1. ERECTION & MAINTENANCE OF E.O.T. CRANES:-

1.1GENERAL:

An E.O.T. crane stands for Electric Overhead Travelling crane. this is used for handling & moving a maximum specified weight of the components called capacity of the crane within a specified area. the crane can be operated manually or by electric power. electrically operated crane can be divided into different sections as follows:-

(a) Bridge girders,
(b) End carriages,
(c) Hoisting trolley also known as crab,
(d) Long travel machinery,
(e) Driver's cabin/Floor operation.

Before maintenance of the crane, it is important that some guidance is available to erect the crane to avoid accident & smooth running of the crane.

1.2ERECTION OF CRANE:-

The crane should be erected on an un-occupied floor where no industrial or construction work is to be carried out during erection. The size of the floor must ensure free & convenient handling of the crane during the erection period i.e. setting the crane in erecting position on the floor, turning the suspended crane etc. the most convenient place for erecting the crane is the space between the columns provided there are no horizontal bracings connecting the roof trusses. the roof trusses used for lifting the crane should be checked for stresses during erection with a dynamic factor of 1.2.

Besides testing the rope & trusses for strength, they should be tested for stability under horizontal forces acting at right angle to the truss plane.

The winches employed for lifting the crane should be equipped with ratched stops.

The wire rope employed for erection must have tags indicating wire breaking forces & should be free of defects, fractures, kinks etc.

The minimum safer factor should be three.

When hoisting the crane or its parts the following conditions should be kept in mind.

(a) The angle of inclination of the slings should not be less than 45º.

(b) To prevent rupture of the rope due to sharp edges of lifted materials, wooden or metal lining should be used.
(c) The number of clamps to be used for fastening the rope should be sufficient.

We should also ensure that the axes of the winch drum should be exactly at right angle to rope direction.

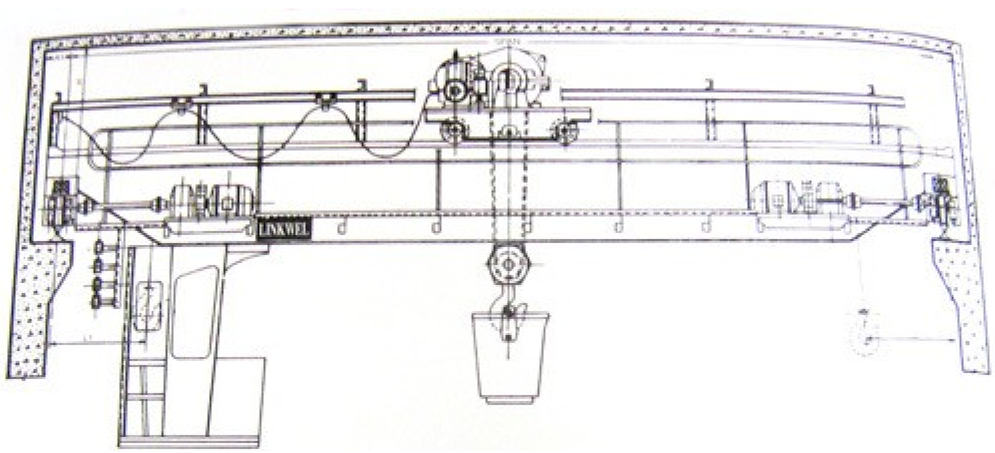

Fig.:- Schematic View of E.O.T. Cranes.

1.3 LIFTING THE CRANE:-

Depending on the weight of the crane, the strength of the rope, trusses, the crane can be lifted by one winch or two or four winches. if the weight of the crane is not very high the crane structure can be assembled at the floor & the complete crane can be lifted. in case the crane is very heavy we may lift different portions of the crane in sequence as follows:-

1. End carriages complete with L.T. wheels fitted in position.
2. Main girders.
3. Hoisting trolley or crab.
4. Driver's cabin & other electrical components.

To simplify the positioning of the different components the crane should be match marked at every joint. every joint should be bolted only by means of machine bolts.

