Steel Optimization of Stacker Recalimer

[1]Shaikh Tozim Nisarhusain [2]Manish Makwana
[1]M.E. Student [2]Assistant Professor
[1,2]Department of Structural Engineering [2]Department of Civil Engineering
[1,2]Noble Engineering College, Junagadh, Gujarat, India

Abstract

In the design industry different components of material handling equipment are generally manufactured by the steel section. In this article, we have tried to design the equipment in such a way that it consumes minimum steel. In this research of the economical design different components have been described. In this part of research, designing a stacker reclaimer in software STAAD PRO. By assuming dimensions, designing the stacker reclaimer of boom size 22m and capacity of 50 tons per hour. The basic requirement of design are taken as per Indian standard Code provision which is suitable. In this project, assumption are made for probable major load which is applied to stacker reclaimer when it is actually in use at site. In this project we get the steel section which have minimum weight and safe in transferring the probable load acting on it. And also we are interested in getting the most suitable shape which have maximum capacity to move bulk material with minimum cross section so, that we can minimize the material cost which is used in construction of the bucket wheel.

Keyword- Stacker Reclaimer, Structural Optimization

I. INTRODUCTION

A Stacker is a large machine used in bulk material handling. Its function is to pile bulk material such as lime stone, ores and cereals on to stock pile. And claimer can be used to recover the material. Gold dredges in Alaska had a Stacker that was a fixed part of the dredges.it carries over size material to tailings pile. Stackers are normally rated for capacity in tph (tones per hour). They normally travel on a rain between stock pits in the stockyard. A stockyard can usually move in at least two directions: Horizontally along the rail and vertically by luffing (Rising and Lowering) its boom. Luffing of the boom minimize dust by reducing the distance that material such as a coal need to fall on the top of the stock pile.

A Reclaimer is large machine used in bulk material handling applications. A Reclaimer function's is to cover bulk material such as ores and cereals from a stockpile .A Stacker is used to stack the material. Reclaimers are volumetric machines and are rated in m^3/h (cubic meter per hour) for capacity. Which is often converted to tph (tones per hour) based on the average bulk density of the material being reclaimed normally travel on a rail between stockpiles in the stockyard. A bucket wheel Reclaimer can typically move in three directions.

II. METHODOLOGY

In the first step, assuming the Stacker is used for design is only allow slewing and travelling movement. The slewing movement is restricted by fixing the boom at junction of mast. And also in this project, assuming that the lower part of mast is fixed at the end. All joints are pin joints. In the design, following the IS Standard method of limit state so all assumption of that method is also follow by this structure. In this project in designing, assuming that the member tied with the help of plate. In further design part, release the force and moment in y direction to allow the luffing movement. Then taking all 3D bay is same for truss in all component. In this project we are taking simple truss system shown in figure. In this project, our structure design is valid in under this boundary so all data is valid for this above assumption.

A. Loads Acting on Stacker Reclaimer

1) Bucket Load in the Form of Concentric Load

In this project, considering the load at which the bucket is in full loading condition. In this the all bucket is fully fill with material and load coming in the bucket joint is maximum. We are design the Stacker Reclaimer in such a way that this load is transfer on to the four leading point of Stacker Reclaimer from free end which is shown in the below. In our design we are interested to design the Stacker Reclaimer of 50tonn capacity so we divided this load to following four points.

2) Belt Conveyor Load in the Form of Uniformly Distributed Load

The belt conveyer is suspended on to the bottom member of the boom. So this load is transfer to the boom to mast in downward direction. This load is taken from mechanical general the density of the belt conveyor is 3.8KN on all bottom member of the boom.

3) Counter Weight Load in the Form of Concentric Load

The counter weight is generally takes 2-3 times of the applied load on the boom. This load is acting in downward direction. This load is transfer to the four point of the counter weight boom which is leading from the free end. The value of this load per point is 2*125=250KN.

4) Earthquake Load

The earthquake load is biaxial loading. It is generally act on three directions. But in STAAD PRO the software support only two direction which are x-plane and z-plane. This load is defined in the STAAD PRO in seismic definition. The modular ratio is take is 0.005 and the Code provision IS 1893:2002 is follow in design.

5) Self-Weight of the Structure

The self-weight act due to effect of gravity acceleration. This force is acting downward direction. The self-weight is automatically calculated in software. We are considering the factor is 1 for dead load.

6) Other Minor Load

Stacker reclaimer also experience other minor load as wind load, friction load, vibration load and blasting impact and much more. We are considering the earth quake which have maximum amount of load than any other than this minor load. So we are not considered that load.

