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Study of Various Parameters on Design of Compressor Shelter

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***Abstract*— Petrochemical plants consist of pipe racks, equipment support structure, compressor shelter etc. In petrochemical plant compressor is required for maintaining the required pressure level, so that each unit can work properly. Any damage to it can cause the shut down of the plant. Here compressor shelter with particular geometry is selected and its analysis and design is carried out. The various parameters which can affect the total quantity of material for the compressor shelter are wind speed, crane capacity, seismic zone, support condition, use of built section, maintenance load on compressor shelter, and removable roof type system. From the results obtained after analysis and design of compressor shelter it was found that seismic force do not govern the design of compressor shelter because of the less seismic mass of the structure. Therefore it was not considered for the study. At a time only one parameter is varied keeping the other factors constant including geometry of the structure and their effect on total quantity of material for the structure is analyzed..**

INTRODUCTION

Compressor shelter is mainly a part of process plant unit. Compressor shelter is the shelter provided for the compressor and its associated equipment to protect them from various environmental agencies such as wind, snow, heat, rain etc. It may be with or without wall cladding. It includes operating platform, hoisting devices such as hoist or crane, which are generally provided for the operation and maintenance purpose. Sometime compressor shelter is provided with two compressors. One is operating and other is provided for stand by If main operating compressor is of electric type then the other one can be steam compressor.

WORK DONE

Compressor shelter with particular geometry is selected and its analysis and design is carried out using STAAD.Pro 2006 software. Following figure shows the 3-D model of compressor shelter generated in STAAD.Pro.

Design of the structural steel members is done according to AISC-ASD [l] standard and design of foundation is done according to ACI 318-05 [2]. The total quantity of steel required for the superstructure of the compressor shelter is 148.55 MT and the total quantity of concrete and re-bars required for the foundation of the compressor shelter is 165.34 m3 and 12.65 MT respectively.

After that parametric study of the compressor shelter is carried out considering the following parameters. At a time only one parameters is varied keeping all other factors constant including geometry of the structure.

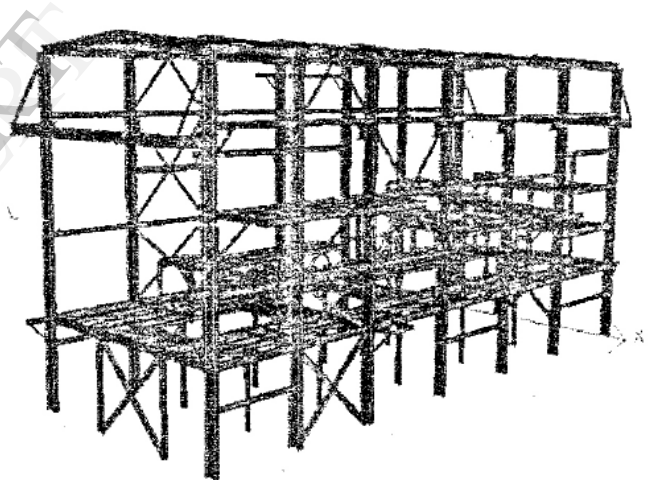

Fig.1 Compressor Shelter

- Variation in wind speed
- Variation in Crane capacity
- Use of different types of support condition
- Use of built up section
- Maintenance load on compressor
- Removable roof type system

Design standards and the design codes are kept constant in all the exercises.

RESULTS OF PARAMETRIC STUDY

Following are the results obtained after the parametric study of the compressor shelter.

A. Variation in Wind Speed

Different wind speeds considered for the study are 40 m/s, 49 m/s, 58 m/s and 67 m/s. Following graphs show the effect of wind on total quantity of structural steel, concrete and re-bars. Wind loads are calculated according to ASCE-7 02 [3]

