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Implementation of Water Tank Design using Staad Pro Software

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Abstract **- Intensity of the wind is the principal reason for wind caused disaster. Hence constructed structures must be prepared by constructor to fight the impending disaster due to wind by understanding the performance of the structure under wind load. In this study a computational analysis of water tank has been carried to evaluate the performance of elevated water tank under the action wind forces. Since these types of tanks have high mass concentrated at the top height of slender supporting structure and that's why this type of structures are mainly susceptible to horizontal forces induced by wind. Elevated water tanks have been investigated to analyze the actions of this structure due to wind force by changing different parameters such as capacity, height of stage, terrain category and wind zone. The results presented in this paper will be useful to the designer to understand the effect of various factors as mentioned above on the magnitude of wind force acting on the elevated water tank. Overhead Intze type tank is a form of expanded water tank resting on staging. Bottom part of tank of Intze tank is abounding in flat structure, thus in flat bottom, the thickness and reinforcement is set up to be high. This work aims to study the performance of the Overhead water tank of Intze type having different configuration of staging under the action of basic wind loads in different terrain category.**

Keywords **- Intze type tank, wind forces, Lateral displacement, STAAD-PRO, Wind Zones.**

I. INTRODUCTION

A water tank is a container for storing liquid. The need for a water tank is as old as civilization, to provide storage of water for use in many applications, drinking water, irrigation, agriculture, fire suppression, agricultural farming, both for plants and livestock, chemical manufacturing, food preparation as well as many other uses. A water tank is a structure utilized to save water to tide over the day-to-day necessity. Cost, shape, size and building materials used for constructing water tanks are influenced by the capacity of water tank. Condition of the water tank is a fundamental layout parameter since nature and power of stresses rely upon the condition of the water tank.

All things considered, for a given cutoff, circuitous shape is supported in light of the way that tensions are uniform and lower diverged from various shapes. Plan of liquid keeping up structure must depend at the circumvention of part inside the strong having appreciation to its inflexibility. Parts can be turned away by technique for keeping up a vital separation from the usage of thick wood covering which keep the basic escape of warmth of hydration from the strong mass the risk of breaking moreover can be constrained by strategy for decreasing the restrictions on free advancement or withdrawal of the structure[1-5].

II. DESIGN OF WATER TANK

A water tank is only a compartment for putting away fluid. The need for a water tank is nearly as old as the progress, with a specific end goal to give water stockpiling to use in a few uses, water system, horticulture, drinking water, rural cultivating, both for plants and domesticated animals, substance producing, fire concealment, nourishment readiness and numerous different employments.

Water tank parameters involve the normal outline of the tank, and select of development materials, linings. Strengthened Concrete Water tank configuration is rely upon IS 3370: 2009 (Parts I – IV). The design based on the locality of tanks, i.e. overhead, on underground or ground water tanks. The tanks can be made of RCC or even of another hand the underground tanks rest below the ground level.

From the position point of view and placement of tank, water tanks are divided into three classes. Those are,

1. Tanks resting on ground
2. Underground tanks

Types of water tank:

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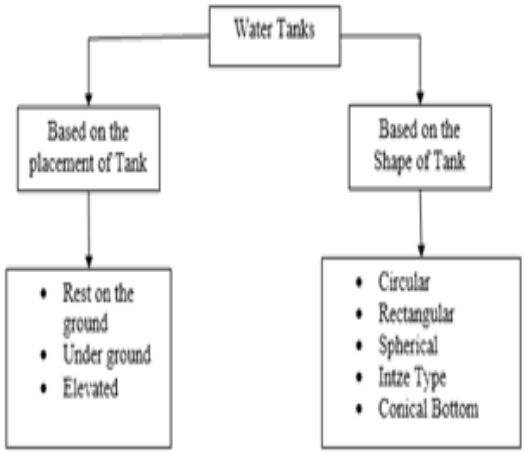

Fig.1. Taxonomy of water tank.

III. PERFORMANCE OF ELEVATED TANKS

Wind stack insurance of fluid tanks is of impressive hugeness. Water putting away tanks ought to stay useful in the post wind stack period to ensure consumable water supply to wind stack influenced region and to provide food the need for battling. Mechanical fluid containing tanks may involve inflammable fluids and very harmful and these tanks must not lose their substance amid the breeze stack. Fluid putting away tanks are by and large of two sorts: hoisted tanks and ground bolstered tanks. Raised tanks are for the most part used for water supply plans and they could be bolstered on RCC shaft, steel or RCC casing, or stone work platform [6].