B. Design of Different Component of Stacker Reclaimer

1) Design of Bucket Wheel

Bucket wheel is mainly used to collect the material from the stock pile and deliver it in to the belt conveyor. Size and shape of bucket wheel is depends on the capacity of stacker reclaimer. Bucket wheel is carry the primary load of the stacker reclaimer. Design consideration of bucket wheel: In this project we are considering that bucket wheel need one minute to complete one rotation. Which means that the angular speed of stacker reclaimer is 1 rpm (rotation per minute). The one unit of bucket wheel has six bucket. Each is hemispherical in shape. Radius of sphere is 1.36 m and the half radius is 0.68. This bucket wheel is made from the stainless steel which have high load carrying capacity. Bucket wheel run on electric motor and it is operated from the operating cabin. Factor affecting the selection of size and shape of bucket wheel.

1) Bucket wheel size mainly depends on the capacity of the stacker reclaimer.
2) It also depends on the angular velocity of stacker reclaimer.
3) It also depends on the density of the material which it is carrying.
4) It depends on material of which it is to be constructed.

2) Design of Boom

Boom of the stacker reclaimer is one of the important part it support the bucket wheel from the mast from the approach. Boom also support the belt conveyor also. Load of this component also taking from mechanical manual as 3.6 KN per m which is acting in downward direction. Boom have created by 3D truss which dimension is 2m in z axis, 2m y axis, and 1.5 x axis and have 22 bays. Section selected for boom is ISMB 350.

Total number of section used in boom is 44 @ weight of 52.4 kg per m.

Total number of inclined section in boom is 22 @ weight of 8.4 kg per m.

Total 42 section used in direction of point load line of action which have properties as 52.4 kg per m as ISMB 350. Its weight is 2200 kg.