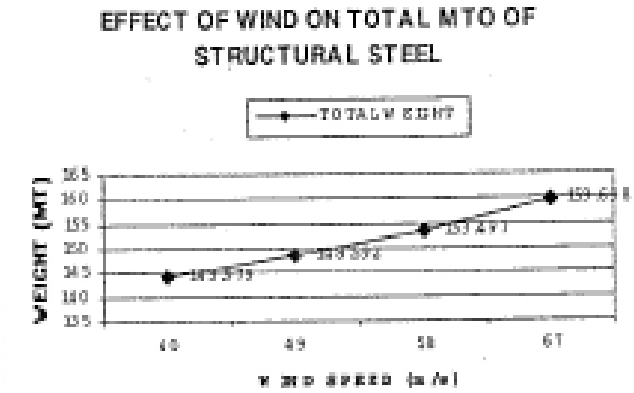

Fig. 2 Total weight v/s Wind speed

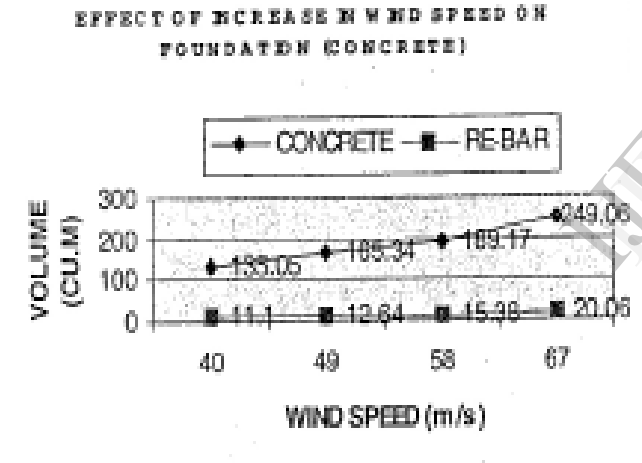

Figure 3 Total quantity v/s Wind speed

B. Variation in Crane Capacity

Different crane capacities considered for the study are 10 T, 20 T, 40 T and 60 T.

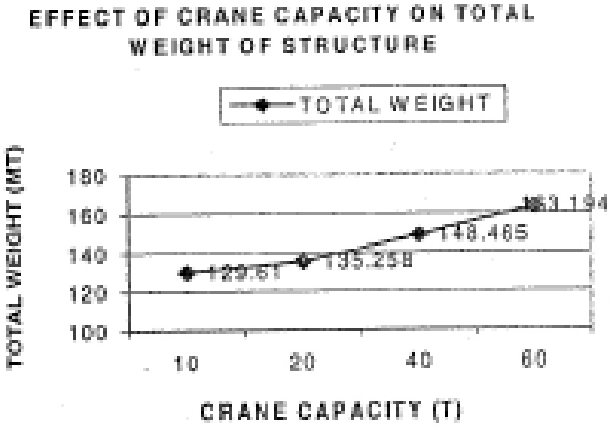

Figure 4 Total weight v/s Crane capacity

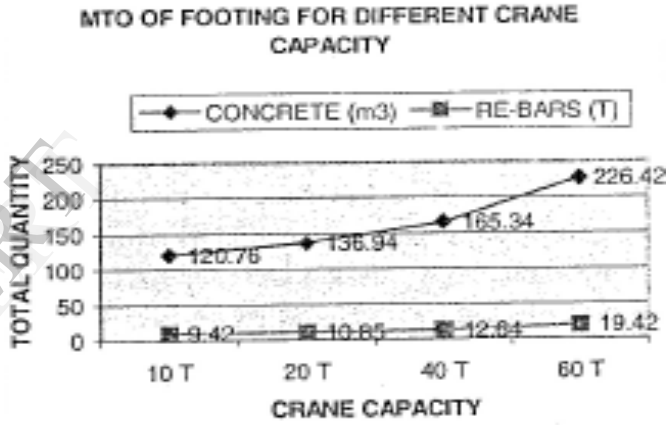

Figure 4 Total weight v/s Crane capacity

C. Use of Different Type of Support Condition

Compressor shelter is having pinned support condition at the base of the structure in base problem. Therefore different types of support condition considered other than pinned support condition are fixed and fixed but released support condition.

Table I TOTAL QUANTITY OF STEEL, CONCRETE AND RE-BARS REQUIRED FOR THE DIFFERENT SUPPORT CONDITION

Support Condition	Pinned	Fixed But Released	Fixed
Structural Steel (Mt)	148.78	148.13	146.32
Concrete (M3)	16534	176.86	235.92
Re-Bars (Mt)	12.64	15.52	17.53

D. Use of Built Up Section

Different types of built up sections were tried in the compressor shelter for the columns and their weight per meter length is compared with that of standard section used in base problem. After the comparison built up section made up of two channel section placed toe-to-toe is selected and again analysis and design was carried out and the results are as follows.

TABLE 2 EFFECT OF BUILT UP SECTION ON TOTAL QUANTITY OF STEEL, CONCRETE AND RE-BARS

Material	Without built up	With built up section
Structural Steel (Mt)	148.78	132.68
Concrete (M3)	165.34	162.11
Re-Bars (Mt)	12.64	12.44

E. Maintenance load on operative platform

During maintenance of the compressor, it is lifted and placed directly outside the compressor shelter or it is placed on the operating platform. If its maintenance operation is carried out on operating platform, then the operating platform is subjected to very heavy load. Thus, here analysis and design of compressor shelter is carried out by assuming that maintenance operation is carried out on operating platform. Results obtained after the analysis and design shows that the total quantity of steel required is 149.217 MT and the total quantity of concrete and re-bars required 171.84 m^3 and 14.0 MT respectively.