Two highlights went to the bleeding edge for the tanks planning:

1. Because thought should give to sloshing fluid impacts and adaptability of holder divider while assessing the breeze stack weight on tanks.
2. It's realized that tanks are lesser malleable and have bring down vitality engrossing limit and repetition contrasted with the customary development frameworks.

IV. OBJECTIVE OF STUDY

Horizontal Displacement in water tank due to wind is critical as they result in sloshing of water and additional displacement. There is a need to investigate various methods to minimize this horizontal displacement.

One method proposed in this direction is to adopt water tanks with inclined legs. Hence the goal of the work is to understand the structural behaviour of water tank subjected to wind with straight and inclined leg [7].

1. Software Used

Analysis of all the models is carried out with the help of STAAD-Pro software. STAAD is a powerful Building data modeling and design software licensed through Bentley. STAAD stands for structural approach for study and design which addresses each aspects of structural engineering i.e. model development, analysis, design, verification and visualization. This is based on the principles of concurrent engineering. One can build his model, verify it graphically, perform analysis and design, review the results, sort and search the data and can create a report within the same graphics based environment. Following are the main options available from the concurrent graphics environment.

1. STAAD-Pro Analysis and design
2. STAAD-Pre Graphics Input Generation
3. STAAD-Post Graphical Post processing, MATLAB used in prediction criteria.

V. DESIGN WIND SPEED

1.Design Wind Speed (Vz):

The basic wind speed (Vb) for any site shall be modified to include the following effects to get design wind velocity at any height (Vz) for the chosen structure.

1. Risk level
2. Terrain roughness, height and size of structure
3. Local topography

It can be mathematically expressed as follows.

Vz = Vb * k1 * k2 * k3

Where ,

Vz = design wind speed at any height z in m/s

Vb = basic wind speed in m/s

k1 = probability factor (risk coefficient)

k2 = terrain, height and structure size factor and

k3 = topography factor.

2.Risk Coefficient (k1 Factor) 6)

k1 factor gives basic wind speeds for terrain Category 2 as applicable at 6 m above ground level based on 50 years mean return period. The suggested life period to be assumed in design and the corresponding k1 factors for different class of structures for the purpose of design. Terrain, Height and Structure Size Factor (k2 Factor)

3.Terrain:

Choice of landscape classes should be made with due respect to the impact of blocks which constitute the ground surface harshness. The landscape class utilized as a part of the Design of a structure may change contingent upon the course of twist under thought. Wherever adequate meteorological data is accessible about the idea of wind heading, the introduction of any water tank or structure might be appropriately arranged. The landscape classifications are said above[8-13].

4.Topography (k3 Factor):

The essential breeze speed Vb assesses the general level of site above ocean level. This does not take into consideration neighborhood topographic highlights, for example, slopes, valleys, precipices, ledges, or edges which can essentially influence twist speed in their region. The impact of geology is to quicken twist close to the

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summits of slopes or peaks of precipices, ledges or edges and decelerate the breeze in valleys or close to the foot of bluffs, soak slopes, or edges. For an overhead water tank of Intze type supported on inclined staging of 20m height. These 6 columns are inclined towards the centre at the top. The columns are rectangular columns having a dimension of 1000x500 mm. The other dimensions considered for water the tank are elaborated below [14-18].
Height of the water tank- 26m
Height of staging- 20m
Number of columns-6
The structure will be modeled and analyzed for wind loads using STAAD-Pro software package.

Table I:

1. Frame Sections:

Member	Size (mm)
Column rectangular type	1000x500 mm
Bracings	400x400mm
Bottom ring Beam	500x500 mm

Table II:

2. Area Sections:

Member	Thickness (mm)
Thickness of top dome	200 mm
Thickness of cylindrical wall	1000
Thickness of conical wall	500
Thickness of bottom dome	300

3. Material Properties:

The material is used for analysis is Reinforced concrete with M-20 grade and Fe-415 reinforcing Steel.

4. Loads considered in the analysis using STAAD-PRO

- Dead load
- Water pressure
- Wind load

Fig.2 analysis using STAAD-PRO

Case 2

For an overhead water tank of Intze type supported on straight staging of 20m height. These 6 columns are straight from bottom to top. The columns are rectangular columns having a dimension of 1000x500 mm. The other dimensions considered for water the tank are elaborated below.
Height of the water tank- 26m
Height of staging- 20m
Number of columns-6
The structure will be modeled and analyzed for wind loads using STAAD-Pro software package.