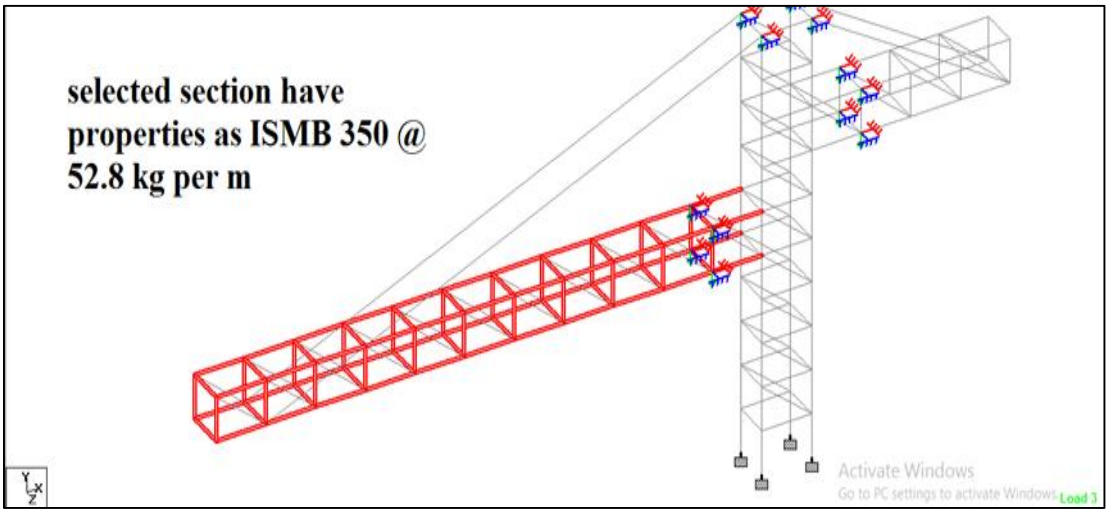

Fig. 1: Boom Design I – Section

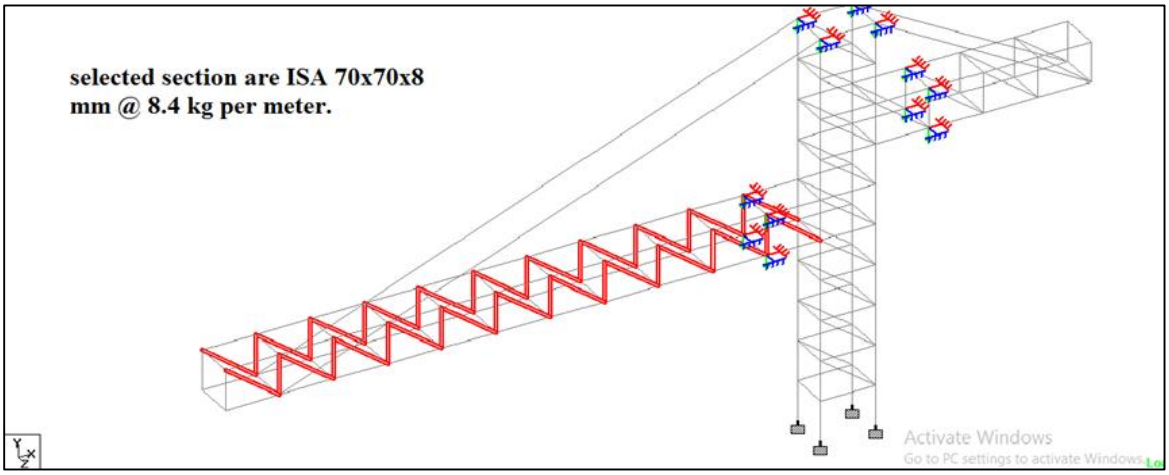

Fig. 2: Boom design C-section

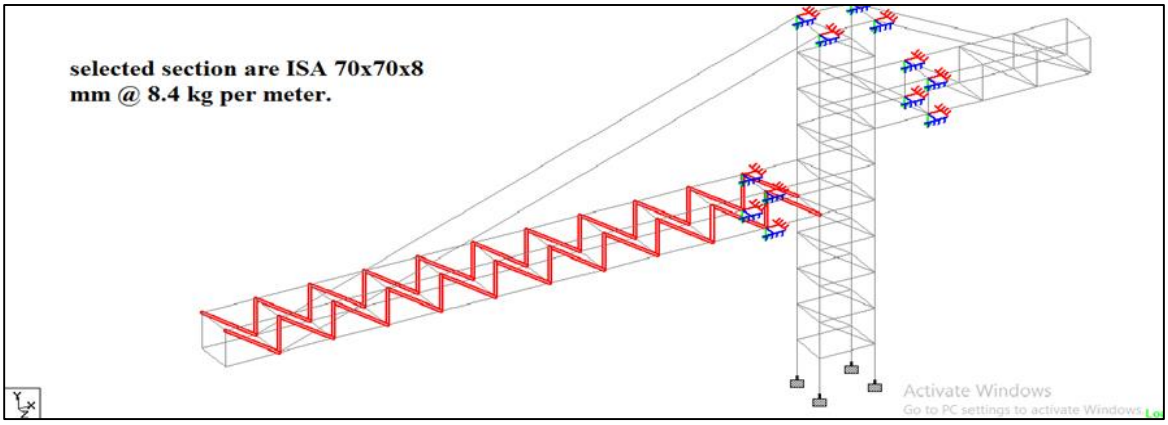

Fig. 3: Boom Design Diagonal Member I-section

Total length of boom main section is 88 m and total weight of steel is 6812 kg and inclined section length is 44 and 370 kg. Total weight steel used is 7182 kg for beam.
Steel have yielding strength of 250MPA and damping of steel is 0.2 % which we are using in design.

C. Design of Mast

Mast is design using simple 3D bay truss system. Mast is vertical component of the sacker reclaimer. Mast is connected with boom so all load on boom are transfer through the boom to mast. Mast experience wind load also but the effect of wind load can neglect because of consideration of maximum magnitude of earthquake. Mast is generally connected with roller at its bottom end which provide stability against overturning.
Section selection for mast: Total no primary section is 120 and properties of this section is ISMB 350 @ weight 52.4 kg per m.