For the safety of the people engaged in erection work, the following safety rules should be observed:-

1. When lifting the crane structure the dangerous zone of assembly must be protected with flags barriers etc. & no un-authorised person should be admitted in the area.
2. Do not lift the crane if the erection area is badly illuminated.
3. Although the lifted structures should not be allowed to suspend for a long time but in case of exception we must see that:-

(a) The safety factors of the ropes & cross girders should be twice than the normal working.

(b) The last line of rope running off the blocked should be clamped near the block.
(c) In case the load is lifted by means of hand winch, remove the handles, apply & secure the brakes.
(d) Post workers to ensure security.

4. It is strictly forbidden to stand or walk under the crane when the crane is being lifted.
5. The scaffolds must comply with the safety rules. the fitter working on top, must handle the parts & tools carefully so as to prevent them to fall down.

The erection supervisor must ensure that all the components are assembled in accordance to the sub assembly drawings. after the crane has been fully erected, we must do the electrical connection exactly as per its wiring diagram. before we actually do the load test we must run all the motions in idle condition. during idle running of different motions we should particularly observe the following:-

(a) Eccentric running of moving parts.
(b) Alignment of shafts.
(c) Fauling of moving components.
(d) Any un-usual noise.
(e) Presence of lubricant at desired surfaces.

After the idle running of different motions & satisfactory performance of motors, limit switches, brakes & controllers we may go ahead with load testing of the crane in accordance to relevant Indian standards.

If the contract for erection & commissioning of the crane is not given to the manufacturer of the crane, it will be desirable to seek their supervision during Erection & commissioning. This will ascertain the alignments of components & thus longer life of the crane.

Fig.:- Aerial View of E.O.T. Cranes.

2. OPERATION:-

2.1 MECHANICAL:-

Before operation, check all parts are lubricated properly as per lubricating chart. electrical wiring is to be completed as per wiring diagram. during initial test it should be checked that bridge, crab & other components mounted on crab are clear of roof beam & walls. all motors are connected properly & that the limit switches cut off the supply to motors in proper direction. In case the limit switches don't cutoff the supply in the proper direction make the necessary changes in wiring. the crane should be run light for a little while before loading the same & it should be checked that all the limit switches work satisfactorily.

Commence lifting the load in stages, starting with not more than 5% of the safe working load & then increasing this gradually in succeeding trails, till you have reached the full load. during this we must ensure that any part of the crane does not show any sign of giving way while going through all motions of hoisting, traverse & travel. finally, test the crane with 25% overload before the same is put into operation.

2.2 ELECTRICAL:-

Before pressing 'ON' Push button of main contactor, see that all drum controllers or master controllers are in off position. there are 4, 6, 8 steps in drum controller depending on HP. of motor. on the 1st step full resistance of resistance box is inserted & smoothly all resistance is cut off by the controller. whenever motor gets supply, brake is released, thus allowing motor to accelerate smoothly. whenever motor supply is cut off, thrustor brake applies brake & brings the motor to stand-still. whenever load reaches extreme position, limit switch cuts off the supply to that motor in that particular direction & load can't be moved further in that direction. the operator can move the load in backward direction by moving the drum controller in reverse direction, or pressing the related push button.

3. SAFE HOISTING PRACTICES:-

Hand operated & electric hoist & trolleys of different types are deigned with the safety of the operating personnel first in mind. your own safety & that of your fellow workers will be assured when overhead materials handling equipment is used as recommended by the manufacturer. disregarding such recommendations endangers life & property. Following are the basic rules worthy of your careful consideration & attention.

1. Do not load beyond the rated capacity- the immediate danger is the possible failure of some load carrying parts. Overloading might also start a defect which could lead to some future failure even at less than rated capacity.

