DESIGN AND ESTIMATION OF COOLING TOWER

MR. SHAILESH J. PAGAR.
DEPARTMENT OF CIVIL, ATMA MALIK INSTITUTE OF TECHNOLOGY AND RESEARCH, SHAHPUR.

MISS. TANVI S. ACHAREKAR[2],
DEPARTMENT OF CIVIL, ATMA MALIK INSTITUTE OF TECHNOLOGY AND RESEARCH, SHAHPUR.

MISS. GAURI S. AKOLKAR[3],
DEPARTMENT OF CIVIL, ATMA MALIK INSTITUTE OF TECHNOLOGY AND RESEARCH, SHAHPUR.

MISS. SMITA S. BHAGAT[4],
DEPARTMENT OF CIVIL, ATMA MALIK INSTITUTE OF TECHNOLOGY AND RESEARCH, SHAHPUR.

MR GANESH B. CHAUDHARY[5],
DEPARTMENT OF CIVIL, ATMA MALIK INSTITUTE OF TECHNOLOGY AND RESEARCH, SHAHPUR.

ABSTRACT

A cooling tower is a device that rejects waste heat to the atmosphere through the cooling of a coolant stream, usually a water stream to a lower temperature. Cooling towers may either use the evaporation of water to remove process heat and cool the working fluid to near the wet-bulb air temperature or, in the case of dry cooling towers, rely solely on air to cool the working fluid to near the dry-bulb air temperature using radiators.

The natural draft cooling tower is an open, direct-contact system. It works using a heat exchanger, allowing hot water from the system to be cooled through direct contact with fresh air. To increase the heat transfer surface area (and optimize the cooling process), hot water is sprayed from nozzles within the tower.

Cooling towers in the 19th century through the development of condensers for use with the steam engine. Condensers use relatively cool water, via various means, to condense the steam coming out of the cylinders or turbines.

Keywords: *Cooling tower***,** *Cooling system, Evaporative cooler, Coolant system.*

1 INTRODUCTION

A cooling tower is a device that rejects waste heat to the atmosphere through the cooling of a coolant stream, usually a water stream to a lower temperature. Cooling towers may either use the evaporation of water to remove process heat and cool the working fluid to near the wet- bulb air temperature or, in the case of dry cooling towers, rely solely on air to cool the working fluid to near the dry-bulb air temperature using radiators.

Common applications include cooling the circulating water used in oil refineries, petrochemical and other chemical plants, thermal power stations, nuclear power stations and HVAC systems for cooling buildings. The classification is based on the type of air induction into the tower: the main types of cooling towers are natural draft and induced draft cooling towers.

Cooling towers vary in size from small roof-top units to very large hyperboloid structures (as in the adjacent image) that can be up to 200 metres (660 ft) tall and 100 metres (330 ft) in diameter, or rectangular structures that can be over 40 metres (130 ft) tall and 80 metres (260 ft) long. Hyperboloid cooling towers are often associated with nuclear power plants, [1] although they are also used in some coal-fired plants and to some extent in some large chemical and other industrial plants. Although these

large towers are very prominent, the vast majority of cooling towers are much smaller, including many units installed on or near buildings to discharge heat from air conditioning. Cooling towers are also often thought to emit smoke or harmful fumes by the general public, when in reality the emissions from those towers do not contribute to carbon footprint, and consist solely of water vapour.

LITERATURE REVIEW

2.2.1 Prof. G. M. Lonare, Pratik Dongare, Nirav Gadakh, Uday Devrukhakar, Vrushabh Auti. **Review on Study of Inlet parameter of cooling Tower, 2022.** This review paper give idea about how we will do study and research on inlet parameters of cooling tower. A cooling tower is a type of heat exchanger used to reduce the temperature of a water stream by extracting heat from water and emitting it to the atmosphere. Cooling towers use the evaporation of water to remove process heat and cool the working fluid to near the wet-bulb air temperature. Cooling towers are able to lower the water temperatures more than devices that use only air to reject heat, like the radiator in a car, and are therefore more cost-effective and energy efficient. They are generally used in HVAC applications. There are many types of cooling towers available. The forced draft cross flow and counter flow cooling tower are the most common ones used in HVAC applications. Forced draft cooling tower is a type of mechanical draft tower which has a blower type fan at the air intake. With the fan on the air intake, the fan is more susceptible to complications due to freezing conditions. The benefit of the forced draft design is its ability to work with high static pressure. Such setups can be installed in more-confined spaces and even in some indoor situations. This fan geometry is also known as blow-through. The fan forces air into the tower, creating high entering and low exiting air velocities. The low exiting velocity is much more susceptible to recirculation

