iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VI **Month of publication:** June 2022

DOI: https://doi.org/10.22214/ijraset.2022.43954

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VI June 2022- Available at www.ijraset.com

Design Approach For Failure Detection Of Connecting Link Of Electric Overhead Traveling Crane Employed In Vigour Metal & Alloy, Butibori, Nagpur, Maharashtra

Vicky Khambalkar[1], Chandrahas Handa[2], Abhinav Ninawe[3]
[1]P G Student, [2]Head Of Department, [3]Assistant Professor, Department Of Mechanical Engineering, K D K College Of Engineering Nagpur, India

Abstract: This paper gives the design approach for failure of connecting link at keyway for electric overhead traveling crane. Failure of connecting link occurs in electric overhead traveling crane which is presently equipped in Vigour Metals and Alloy, MIDC Butibori, Nagpur, Maharashtra, India. The capacity of electric overhead traveling crane is 5 Tons. Within this work, as per problem identification in same industry, an approach of failure analysis for critical part of crane had been carried. In this paper, discussion of the torque, maximum shear stress, equivalent shear stress, shear stress, bending stress, bending moment, twisting moment, forces, etc., which are induced in connecting link while performing some operation or loading and unloading of materials or containers have done. To identify and minimize this failure occurs in connecting link, detail literature search and analytical treatment is carried.

Keywords: Connecting link, keyway, electric overhead traveling crane, shear stress, torque, bending moment, failures, design approach, etc.

I. INTRODUCTION

Electric overhead Travelling crane is employed in Vigour Metals and Alloy, MIDC Butibori, Nagpur, Maharashtra, India. The function of electric overhead travelling crane is move the containers and materials from one location to another location in a perfect manner and also used for loading and unloading. Due to this some stresses are induced in connecting link of electric overhead travelling crane and failure occurs. In present paper, study failure of connecting link of electric overhead travelling crane which is place in the Industry.

Fig. 1 Connecting Link

Type of electric overhead travelling crane are as follows

1) Single Girder Cranes
2) Double Girder Cranes
3) Gantry Cranes
4) Monorails

Component of electric overhead travelling bridge crane :-

The main function of electric overhead travelling crane is lift, lower and moves the material and containers longitudinally and horizontally in the industry. The load is lifted by crane hook which has cabled to a hoist mechanism. The hoist mechanism is suspended on trolley and trolley moves horizontally along the electric overhead travelling crane bridge. The fig. 2 shows component of electric overhead travelling crane.

