International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 11 Issue 5 ǁ May 2023 ǁ PP. 820-824

Simulation of dynamic load-bearing state of double girder crane

Hong Tien Nguyen[1], Tuan-Linh Nguyen[1], Van Trong Thai[2], Tan Huynh Nhu[3]
[*1]*Faculty of Mechanical Engineering, Hanoi University of Industry, Vietnam*
[2]*Department of Academic Affairs, Hanoi University of Industry, Vietnam*
[3]*Mechanical Center Hanoi University of Industry, Vietnam*

Abstract
The paper investigates a model of a double girder crane with a closed rectangular cross-section. The crane consists of a main girder and two side beams, which allow the entire crane to move along the length of the factory. The movable loads of the crane are represented by rail trolleys that are suspended by a pendulum. The strength of the crane structure is analyzed using the Abaqus software, which enables the identification of locations that are subjected to high stress and deformation. Based on the simulation results, a plan to improve the girder structure of the crane is proposed to ensure optimal working conditions throughout its lifespan. This study provides valuable insights into the design and performance of double girder cranes and can be used to optimize the structural design of cranes for better efficiency and safety in industrial settings.
Keywords: *Oscillation, dynamic load, simulation, double girder crane, reliability, durable, stress, strain, force, moment, deflate.*

Date of Submission: 16-05-2023 Date of acceptance: 30-05-2023

I. INTRODUCTION

1.1. INTRODUCTION

A double girder overhead crane, also known as a bridge crane, is a type of heavy-duty crane commonly used in industrial settings for the handling of large and heavy loads. These cranes are designed to provide maximum efficiency and versatility for a wide range of material handling applications. With its double girder construction, it offers improved stability, increased lifting capacity, and a wider lifting span compared to single girder cranes. The double girder overhead crane is an indispensable tool for factories, workshops, warehouses, and other industrial facilities where the handling of heavy loads is a daily routine.

Crane is a kind of lifting equipment, which is divided into two main types: single girder crane and double girder crane. This equipment usually consists of a system of supporting beams placed highly in the workshop. Cranes are used in many different fields, their main use is to lift and move goods, materials and equipment from one location to another. The two ends of the main girder are connected to the side girder, on which the wheels and motors are located. Side girders help move the entire crane along the factory. Block-and-tackle is mounted on the main girder to lift and move loads along the main girder [1]. Depending on the requirements of use, people use different lifting loads and speed levels. When lifting and moving loads, oscillations are often generated, which causes the crane to bear dynamic loads. Therefore, when designing cranes, it is necessary to consider vibrations to ensure safety and high reliability in use.

The optimal design of the crane plays an important role in determining the appropriate size of the structure on the basis of ensuring sufficient strength with minimal weight. Such a design reduces costs and also has a positive impact on the crane structure. In cranes, metal structures account for 60% to 80% of the total machine weight. Therefore, many designers are still struggling to solve the problem of reducing crane weight but ensuring the reliability of all structures during its service life. It is very important to calculate to ensure that the metal structure has high strength, rigidity, stability and reliability during operation. The result of this calculation is: repair costs, dealing with downtime leading to stalled goods supply, no crane failure leading to loss of life and equipment. In recent years, several studies have been carried out to optimize the crane structure. Simulation solutions are considered very good for crane design analysis and evaluation. M. Bhutta, et el used finite element analysis for design optimization of twin beam crane arm [2]. Gerdemeli et el used numerical methods to analyze and simulate the deformation process of the crane under load [3]. Mabrouk et el studied to improve crane design under load fluctuation by simulation method [4], some authors have focused on optimizing structure by finite element method, tissue methods and simulate numbers as in some works [5-9]. However, these studies have not mentioned the problem of vibration leading to bearing dynamic loads of the crane structure when working. In addition, the vibration analysis and simulation of the crane structure under dynamic loads to ensure continuous working for a long time is an important issue, but it is still very limited in current studies and has not been studied for specific results for a long time. To solve these problems, we use Abaqus software to simulate and analyze to give a better structure for double girder crane.

1.2 SIMULATION OF DYNAMIC LOAD-BEARING STATE OF DOUBLE GIRDER CRANE

1.2.1 Oscillation modeling

The hoist slides on two runway rails, the trolley frame slides on the hoist and the hook block hangs single pendulum type heavy load. Such movements will create oscillations on the crane girder. We have built the oscillation modeling as shown Figure 1, where A and B are sliding mount links, the force acting in this case is a harmonic function.

