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Improving Efficiengy of EOT Crane by Maintaning Gear Ratio and Increasing Speed of Crane: A Case Study

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***Abstract*: It is observed from many times that the speed of Electrical Overhead Travelling (EOT) cranes in many industries is not giving proper efficiency due to improper gear ratio in gear boxes. This fault was common on most of the cranes in companies and no body is bothering about this problem. Increasing the speed of EOT cranes can increase the efficiency of the crane as well as the productivity of the company. This fault is studied in one the furnace division in steel plant at Hyderabad and fault of gear ratio is eliminated by changing gear sizes and number of teeth. In this paper experience of increasing speed of EOT cranes is written with proper case study in steel plant and fault is eliminated with the help of management.**

Keywords: Difficult work system, enclosed work place, visibility, Improved Specifications

INTRODUCTION:

The case study was conceded out at a well known privately owned incorporated steel manufacturing company situated in the southern state of India. Case study having many interviews with the management, labors, maintenance persons, foremen, production manager etc. which gives details of current situation of EOT cranes in plant as well as helps to improves the condition of cranes. The concerned place of work is
maintenance area at furnace division in plant which is located at the north-west corner of the plant.

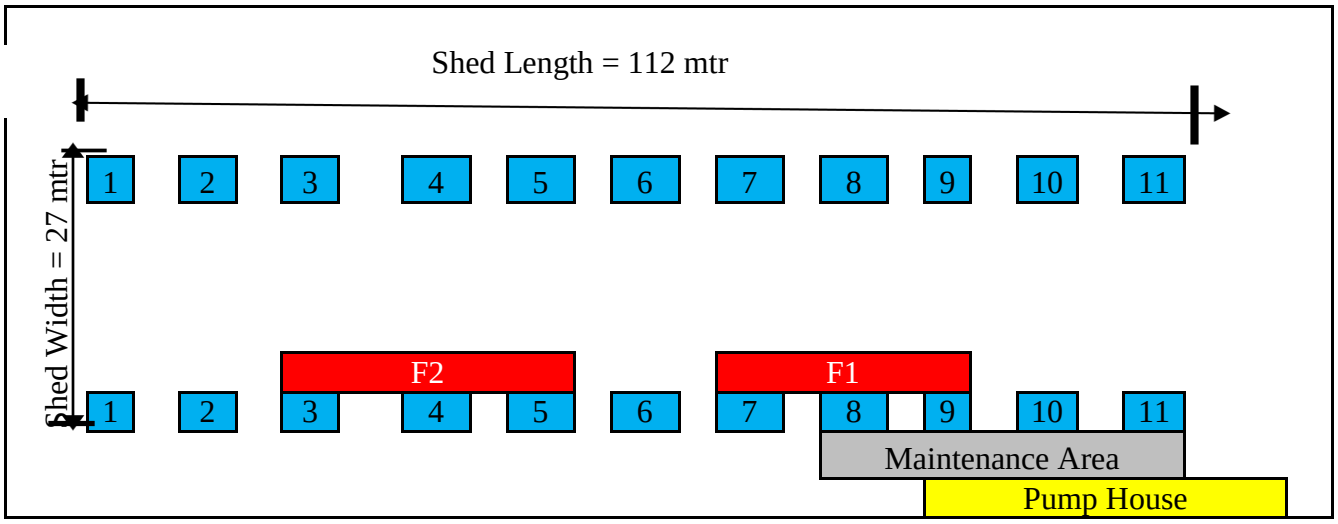

Fig 1: Layout of Furnace Division

As shown in figure, the shed length is 112 meter and the width of shed is 27 meter as well as shed height is 10 mtr, it is having two furnaces that is F1 and F2 with maintenance area at rear side of the furnace 1 and side by is the pump house which provides soft water in both the furnaces for proper functioning as well as it provides cooling to the furnaces

F1 = Furnace number 1

F2 = Furnace number 2

1 to 11 = Shed column serial numbers

Complete shed is covered by asbestos sheet. The approximately difference between each columns is 11 meter and having big scrap yard area, sponge iron yard, BP set yard, finished goods say ingot storing yard etc. The company is having man power of approximately 800 numbers including both men and women in day shift and men only in night shift. The main production of company is manufacturing ingot of size 3.5" X 4.5" X 60". Total production of ingots in company is 2500 tons per month. The whole production is covered with the help of overhead EOT cranes and overhead EOT cranes are the backbone of the company. With out this the production of ingot would be nil. The company is having 5 overhead EOT cranes with the capacity of 5 ton to 15 tons. All the cranes are operated by crane operators. Cranes operator is sitting at the cabin which is situated at the one side of the crane.