Table III:

5. Frame Sections:

Member	Size (mm)
Column rectangular type	1000x500 mm
Bracings	400x400mm
Bottom ring Beam	500x500 mm

6. Area Sections:

Table IV:

Member	Thickness (mm)
Thickness of top dome	200 mm
Thickness of cylindrical wall	1000
Thickness of conical wall	500
Thickness of bottom dome	300

7. Material Properties:

The material is used for analysis is Reinforced concrete with M-20 grade and Fe-415 reinforcing Steel.

8. Loads considered in the analysis using STAAD-PRO

1. Dead load
2. Water pressure
3. Wind load

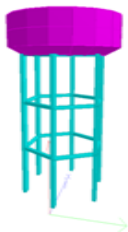

Fig.3 analysis using STAAD-PRO

Table V: Wind Forces (KN) for different wind Zones of terrain category 1.

Staging height (m)	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI
10m	35.69	42.58	48.492	51.799	55.62	61.182
20m	38.115	45.474	51.788	55.319	59.4	65.34
21m	38.219	45.598	51.929	55.47	59.562	65.519
25m	38.635	46.094	52.494	56.073	60.21	66.231
26m	38.739	46.218	52.635	56.224	60.372	66.409

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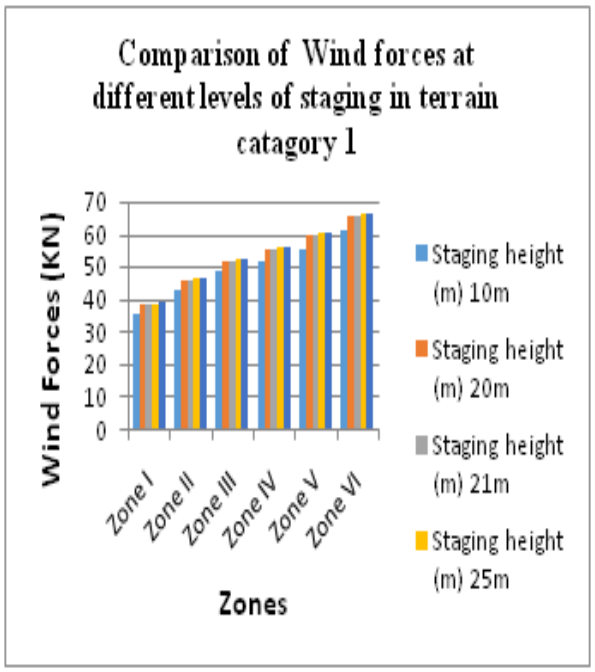

Fig.3 Variation of Wind Forces in Different Wind Zones of Terrain Category I.

Table VI: Wind Forces (KN) for different wind Zones of terrain category 2.

Staging height (m)	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI
10m	33.957	40.513	46.138	49.284	52.92	58.212
20m	36.382	43.407	49.434	52.805	56.7	62.37
21m	36.556	43.614	49.669	53.056	56.97	62.667
25m	37.249	44.441	50.611	54.062	58.05	63.855
26m	37.422	44.647	50.864	54.313	58.32	64.152