2.2.2. Pratik Pranay Pradhan, Pallavi Pratap Chavan, Dr. Pravin kumar . D. Patil. **DESIGN OF COOLING TOWER, 2022. A** cooling tower is an device which is semi-enclosed that evaporates water by means of touch with air or A cooling tower is a warmness rejection device that rejects waste heat to the environment through the cooling of a water movement to a lower temperature. It is made from FRP, wooden, steel or concrete shape. Comigated surfaces or baffles or perforated trays are supplied in the tower for uniform distribution and higher atomization of water inside the tower. The hot water popping out from the condenser is fed to the tower at the top and allowed to tickle in form of skinny drops. The air flows from backside of the tower or perpendicular to the path of water waft after which exhausts to environment after powerful cooling of water. To prevent the escape of evaporated water debris with air, drift eliminators are supplied on the pinnacle of the tower. Cooling tower reduces temperature of circulating water so that water can be utilized in warmth trade device and condensers. Cooling towers are equipment gadgets usually used to use up warmth from strength technology units, water-cooled refrigeration, air con and commercial tactics. Cooling towers offer an high-quality alternative mainly in places in which enough cooling water cannot be effortlessly obtained from natural resources or where challenge for the surroundings imposes some limits on the temperature at which cooling water may be again to the surrounding.

2.2.3. Hector L. Cruz B.Sc. CPr/Env, Bechtel Power Corporation 5275 Westview Drive, Frederick, Maryland, USA, 21703.

ESTIMATING COOLING TOWERS FOR POWER

PLANT APPLICATIONS, 2006. It has always been difficult to estimate size and cost of well designed counterflow induced-draught cooling towers due to the interrelationship of approach temperature and cooling range associated with each design. Attempts to estimate the cost of a tower by assessing currency per cell, per square foot, per gallon, or currency per other single metric, have never been sufficiently accurate due to the asymptotic nature of the approach temperature versus the tower size arithmetic function. To determine accurate qualitative metrics for cooling tower estimating purposes requires assessing two-variable second order equations in water-flow-rate/approach-temperature, temperature- range/approach temperature,wet-bu1btemperature/approach-temperature and approach temperature/cost. Although developed for the power industry, the operative model, design, and qualified costing techniques are also valid for large petroleum and chemical process projects, provided the heat duty dissipated, ambient conditions, water quality and flow rate can be accurately predicted. A set of equations are developed which can be used to estimate the significant costs of a proposed cooling tower.

2.2.4. Xiao-yong Sun, Zi-hou Yuan, Yi-chen Yuan. **Field measurement research of wind pressure inside ribbed cooling tower, 2021.** Due to the limitation of engineering conditions and meteorological conditions, the on-site measured data inside the cooling tower is relatively lacking. Field test data for ribbed cooling towers is even less. In order to provide a scientific wind load basis for engineering design, we choose a bibbed cooling tower for field measurement in Toksun County, Xinjiang, which is windy all the year round, so as to understand the inner wind load characteristics of the cooling tower under the prevailing wind direction and the maximum wind speed direction. It is found that the average wind pressure coefficient measured in the field is not completely consistent with the wind pressure coefficient in the Code

