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Analysis of the Crane Girder

Abhijeet Singh

Assistant Professor,
Mechanical and Automation Engineering, Amity University Jharkhand, India

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Abstract – A crane is a machine that is used to raise and lower loads as well as move them on a level plane. Overhead cranes have been used enormously for such movement of goods in an industry. Amongst the different components of an electric overhead transport crane (EOT), girders have been an important one. The entire weight of the crane consisting of the load as well as self-weight rests on the girder, hence the proper designing and analysis of the girder becomes very important for the safe running of the crane. The current study deals with the numerical analysis of an EOT girder for the deflection that occurs in the girder under the prescribed load of the crane. The analysis shows that the deflection occurring in the girder at the highest load is under the acceptable limit.

Key Words: EOT crane, Girder, ANSYS, CATIA

1. INTRODUCTION

A crane is a machine that can raise and lower goods as well as move them on a level plane. It is often equipped with a derrick, wire ropes or chains, and piles. It is mostly used to lift heavy objects and transport them to various locations. It makes use of at least one fundamental machine to provide mechanical benefit and so move loads beyond a man's normal capacity. Cranes are commonly used in the automobile industry for freight stacking and dumping, in the construction industry for material development, and in the assembly industry for gathering heavy hardware.

The first development cranes were created by the Ancient Greeks and were powered by men or load animals like as jackasses. These cranes were used in the construction of towering constructions. Harbor cranes were familiar with loading and unloading ships and assisting with their construction in the High Middle Ages; some were even placed into stone pinnacles for added strength and solidity. The oldest cranes were made of wood, but as the Industrial Revolution approached, cast iron and steel took control.

1.1 Literature Review

Jacek Olearczyk , Mohamed Al-Hussein, Ahmed Bouferguène[1] proposed a philosophy for the crane determination process and acquaints numerical calculations with evaluate the development of multi-lift tasks. In such manner, appropriate crane choice and site design enhancement can essentially expand efficiency and abbreviate the lifting plan. The measured lift process is separated into three phases: crane burden and limit check, crane area, and blast and super lift freedom. Each stage's boundaries are presented, broke down, and graphically clarified. The strategy rationale is upheld by a summed up numerical calculation and is applied and tried on a contextual investigation.

Eihab M. Abdel-Rahman, Ali H. Nayfeh, and Ziyad N. Masoud [2] examined crane models that were written down, grouped them, and discussed their uses and limitations. The most often used crane model is broken down in a summarised layout. They also evaluate crane control approaches in writing, organise them, and investigate their uses and limitations. It also recommends appropriate models and control standards for various crane applications, as well as bearings for future development.

The idea of retrofitting current pinnacle cranes with self-loader devices for movement control is investigated by Yehiel Rosenfeld and Aviad Shapira[3]. The suggested changes are intended to increase the cranes' competency and capacity to deal with the challenges of today's heavily scheduled construction projects. The idea offered by the suggested upgrades acknowledges the large distance route of the crane's snare and the fine movement in the stacking and dumping zones, based on work studies and research of prolonging cycles. The regular financial benefits resulting from the update of the crane's exhibition, in terms of the two types of movement, significantly outweigh the cost of integrating the many gadgets.

A.Z. Garni, et al. [4] honed down on the problem. It is proposed that a nonlinear, unique model of an overhead crane be developed that covers concurrent travel, cross, and lifting/lowering operations. Nonlinear critique forms of control are explored, and mathematical results are obtained in order to satisfy set limit requirements and practical imperatives for states and controls while limiting the influence and last time. The results demonstrate that the crane may be moved to the desired location in the shortest time possible while reducing the impact of the heap during the transfer and at a certain time using the proposed control layout. A few mathematical aftereffects of the controls, objectives, and states are provided, demonstrating how well the suggested approach works.

Eugeniusz Rusinski, Artur Iluk, Kazimierz Malcher, and Damian Pietrusiak [5] issued a study that examines the causes of the turbogenerator corridor disaster. The potential circumstances of the event was recreated using information from the crane administrator, witness, and the Office of Technical Inspection report. The rotor drop was the result of a contemporaneous occurrence of a development of negative variables, according to the mathematical reproduction and examinations of the presented evidence. The document lays down the events one by one, highlighting all of the causes that contribute to the mishap's recognised status.

A.A. Marquez , et al. [6] , Catastrophic disappointment of cranes is a possibly extremely risky occasion and has regularly deadly results. The disappointments of two cranes are examined in this review. The two cranes have various plans, however normal underlying drivers have been recognized, connected with lacks in the plan and development of their bases. Striking likenesses in disappointment conditions are examined in this review. These remember blunders for the distinguishing proof and understanding of past side effects, in the relief measures embraced and, in the dangers, accepted by faculty, because of absence of data and preparing. The cranes are thin designs exposed to huge burdens that produce substitute anxieties in the bases. The impacts and ramifications of variable burdens are regularly not totally perceived or esteemed by developers and administrators, which are utilized to manage characteristically static burdens. A regulating hole in the recognizable proof of liabilities getting from the gear lease or deal contracts has been distinguished and is examined. At long last, these disappointments stress the significance of early signs. Frequently, what gives off an impression of being a minor hitch ends up being a dangerous fiasco.

