Design Modification & Analysis on Girder of EOT Crane

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Abstract— Girder is the important component of E.O.T Crane which is used for handling and transporting the vertical loads. In RSM of BSP 13 & 26 m rails are manufactured but the end carriage is designed for 13 m rails and due to this end carriage are overloaded with 26 m rails also. Due to this causes, cracks developed on runway girder, wheel and motors. The main purpose of the present study is to avoid crack propagation in the crane girder by decreasing the stress concentration factor. To decrease the stress concentration factor, design of crane girder is slightly modified by providing fillets at the sharp edges and also load analysis performed on girder to find the load safe load bearing capacity. After preparing the 3D CAD Model of girder it is exported to Solid works software to find out the result by FEA analysis. After a comparison of the finite element analyses and the analytical calculations, the analysis was found to give the most realistic results.

Key words: EOT (Electric Overhead Travelling), RSM (Rail and Structural Mill), Girder, Analysis

I. Introduction

E.O.T. cranes (Electric Overhead Travelling Cranes) are a type of end carriage cranes which is used for handling and moving a maximum specified weight of the components called capacity of cranes within a specified area. The cranes can be operated manually or by electric power.

The E.O.T. Crane are used in various industries and steel sectors. In Bhilai Steel Plant it is widely used in Rail & Structural Mill (RSM) for lifting heavy metals and material movement. Its maximum loading capacity is about 10 tones.

In RSM (Rail & Structural Mill) of Bhilai Steel Plant, 13m and 26 m rails are manufactured usually and End Carriages were designed for handling and transporting this 13m structural rails.

To lift this structural rail two common types of cranes running on elevated runway girders are used:

- Top Running Bridge cranes running on single and double girder spanning between the end carriages.
- Under slung Bridge cranes with special end carriages where the wheels are running on the bottom flange of running girders.

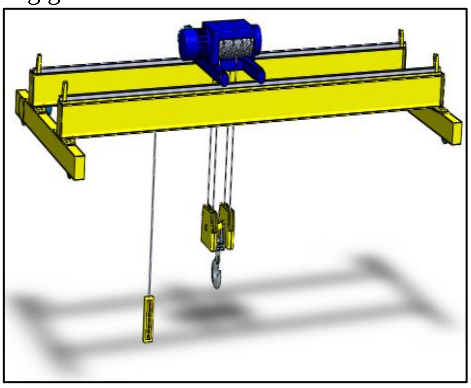

Fig. 1: Typical 3D CAD Model of EOT Crane

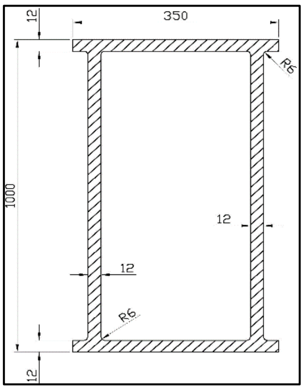

Fig. 2: Typical modified section of box girder

S. No.	Parameters	Values
1	Type of crane	Double girder type
2	Capacity	10 ton
3	Span	20 m
4	Trolley weight	2.5 ton
5	Hook approach	1.5 m
6	Location	Indoor (in sub store)
7	Crane weight	12 ton
8	Trolley wheel center to center	2 m
9	Lifting Height of Crane	15 m
10	Impact factor	1.32
11	Duty factor	1.06