2.2.5. E V Boev Ufa State Petroleum Technological University, Kosmonavtov str., 1, Ufa, 450062, Republic of Bashkortostan, Russia. **Sprinklers of cooling towers, 2020.** The systems of reverse water supply are one of the most important elements of a technological complex of the enterprises of many industries: chemical, oil processing, petrochemical, machine building, metallurgical, etc. Productivity of processing equipment, quality and prime cost of a product, a specific consumption of raw materials and the electric power depend on quality and overall performance of systems of reverse water supply. Temperature conditions of any production are observed by means of recirculated water supply systems, which are most often equipped with fan and tower cooling towers. This article describes the design of drip-film sprinklers, which are one of the main components of the cooling tower

2.2.6. S.KALIAPPAN*, C.SATHISH AND T.NIRMALKUMAR Centre for Environmental Studies, Anna University, Chennai 600 025, India. **Recovery and reuse of water from effluents of cooling tower, 2005.** Membrane technology is emerging as a viable and economical option in the reclamation of wastewater. The present study involves the feasibility of recycling and reusing the wastewater let out from a fertilizer unit. Cooling water blowdown from the waste stream has high salt concentration. An economically and technically viable reverse osmosis process has been employed to treat the wastewater. Feed water needs to be pretreated to apply reverse osmosis process. Effluents from the cooling tower of the fertilizer unit studied contained about 50 mg/1 of suspended solids and need to be removed prior to treatment with reverse osmosis unit to remove total dissolved solids (2500 mg/1). Pretreatment with a microfilter of sizes 5 and 1 mm and carbon filter completely removed the suspended solids achieving a silt density index of 5. The best level of TDS (270 mg/1) was achieved at a maximum pressure of 413 103 Pa. The maximum amount of salt rejected by the membrane was 89.2% and the maximum recovery of 56.0% was obtained at a pressure of 413 ” 103 Pa

2.2.7. Bin Yangl, 2, Xuanzuo Liu1 , Zhouli Zhao1, 2, Jinchun Song1,* and Chi Chen2 1 School of Mechanical Engineering &Automation, Northeastern University, Shenyang, China. **The analysis of the influence of packing and total pressure on cooling performance of the cooling tower, 2018.** t. Packing of the cooling tower, in which the heat exchange mainly, plays a decisive role in the cooling performance of the cooling tower. This thesis conducted the three-dimensional numerical simulation of the cooling tower based on CFD software FLUENT and analysed the physical characteristics of the gas-liquid two phase. The axial flow fans with two different blade profiles are simulated to make the cooling tower has different total pressure under the same air volume, concluding that the total pressure of the cooling tower has little influence on the performance of the cooling tower. Also, the influence of the packing resistance coefficient and height on the cooling performance is studied, finding that increasing the packing height is more conducive to improving the cooling performance compared with the increase of the packing resistance coefficient.

2.2.8. David Alan Ferree, Chickasha, OK(US), Billy Wayne Childers, Jr, Chickasha, **OK(US).Unite State Patent, Patent no: US8585024 B2, 2019. A** water cooling tower having an improved water collection system. The cooling tower has an outer shell, legs, and one more layer of material through which water cooled moves vertically downward. The water is distribute across the surface of fill material by piping an nozzle. A fan underlying the fill material movies air vertically upwards through the fill material, has upper and lower through the fill material. Preferably, the lower troughs are positioned beneath the spaces between upper troughs, to catch water falling between the upper troughs. A number of hinged baffles close off the space between lower troughs, but rotates upward in response to upward air flow and open the spaces between the lower troughs.

2.2.9. **Gould P.L. et. al. (2004)** carried out nonlinear analysis of a collapsed heater stack. They represented results of response spectrum analysis of two heater stacks. Then the nonlinear static analysis of collapsed stack was represented using demand-collapse comparison. Then the results represented show that the effects of openings and the orientation of the motion with respect to the opening.

2.2.10. Ghomi S. S. (2005) assessed the stability of R. C. column supported hyperbolic cooling tower for seismic loads. Nonlinear finite element analysis was carried out due to two kinds of earthquake records to define stability factor of R. C. cooling tower with long X supporting columns. For modeling of R. C. cooling tower shell elements were used. And for ring strip foundation and columns were modeled with solid elements. Transient elements were used at the intersection of column and shell elements. Plastic deformations were observed in shell elements near columns.