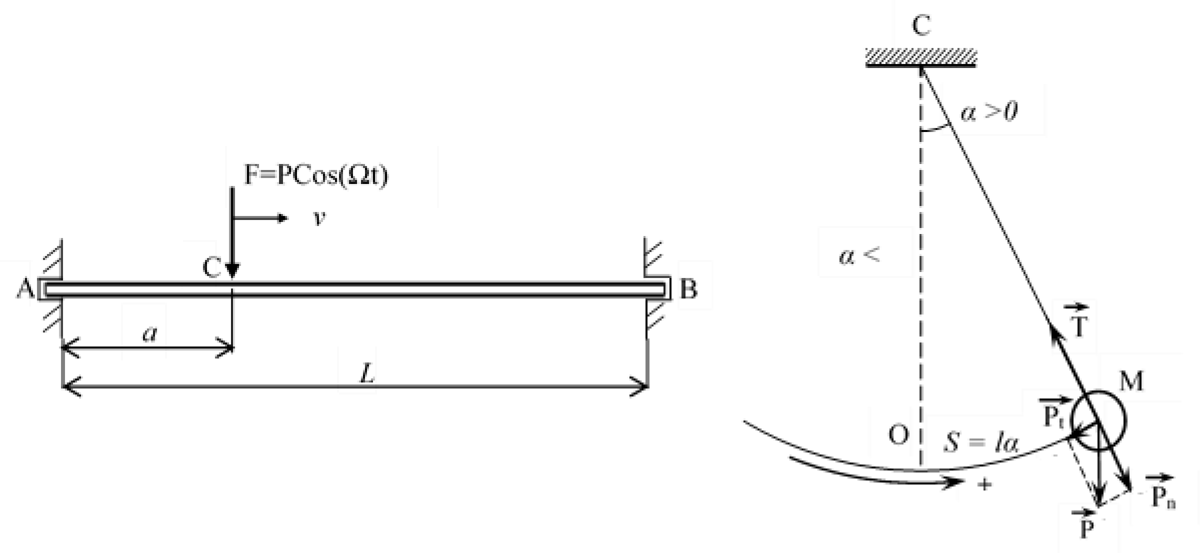

Figure 1. The oscillation modeling

The object lifted has mass M, its load is decomposed into two components as normal load and tangential load. When the hoist slides on the rail with speed v, the lifting body will oscillate in a simple pendulum around the equilibrium position O by an angle α. Therefore, the force acting on beam AB will change periodically F = Pcos(Ωt).

The double girder crane assembly was modeled using SolidWorks software and subsequently imported into Abaqus software for simulation. Figure 2 displays the model of the double girder crane.

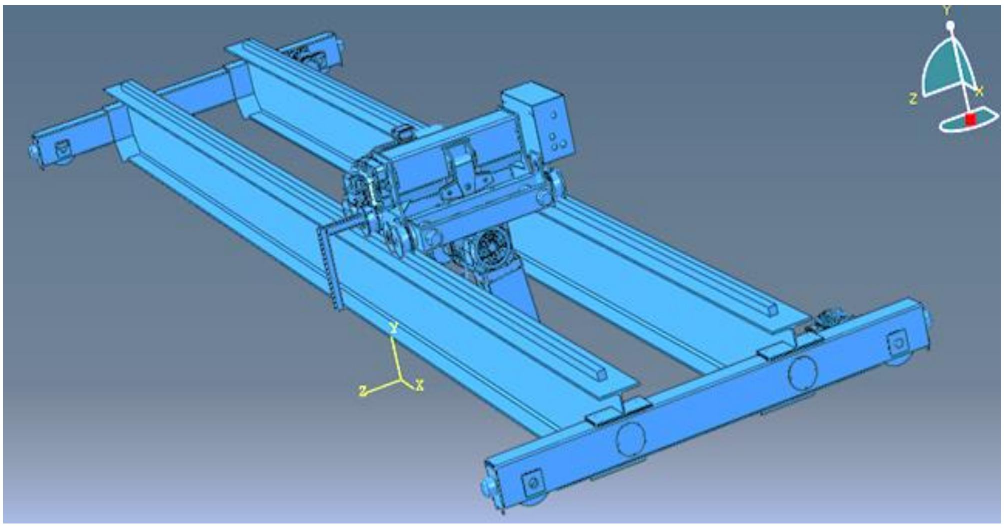

Figure 2. Model of double girder crane

1.2.2 Simulation of dynamic load condition

Material model

The material model imported is steel, and its parameters are presented in Table 1.

