0.25 = 591.11 kg = 5798.789N

Where,

a = Conveyor length (m) = 19.0 m

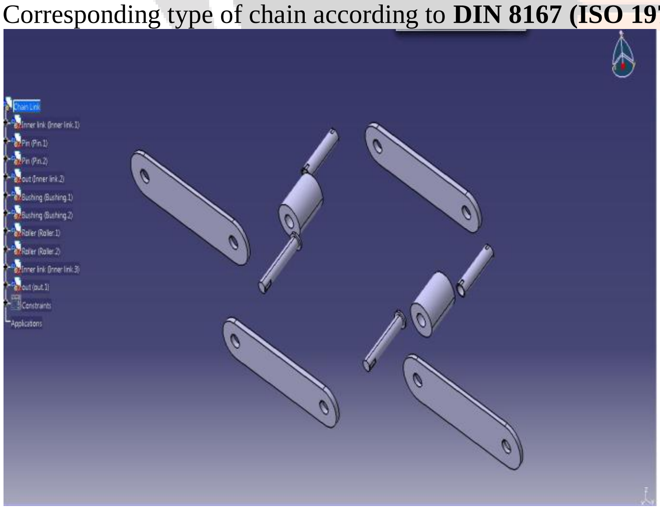
4. Selection of suitable chain

Selected chain must resist the weight of transported material multiplied with safety coefficient (k = 8).

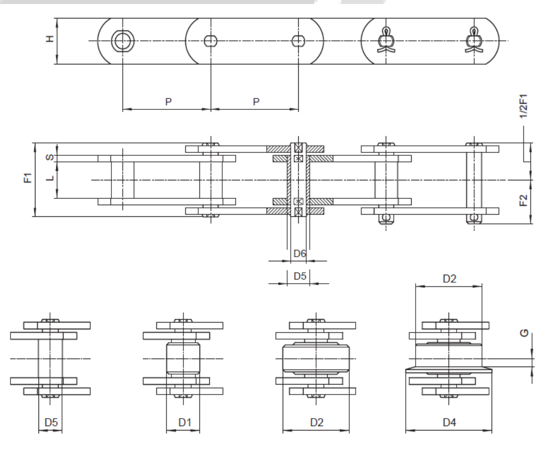
Thus its breaking strength must be:

FB = P1. k = 5798.789 x 8 = 86390.21 N = 86.390KN

Corresponding type of chain according to **DIN 8167 (ISO 1977) is MRC 80 x 125.**



3D model of chain link



DIN8167 Chain Model

3. ANALYSIS OF CHAIN LINK

ANSYS 16.0

Ansys is user friendly finite element analysis software which can also use for modeling and meshing varies kind of analysis can carried out in Ansys. ANYAS 16.0 include the following new enhancement that improves the solution procedure and features high performance computing due to shared memory parallel capability in Ansys distributed Ansys now run on windows 32- and 64-bit systems PCG Lanczos method provides a robust and efficient option for large modal analyses.

DIFFERENT TYPES OF ELEMENT

A) Element

As the geometry of the structure modal has been established the grid points are connected by finite element, each element has its own characteristics. The different element is described below:

B) Line Element (1D Element)

Line elements are also called one-dimensional elements, are used to represent rod and beam behavior. One-dimensional element is one in which the properties of the element are defined alone a line or curve. Typical applications for the one-dimensional element include truss structure, beam, stiffeners and many others. A rod element support tension, compression and axial tension, but not bending. A beam element includes bending.

C) Surface Element (2D Element)

Surface elements, also called two-dimensional elements, are used to represent a structure whose thickness is small compared to its other dimensions. Surface elements can model plates, which are flat or shells, which have single curvature (Like a cylinder) or double curvature (Like a sphere). For grid points connected to plate elements, stiffness terms exist for five of the possible six degrees of freedom-the rotational DOF about the normal to the plate is “unconnected”.

D) Solid Elements (3D Elements)

Solid (Three-Dimensional) elements are used to represent the behavior of thick plates and solids. Solid elements connect only translational degrees of freedom, no rotational degrees of freedom are connected to solid elements.

E) Scalar Elements

Scalar elements are referred to as zero dimensional elements, consists of the springs, masses and viscous dampers. All scalar elements are defined between two degrees of freedom and ground. Stiffness for scalar elements has to be defined.

Static Structural Analysis of Existing Chain Link

A static analysis calculates the effect of steady loading condition on a structure, while ignoring inertia and damping effects, such as those caused by time varying loads. A static analysis can, however, include steady inertia load (such as gravity and rotational). Static analysis determines the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects.

Steady loading and response conditions are assumed; that is, the loads and the structure’s response are assumed to vary slowly with respect to time.