2.2.11. **Ghomi S.S. (2006)** carried out both linear and nonlinear analyses of R.C. cooling towers under earthquake excitation. The cooling tower supporting on X-type column support was analyzed under seismic excitation. Firstly a linear finite element analysis with elastic elements was considered Linear and nonlinear behaviour of R.C. cooling tower under dynamic loading 19 then nonlinear finite element analysis with nonlinear representation of concrete columns was carried out. Because of axisymmetric nature of cooling tower only half part was considered for analysis.

2.2.12**.Gheorghe K.L. (2011)** did free vibration analysis of large cooling tower using bar type finite elements with inner nodes. The cooling tower shell was discretised using isoparametric bar type finite element with three or four inner nodes. The supports were modeled as flexible connections providing flexibility in three directions. Nonlinear analysis was carried out and nonlinear equilibrium equations were solved using Newton Raphson method.

2.2.13 **Tabeshpour M. R. (2012)** performed nonlinear dynamic analysis of chimney–like towers. Various types of elements can be used for representing cantilever type towers. To overcome the limitations in computation time he represented tower using beam-column elements. To verify modeling procedure two case studies were considered. Then nonlinear static analysis and nonlinear dynamic analysis was carried out. Then damage indices were calculated to find out the most probable mode of failure under severe excitation.

METHODOLOGY

NATURAL DRAFT COOLING TOWER

The natural draft cooling tower is an open, direct-contact system. It works using a heat exchanger, allowing hot water from the system to be cooled through direct contact with fresh air. To increase the heat transfer surface area (and optimize the cooling process), hot water is sprayed from nozzles within the tower. This increases both the temperature and humidity of the air in the tower. The warmer, moister air moves to the top of the tower, while the cold water is collected at the bottom. The fresh air supply is located in the bottom of the natural draft cooling tower to take advantage of the difference in density between the hot air at the top and the atmospheric air outside the cooling tower.

Industries using the natural draft cooling tower

This "natural draft" type of cooling tower is mostly used in power stations, but is also found in energy-intensive facilities like oil refineries, petrochemical plants and natural gas plants. They are installed to remove heat from the circulating water system. These structures use the chimney effect, which means that they are shaped in such a way as to draw natural draft into the tower. Their structure is generally concrete or sometimes steel.

Principle of the natural draft cooling tower

Air flow is obtained in natural draft cooling tower systems by way of the chimney effect of the cooling tower's actual structure, which uses the natural pressure difference. Warm and moist air is less dense, which causes it to rise out of the cooling tower into the atmosphere and draw in denser fresh air. The difference between the warm air inside the tower and the cooler air outside creates the perfect air flow. For sufficient air flow to occur, a specific mathematical formula is used to calculate the height of the cooling tower to ensure it is almost as large as the density difference. This means cooling towers using this system tend to be large: around 200 meters tall and 150 meters in width. There is also a significant amount of water flowing in the towers. The shell itself is typically made from concrete in a hyperbolic shape. The natural draft cooling tower is the preferred choice for cool and humid climates and for heavy winter loads.

Hot water that needs cooling in the natural draft cooling tower is pumped in via the hot water inlet. The inlet is connected to nozzles that spray the water over the fill material, which provides a large surface area for heat transfer. At the bottom of the tower, the structure is open to draw in fresh air, which then flows upward and allows for direct-contact heat transfer between the warm water and the air. The hot water releases heat after coming into direct contact with the fresh air, and some of the hot water is evaporated. Cold water is collected at the bottom of the tower. The warm and moist air is discharged from the top of the tower into the atmosphere.