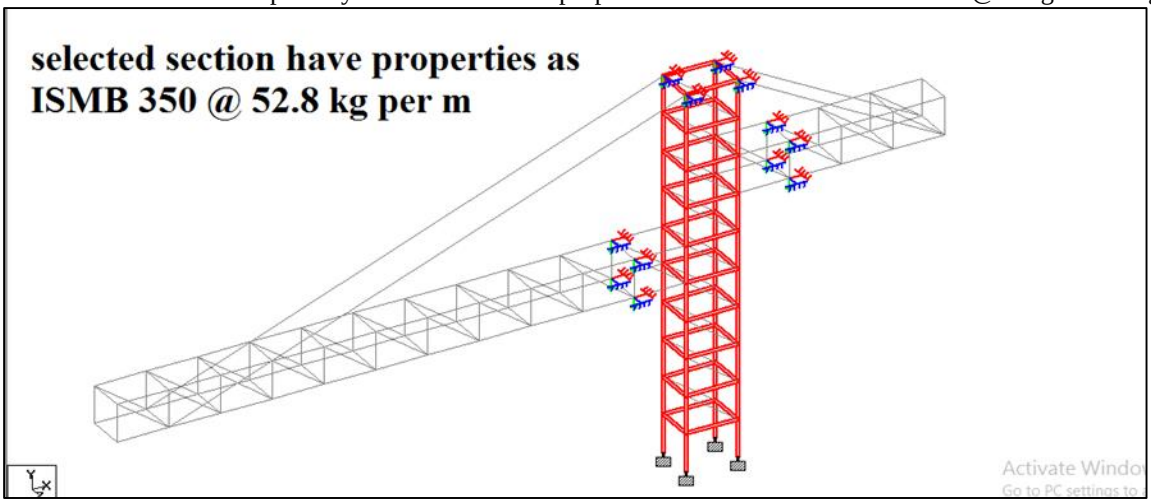

Fig. 4: Mast Design I-section

The total incline section is 20 and its properties is ISA 70x70x8 @ weight 8.4 kg per m.

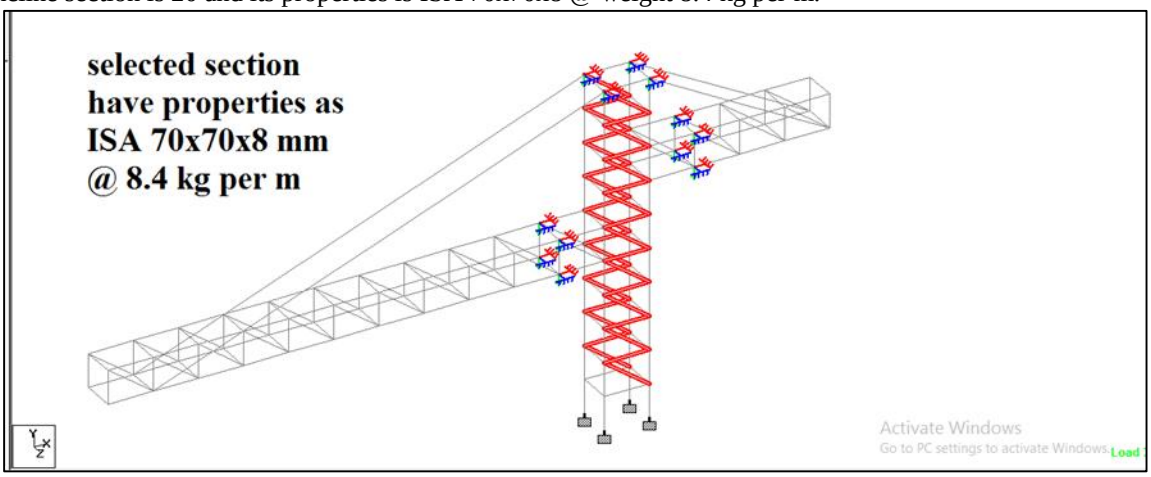

Fig. 5: Mast Design L-section

Total weight of steel used in mast is given by 11720 kg including angle section.
In mast inclined bracing are mainly place to resist the buckling of the section and wind load.

D. Design of Counter Weight Boom

Counter weight boom is generally carry a load 2 to 3 times more than the bucket wheel load. This load is acting at the end of the counter weight. This is also a cantilever portion which is connected at mast and one end is free. Counter weight is also design by using 3D simple truss. Section selection in counter weight boom design: Counter weight boom have design by using two type of section i.e. primary I section and angle section.