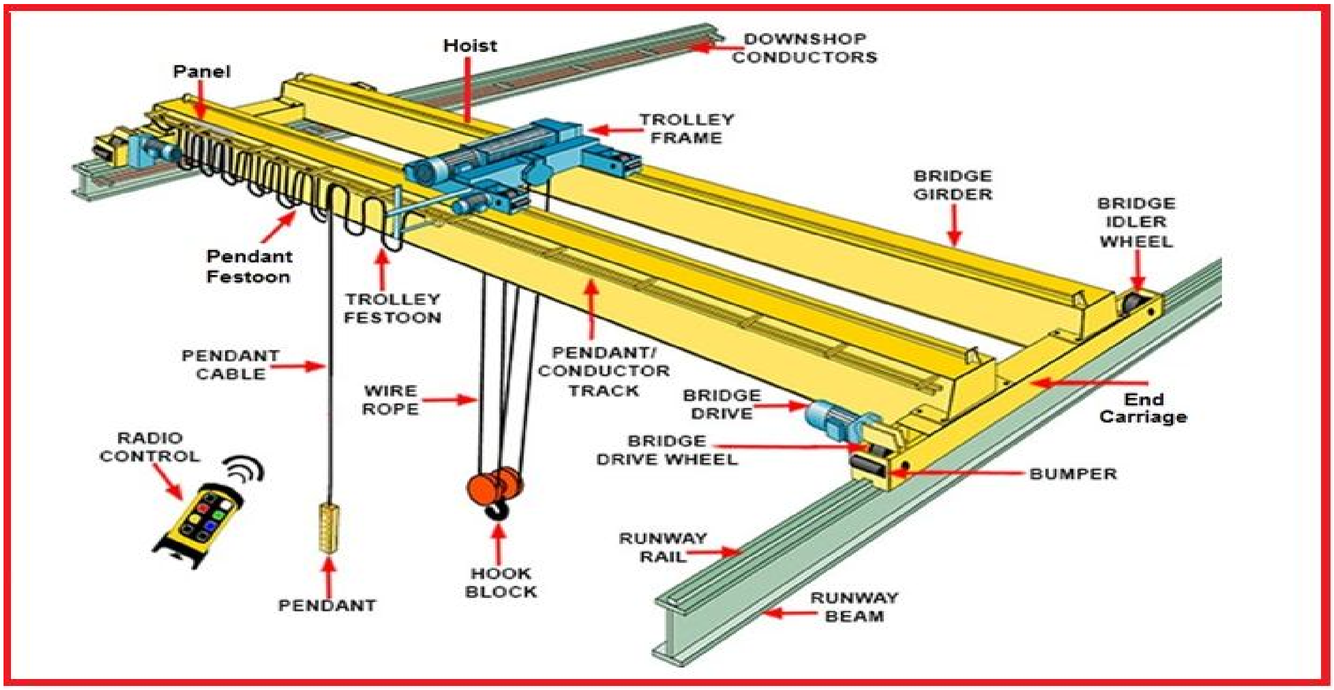

Fig. 2 Component of electric overhead travelling bridge crane

Fig. 3 5 Ton EOT Crane

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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A. Bridge

Structural component of an electric overhead travelling crane called Bridge. Range of bridge means to width of industry. The bridge brings or convey to hoist mechanism which can move along the length of the girder while operation.

B. Runway

In runway, the electric overhead travelling crane operates by truck and support system. The runway or designed accordingly by industry surface area.

C. Runway Rail

Electric overhead travelling crane travels on runway rail and runway rail supported by the runway beams.

D. End Trucks

End trucks assembly consist of bearing, wheels, structure members and axels, etc. and it is supports trolley cross member and bridge girder.

E. Hoist Mechanism

The function of hoist mechanism is to move, lower, lift and place the material or objects in precise manner in the industry. It consist of a rope, drum, gear, shaft, coupling, brakes and motor, etc.

F. Trolley

The mechanism of trolley is move the hoist horizontally and longitudinally along the girder of electric overhead travelling crane.

G. Bumper

The function of bumper is to absorb the energy for reducing the impact while moving crane reaches the end of crane.

H. Controls

All controls of an electric overhead travelling crane is on the hand of operator. Crane operation which control are the gripping and ungripping load, lowering, lifting and transporting the load.

