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International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.43359

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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 V May 2022- Available at www.ijraset.com

A Review of Failure Analysis of Different Part of Electric Overhead Traveling Crane

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Abstract: ***This review paper gives the discrimination of various failure analysis accomplish to find Crane hook, Rope, Rope Drum, Coupling, Gear and Motor Shaft failure. These are very significant parts of EOT crane used for lifting, lowering and move with the help of links or rope and highly liable component which are always subjected to failure due to amount of stress, dynamic and statistic load concentrations which can lead to its failure. To minimize the failure of different part of EOT Crane by Using safe design with appropriate manufacturing processes and obstructive mechanical maintenance techniques. Failure of any parts of crane causes the unneeded shutdown and its lead to heavy loss. The main aim of this paper is to study various component of EOT crane failure analysis and finding out root cause failure of different parts of crane. Through this paper various literature have been comprehensively compared to get Crane hook, Rope, Rope Drum, Coupling, Gear and Motor Shaft failure analysis.***

Keywords: Crane hook, Rope, Rope Drum, Coupling, Gear and Motor Shaft, Stress, EOT Crane, techniques, etc.

I. INTRODUCTION

Electric overhead Travelling crane is a machine which is lift, lower and move heavy material from one place to another in a precise manner in industry or construction sites. It is equipped with hoist mechanism contains motor, pulley, rope drum, coupling gear and motor shaft, etc. Electric overhead Travelling crane are widely used in many industries under safe working load. capacity of cranes depend on the types of crane and purpose of industry. Cranes are used in manufacturing industry, construction sites, transport industry for loading and unloading. Due to this random loading and unloading Crane hook, Rope, Rope Drum, Coupling, Gear and Motor Shaft failure occurs in EOT Crane. Various type of overhead cranes used in industry are single girder cranes, double girder crane, gantry crane and monorail, etc. Basic component of electric overhead crane are girder, end carriage, hoist, hoist cable, crane hook, rack and pinion mechanism, pulley, runway, runway rail, trolly, motor, etc.

II. LITRATURE REVIEW

The various literature available of web, book, manual were reviewed and the literature related to failure of different component are discussed. The various components for which the review is done are connecting link, gears, cable, etc.

A. Coupling

1) R Grega, M Kacir, J Krajnak is described that, This project report is about “failure analysis of flexible coupling by self heating”. In this paper, In order to reduce torsional vibration in shaft, mostly flexible coupling are to be used. The incorrectly attributed to overload of coupling causes failure in the flexible parts. The objective of this article to study and conclude that self heating occurs in flexible coupling by the experimental analysis. The main reason of failure of flexible coupling is self heating which cause increase in the temperature we can studied the experimental identification of self heating occurs in various type of flexible coupling. Although these coupling are design different, they are used for a torque.[1]

2) Kondru Nagendra Babu, Dr. D Suneel, is described that, This project report is about “Failure Analysis of Flange Coupling with Two Different Materials”. In this paper, A coupling is a device which transmit power from motor to gearbox by connecting links and these connecting link called shaft. Electric motor shaft and output shaft are couple in flange coupling. And these may be slip or get disconnected depending upon the torque limit. Power transmission through this system is very effectively without losing of power and torque. They can last long if maintained properly. Main purpose of this paper is to deals with the possible cause of failure for a flange coupling which can occurs mostly at the area of contact of coupling and shaft analysis of such failure analyze solution, To minimize the failure occurs. The model of flange coupling has done in ANSYS for finite element analysis. Select proper material and stress concentration point. After this, a different material means better one which would withstand more amount of stress and failure results has noted. After results comparison made and suggestion has prescribed.[2]

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3) Kondru Nagendra Babu, Syed Chandpasha, Khatroth.Dattaterya, Kachve Jathin, is described that, This project report is about "Design and Failure Analysis of Flange Coupling with Uniform Strengthen Bolts" In this paper, Flange coupling is a device to transmit power and torque by connecting of two rotating shaft of different diameter. Flange coupling permitting some degree of misalignment of rotating shaft. The main purpose of this paper is to increase the strength of bolt and reduce stress. The stress in the shank would be smaller than that in the threaded part of the bolt. So that larger portion of the stress would be absorbed at the region of the threaded portion which can fracture the tread part because of tits length. Design of flange coupling has done in CATIA and analysis has done in ANSYS. After experimental observation of ANSYS analysis and theoretical calculation, it is conclude that the design is safe.[3]