Table 1. Material model

Parameters	Young's Modulus	Poison's Ratio	Mass Density
Value	2.1*1011	0.3	7800

Setting boundary conditions and loads

After analyzing the oscillator model, the boundary conditions have been established. The load is applied as pressure. The hoist moves on the rail from point A to B at a speed of v. The values of force and velocity parameters of the hoist slides are depicted in Figures 3 and 4, respectively.

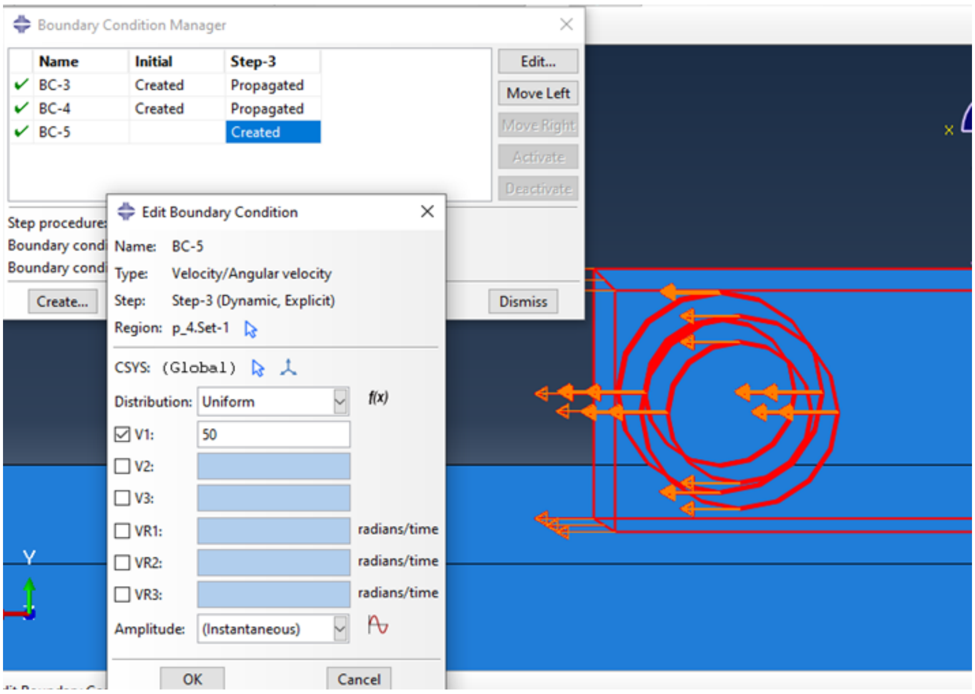

Figure 3. Boundary conditions setting

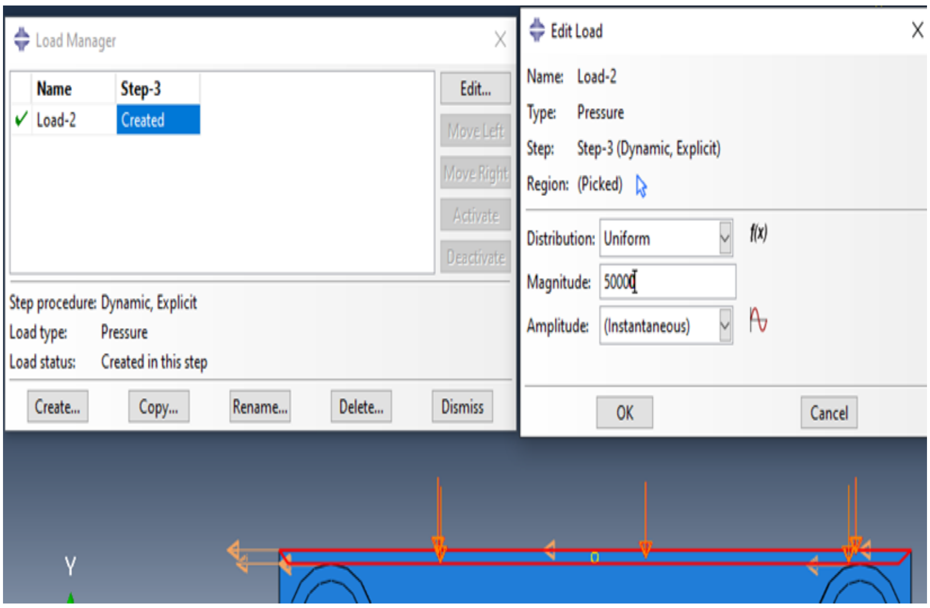

Figure 4. Load setting

II. RESULT AND DISCUSSION

Upon constructing the model, establishing the material model, boundary conditions, loads, and meshing, the simulation was carried out. As a result, we obtained the simulation outcomes of the hoist slides running on the crane girders, which are illustrated in Figure 5.

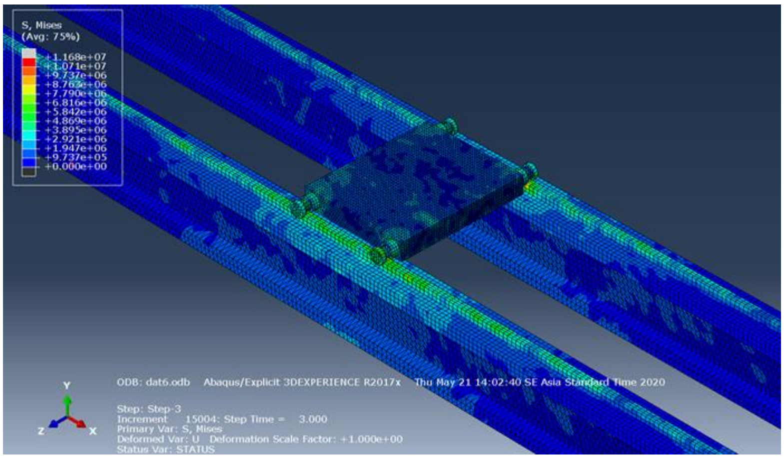

Figure 5. Simulation of hoist slides running on crane girders

The stress and strain diagrams are shown in Figures 6 and 7.