I. Position of Connecting Link

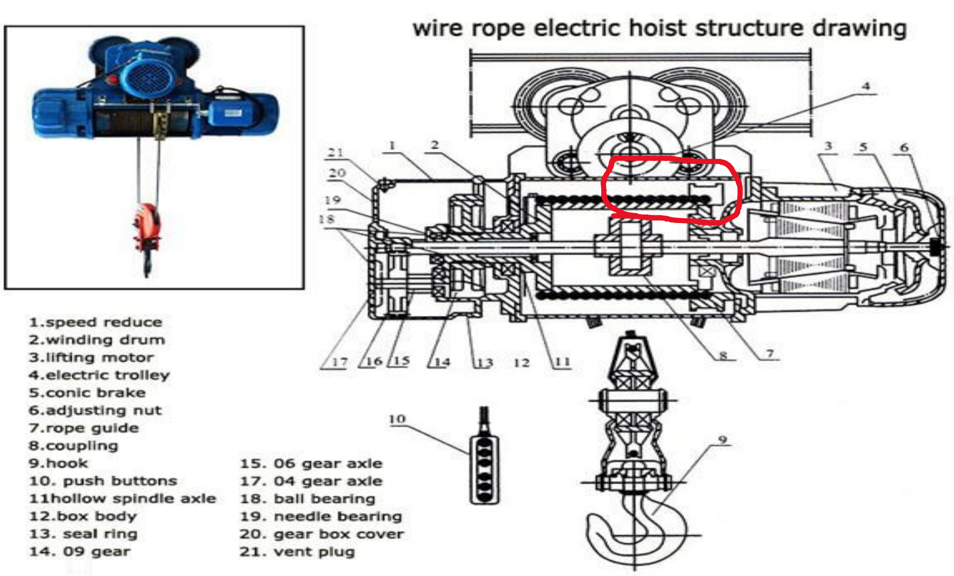

Fig. 4.1 Position of Connecting Link

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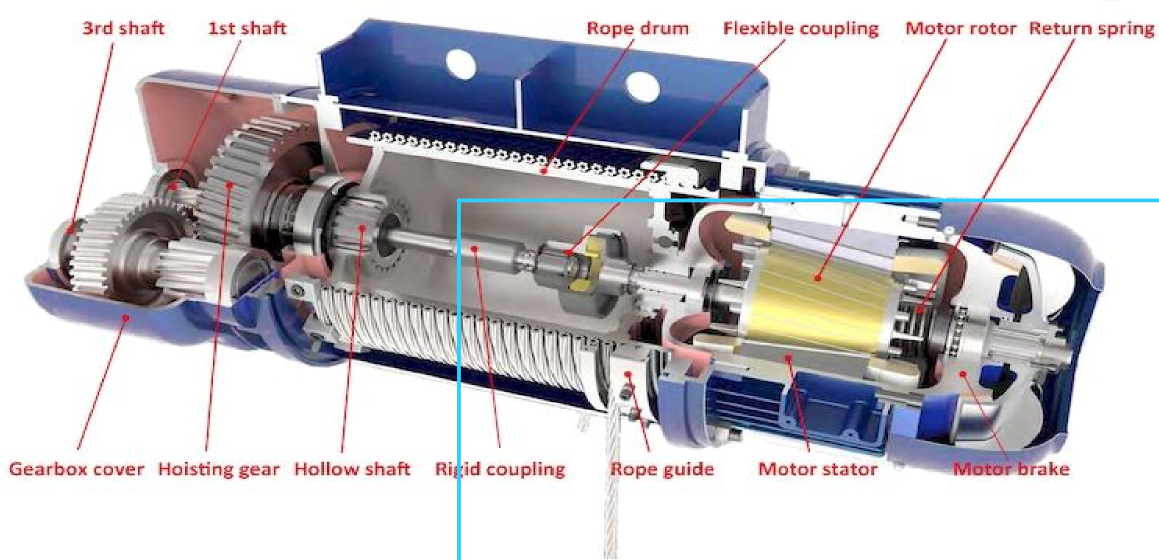

Fig. 4.2 Position of Connecting Link

Component of hoist mechanism are as follows
1) *Motor*
2) *Integrated brakes*
3) *Controls*
4) *Wire rope*
5) *Hoist drum*
6) *Load block*
7) *Load hook*

II. LITRATURE REVIEW

Sumit P. Raut , Laukik P. Raut, is described that, This project report is about, "A Review of Various Techniques Used for Shaft Failure Analysis". There are so many type of methodology use for calculating the failure analysis of the rotating shaft used in different type of application by so many authors are reviewed in this paper. In present paper, there are so many comparison of different methodology used, their application and drawbacks by various author. The main objective of today work is to study the different methodologies used for shaft failure analysis and to select the best methodology suitable for the failure analysis of rotating shaft used in gear box which is mounted on the overhead crane in order to prevent repetitive.[1]

Hariom, Prof. Vijoy Kumar, Dr. Chandrababu D, is described that, This project report is about "A Review of Fundamental Shaft Failure Analysis". In this review paper we are trying to gives the insight of various analysis are to be carried out to identify the cause of shaft failure. Usually roller shaft failure can be optimized by preventive mechanical maintenance process. Also using safe design with proper manufacturing procedure. These are so many literature has been systematically compared as well as reviewed to get a perfect reason of shaft failure analysis. As we knows every methodology has it positive as well as negative results as compared to one another used by specific industrial segment. Failure of shaft in running condition leads to unnecessary shutdown which ultimately cause the production time disturbance or can say barrier in continuous production time. The main objective of this paper is to study each and every failure condition of shaft and choose the best method to overcome that failure.[2]