B. Crane Hook

1) Mahesh Solanki, Antriksh Bhatt, Anilkumar Rathour, is described that, This project report is about "Design, Analysis and Weight Optimization of Crane Hook: A Review" In this paper, Crane hook are very consequential and highly liable component used for loading, unloading, lifting and lowering material with the help of rope or chain. Failure occurs in the crane hook due to the amount of stress concentration. The main purpose of this present work is to study the different design specification and induced stress in crane hook. To minimize induced stress concentration on crane hook in its loaded condition for different cross section, the design and drafting of crane hook would be done by using ANSYS 14.5 Finite element analysis and the stress which is to be found to be in various cross section are compared with design procedure. For strength, durability evolution of structure and machine element. The stress concentration factor are used. In this present work also we investigate that the weight reduction.[4]
2) Dr. P. Ravikanth Raju, Somagani Upendar, is described that, This project report is about "Design And Analysis Of A Crane Hook" In this paper, The present study of this paper is to design of the crane hook has done by analytical method and also design analysis is done for different material. Material selection for design are wrought iron, forged steel and high tensile steel. Crane hook is important part of crane used for lifting and moving load with the help of wire rope, chain and links. Crane hook failure occurs due to bending stress and deformation. To reduce this bending stress, first study the induced stress area. It help to minimize the failure of crane hook. The continuous use of crane for loading and unloading of material or object. It may be cause failure. Design calculation has done by analytical method and model design in Cad software and analysis done in ANSYS. After comparing results by analytical method and FEA analysis the design is safe and have higher capacity of loading and unloading of material.[5]
3) S. K. Lakshmana Moorthy, B. Prakash, is described that, This project report is about "Design and Analysis of Crane Hooks of Different Cross Sections Made of Hardened-Tempered Alloy Steel AISI 6150 and AISI 4140" In this paper, the stress, strain and deformation of crane hook has studied while subjected to continuous loading and unloading at its curve inner surface. the maximum stress are developed at its curve inner surface and the failure due to random loading and unloading occur at this curvy inner surface. Design of crane hook would be done in solidworks software. Finite element analysis has done in ANSYS 15.0 software. Determine stress, total deformation and strain in ANSYS by applying loading condition, material selection properties and supports. After experiment of different material and shape of crane hook. It may be conclude that the trapezoidal shaped made of hardend and tempered alloy steel has well suitable for crane hook.[6]

C. Key and Keyway

1) Felix Kresinsky, Erhard Leidich Is described that, This project report is about "Different Failure Mechanisms in Keyed Shaft-Hub Connection under Dynamic Torque Load". In this paper, A design of keyed shaft-hub connection is to transmit power torque without losing in the shaft driving system. Failure occurs in this system stress generate due to random loading and unloading of material. And create uncertain gaps. Also failure occurs at keyway of shaft, to minimize this failure. Keyed shaft-hub connection would be experimentally investigate and analyze due to torsional loading and stress. First way to design keyed shaft-hub connection is the maximum permissible contact pressure in the keyway and it will increases so this cause unacceptable plastic deformation of the keyway. Secondly, is the fatigue strength of the shaft or connection. The result are compared and observed after large amount of experiment of keyed shaft-hub connection under torsional loading and dynamic load, most of the investigation focused on cause of plastic deformation of the keyed shaft-hub.[7]
2) Mithilesh Kumar Sahu, Pardeep, is described that, This project report is about "Optimization of the Keyway Design with Consideration of Effect of Stress Concentration on Different Materials" In this paper, Key and keyway are used for coupling purpose of rotating shaft. It is also called shaft-hub connection. Failure of key and keyway occurred due to twisting moment,

and shear stress concentration in specific area of shaft hub connection. The main purpose of this paper is to finding out the stress contact point and analyze the results obtaine by analytical method and analysis by ANSYS(11.0). This analysis has done for different shapes of key and keyway by selecting different material. Failure occurs at shaft and keyway in shaft connection is due to shear stress. The fatigue life of key and keyway would be improved as compare to simple rectangular key and square key by providing fikket and chamfer at corners. To obtain minimum magnitude of maximum shear stress, shaft should have made by stainless steel and having keyway with circular fillet in compare to different material and shapes used for analysis.[8]

