Stress Analysis of Traverse Beam Crane Hook Used in Steel Melting Shops of Steel Plant by ANSYS and CATIA

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Abstract: The crane hook is fabricated with eight plates of 25 mm thickness and cut to the required size and dimensions as shown in the figure. The plates are riveted. Each crane hook carries 125 tones load. For this load the stress is found to be high and so high carbon steel with higher yield strength is suggested. After analyzing with different materials, a material is confirmed to be used for the manufacturing of the crane hook. High Carbon Steel is suggested to be used as the material which is having high yield strength.

Keywords: Stress Analysis of Traverse Beam Crane Hook, Modeling, Meshing, Loading, Solution Finding, Material Selection for Longer Life

1. Introduction for the Scope of the Present Work

Theoretical and simulation analysis is carried out for the design of a traverse beam used in steel melting shop –II of Visakhapatnam steel plant. A crane fixed to a traverse beam is used in the steel melt shop to charge molten pig iron in a ladle to the steel converter. The analysis and simulation is carried out for the crane hook. The need for fixing the more life and high load carrying hook is the main criteria in this work [1-4].

2. Main Work

The crane hook is fabricated with eight plates of 25 mm thickness and cut to the required size and dimensions as shown in the figure. The plates are riveted. Each crane hook carries 125 tones load. For this load the stress is found to be high and so high carbon steel with higher yield strength is suggested. After using different materials, a material is confirmed to be used for the manufacturing of the crane hook. High Carbon Steel is suggested to be used as the material which is having high yield strength.

Four materials and some designs are chosen for the use of crane hook, but from the different materials like Carbon steel, Cast Steel, SAE 1025 Water quenched, SAE 1096 Oil Quenched steel and Stainless steel [5-8]. Finally Carbon steel give the optimized results and the material is finalized for the fabrication purpose and the crane is working safely without any interruption since three years [9].

3. Methodology

The crane hook is constructed using eight plates of 25 mm thickness and cut to the required size and dimensions as shown in the figure 1. The plates are riveted [10-14]. Each crane hook carries 125 tones load. For this load the stress is found to be high and so high carbon steel with higher yield strength is suggested [15-19]. This is reflected in the table titled ANALYSIS.

The following are the various steps involved in the analysis of each pin used in traverse beam assembly [20-23]. The steps are as follows.

- Preferences →structural →ok
- Pre-processor: It involves
  - Definition of element: - A 8 node 185 structural element, SOLID brick 8 node 45 is chosen for the analysis of the
The detailed properties of the element are discussed a little later.

**ELEMENT TYPE →ADD/EDIT/DELETE→ADD→ SOLID BRICK 8 NODE 45→OK**

b. Real constants:-since the model is a 3-D solid, there are no real constants.

c. Material properties:-The material selected is Fe 800 indicates tensile stress of the material, ‘W’ indicates that the material is weld able, ‘c’ indicates that the steel is killed. The young’s modulus of the material is $8 \times 10^8$ N/mm$^2$, poison’s ratio is 0.3.

**MATERIAL PROPERTIES→MATERIAL MODELS.**

d. Modelling: - after defining the material properties, the next step is the creation of the model which constitutes a major part of the analysis. The solid model which is created using CATIA v5 is imported into ANSYS. The IGES extension file is imported from catiav5 in ANSYS.

e. Meshing: it is the process of discretizing the model into finite elements of simpler geometry. The material properties and the governing relationships are considering the loading and constraints results in a set of equations. Solving these equations by numerical method gives us an approximate behaviour of the model.

• **SOLUTION:-**

This is the phase where the loads and constraints are applied.

**SOLUTION→ANALYSIS TYPE →NEW ANALYSIS→STATIC→OK.**

a) CONSTRAINTS:- the constraints are applied at both the ends of pin.

**DEFINE LOADS→APPLY→STRUCTURAL→DISPLACEMENT→ON NODES →SELECT THE ALL NODES AT BOTH ENDS→OK→ALL DOF→OK**

b) LOADS:-

**LUMPED LOADING: -** it means that the total loading of 125tons on middle of pin.
4. Results and Discussion

Results are obtained from analysis of Crane hook using ANSYS for 125 tons load acting on Crane hook. The maximum von-mises stress is 348.56 N/mm$^2$ and the maximum Principal stress is 356.49 N/mm$^2$. Hence material No.5 is selected for Crane Hook at 125 tons load by using a factory of safety of 4.

5. Conclusion

a. A traverse beam crane hook carrying a load of 250 tons has been designed, fabricated, tested and put into service in SMS-II (Steel Melting Shop-II) of Visakhapatnam Steel Plant.

b. Theoretical analysis has been carried out with the aid of CATIA and ANSYS software to predict the stress exerted on the traverse beam crane hook. This theoretical analysis was carried out before applying the actual load on the crane with traverse beam.

c. Since the payload is hot molten metal and any failure of the components could be disastrous in terms of human life, injury, and other economic costs, a factor of safety of 4 was considered in the design process.

d. Manual calculations of von Mises and principal stresses were also carried out. These values compare fairly well with the ANSYS results for all components. 182 MPa with manual calculation vs. 169 MPa of ANSYS results for pin 1; 163 MPa with manual calculation vs 181 MPa with ANSYS for pin 2.

e. Material selection was done from a set of available materials and choice was made based on that material which exceeded the minimum stipulated factor of safety.

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