The disappointing assessment of two overhead crane shafts was presented by. Domazet, F. Luka, and M. Bugarin[7]. The break in the overhead crane drive shaft started in a little range filet between two diverse shaft widths. Another shaft was created with a larger fillet, resulting in a decreased pressure concentration in this area. The failure of the overhead crane gearbox shaft began at the spot where two pressure raisers crossed, when the shaft distance across was adjusted, and in the keyway corner. To restrict pressure concentration in this area, another shaft was created with a larger fillet and a larger size range of the keyways corner. In both situations, the introduced couplings were replaced with gear couplings to allow for equal and rakish misalignment as well as avoid additional weight due to misalignment. The investigation reveals that by altering the major nuances, the weakness life might be substantially extended.

Apeksha.K.Patel, Prof. V.K.Jani[8], examined with regards to the plan estimation of the parts that partake in raising instrument of an electric overhead crane(E.O.T.) . Other primary piece of the EOT crane, the brace on which the whole raising parts are mounted over a crab is likewise talked about and broke down utilizing ANSYS.

Abhinay Suratkar, Vishal Shukla[9] examined the plan of an electric overhead crane and its parts alongside the support. A twofold brace EOT crane was analyzed. The brace of which was a container type support. The cross-part of the case support was displayed utilizing a demonstrating programming and afterward utilizing a 3D planning programming the whole construction of the brace was displayed. In the wake of demonstrating utilizing an examination apparatus the model was broke down by applying the heap and the diversion and stresses were estimated. Because of this review, a plan streamlining strategy for an overhead crane is proposed.

Sung Pil Chang, Jeong-In Suh [10], studied to see if the Latin Square Design Method was useful in determining the strength of links and to evaluate the crucial exhaustion behaviour of wire ropes used as holders in designed overpasses. For confirmation, three boundaries were used: mean pressure, stress reach, and example length. Except for pressure range, the effects of these restrictions are debatable. These three chosen bounds were revealed to be enormous. The influence of the pressure range was consistent with our expectations, while the impact of the example duration was unexpected. It was also discovered that the influence of mean pressure was dependent on the level chosen. As a result, the Latin Square Design Method may be used to confirm the limits that determine fatigue behaviour under symmetry.

Raimee B. Mazlan[11], Yunan Prawoto, Yunan Prawoto, Yunan Prawoto, Yunan Prawoto, Yunan Prawoto, Yunan Prawoto, Yunan Prawoto, Yunan Prawoto, Yunan Prawoto, Yunan Prawoto, Yu It includes tested hypotheses as well as computational, mechanical, and metallurgical representations. The basic technique used allows one to grasp the basic concept of wire rope and use it to research, planning, and field disappointment investigation.

C. R. Chaplin[12], The unavoidable weakening of wire rope in help is talked about with an outline of the results as far as investigation and substitution rules. Subtleties are introduced of explicit debasement components saw in three distinct applications: a mine lift rope working on a drum winder, a securing rope for a seaward construction and a twist safe single-fall seaward crane rope. For each situation the systems are dissected, and steps illustrated to mitigate the issues. It is inferred that speculation is unseemly: support, examination and dispose of strategy still up in the air in acknowledgment of the debasement instruments that work in various rope applications.

Another model for reproducing the mechanical reaction of a wire rope with an autonomous wire rope centre was introduced by D. Elata, R. Eshkenazy, and M.P. Weiss[13]. The rope is subjected to a pivotal load as well as a hub force. Unlike previous models that took into account the strong reactivity of wound strands, the new model fully considers the twofold helix configuration of individual wires inside the injured strand. This allows the wire level pressure to be directly related to the whole burden delivered at the rope level. Individual wire fibre reactions are predicted by the model. Two elective kinematics of the wires are thought of and used to foresee the rope's adaptable reaction. The suggested kinematics have been conceptually accepted, and the expected rope reaction matches fresh trial data. The new model allows for the extraction of pressure at the wire level, which may be used to assess global aspects of the rope such as the power relationship between wires, rope stiffness, strength, and weakness life.