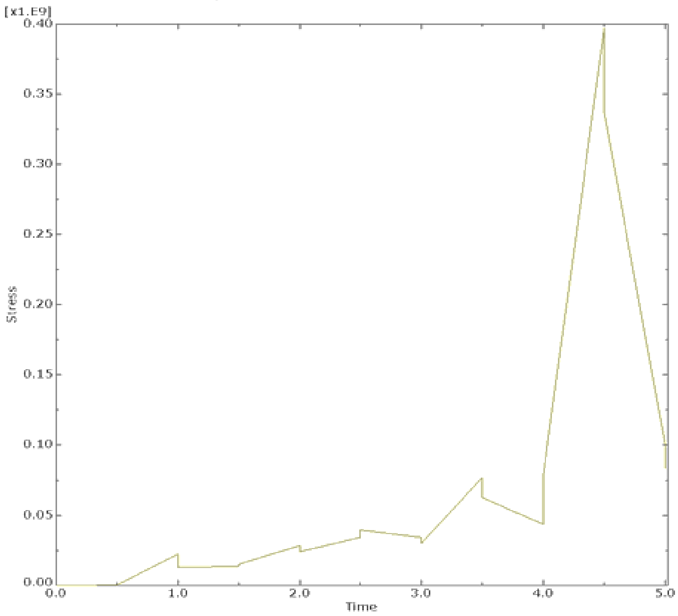

Figure 6. Stress diagram

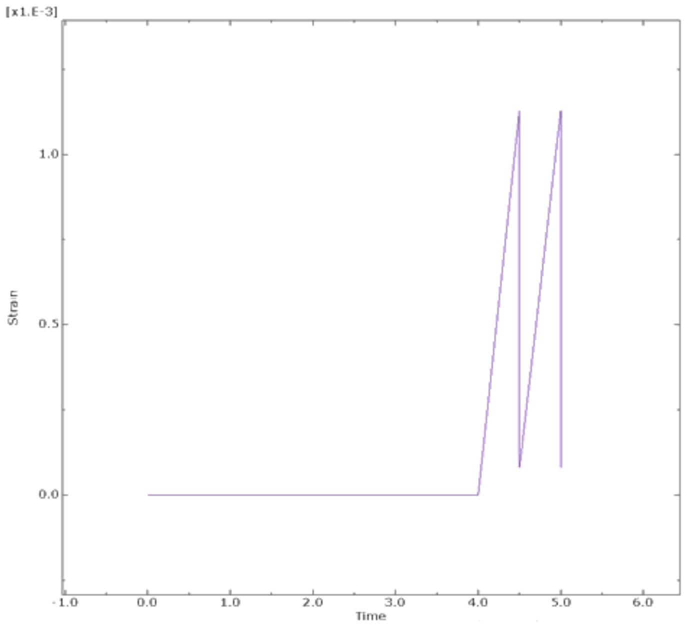

Figure 7. Strain diagram

Through the diagrams shown in Figures 6 and 7, it can be seen that the stress changes continuously over time, increasing gradually from 0 to 4 seconds. Between 4 and 5 s the stress increases most and then gradually decreases to 0. Strain is almost non-existent at the initial 0 to 4 s interval but in the 4 to 5 s interval it is strong deformation.

III. CONCLUSION

In conclusion, a dynamic model of a double girder bridge crane with varying harmonic loads has been successfully developed and analyzed. The simulation results indicate that the stress and deformation of the crane system continuously change over time, with the main girder experiencing maximum stress at 4.5 seconds and strong deformation occurring between 4 to 5 seconds. This information is crucial in understanding the crane's behavior and performance during its operation, and can aid in optimizing its design and improving its efficiency and safety.

REFERENCES

[1]. Ajla Bećirović, Dušan Vukojević, Fuad Hadžikadunić, Optimization of double box girder overhead crane in function of cross section parameter of main girders Conference, TMT 2011 - 15th International Research/Expert Conference "Trends in the Development of Machinery and Associated Technology"At: Prague, Czech Republic, 2011.
[2]. M. Bhutta, M. Misbahuddin, M. Qureshi, H. Mughal, Using finite element analysis for design optimization of twin beam crane arm, Science International 28 (SECTION A, Jan-Feb.):131-138, 2016.