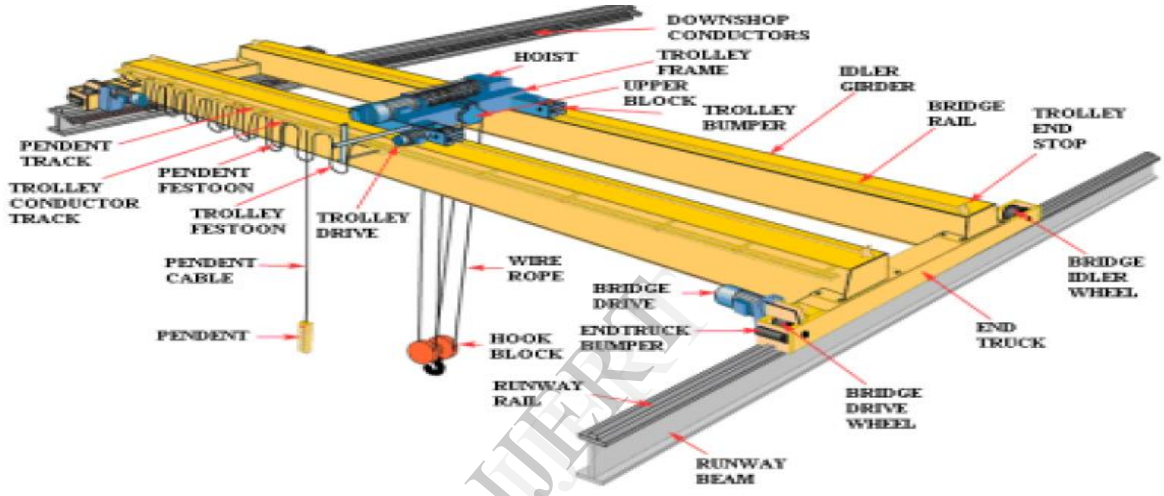

Figure 2: structure of overhead EOT crane

The overheads EOT crane is shown in figure 2. Cranes are industrialized machines that are mainly used for resources travels in construction sites, fabrication halls, assembly lines, storage space areas, power stations and similar places. Their design features vary commonly according to their most important operational specifications such as: kind of motion of the crane structure, weight and type of the weight, position of the crane, geometric features, operating regimes and environmental conditions. It is having crane runway girder which is equipped with wheels for travelling. This type of travelling is called Long travel or LT of the crane. In this the whole crane structure is moving at the direction of the axis of the shed. Crane runway girder is also known as End carriage which carries Crane Bridge. All the cranes in the company are double girder cranes. Double Girder EOT Crane can be fitted with walkways and assembly platforms and thus also suitable for maintaining workshop fittings. One of the company's double girder EOT crane Technical Data at the time of study is below.

Table 1: Double Girder EOT crane Technical Data before work

S No.	Crane Parameter	Unit of Parameter	Value of Parameter
1.	Class of Duty	BIS System	4
2.	Main Hoist Capacity	Ton	15
3.	Span of Crane	Mtr	27
4.	Speed of Hoist	Mtr/min	15
5.	Base of Trolley	Mtr	2.5
6.	Gauge of Trolley	Mtr	5.3
7.	Distance of Trolley Base	Mtr	1.5
8.	Weight of Trolley	Ton	3.2
9.	Total Crane Weight	Ton	31
10.	Quantity of Long Travel Wheel	Numbers	4
11.	Quantity of Driving Wheels	Numbers	2

12.	Long Travel Drive Speed	RPM	19.54
13.	Long Travel Wheel Diameter	Millimeter	848
14.	Long Travel Rail Size	Millimeter	110
15.	Cross Travel Speed	Mtr/min	42
16.	Cross Travel Wheel Diameter	Millimeter	232
17.	Main Hoist Number of Falls	Numbers	4
18.	Girder Weight	Ton	16.6
19.	Platform Weight	Ton	1.9
20.	Electrical Panel Weight	Ton	.510
21.	Long Travel Machinery Weight	Ton	.385
22.	Crane Operator Cabin Weight	Ton	1.10
23.	Main Hoist Gearbox Stages	Ton	4
24.	Long Travel Gearbox Stages	Ton	3
25.	Derating Temperature	Celsius	50
26.	Main Hoist Motor Capacity	HP	50
27.	Main Hoist Motor Speed	RPM	950
28.	Long Travel Motor Speed	RPM	960
29.	Long Travel Motor Capacity	HP	7.5 x 2
30.	Wire Rope Diameter	Millimeter	25

Troubles with Existing Crane Speed:

It was observed initially that the overall production of the company was 1800 tons per month. All the members were worried about the production of the company because to withstand in the market, company has to produce overproduction with good quality. So, after considering below factors such as,

a. Height of the shed
b. Span of the crane
c. Column distance
d. Weight of the crane according to lifting capacity
e. Speed of the long travel side
f. Wheel diameter of long travel
g. Wheel diameter of cross travel
h. Operator's performance and health of crane operator
i. Proper voltage supply in EOT crane's motors
j. Rail alignment of long travel
k. Wire rope drum diameter
l. Speed ratio of all gear boxes i,e long travel, cross travel and hoist

Above were the some factors which were observed completely during case study. It is seen that speed of the crane affects the overall production of the company. Its speed is slow as compared to its long travel motor capacity.

