ANALYSIS & DESIGN OF WAREHOUSE BUILDING

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Abstract : The Structural Engineers comes across analysis and design of various structures. The structural engineers aims at designing safe, serviceable, durable and economical structures. The advent of some important computer software packages had helped in analysis and design of complex structures in short period of time.

By anticipating, the growth of E-commerce industry in Gulbarga in near future, there will be need of warehouses, hence a site was selected on the outskirts of Gulbarga city, near Malgatti village, around 2km from here. The area of site was approximately 17000sqm and the built up area proposed was approximately 5020sqm. Proper planning was done with all the necessary facilities required in the modern warehouses, using Auto CAD software. Survey work was carried out on the site and block leveling was done to estimate the quantity of earthwork required. Earthwork excavation quantity was obtained from MS EXCEL. Further, the analysis and design of warehouse building was done in STAAD Pro software. Lastly, the estimation of building was carried out. The estimated cost of the proposed building is **4.25 crores.**

I. INTRODUCTION

The aim of structural design is that the structure should be safe, durable, serviceable and economical with respect to initial cost and maintenance cost.A large number of software packages are available which helps structural engineers to carry out analysis of complex structures, their material properties and various boundary conditions. Hence the analysis and design is carried out by using software.

Design process:

A basic plan is a craftsmanship and study of planning, with economy and class, protected, workable, and sturdy structures.The whole procedure of basic arranging and configuration requires creative mind and calculated deduction as well as sound learning of study of auxiliary building, information of down to earth angles, and nature with pertinent plan codes.The process of design starts with planning of structure, primarily to meet the requirements of the client. The requirements by the client may not be well defined, since he is not aware of the complexities and impracticabilities of some structures. The functional aspects and the aspect of aesthetics is usually decided by the Architect, and the aspect of safety, durability, and serviceability are attended by structural engineIn this project work, it is aimed to analyse and design a typical public warehouse building. This warehouse building can be used by sellers, importers, exporters and other industrial companies to store their goods on rental basis.

This building is mostly steel oriented building, with all its components are made up of steel. The structural steel have the following advantages:

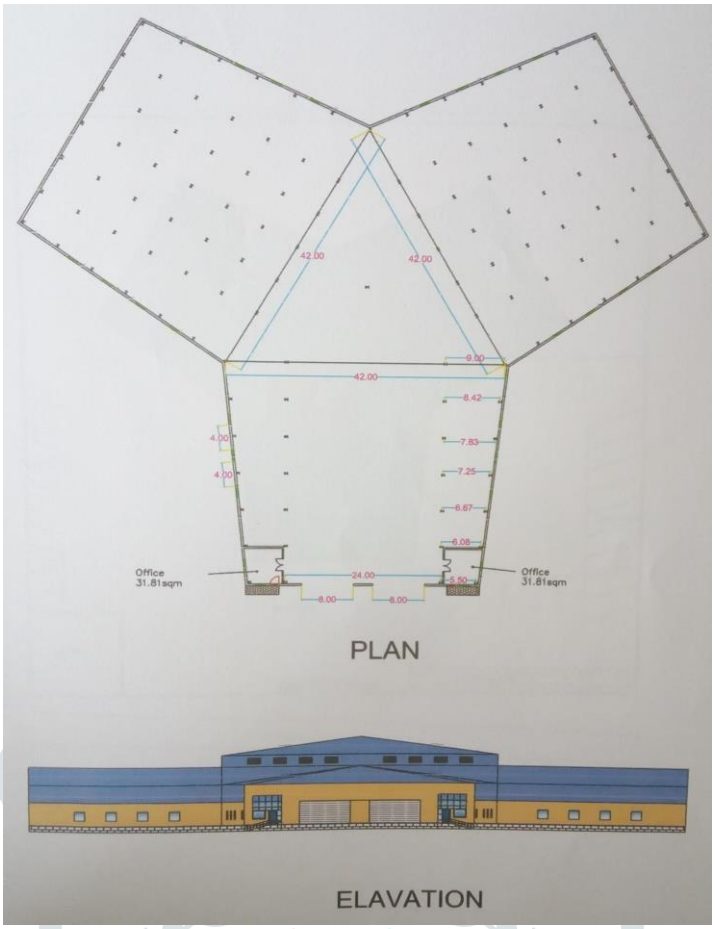
1) The steel members have high strength. Therefore, these members can resist high loads with comparatively light weight and small size.
2) These steel members can be easily fabricated and transported.
3) These members are gas and water tight, because of high density of steel.
4) The steel members have long service life, because of high and homogenous strength of steel.
5) The steel structures may be inspected quickly and conveniently.
6) They have high scrap value.