III. DESIGN CALCULATION OF CONNECTING LINK

Specifications
Material = EN 24
L = total length of rod,
d_1 = small diameter of rod,
r_1 = small radius of rod ,
d_2 = larger diameter of rod,
r_2 = larger radius of rod,

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D = diameter of helical gear,
R = radius of helical gear,
No. of teeth = 16 (helical gear),
Power = 5.5 kw or 7.5 HP,
weight of motor = 35 kg,
Power factor = 0.75,
Motor Efficiency = 82 %,
Motor RPM (N) = 1400 rpm

A. Shaft subjected to twisting moment,

$$\frac{T}{J} = \frac{\tau}{R}$$

- Torque,

$$T = \frac{P*60}{2\pi N} \text{ N-mm or N-m}$$

- Polar moment of Inertia for solid circular shaft,

$$J = \frac{\pi * d_1^4}{32} \text{ mm}^4 \text{ or m}^4$$

- Shear stress,

$$\tau = \frac{T * r_1}{J} \text{ N/mm}^2 \text{ or N/m}^2$$

B. Shaft subjected to Bending Moment,

$$\frac{M}{I} = \frac{\sigma}{y}$$

- Tangential force on Helical gear,

$$F_t = \frac{T}{R} \text{ N}$$

- Reaction at right hand side,

$$R_1 = \frac{F_t * L_1}{L} \text{ N}$$

- Bending Moment at section where gear sits,

$$M_1 = R_1 * L_2 \text{ N-mm or N-m}$$

- Radial force,

$$F_r = F_t * \tan\alpha \text{ N}$$

- Bending Moment due to radial force in a vertical plane in gear section,

$$M_2 = = \frac{F_r * L_1 * L_2}{L} \text{ N-mm or N-m}$$

- Resultant Bending Moment of shaft at a section where gear is mounted,

$$M = \sqrt{M_1^2 + M_2^2} \text{ N-mm or N-m}$$

- Moment of Inertia of solid shaft,

$$I = \frac{\pi * d_1^4}{64} \text{ mm}^4 \text{ or m}^4$$

- Bending stress,

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{\sigma}{r_1}$$

$$\sigma = \frac{M}{I} * r_1 \text{ N/mm}^2 \text{ or N/m}^2$$

C. Shaft subjected to combined Twisting & Bending Moment

- Maximum Shear Stress Theory or Guest's Theory,

  $\tau_{max} = \frac{1}{2}\sqrt{\sigma^2 + 4\tau^2}$ N/mm^2 or N/m^2.[16]

- Equivalent Twisting Moment,

  $T_e = \sqrt{M^2 + T^2}$ N-mm or N-m

- Maximum Normal Stress Theory or Rankine's Theory

  $\sigma_{max} = \frac{1}{2}\sigma + \frac{1}{2}\sqrt{\sigma^2 + 4\tau^2}$

- Equivalent Bending Moment,

  $M_e = M + \sqrt{M^2 + T^2}$ N-mm or N-m

- Equivalent (von- Mises) stress = $\sqrt{3\tau^2}$ N/mm^2 or N/m^2.[18]

For design a shaft is to use the ASME code. According to this code, the permissible shear stress Ta for shaft without keyways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of material whichever is minimum,
The material uses for connecting link is EN 24.[17]
Hence, $S_{yt} = 470$ N/mm^2
$S_{ut} = 689$ N/mm^2
For Maximum stress, $\tau_{max} = 0.3 * S_{yt} = 0.3 * 470$
$\tau_{max} = 141$ N/mm^2
Similarly, $\tau_{max} = 0.18 * S_{ut} = 0.18 * 689$
$\tau_{max} = 124$ N/mm^2
The small value from this two is 124 N/mm^2 and keyway is present on connecting link so the value are to be reduced by 25%.
Permissible shear stress = O.75 * τ_{max} = O.75 * 124
= 93 N/mm^2
Thus for safe design, if the actual stresses develop in shaft will less than the permissible shear stress then shaft is safe for current design.