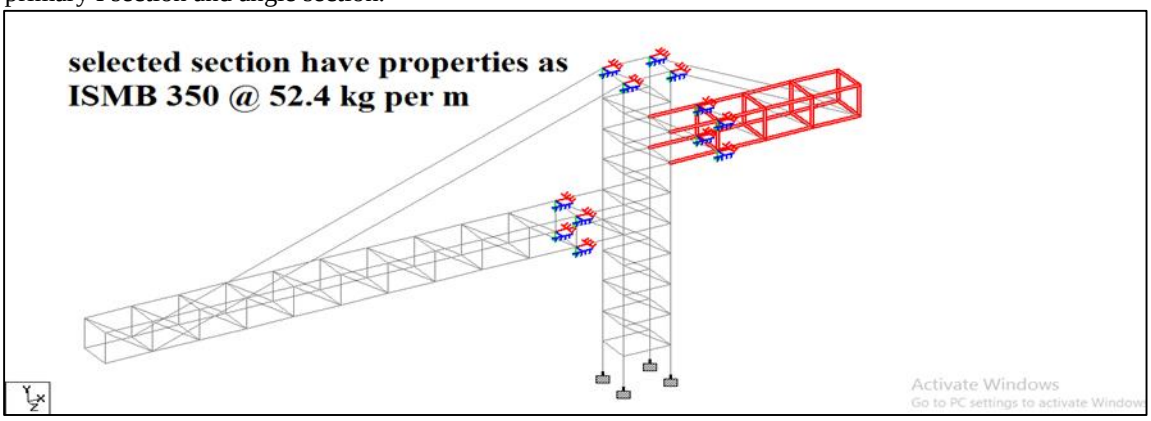

Fig. 6: Counter Weight Design I-section

There are 48 I- section are used in design and 16 angle section are used.
Total weight of I section is 2535 kg and total weight of angle section is 135 kg. So total steel used in counter weight boom is 2670 kg.

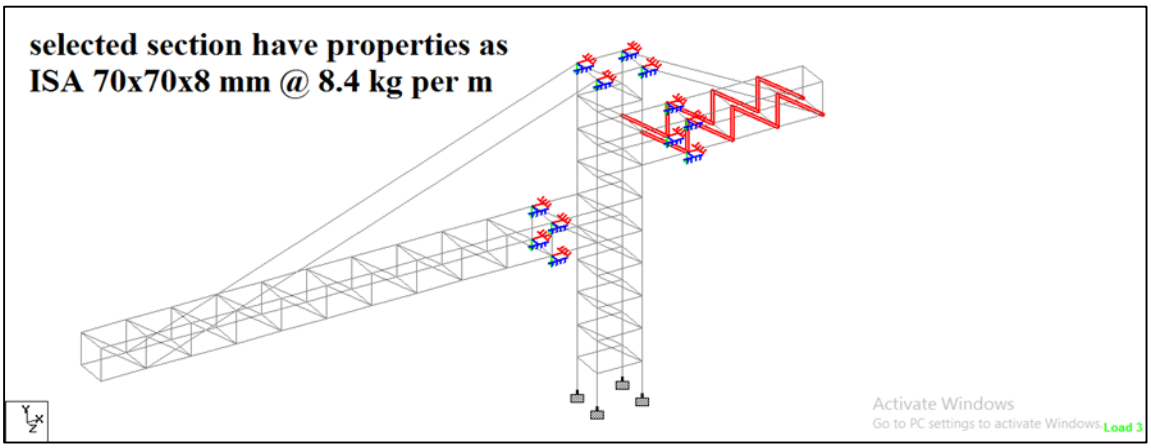

Fig. 7: Counter weight Design L-section

III. CONCLUSION

In this project as per our specification (capacity 50 ton per hours and boom length 22 m) of structure found that ISMB 350 is in a maximum case safe for the structure. But also 44 beams are failed in different load. For the failure in compression in this project, found that there is no need for increase in grade of steel because it is also depends on effective length and radius of gyration. For the simplicity in erection we increase radius of gyration of section. So the structure will remain economical. As per market survey we found that this kind of structure have price 40 lac to 90 lac and in our design it is of 35 lac so it is economical than other designs.. Bucket wheel we are taking 6 bucket having dimension of 1.38m diameter of hemisphere in shape for the stacking of coal with minimum cross sectional area.

REFERENCES

[1] Michael G. Kay, Material Handling Equipment North Carolina State University January 2012.
[2] Computer aided analysis of load/stress/dynamic behaviour for special bridge-type stacker-reclaimer by vlada gašic, nenad zrnic, srdan bošnjak in 2007.
[3] Development and Structural Analysis of Masthead for a Twin Boom Stacker by K Vamsi Krishna, S Porchilamban Post Graduate Student, Assistant professor Mechanical and production engineering, Sathyabhama university, Chennai, India, IJEDR | Volume 2, Issue 1 | ISSN: 2321-9939.
[4] Ghosal. S, Misra.D, Saha.T.K, Chakravorthy.D, Failure analysis of Stacker-cum-Reclaimer in ore handling plant, Journal of failure analysis and prevention, vol 8, pages 564-571, 2008.
[5] Methodology to Calculate the Effective Reclaiming Capacity of Rail-Mounted Boom-Type Bucket Wheel Reclaimer and Stacker/Reclaimer By D. Komljenovic, J. Paraszczak,
[6] Fytas, Canada and C. Drebenstedt, Germany