2. ANALYSIS OF THE CRANE GIRDER

Overhead voyaging EOT crane comprise of three essential movements for example lifting, long travel and cross travel. A twofold brace EOT crane is worked of welded box type development with underlying steel plate. A twofold box support is fitted to end carriage gathering through stray pieces. A streetcar get together is put on the rails which are welded to twofold box brace. The twofold box braces are exposed to cross over and horizontal burdens by oneself load of the crane, the appraised (snare) load, oneself load of streetcar and the powerful loads. With a twofold box support development, the streetcar runs over the braces. A commonplace part of box support displayed in Fig. 1.

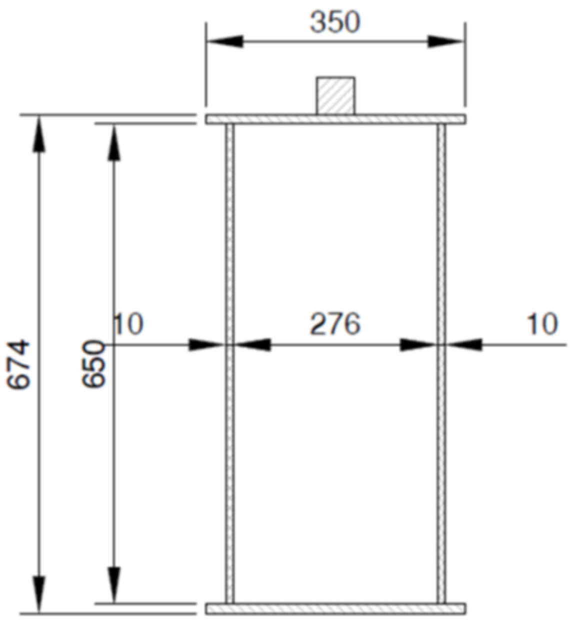

Fig.1. Typical cross section of box girder

STEPS

Step 1: Designing of the cross-section of the girder using CATIA

The cross-section of the box girder is being made using the designing software CATIA which is being shown in figure 2.

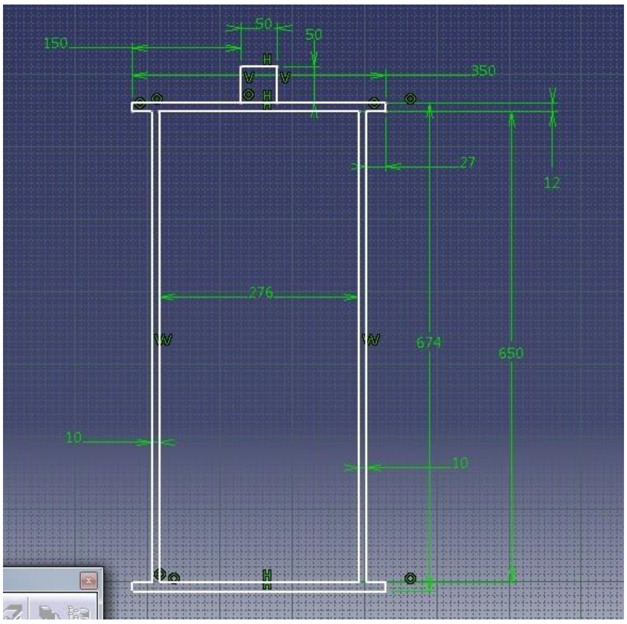

Fig.2. Cross section of box girder using CATIA

In order to get the complete length of the girder, the extrude option was used to the given cross-section and the length was extended to the required length. And then use the mirror option to get the double box girder. Figure 3 shows the picture of the double girder formed after the use of mirror image in CATIA.

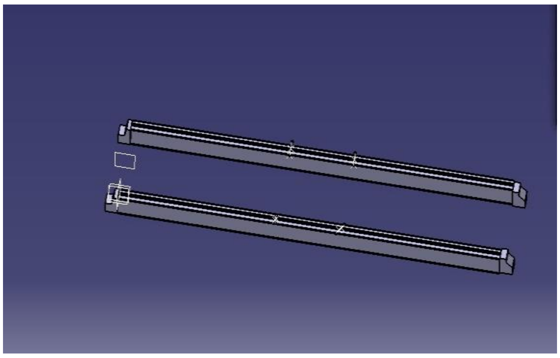

Fig. 3. Extruded double girder

Step 2: Analysis of the structure

Save the above CATIA file into .igs format and proceed for the analysis of the girder using ANSYS.

Go to the structural analysis tab in ANSYS. A dialogue window appears, from which you may choose geometry and import the igs file. The geometry window appears, and you can quickly examine the coordinates by selecting the coordinate option. The boundary conditions have been specified as a fixed constraint once the material has been assigned. A mesh is then constructed. The total number of nodes produced was 3471, with 9498 components. A triangular type element is employed in this investigation. Figure 4 shows the solid mesh model.