2. Do not use any overhead materials handling equipment for handling personnel.

3. Conduct a periodic visual inspection for signs of damage or wear. Particular attention should be paid to the cable or chain & hook. If the cable or chain show signs of wear or damage or hook is distorted or opened call it to the attention of the safety engineers before loading the hoist.
4. Do not use hoisting cables or chains as a substitute for slings, use slings only. cable or chain slings should be of proper size & type for load handling - never use slings showing physical damage of any degree.
5. Whenever the hoist is lowered in such a manner as to take the load off the wire ropes, the operator should determine, before again making a lift, if the wire rope is properly reaved on the drum.
6. Stand clear of all loads- If you must travel a load over the heads of other personnel, give ample warning of your intention before you move.
7. Always "inch" the hoist into the load. Running into the load at full hoist imposes excessive overloads on the hoist & could result in failure of part & / or supporting structure. This is particularly true with the high hoisting speeds.
8. Limit switches are for emergency use only & should not be tripped during normal operation. if it is necessary to travel to the limit, use extreme caution & approach the limit in slow speed or by "inching". do not leave hook block in contact with limit switch at the end of the operation. a phase reversal with the block in this position will properly result in damage to the hoist if the down button or control rope is operated.
9. Be sure the hoist raises & lowers properly when the corresponding push buttons on control ropes are operated- a reversal of direction indicates a phase reversal in the current conductor, the reversal of the rope on the drum or an interchange

of wires on the push button- any of which would cause the limit switch to be inoperative. do not under any circumstances operate the equipment until the trouble has been found & corrected.

10. Centre the hoist over the load before lifting- do not side pull or end pull.
11. Know the hand signals for hoisting, cross travel & crane travel if working with cab operated hoists or cranes. Operators should accept the signals of only those persons authorised to give them.
12. Do not leave the load suspended in the air unattended.
13. Do not jog controls unnecessarily. hoist motors are generally high torque, high slip types. each start causes an inrush of current greater than the running current and lead to over-heating & heat failure, burnout, if continued to excess.

3.1 SAFETY IN DESIGN & CONSTRUCTION OF E.O.T. CRANES (ELECTRICALS):-

3.1.1 BUILT IN SAFETY FEATURES- ELECTRICALS:-

1. Emergency switches at corners to stop the crane in case of emergency. provisions can be made to warn operator through indicating lamp.
2. Reversing contactors are inter-locked electrically to avoid short circuit.
3. Bell/Warning horn are provided for signaling crane operation & to warn people at floor level.
4. Display of sign board like danger board, instruction regarding the opening of panel doors for safety of maintenance personnel/operator.
5. Use of master controllers to enable operation of crane at lower control voltage there by avoiding danger of line voltage to operators.
6. Adequate earthing of all electrical components.
7. Interlocking of master controllers, starter contractors, overload relays, over hoist limit switches with main circuit breakers/ contactors to avoid accidental starting of various motions of crane.
8. Provision of anti-drop circuit in case of hoist motion for preventing, drifting of load.
9. Provision of plugging circuit for cross & long travels to avoid jerking & smooth Stopping of travel motion.
10. Selection of motor brakes, switch gears.
11. Equipping the cabin with adequate lighting & provision of fan & exhaust fan as needed.
12. Design of the cabin worked out taking into consideration of ergonomical aspects like sufficient head room, suitable chair & placement of control equipments like master controllers P.B. Stations within easy reach of operator.
13. Provision of door switches in case of cross contactors being angle iron/copper contactors & wherever considered necessary as safety measures.

Fig.:- Aerial View of Double Beam E.O.T. Crane.

3.1.2 <u>OPERATION SAFETY FEATURES</u>:-

1. In individual motion panels, provision is made for protecting motors against short circuit. this is achieved either by providing H R C fuses or MCB or MCCB.
2. Every motor is protected against O/L relays by providing thermal or magne. O/L relays.
3. Single phase preventors are provided in selective cases where supply conditions & operational safety demands for.
4. Under voltage protection.
   main incoming circuit breaker/contactor is provided with under voltage protection.
5. Limit switches are provided for excess movement in respective direction. This avoids toppling, hitting, damage to other machineries.
6. Selection of motors, brake, clutches & other switch gear & control gear equipments done carefully taking into account repeated reversals. higher inertia loads & frequent starting & stopping suitable safety factors are considered for selection.

Fig.:- Pictorial View of E.O.T. Crane Used in powerhouse.