Creation of Project Team

Seeing that the administration was influenced about the value of a better redesign of the existing crane long travel gear box in order to deal with the problems as stated, a maintenance execution team was created. The maintenance squad consisted of eight members from the company. One Mechanical Maintenance Engineer, 1 mechanical ITI fitter, 2 welder, 4 helpers, and two members from the institute for the purpose of research. All members make the well talented team having experience of 5 to 10 years. The team member from organization were answerable for providing the important data as necessary, initiating trial for project implementation including purchasing of inventories required for execution of work. The member from institute provides the data and know-how as required for designing the long travel gearbox.

Methodology

The methodologies worn to meet the objectives are,

(i) examination of the existing blue print of design
(ii) Detailed re-design steps of gearbox
(iii) Testing of new gearbox
(iv) Installation of newly designed crane long travel gearbox in crane.

Calculation for lifting capacity of crane and lifting height in meters are

1. Total Lifting Capacity (W) = 15 ton
   = 15 X 10000 N
   = 150000 N
2. Lifting Height = 7.5 meter
   = 7.5 X 1000
   = 7500 mm

Now discussing all the steps of methodology one by one to get optimized result.

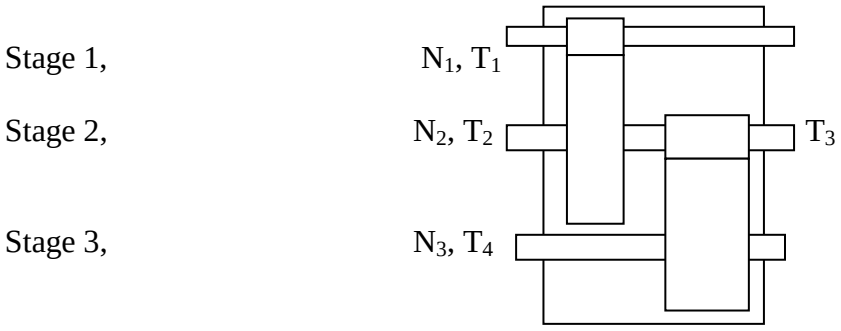

Fig 3: Schematic Diagram of Gear Box

Examination of the existing blue print of design:
In this step every body in project team examines the existing blue print of design. It is observed that the speed of Long Travel is very slow as that of the motor capacity of LT.
Stages of long travel gear box = 3
Stage 1: I/P motor (N_1) = 960 rpm
So, pinion speed is (N_1) = 960 rpm
No. of teeth in pinion (T_1) = 14
Stage 2: No. of teeth in gear (T_2) = 89
No. of teeth in pinion (T_3) = 11
Stage 3: No. of teeth in gear (T_4) = 85
By considering rpm and number of teeth and using formula,

$$N_1 T_1 = N_2 T_2$$

For finding rpm of stage 2 (N_2) $= (N_1 T_1) / T_2$
$= (960*14) / 89$
$= 151$ rpm
So, stage 2 shaft rpm is 151
Now by using N_2,
Find the speed of stage 3 (N_3) $= (N_2 T_3) / T4$
$= (151*11) / 85$
$= 19.54$ rpm
So, stage 3 shaft rpm is 19.54
After analyzing, it is finding that input rpm of long travel gear box is 960 rpm and output speed is 19.54 rpm. This speed is very slow for a steel plant crane and this will adversely affect the production of the plant. To eliminate this consider next step,
Detailed re-design steps of gearbox:
In this step, drawback of first stage is eliminated by changing the gear ratio of long travel gear box. Calculation for new gear ratio to get optimal speed is,
Stages of long travel gear box = 3
Stage 1: I/P motor (N_1) = 960 rpm
So, pinion speed is (N_1) = 960 rpm
No. of teeth in pinion (T_1) = 20
Stage 2: No. of teeth in gear (T_2) = 87
No. of teeth in pinion (T_3) = 14
Stage 3: No. of teeth in gear (T_4) = 79

By considering rpm and number of teeth and using formula,

$$N_1 T_1 = N_2 T_2$$

For finding rpm of stage 2 (N_2) $= (N_1 T_1) / T_2$
$= (960*20) / 87$
$= 220.69$ rpm
So, stage 2 shaft rpm is 220.69
Now by using N_2,
Find the speed of stage 3 (N_3) $= (N_2 T_3) / T4$
$= (220.69*14) / 79$
$= 39.12$
So, stage 3 shaft rpm is 39.12
Surprisingly, it is finding that input rpm of long travel gear box is same as 960 rpm but output speed is dramatically changes as 39.12 rpm. Almost double the previous speed, this speed is very fast for a steel plant crane and that will increase the production of the plant.
Testing of new gearbox:
After successful completions of design of long travel gear box, it is time to test the gearbox for wear and tear as well as for vibration. It was found that there is no unwanted sound or vibration in new gear box. So, new gear box is ready to install in long travel of crane.
Installation of newly designed crane long travel gearbox in crane:
Installing new gear box in long travel of crane increases the speed of the crane with out vibration and sound. Even that speed is not affecting the shed and column of plant in which crane is running.

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