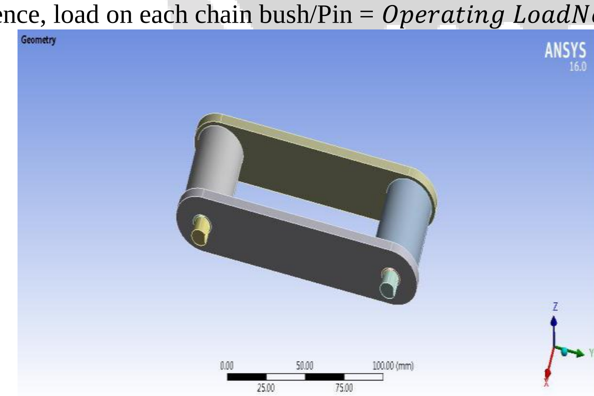
Existing Chain:

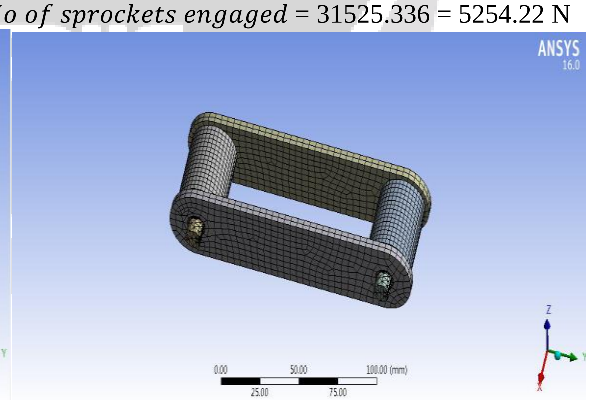
Break strength of chain is = 47288 N, Chain Factor of Safety: 2 (minimum possible/available) FOS = 2

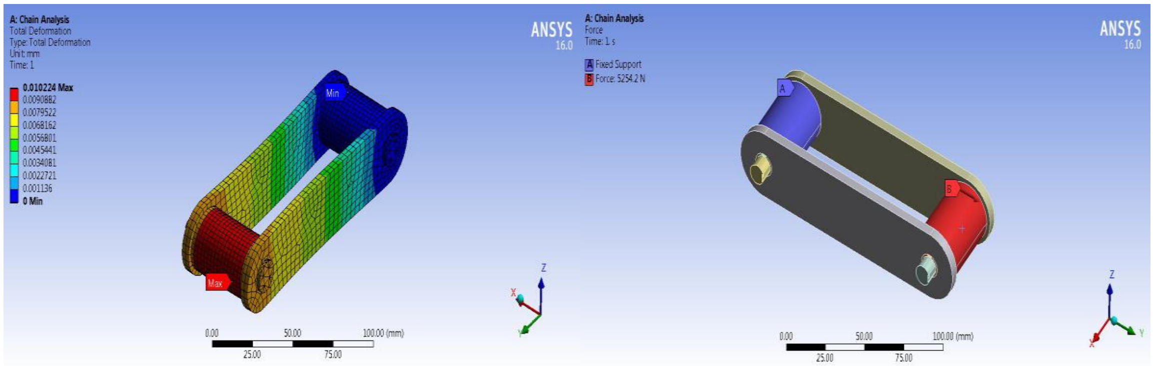
Operating load = 2/3 (Brake strength) = 2/3 (86390.21) = 31525.33 N

No of sprockets = 13 ---- Given (Minimum 6 sprockets will be engaged during rotation of chain)

Hence, load on each chain bush/Pin = $Operating\ LoadNo\ of\ sprockets\ engaged$ = 31525.336 = 5254.22 N







Analysis of roller chain for various materials

It is clear that we need to replace the material of the chain to overcome the problem of corrosion and to give the chain higher strength. Chemical analysis by optical emission spectrometry showed that existing material for roller chain is having lesser percentage of elements like NI, Cr, Mo than required as per ASTM standards[10]. This basically results into reduced hardness of component. For this purpose we have selected following materials for roller chain for analysis.

1. 8620-I (chrome-nickel-moly) Alloy Steel, 2. SS 60-A Mild (low-carbon) Hot Dipped Galvanized Steel

3. 1020 Mild (Low-carbon) steel, 4. Stainless Steel

Optimization on basis of change in thickness of outer strip of roller chain link.

Since the current design of roller chain link is beyond safe limit there is scope for weight reduction by changing dimensions of link. Up till now weight reduction by reducing diameter of outer link, centrally located holes, and circumference of the link plate edge is tried. But results can be better by reducing the thickness of the inner and outer link of the roller chain. Thickness of the link is 5mm. We will reduce thickness in step by step manner with decrement of 0.25mm and will carry out FEA on the model. Existing design of roller chain is having outer strip of thickness of 5mm for newly selected material. We will reduce thickness 0.25mm in each step and analyze the effects on deformation; von misses stress and frictional stress for weight reduction. This will continue up to thickness becomes 4mm

Optimization on basis of change in diameter of roller chain link

As we studies in previous section further weight reduction is possible in roller chain. Now the parameter selected for further weight reduction is outer diameter of the roller of the roller chain. As there is slip fit between roller and pin inner diameter of the roller is fixed. But outer diameter of the roller can be reduced for weight reduction. Current outer diameter of roller is 30 mm. We are going to reduce the diameter in step by step manner by decrement of 2.50mm up till 20mm.

CONCLUSION

From the FEA and Experimental analysis results we can conclude that optimal value of thickness of outer link in 4mm and that of outer radius of roller is 20mm respectively. Though weight reduction we obtained for a single link seems tiny but with collective effect for such number of links is significant. Following specific conclusion can be drawn from results obtained.

1. Experimental testing is done on SS 60 Mild Steel (Newly designed) model of roller chain and results were found close to FEA results.

2. Weight in the newly designed roller chain link is reduced by 37.27%.

3. Newly selected chain is having von-misses stresses 29.94 %, Frictional Stresses 29.78 % and deflection 29.95 % greater but is within allowable range.

4. Finally selected model for roller chain is having 4.0 mm thick outer link plate with roller diameter as 20 mm with SS 60 Mild steel material

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