Table 1: Design Considerations for E.O.T Crane Notations Used

A. *Manual Calculation [1]*

- $W_d = 1.5 \text{ x } 10000 = 15000\text{Kg} = 147.150\text{KN}$
- $W_t = 0.25 \text{ x } W_d = 3750 \text{ Kg} = 37\text{KN}$
- $W_{cr} = 0.75 \text{ x } W_d = 11250\text{Kg} = 110\text{KN}$
- $W_{wm} = 1.07 \text{ x}\left(\frac{Wt+Wd}{4}\right) = 1.07 \text{ x}\left(\frac{147.150+37}{4}\right) = 49.26$ KN per wheel
- $M_1 = \Psi \frac{(Wd+Wt)\text{x}\{S-Tc/2\}2}{8\times S}$
  $= \frac{1.2 \text{ x } (147.150+37)\text{x }(20000-1000)^2}{8\times 20000}$
  $= 498586.125$ KN-mm
- $M_2 = 0.25 \text{ x } M1 = 124646.53$ KN-mm
- $Wg = (Wcr-Wt) - 2 \text{ x } We = (110-37) - 2 \text{ x } (11.772) = 62\text{KN}$
- $M_3 = \frac{Wg \text{ x } S}{8} = 1.1 \text{ x}\frac{62 \text{ x } 20000}{8} = 170.5$ KN-mm
- $M_{max} = M_1 + M_2 + M_3 = 623403.15$ KN-mm
- $Z = \left(\frac{Ix-x}{500}\right) = \left(\frac{3909430000}{500}\right) = 7818860 \text{ mm}^3$
- $\sigma_b = \frac{Mmax}{Z} = \frac{623403150}{7818860} = 79.73\text{N/mm}^2$

Sectional properties of double box girder		
S .No	Description	Values
1	I xx(mm^4)	3909430000
2	I yy(mm^4)	532117000
3	A (mm^2)	31825
4	Material	IS:2062 E 250 B

Table 2: Sectional properties of double girder crane

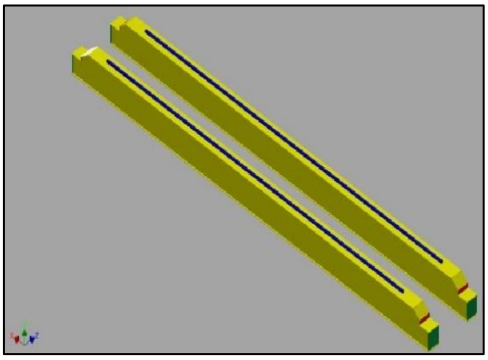

Fig. 3: E.O.T Crane Girder

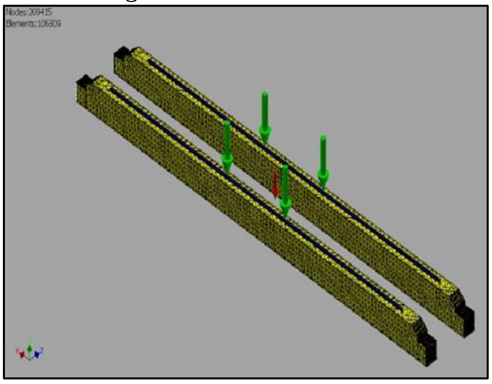

Fig. 4: Load applied on crane runway girder

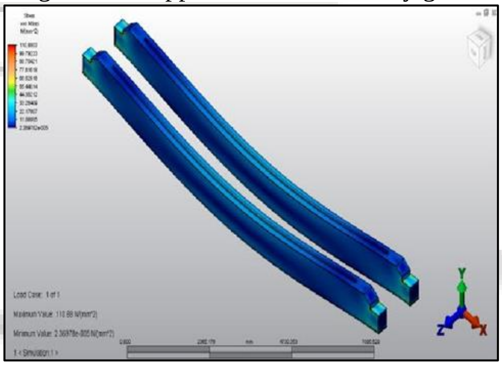

Fig. 5: Von-misses stress report of crane girder

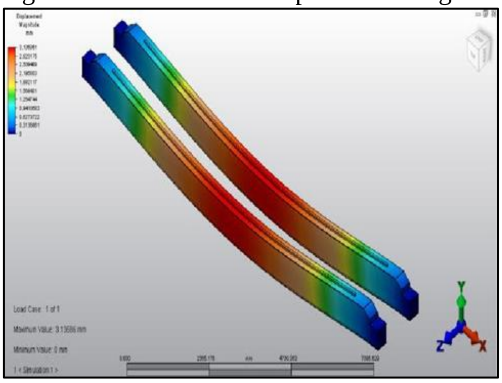

Fig. 6: Equivalent stress report of crane girder

II. Conclusion

From the above comparison between the allowable parameters of Indian Standard codes and the results of finite element analysis of re-designed box girder, it is clearly seen that the maximum stress & displacement which is obtained from the Finite Element Analysis are within the allowable limit of the Indian standard codes. The safety factor is also higher on the permissible value against the Indian standard codes (IS: 3177; 807).

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