Advantages of a natural draft cooling tower

Some advantages of natural draft cooling tower systems include power savings due to the absence of an electrical fan; no corrosion problems; low maintenance; and no recirculation of air because the stack outlet is located high up. This is useful in vertical plant situations where space is an important consideration. Hamon will do a full assessment of the site plot to determine the best use of the available land when helping to engineer, design, and build each unique cooling tower

MAINTENANCE

Clean visible dirt & debris from the cold water basin and surfaces with any visible biofilm (i.e., slime). Disinfectant and other chemical levels in cooling towers and hot tubs should be continuously maintained and regularly monitored. Regular checks of water quality (specifically the aerobic bacteria levels) using dip slides should be taken as the presence of other organisms can support legionella by producing the organic nutrients that it needs to thrive.

- **Water treatment**

Besides treating the circulating cooling water in large industrial cooling tower systems to minimize scaling and fouling, the water should be filtered to remove particulates, and also be dosed with biocides and algaecides to prevent growths that could interfere with the continuous flow of the water. Under certain conditions, a biofilm of micro-organisms such as bacteria, fungi and algae can grow very rapidly in the cooling water, and can reduce the heat transfer efficiency of the cooling tower. Biofilm can be reduced or prevented by using chlorine or other chemicals. A normal industrial practice is to use two biocides, such as oxidizing and non-oxidizing types to complement each other's strengths and weaknesses, and to ensure a broader spectrum of attack. In most cases, a continual low level oxidizing biocide is used, then alternating to a periodic shock dose of non-oxidizing biocides.

- **Algaecides & Biocides**

Algaecides, as their name might suggest, is intended to kill algae and other related plant-like microbes in the water. Biocides can reduce other living matter that remains, improving the system and keeping clean and efficient water usage in a cooling tower. One of the most common options when it comes to biocides for your water is bromine.

- **Scale Inhibitors**

Among the issues that cause the most damage and strain to a water tower's systems is scaling. When an unwanted material or contaminant in the water builds up in a certain area, it can create deposits that grow over time. This can cause issues ranging from the narrowing of pipes to total blockages and equipment failures. The water consumption of the cooling tower comes from Drift, Bleed-off, Evaporation loss, The water that is immediately replenished into the cooling tower due to loss is called Make-up Water. The function of make-up water is to make machinery and equipment run safely and stably.

- **Legionnaires' disease**

Another very important reason for using biocides in cooling towers is to prevent the growth of Legionella, including species that cause legionellosis or Legionnaires' disease, most notably L. pneumophila, or Mycobacterium avium. The various Legionella species are the cause of Legionnaires' disease in humans and transmission is via exposure to aerosols—the inhalation of mist droplets containing the bacteria. Common sources of Legionella include cooling towers used in open recirculating evaporative cooling water systems, domestic hot water systems, fountains, and similar disseminators that tap into a public water supply. Natural sources include freshwater ponds and creeks.

DESIGN & ANALYSIS OF STRUCTURE

- **DATA**

Height of Cooling Tower = 77.0 m

Top Diameter of Cooling Tower = 35.0 m

Base Diameter of Cooling Tower = 58.5 m

Throat Diameter of Cooling Tower = 31.0 m

Distance of Throat diameter from top= 19.0 m

- **CODE REFERENCE**

IS 456:2000 : Plain & Reinforcement Concrete Coad of Practice (4^{th} Version)

IS 11504:1985: Criteria for Structural Design of Reinforced Concrete Natural Draught Cooling Tower

IS 875- Part-3 : Wind Load on Building & Structure (Wind Load Cal)

IS 875- Part-5 : Temperature Load on Building & Structure (Temperature Load Cal)

IS 1893:1984 : Criteria for Earthquake Resistance Design of Structure.