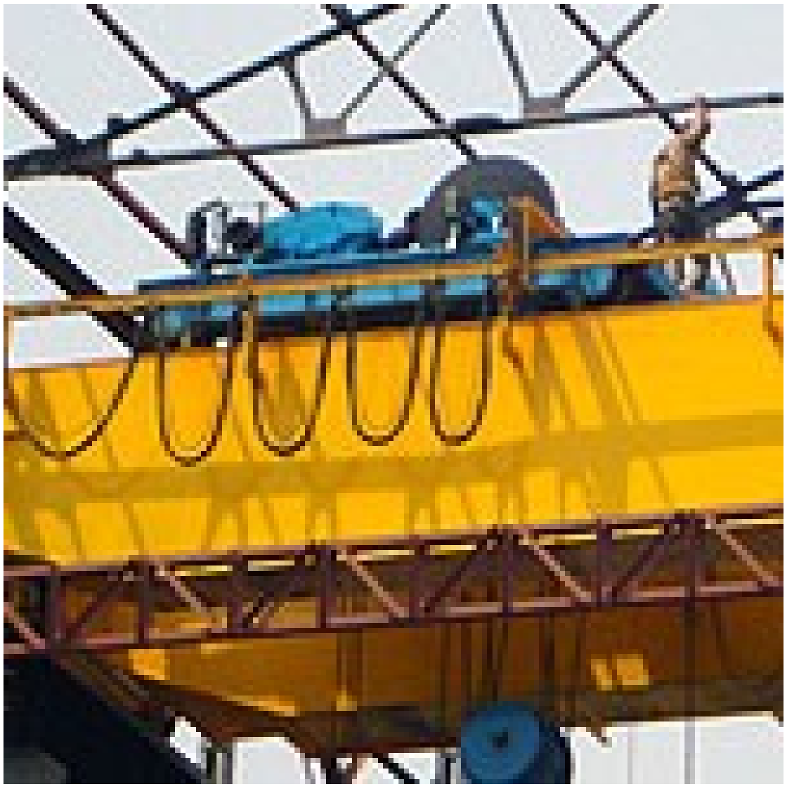

Fig.:- Aerial View of Double Girder E.O.T. Crane.

4. <u>CALCULATIONS</u>:-

4.1 <u>ELECTRICAL</u> :-

To determine the relationship between rotor weight, MVA rating & speed.the rotor weight was proportional to the output & inversely proportional to the square root of the speed.however, a wide variation in rotor weight was found, which could only be explained by variations in unit design & method of rating.

The formula is given by:

$$R_w = 50(MVA/n^{0.5})^{0.74}$$

Where, R_w= Rotor weight in tones for rotors with standard inertia.
MVA= Rotor rating at 60°C temperature rise.
n = Rotor speed, 90 rev/min minimum.

This equation is used to determine the weight of a generator rotor for units with standard inertia & speeds in excess of 90 rev/min. Data obtained for units with slower speeds indicated a wide variation in rotor weight .when plotted in the same manner, & therefore it was not possible to derive a formula for large slow speed units.the study had to be confined to relatively small rotors with ratings below about 100MVA.since large rotors are connected to major power networks where added inertia is not a requirement.it is only on small & isolated systems where extra inertia is required for stability. Standard inertia for generator rotors can be determined from the following equation.

$GD^2 = 310\,000(MVA/n^{1.5})^{1.25}$

Where, GD^2 = Standard inertia (tonne/m^2)
G = Rotor weight(tonne)
D = Diameter of gyration(m)

So as to allow for the effect of extra inertia on rotor weight.
Equation was expanded to include a coefficient as follows:-

$R_w = 50(MVA/n^{0.5})^{0.74}\{ 1+ C(K-1)\}$
Where,
C= Coefficient of added inertia.
K = Inertia ratio defined as rotor inertia divided by standard inertia.

In the case of an overhauling load when using an adjustable frequency control & a squirrel cage motor, the speed of the motor & load is directly a function of the applied frequency to the motor. By changing the applied frequency to the motor, the synchronous speed of the motor changes in accordance with the following equation:

$$\text{Synchronous speed} = \frac{120 * f}{P}$$

Where, f is the applied frequency & P is the number of poles in the machine.

4.2 MECHANICAL:-

4.2.1 TORQUE:

The horsepower equation may be used to determine the maximum continuous full-load torque a motor can produce. The equation is:

$$T = \frac{HP \times 5250}{N}$$

Where, HP= Power in horse power.
N= Speed in r.p.m.