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Modification of Bundle Former Piston by Failure Analysis to withstand the Fatigue

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ABSTRACT

The failure analysis of bundle former piston rod with a detailed study of various reasons regarding the failures. The different approaches of design parameters are considered and suitable regulation is specified. The present work compares the results of the theoretical design calculations against the experimental work. And an analysis will be done in ANSYS Software.

KEYWORDS:Solid works, Ansys

1. INTRODUCTION

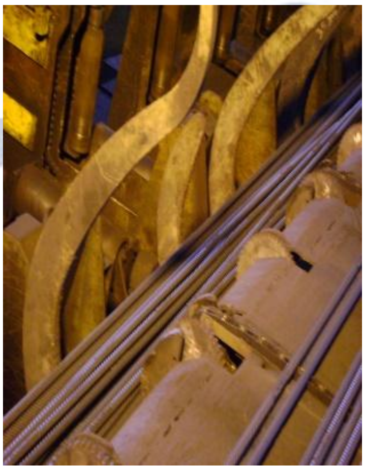
1. Description of Bundle Former

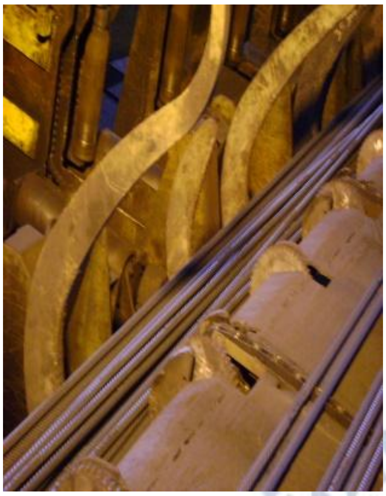
Bar Separating Unit

The steel TMT bars from the rolling mill area would be transferred to bar separating mill by means of rollers. The bar separating unit will separate the bar into discretized units from where they are separated by means of bundles. The number of bars that are allotted to a bundle would be based from the operation characteristics like the size or the diameter of the individual bar unit.

Bar Collecting Unit

The steel bars from the separating area are transferred to a collecting unit called Bar Collecting Unit. In this unit the bars from the rolling chain are made to fall into a hook shaped collecting tray operated by means of hydraulic cylinder and piston Unit. The number of bars that are collected into the tray is calculated by means of a sensor mounted on the rolling chain unit at the beginning of the bar that is falling into the tray. The Function of this collecting unit is to collect the bars falling from the separating unit and transfer the same to the rollers where the bundle former presses the bulk of bars to make it a bundle and then a strapping machine puts straps to the bundle.





Bundle Former

This hydraulic Unit consists of a hydraulic cylinder-piston unit, which is used to reciprocate the piston through a guide. The cylinder specifications are 100mm bore diameter with a stroke of 600mm. The piston rod diameter is 70mm. The end of the piston is threaded with reduction in diameter; this threaded part is joined to a clevis head. This clevis is the important structure in this bundle former unit because it is in this area the reciprocating mechanism is converted in to rotating mechanism at arms of the bundle former. The reciprocating motion is converted into rotating by means of a link provided at the clevis part, this links is joined to arms eccentrically, and hence the short reciprocating motion is converted to rotating motion.

2. METHODOLOGY

A) THEORETICAL ANALYSIS

1.FATIGUE LOAD

2.IMPACT LOAD

B) EXPERIMENTAL ANALYSIS

1.FATIGUE LOAD

2.IMPACT LOAD

C) FAILURE ANALYSIS

DRAFTING OF PISTON ROD

ANALYSIS OF BUNDLE FORMER PISTON ROD

ANSYS Workbench is a new-generation solution from ANSYS that provides powerful methods for interacting with the ANSYS solver functionality. This environment provides a unique integration with CAD systems, and your design process, enabling the best CAE results.

ANSYS Workbench is comprised of five modules:

Simulation for performing structural and thermal analyses using the ANSYS solver CFX-Mesh for generating a CFX-Pre mesh for the CFX-5solver Design Modeler for creating and modifying CAD geometry to prepare the solid model for use in Simulation or CFX-Mesh Design Explorer and Design Explorer VT for investigating the effect of variations input to the response of the system FE Modeler for translating a Nastran mesh for use in ANSYS.

3. THEORETICAL ANALYSIS

Features	Results		
	Experimental		Theoretical
	Fatigue	Impact	
Life (cycles)	8,31,763.7	4,19,758	10,00,000
Maximum amplitude Stress (N/mm^2)	53.47	68.84	50.08

Theoretical Results

The axial endurance limit value of the material under the specified design of the work geometry using several derating factors like k_a, k_b ,k_c, k_d, k_e. The axial endurance limit value is taken as the maximum operating stress value or the working stress.