F. Removable Roof System

Sometimes appropriate capacities of cranes are available in plants for lifting heavy weights, so that during maintenance, roof of the compressor shelter is removed and compressor is lifted with the help of crane and placed outside the compressor shelter. Thus there is no need of crane in compressor shelter. In such case the total quantity of steel required for the compressor shelter is 123.32 MT and the total quantity of concrete and re-bars required are 108.31 m^3 and 8.97 MT respectively. As there is no crane load, therefore wind is the only force, which can govern the design of compressor shelter. Thus analysis and design of compressor shelter subjected to different wind speed is carried out. Different wind ss peeds considered for the study are 40, 49, 58 and 67 m/s. Following graphs shows the variation in the total quantity of steel, concrete and re-bars with the variation in the wind speed.

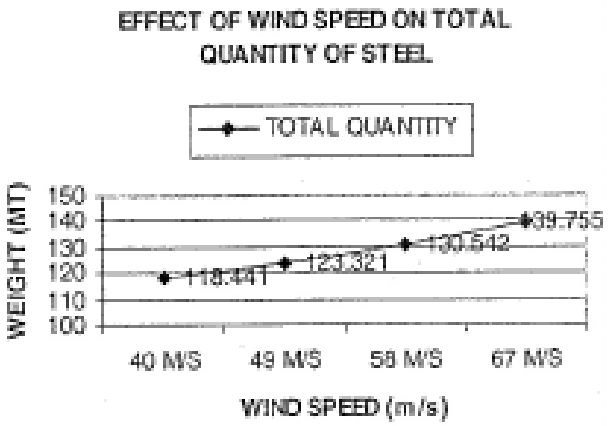

Fig. 5 Total weight v/s Wind speed

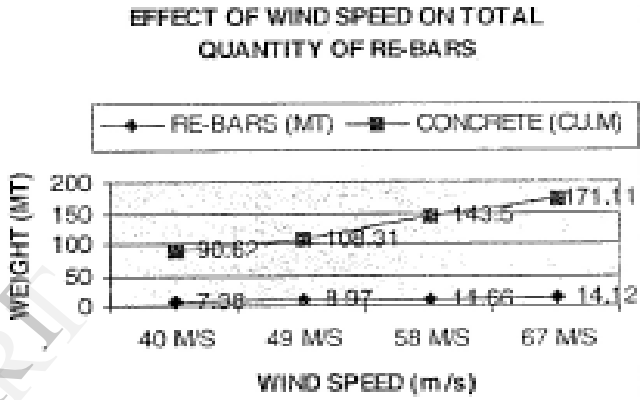

Fig. 6 Total quantity v/s Wind speed

CONCLUDING REMARKS

1. For every increase of 9 m/s in wind speed in compressor shelter with fixed roof system the increase in the total quantity of steel is around 3.48%.
2. For every increase of 10 T in crane capacity in compressor shelter with fixed roof system the increase in the total quantity of steel is around 4.61%.
3. Adequately When fixed support condition is used in compressor shelter with fixed roof system instead of pinned support condition the total quantity of steel is reduced by 1.66% but the increase in the total quantity of concrete and re-bars is very large.
4. Similarly when fixed but released supportcondition is used in compressor shelter with fixed roof system instead of pinned supports the total quantity of steel is reduced by 0.63% but the total quantity of concrete and re-bars required are increased.
5. Use of built up section in compressor shelter with fixed roof system decreases the total quantity of steel by 10.62% and the total quantity of concrete and re-bars required are also reduced. Thus it is concluded that built up section leads to the economical design of compressor shelter.
6. Due to the maintenance load on the operating floor the total quantity of steel is increased to 149.217 MT and the total quantity of concrete and re-bars required are increased to 171 m^3 and 14.0 MT respectively.

7. Because of the use of the removable roof type system in compressor shelter instead of fixed roof system the total quantity of steel reduced by 17% and the total quantity of concrete and re-bars required are also reduced. Thus removable roof type system results in economical design of compressor shelter.

REFERENCES

[1]. AISC-ASD, "Allowable stress design", American Institute of Steel Construction, 1989.

[2]. ACI 318-05, "Building code requirement for structural concrete" American Concrete Institute, 2005.

[3]. ASCE 7-02, "Minimum design loads for building and other structures", American Society of Civil Engineers, 2002.