II. ARCHITECTURAL PLANNING

To impart maximum possible benefits for a warehouse building within limitation, will always a greater task for both architect and civil engineers even though we have found a way which will impart maximum benefits to the client. Here we had given more consideration over environmental aspects such as air, and light, ventilation. The shape of this building is different from the usual rectangular warehouse buildings, which imparts aesthetically good from every point of view.

This warehouse building is divided into 3 wings, the 1st wing consist of two offices and two large entrances for the entry and exit of goods. To maximize the storage, the other two wings are provided with a mezzanine floor of area approximately 2822sqm(including both wings). The total builtup area is approximately 5020sqm.The storage capacity is approximately 30000cum.

Apart from these, the warehouse is surrounded with all the modern facilities like vehicular parking, truck parking, weighing point, a small canteen, toilets, pump room, OTS substation, Electrical room, security office at the main entrance.The details of plan, elevation, layout is given in the **fig2.1, fig 2.2, fig 2.3** respectively.



III. STRUCTURE DESIGN

The process of structure design involves the following stages:

1. Structural planning.
2. Estimation of loads.
3. Analysis of structure.
4. Member design.
5. Drawing and detailing.

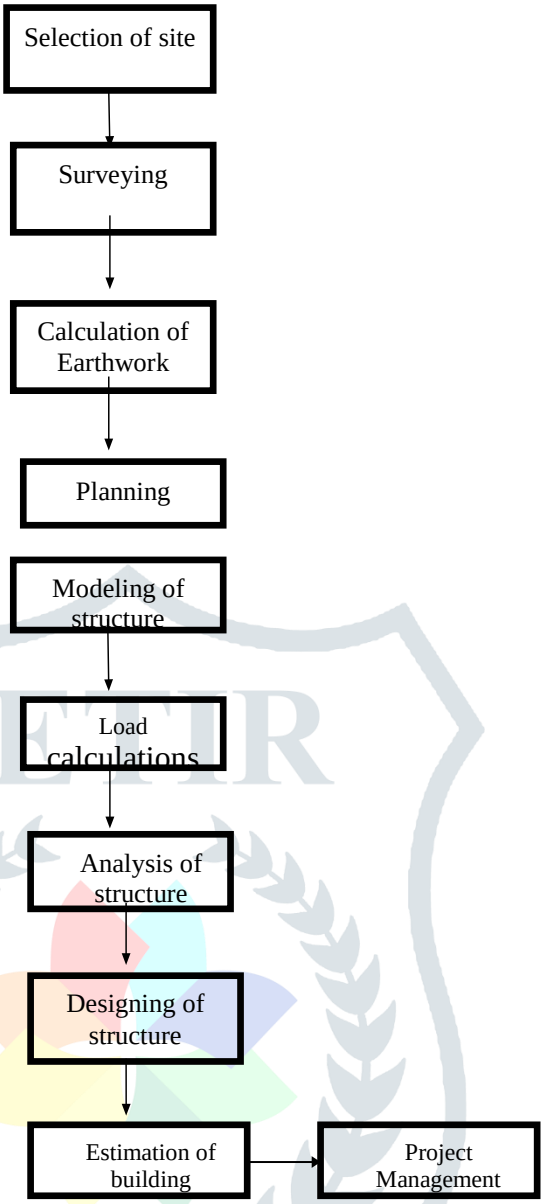
Structural Planning:

This involves determining the form of structure, its materials, its structural system, the layout of its components, the method of analysis and the philosophy of structural designs.The principle elements of "WAREHOUSE BUILDING" are:

I. Trusses to support large area of GI roofing sheets.
II. Beams to support composite slab.
III. Columns to support Beams and trusses.
IV. Footings to distribute concentrated column loads over large area of supporting soil.
V. After finalizing the architectural plan of the warehouse building, the structural planning of the building frame is done. This involves the determination of the following:

i. Selection of suitable configuration of truss.
ii. Column positions.
iii. Beam location.
iv. Selection of economical sections.
v. Finalising the economic height of truss.
vi. Finalising the economic spacing of truss.
vii. Type of footing required.

IV FLOW CHART OF VARIOUS ACTIVITIES OF PROJECT



V EARTHWORK ESTIMATION

On development ventures it is regularly important to alter the current ground levels to make stages to expand on. Precisely ascertaining the volumes of soil that must be expelled (cut) or included (fill) to make the last ground levels is a fundamental piece of the arranging procedure.