Amplitude stress factor σ_a= (Se)a=50.08 N/mm^2.

Experimental Results

Case (1) Pure fatigue

The working condition shows that, the piston has to transfer a maximum load of 78.5 KN to the arms by means of the threaded portion which is projected from the piston rod. Therefore, the total load is transmitted by this threaded portion to the clevis. Hence, we calculated the stress on the threaded portion.

A) The compressive stress on threaded joints

σ_{max}= 68.1714 N/mm$^{2.}$

B) Maximum tensile stress acting

σ_{max} = - 34.78 N/mm^2

The stress amplitude factor (σ_a) due to pure fatigue considerations

$$= \frac{\sigma_{max} - \sigma_{min}}{2}$$

= 53.47 N/mm^2

Case (2) Impact loading

The stress developed due to instantaneous impact loading

= 69.5 N/mm^2

$$\text{Stress amplitude} = \frac{69.5 + 68.174}{2}$$

=68.8375 N/mm^2

Life calculation

1) The total no. of cycles for which the work functions normally without failure owing to pure fatigue criteria = 8,31,763.77 cycles.

2) The total no. of cycles for which the work functions normally without failure owing to impact loading fatigue considerations

fatigue criteria = 4,19,758 cycles.

Case 1 - Modification of Design Parameters to with-stand fatigue

A) Increasing the diameter of the threaded portion

To withstand the fatigue load, we generally take the area of cross-section on which the load is acted. Hence the stress varies with the value of diameter. **"**Increase of diameter at the thread portion definitely reduces the. Hence failure may not take place**".**

B) Increasing the Fillet Radius

As we already expressed in the above the stress concentration varies rapidly, when considered at the portions where the cross-sectional area reduces abruptly. Using a proper fillet radius at such portion will decrease the stress concentration and thereby increases the fatigue life of the work.

Case 2 - Modification Design Parameters to alleviate Fatigue

A) Decreasing the span/ overall length of Hydraulic Frame

We know that, reversal of stress is caused when the clevis part is hitting the top cover plate of the hydraulic frame. The frame is mounted on the line in such a way that the plate obstructs the stroke of the piston rod at the return stroke for about 20 mm.

If the length of the frame is machined by the above-mentioned length, the fatigue failure case would not arise.

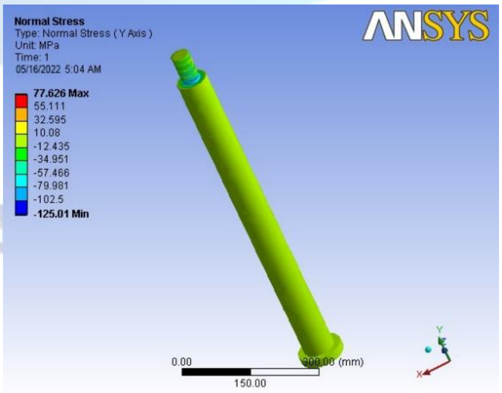
B) Increasing the hole diameter of the Cover plate on Hydraulic Frame

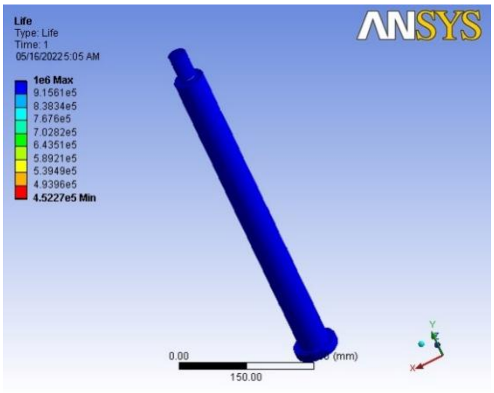
We know that, the piston reciprocates freely through the top cover plate throughout the operation. The problem occurs only when the clevis part which is threaded to piston hits the top cover plate during the return stroke.

If the diameter of the hole of this cover plate is increased in order to freely reciprocate the piston rod along with the clevis to pass through it, then the case of fatigue will not be raised.

Ansys Software Simulation

- The properties of the material are already defined in its database.
- There is a provision to state the frequency of stress alterations.
- The load isdistributed across the threads of the piston and its cross- sectionalarea





4. CONCLUSION:

The failure analysis of bundle former piston rod is done by taking not only the theoretical considerations but also the most approximate practical calculation by employing finite element analysis software packages ANSYS work bench. The various types of failures on bundle former machine are identified. The root causes for the failure are identified and analyzed. The cause is "Fatigue ". The 3-D model of bundle former is developed in solid works software with the help of detailed diagram of individual parts the analysis is discussed and the necessary improvements to alleviate the failures such as

1. Modification of design parameters to withstand fatigue
2. Modification of design parameters to alleviate fatigue

are proposed.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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