3) Swati Verma, S. K. Srivastava, is described that, This project report is about "Effect of Keyways in the Design of Drive Shaft: A Case Study" In this paper, The interruption in drive shaft appear due to presence of keyway, groove and crack, etc. The main reason to present paper is to study the equivalent stress, maximum shear stress and total deformation produced in circular solid shaft and hollow shaft in the presence of keyway. The volume of material does not change, its constant. In the solid drive shaft, the effect of different shape of keyway are studied with respect to their equivalent stresses; maximum stresses and deformation under the action of provided torque. The 3D modeling design and analysis of solid shaft have done using ANSYS software. After analysis of solid shaft it conclude that rectangular keyway is much better than the other shape of keyway from the design point of view of drive solid shafts.[9]

D. Rope Drum

1) Jayakiran Reddy E, bhanodaya Kiran Babu N, Bala Raju A, is described that, This project report is about "Reverse Engineering Technique for Enhancing the EOT Crane Rope Drum". In this paper, Electric Overhead Traveling Crane is used in the many industry for loading and unloading of material and place material from one location to another. For maximizing the efficiency of Electric Overhead Traveling Crane, the industry apply different approaches. One among them is reverse engineering approach. This approach would be prescribed to improve the efficiency of the Electric Overhead Traveling Crane drum shaft. To improve the drum shaft loading capacity, efficiency and life the proposed drum shaft has equipped with the gear sleeve and gear hub.[10]

2) Digvijay D. Patil, Prof. Kiran M. Narkar, is described that, This project report is about "Design and Finite Element Analysis of Rope Drum and Drum Shaft for Lifted Material Loading Condition". In this paper, The objective of present work is to study load calculation and design of rope drum and drum shaft for a maximum material load to be lifted. When object is lifted but the hoist mechanism, the drum shaft has braked to hold the load and transport to other location and unloading. So the load is directly acts on rope drum, drum shaft and wire rope. In this paper, the computer aided model of rope drum shaft assembly prepared in CATIA V5. Rope drum shaft assembly model is converted into IGS and STP format and put it into ANSYS software for finite element analysis.[11]

3) Haixiang Xu, Fengqi Wu, is described that, This project report is about "The Analysis Of Crane Drum Brake's Frictional Behavior Based On Adams". In this paper, Crane drum brake is most important safety equipment. The function of crane drum brake is stopping the hoist mechanism and travelling mechanism and assurance of lifted load would be perfectly braked and decelerated. The performance of crane drum brake depends on temperature, friction coefficient of friction material, vibration of brake during braking, smoothness of contact surface and influence of complex environment, etc. The main purpose of this paper is to analysis the change of friction factor under the influence of relative sliding speed and load. ADAMS software has used for finite element analysis.[12]

E. Wire Rope

1) Goutam Mukhopadhyay, Ankush Sharma, Sandip Bhattacharya, is described that, This project report is about "Failure Analysis of Wire Rope of Ladle Crane in Steel Making Shop". IN this paper, Wire rope of ladle crane in steel making shop has failed after nine month of service. Wire rope is a 6*36 construction wire rope conforming to IS 7904 : 1995-X grade. It has high carbon steel. After investigation of wire rope the reason of failure occurs due to broke strands with dry damaged core and inner core strands nicking along its length. Insufficient lubrication provide to wire rope results in dry core. The fracture point of wire rope exhibited chisel shaped marks. This chisel shaped marks showed using SEM in Fractography. The assign bending fatigue consideration of rope diameter, sleave diameter, co-efficient of sleave shape, factor of safety, metallic area and working load would be check in the six month of span. Microstructural investigation also draw pearlite in the matrix. Irregular lubrication led to fretting wear between the internal wires. Changing of the schedule of the wire rope from 9 to 6 month would be recommended. The appropriate investigation and application of heat resistant lubricant. The heat resistant lubricant are micronized solid lubricant molybdenum. This should be apply to avoid such failure in future.[13]