IV. CONCLUSION

In this work we have study the design approach for failure of connecting link of Electric overhead Traveling crane. We conclude that if actual stresses developed in connecting link will less than the permissible shear stress then the design of connecting link is safe. For future scope, we can say that this project is very useful for design a shaft.

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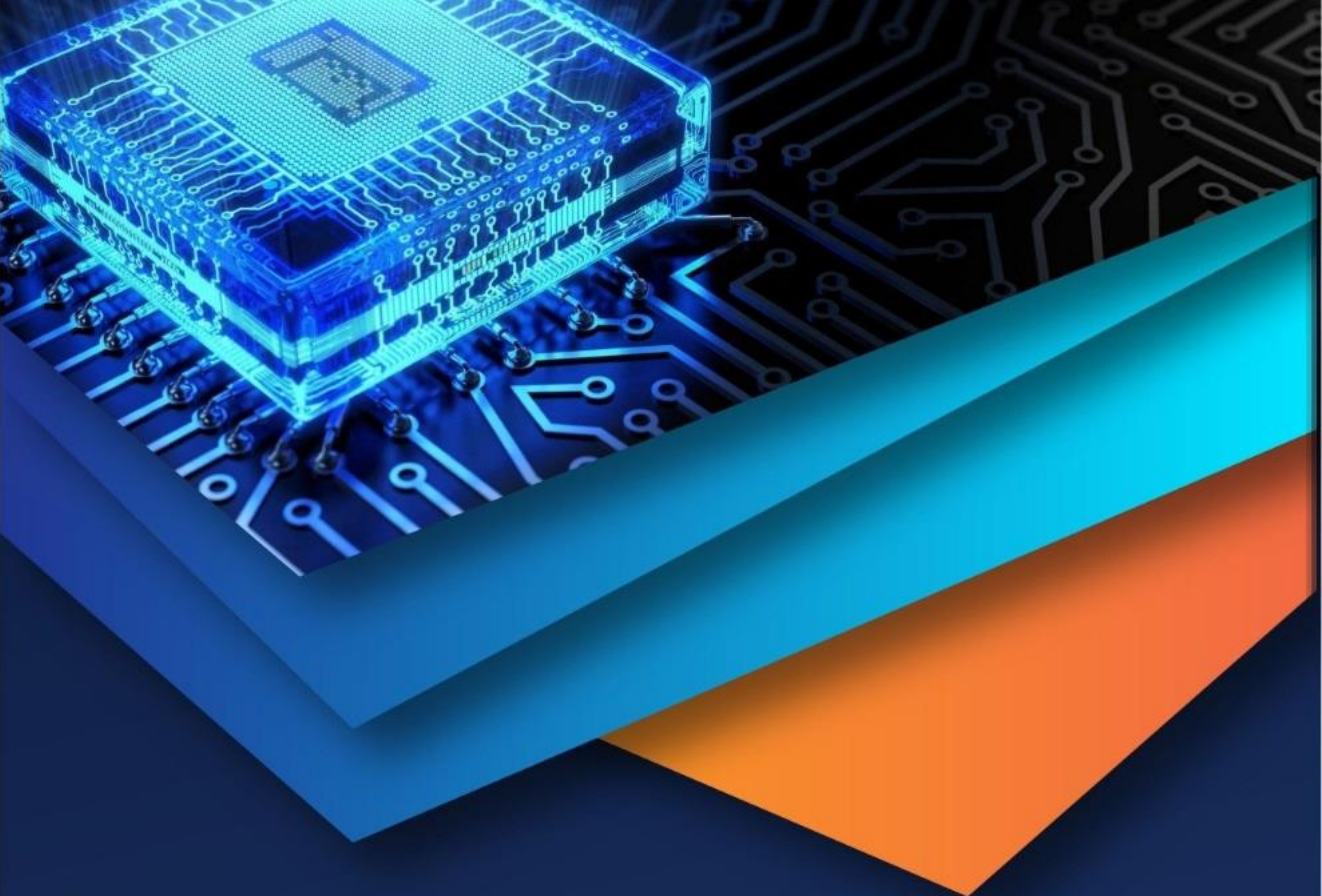

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