[3]. I. Gerdemeli, G. Akgun, S. Kurt. Design and analysis with numerical method of gantry crane main beam, International Conference on Innovative Technologies, IN-TECH 2013,Budapest, 10. - 12.09.2013.
[4]. Mohamed H. Mabrouk, Sherif M. M. Abdelkhalek. Design and Implementation of a Light Duty Gantry Crane, International Journal of Engineering Research & Technology, 2014.
[5]. Maw-Sheng Chern, Rong-Hong Jan. Reliability Optimization Problems with Multiple Constraints, IEEE transactions on reliability, Vol.R-35, No. 4, 1986.
[6]. Abdul Hafid, Djati Salimi, Ewitha, Sitti Hijraini Nur. Analysis and Design of Crane Beam of experimental Power Plant Turbine Building, Journal of Physics: Conf. Series 1198, 2019.
[7]. Abhinay Suratkar, Vishal Shukla, Dr. K. S. Zakiuddin. Design Optimization of Overhead EOT Crane Box Girder Using Finite Element Analysis, International Journal of Engineering Research & Technology, Vol. 2 Issue 7, July, 2013.
[8]. Apeksha.K.Patel,V.K.Jani. Design and dynamic analysis of 70T double girder electrical overhead crane, Journal of information, Knowledge and research in mechanical engineering, volume 2, issue 2.
[9]. Tu, J. andChoi, K.K. A New Study onReliability BasedDesign Optimization, ASMEJournal of Mechanical Design, Vol. 121, No. 4,1999, pp. 557-564.
[10]. Yung-Li Lee, Jwo Pan, Richard B. Hathaway, Mark E. Barkey. Fatigue Testing and Analysis, Elsevier Inc, 2005.
[11]. Ajit Kumar Verma, Srividya Ajit, Durga Rao Karanki. Reliability and Safety Engineering, Springer Series in Reliability Engineering, 2016.
[12]. Thomas A. Crus. Reliability-based mechanical design, Marcel Dekker, Inc.1997.
[13]. Arora, J.S. Introduction to Optimum Design, McGraw-Hill, New York, NY, 1989.