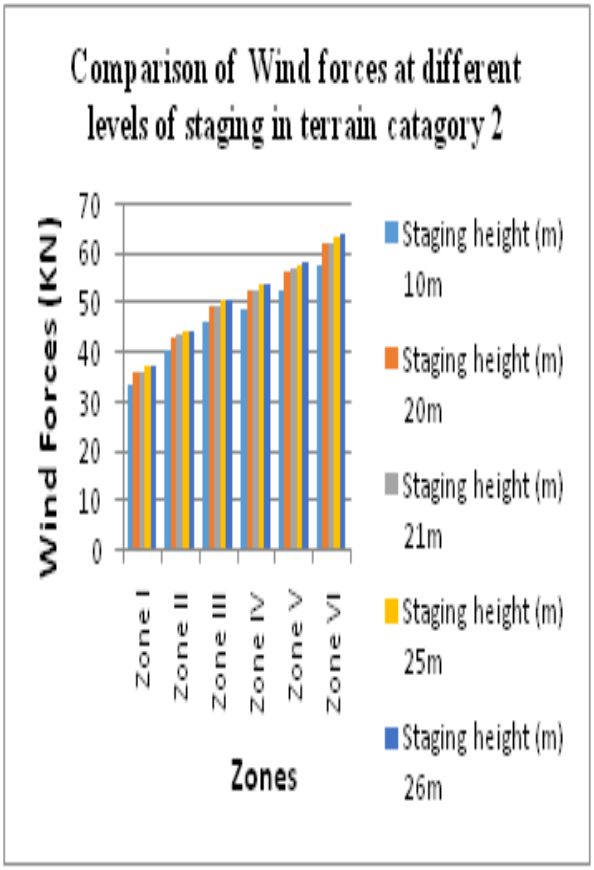

Fig.4 Variation of Wind Forces in Different Wind Zones of Terrain Category 2.

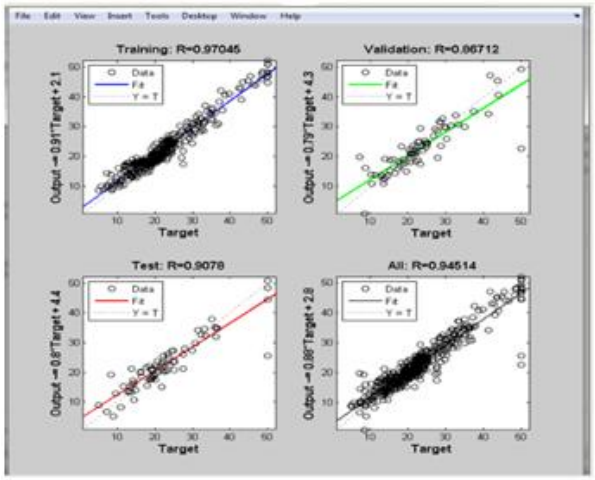

Fig.5 Artificial neural network prediction sample.

VI. DISCUSSIONS

1. General:

The examination looks at the execution of overhead water tank of INTZE write having slanted legs and straight legs. It has been examined before that Lateral Displacement in water tank because of wind stack is basic as they brings

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about sloshing of water and extra vibrations, which can be a noteworthy reason for disappointment of water tank. Subsequently there is a need to research different techniques to limit this level relocation. In the present examination, we have thought about Overhead water tank of intze write having slanted legs and overhead tank having straight legs to decide the execution assessment of water tank. Keeping in mind the end goal to think about the adequacy of every one of these models configuration wind powers, sidelong relocation along the tallness of tank for various zones of India in various landscape classes are assessed. Encourage the computed Design wind powers and sidelong relocation along the distinctive level of organizing are then contrasted and exhibited. The outcomes composed in different figures have been examined in detail.

2. Design Wind forces:

Designed Wind forces for zone I is about 19 to 21% less than the that of zone II, about 35 to 37% less than that of zone III, about 45 to 47 % less than that of zone IV, about 55 to 57% less than that of zone V, about 71-73% less than that of zone VI. The breeze powers increment from wind zone I to VI on account of the expansion in fundamental breeze speed because of increment in chance coefficient k1.

As the breeze drive step by step increments from ground level up to the 10-meter stature according to the proposals of IS Code 875 section III. The Designed breeze powers are analyzed for 10, 20, 21, 25 and 26-meter statue of the tank it is watched that the outlined breeze powers increment with tallness in each zone. This is on the grounds that uncovered region territory tallness and size factor k2 increment with the expansion in organizing stature. It is additionally watched that of all the territory classes 1,2,3,4 of wind zones, the landscape category1 is seen to be basic since it is open landscape without any checks.

3. Lateral Displacement for Inclined legs:

Lateral displacements for zone I is about 29% less than that of zone II, about 45 to 46 % less than that of zone III, about 50 to 52% less than that of zone IV, about 56 to 58% less than that of zone V, about 63 to 65 % less than that of zone VI. There is an increase in lateral displacement from zone I to VI, there is also increase in lateral displacement with increase in height of staging because of increase in wind forces.

4. Lateral Displacement for Straight legs:

Lateral displacements for zone I is about 29% less than that of zone II, about 45 to 46 % less than that of zone III, about 50 to 52% less than that of zone IV, about 56 to 58% less than that of zone V, about 63 to 65 % less than that of zone VI. There is an increase in lateral displacement from zone I to VI, there is also increase in lateral displacement with increase in height of staging because of increase in wind forces.

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