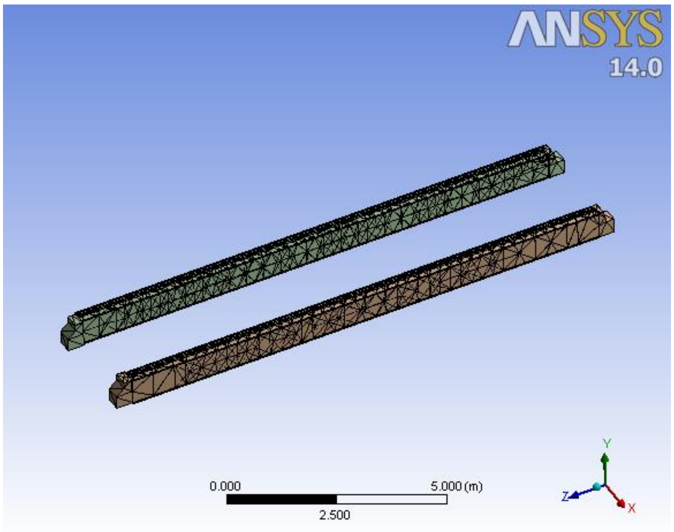

Fig.4. Triangular meshing of the girder

Step 3: Calculation of load

Now fix the ends and apply the point load.

Calculation of the load due to each wheel:-

Rated capacity (R_c) = 10000kg

For safe working let the rated capacity be 12000kg

Weight of the trolley, W_t = 2900 kg

= (2900*9.81)N = 28449N= 28.45KN

Design load,

$W_d = (W_t + R_c)*\psi$ [ψ= Dynamic coeff. factor = 1.32]

= (28.45+12*9.81)* 1.32

= 192.94 KN

Load per wheel

= D.F.* ($(W_t+W_d)/4$) [D.F.= duty factor = 1.06]

= 1.06* (55.3475)

= 58.668 KN ≈ 60 KN

So the net load per wheel = 60 KN.

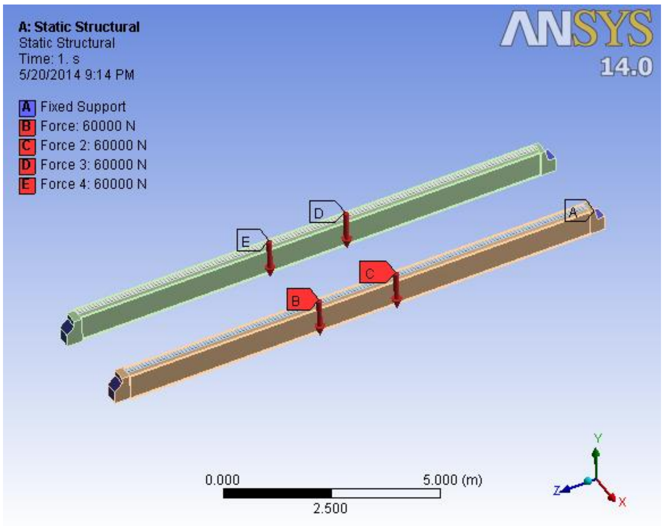

Fig.5. Loads applied to the girder

Applying the value of load in the software we get the deflection of the beam or girder which is found to be 3.5 mm which is under the limits.

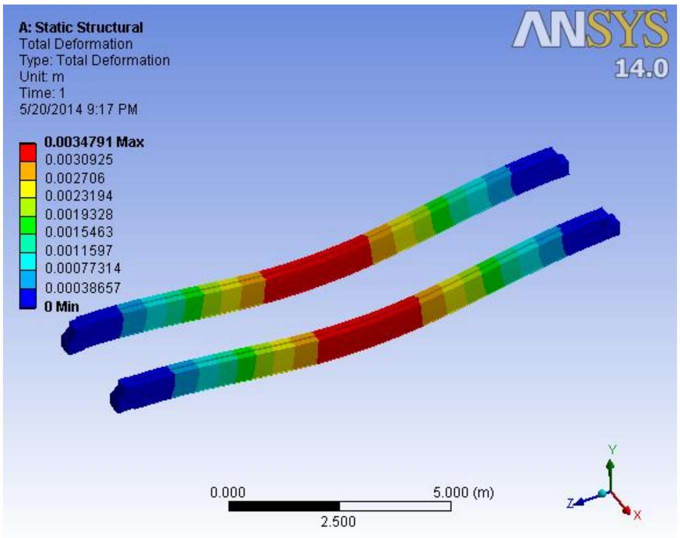

Fig.6. Deflection due to the load applied

3. CONCLUSIONS

The numerical analysis of the girder of an EOT crane has been conducted successfully. It has been noticed that at the working load i.e. the load which is being applied to the girders which includes the load lifted by the crane as well as the self-weight of the crane, the girder is stable and does not shows much deflection. In the analysis of the box girder it is being found that the deflections are within the limits.

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