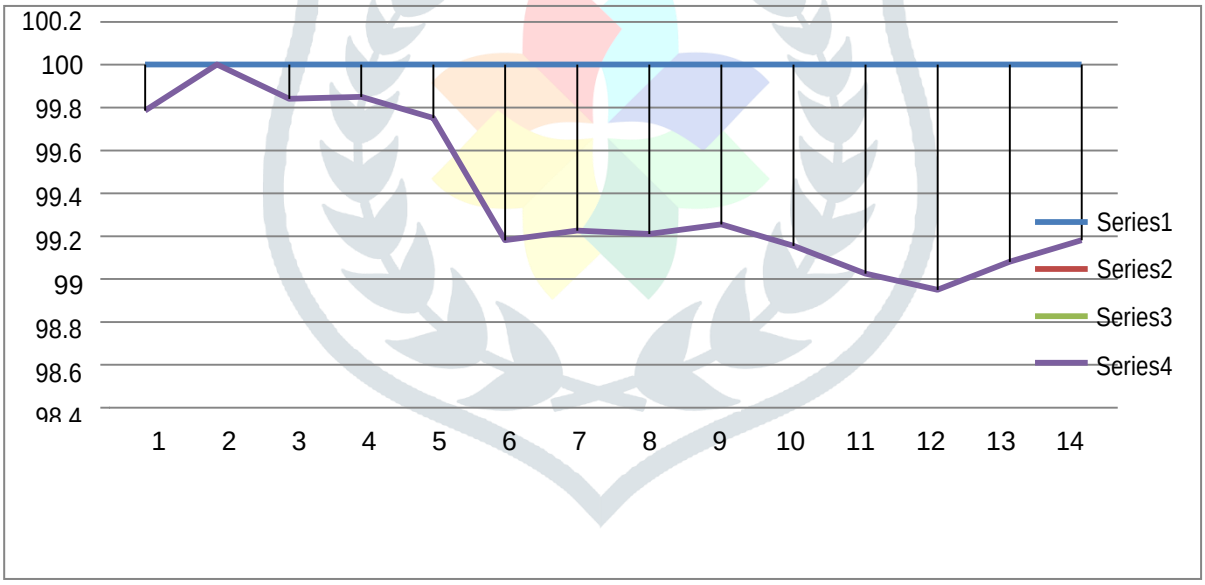
From block leveling sheet, the values of different RL were noted. These values are then inserted into Excel sheet. By applying the logical formulae in it, the Earthwork quantities were obtained.

Steps involved in Earthwork estimation:

- The first chainage line, which contains 14no. of stations with different RL @ every 10m interval is selected.
- A suitable RL of formation is adopted.
- The RL of formation and the RL of every station is subtracted to get Height.
- The difference between the heights of successive stations will give the mean depth(d).
- Multiplying mean depth to the formation width(B) will give the Central area(Bd).
- Then this central area is multiplied with the length(10m) gives the volume or quantity of each block of 10mx10m.
- The quantity obtained may be either Banking or cutting depending upon the height above or below the Formation level.
- This procedure is repeated for other chainages.
- Hence the total Quantity of Earthwork is obtained.
  Earth work calculation are shown in **Table 6.1** to **6.14** and **Fig 6.1** to **6.14.*The total earthwork quantities obtained is Banking=2082.6cum, Cutting=3600cum.***

Table 5.1 Earthwork calculation at first chainage line .

Formation level (m)	Stations	RL (m)	Height(m) FL-RL	Mean Height (m)	Formation width "B" (m)	Central area "Bd" (m^2)	Total area (m^2)	Length (m)	Banking (m^3)	Cutting (m^3)
First chainage line										
100	1	99.785	0.215							
100	2	100	0	0.108	10	1.075	1.075	10	10.75	0
100	3	99.84	0.16	0.08	10	0.8	0.8	10	8	0
100	4	99.85	0.15	0.155	10	1.55	1.55	10	15.5	0
100	5	99.75	0.25	0.2	10	2	2	10	20	0
100	6	99.18	0.82	0.535	10	5.35	5.35	10	53.5	0
100	7	99.225	0.775	0.797	10	7.975	7.975	10	79.75	0
100	8	99.21	0.79	0.783	10	7.825	7.825	10	78.25	0
100	9	99.254	0.746	0.768	10	7.68	7.68	10	76.8	0
100	10	99.155	0.845	0.795	10	7.955	7.955	10	79.55	0
100	11	99.025	0.975	0.91	10	9.1	9.1	10	91	0
100	12	98.95	1.05	1.013	10	10.125	10.125	10	101.25	0
100	13	99.08	0.92	0.985	10	9.85	9.85	10	98.5	0
100	14	99.18	0.82	0.87	10	8.7	8.7	10	87	0



Graph – 5.1 c/s at first chainage line .