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2) El Barkany, A. Benali, M. El Ghorba, A. Choukir, is described that, This project report is about "The Inspection of Crane Wire Ropes in Moroccan Service: Discard Criteria and Monitoring Procedure". In this paper, In crane hoisting mechanism safe use of wire rope is pivotal for crane operation. Safe used of wire rope depend on rope inspection and rope condition. The objective of present work is to failure occurs in wire rope in service in MOROCCO. In this paper, wire rope defects and condition of a wire rope would be studied. Specially focused on condition that may assist to internal damage such as wear, broken wire and corrosion. Visual inspection electromagnetic and radiography nondestructive test are used in wire rope control. Form the result of this testing it is found that safety status of wire rope. It is conclude that the inspection and maintenance must be applicable after a specific time period.[14]
3) Shaiful Rizam Shamsudin, Mohd Harun, Mazlee Mohd Noor, Azmi Rahmat, Rohaya Abdul Malek, is described that, This project report is about "Failure Analysis Of Crane Wire Rope". In this paper, The main purpose of this paper is to study the failure of multi strand wire rope due to fracture. The wire rope consist of one central strand and six strands around it. The diameter of large wire was around 1.52 mm – 1.78 mm and small wire was 0.78mm – 0.94mm. The smaller wires were fracture in a ductile way under external load and larger wires were fracture by cyclic torsional stresses.[15]

F. Drive and Gear Shaft

1) Zeljko Domazet, Francisko Luksa, Miro Bugarin, is described that, This project report is about "Failure of Two Overhead Crane Shaft". In this paper, Failure occurs in two overhead crane shaft. Due to rotating bending fatigue failure occurs at drive shaft and gearbox shaft of an two overhead crane. Fracture is observed in the two overhead crane drive shaft in small radius fillet between the two different diameter of drive shaft. After experimental investigation a new drive shaft of two overhead crane would be made with larger size fillet and result is to minimize stress concentration in the region. The failure of gearbox shaft occurs in the intersection of two stress raises due to a change in the shaft diameter and keyway corner. A new two overhead crane gearbox shaft would be made with a larger size fillet and radius of keyway corner to minimize stress concentration. In both case of two overhead crane drive shaft and gearbox shaft would be replaced install coupling by gear coupling. Gear coupling allow parallel and angular misalignment and avoid additional load due to misalignment. This experimental analysis with a change in the structural details.[16]
2) Sumit P. Raut, Laukik P. Raut, is described that, This project report is about "Failure Analysis and Redesign of Shaft of Overhead Crane". In this paper, The present study of this paper deals with the failure analysis of shaft of overhead crane and redesign the shaft. The crane having capacity of 25 tonne. Shaft failure occurs due to torsional load, low tensile, compressive stresses and dynamic load. shaft fails in gearbox which is mounted in hoist system of overhead crane. To find out the reason of failure of shaft in gearbox, it is necessary to 3D modeling of shaft in Pro-E/CATIA software then finite element analysis in ANSYS 11 software and compare the analytical and ANSYS results. The shaft has redesigned with suitable material.[17]
3) O. A. Zambrano, J. J. Coronado, S. A. Rodrıguez, is described that, This project report is about "Failure analysis of a bridge crane shaft". In this paper, The main reason to present paper is to study the shaft of bridge crane fractured in the keyway with evidence of fatigue . For fatigue analysis of shaft, the chemical analysis, fractography, micro-structural characterization, finite element simulation and hardness measurement were used. The microstructure was mostly abated martensite; greatest amount of manganese, sulfite micropores and oxide inclusions were found. Because of these factor fatigue failure occurs. For precaution, first assure the chemical composition and microstructure of the material then use magnesium or calcium additives in the steel casting process after these all, achieve the design parameter recommended by the standard to avoid high stress concentration factor.[18]

G. Hoist Mechanism

1) Dhaval H. Kanjariya, is described that, This project report is about "A Review on Design and Analysis of Hoisting Machinery in EOT Crane". In this paper, Electric Overhead Traveling Crane is material handling used in industry because of fast speed, safety reliability, economy, etc. there are many component used for hoisting mechanism in Electric Overhead Traveling Crane. Hoisting mechanism consist of rope drum gearbox shaft, coupling, drive shaft, motor, etc. the main aim of this paper, discussed about various part of hoisting mechanism. Design calculation and analysis of various part of hoisting mechanism carried out by using Finite element Analysis.[19]

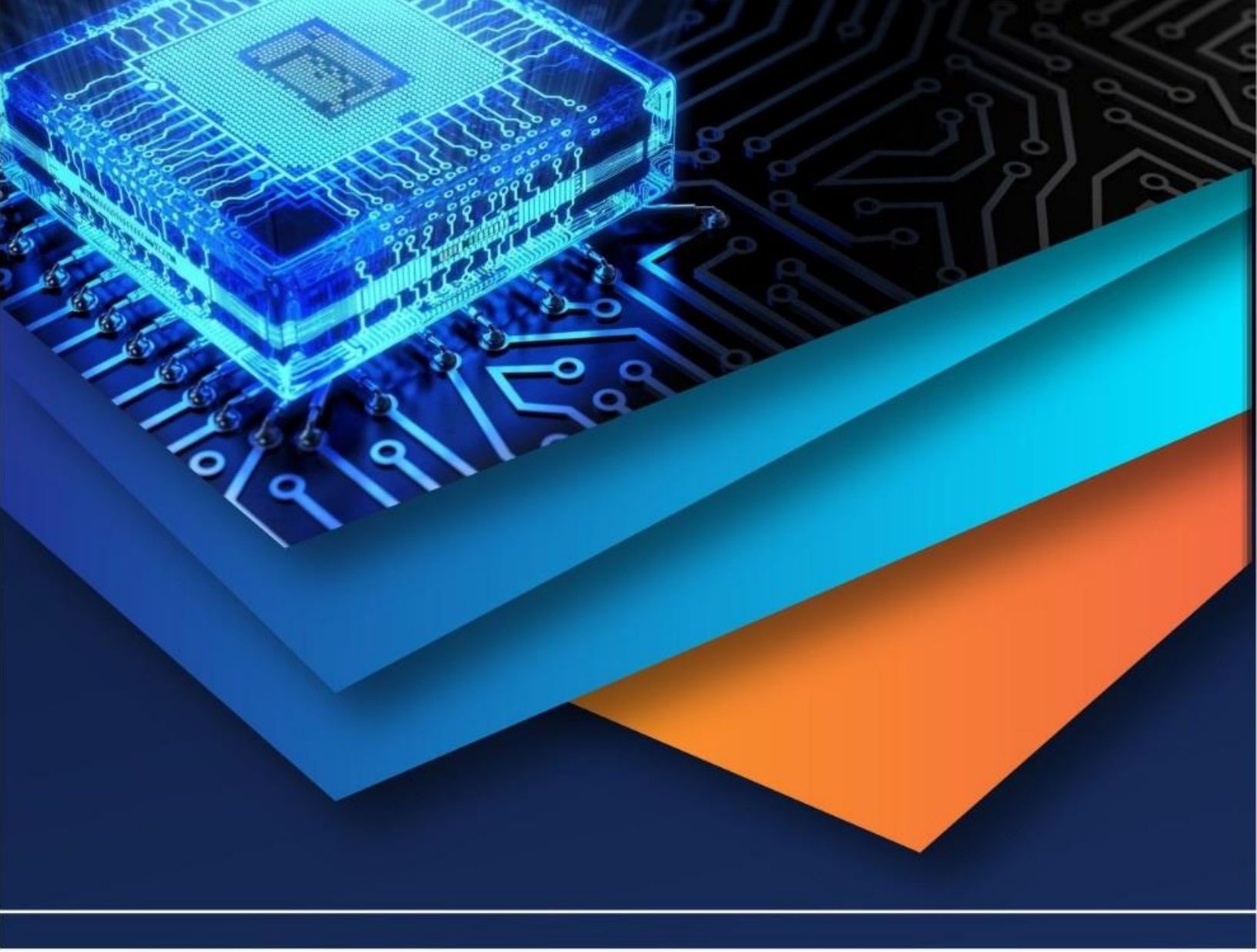
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III. CONCLUSION

In this work we have reviewed the work done on Electric overhead Traveling crane, basic component of EOT Crane. For different component used to perform function. There is rope drum, gearbox shaft, drive shaft, motor, coupling, breaks used in hoisting mechanism. Hoisting mechanism is used for lifting, lowering the material and also move it horizontally

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