VI. PROPOSED 3D MODEL OF WAREHOUSE

The 3D Model of warehouse building is shown in **Fig – 6.1**

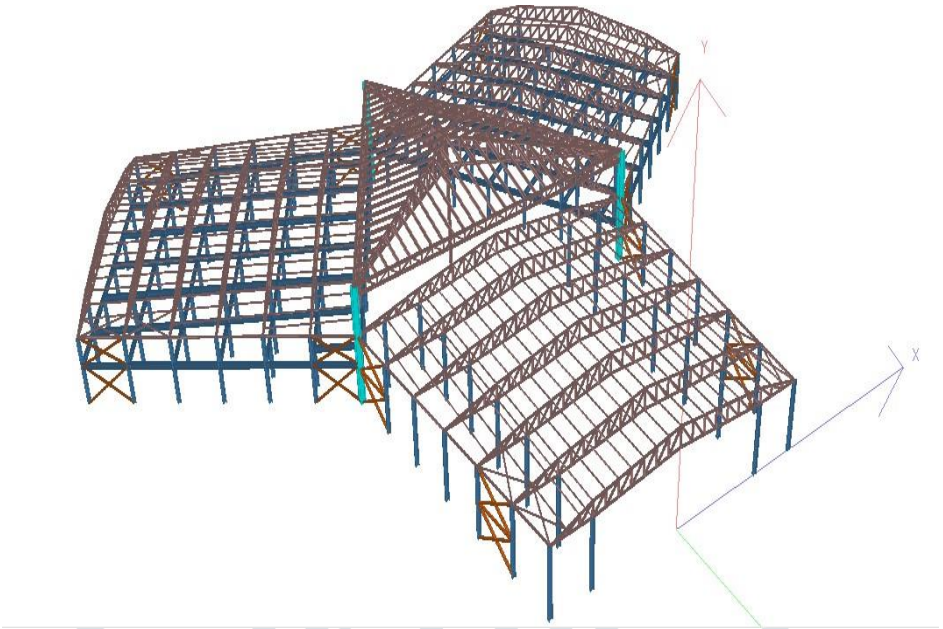
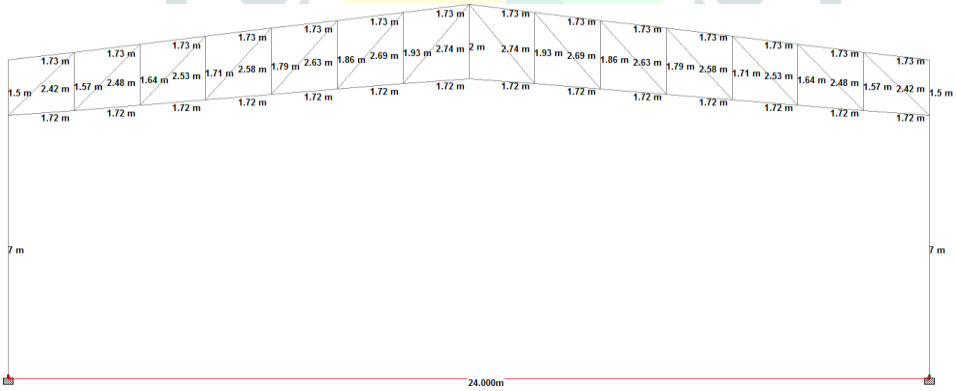


Fig – 6.1 3D Model of warehouse building

VII. LOAD ANALYSIS

7.1 CALCULATION OF LOADS ON MAIN TRUSS OF 24 M SPAN (MT TRUSS)



Loading: kN/m^2

Dead load: GI sheeting\ = 0.085

Fixings = 0.025

Services = 0.100

Total load = 0.210

For 6 m bays, Roof dead load = 0.21 * 24 * 6 = 30.2 kN

=31 KN

Dead Loads

Intermediate nodal dead load (W_1) = 31/14 = 2.21 kN

Dead load at end nodes (W_1 / 2) = 2.21/2 = 1.10 kN

(Acts vertically downwards at all nodes)

Wind load (IS: 875-1987):

Basic wind speed = 44 m/s(AS PER HYDERABAD CITY) Wind load F on a roof truss by static wind method is given by

$F = (C_{pe} - C_{pi}) * A * p_d$

where, C_{pe}, C_{pi} are force co-efficient for exterior and interior of the building.

Value of C_{pi}:

Assume wall openings between 5-20% of wall area.
Then, $C_{pi} = \pm 0.5$

Value of C_{pe}:

Roof angle = $\tan^{1}(1.5/12)$ = 7.12 =8

Height of the building to eaves, h=7m

Lesser dimension of the building in plan, w=24m Building height to width ratio is given by, h/w=7/24=0.29<0.5

VIII. CONCLUSION

Computer aided design is the requirement of high rise buildings and buildings with complex plans, to accurately analyse and model the proposed structure.

Modern software such as STAAD PRO can be used as a tool to understand the wholistic behaviour of any structure and design also using RCC , steel and composite construction .

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