1.1 LOADING CALCULATION

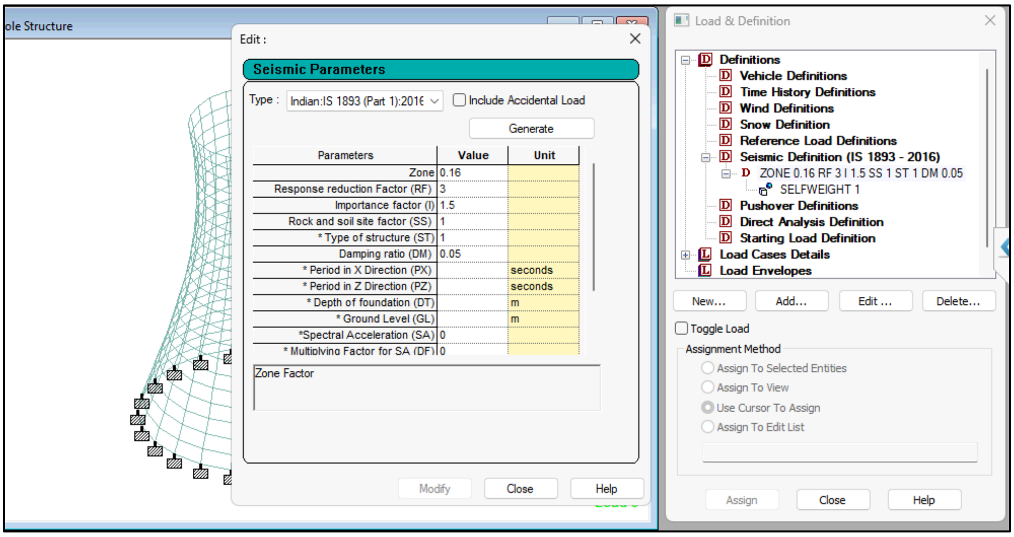
4.1.1 DEAD LOAD

Dead Load will be applied directly on Staad Model.

1.1.2 EARTHQUAKE

Location of Structure	=	Mumbai
Zone of Structure	=	Zone-III
Zone Factor	=	0.16

Earthquake definition will be added in Staad model.



1.1.3 WIND LOAD ANALYSIS

Wind is essentially the large-scale movement of free air due to thermal currents. Wind is air in motion relative to the surface of the earth. The primary cause of wind is traced to earth's rotation and differences in terrestrial radiation. The radiation effects are primarily responsible for convection either upwards or downwards. The wind generally blows horizontal to the ground at high wind speeds. Since vertical components of atmospheric motion are relatively small, the term „wind" denotes almost exclusively the horizontal wind, vertical winds are always identified as such. The wind speeds are assessed with the aid of anemometers or anemographs which are installed at meteorological observatories at heights generally varying from 10 to 30 meters above ground. It is very difficult for a designer to predict effects of wind loading precisely by analytical method because of winds uncertain variability therefore approximate design techniques are used.

The wind load exerted on cooling tower can be considered as a sum of quasi-static component and dynamic component. The static-load component of wind is that force which wind will exert if wind blows at mean steady speed and steady displacement in structure will be produced. The dynamic component will cause oscillations in structure. Three reasons behind dynamic component are-

- Gusts-They cause dynamic pressure changes starting inline oscillations.
- Vortex shedding- It creates cross-wind dynamic forces causing transverse vibrations.

1.1.3.1 DESIGN OF WIND SPEED

The basic wind speed (Vz) for any site shall be obtained from Fig. 1 and shall be modified to include the following effects to get design wind velocity at any height (Vz) for the chosen structure:

a) Risk level;

b) Terrain roughness, height and size of structure; and

c) Local topography.

It can be mathematically expressed as follows:

$$V_Z = V_b K_1 K_2 K_3 K_4 \qquad (3.23)$$

Where
Vz = design wind speed at any height z in m/s;
K1= probability factor (risk coefficient);
K2 = terrain, height and structure size factor; and
K3= topography factor
K4= importance factor for the cyclonic region

- **Risk Coefficient (K1 Factor)**

The suggested life period to be assumed in design and the corresponding K1 factors for different class of structures for the purpose of

design is given in Table 1 in IS 875 (Part 3). In the design of all buildings and structures, a regional basic wind speed having a mean return period of 50 years shall be used except as specified in the note of Table 1 in IS 875 (Part 3).

- **Terrain, Height and Structure Size Factor (K2 Factor)-**

Terrain Selection of terrain categories shall be made with due regard to the effect of obstructions which constitute the ground surface roughness. The terrain category used in the design of a structure may vary depending on the direction of wind under consideration.

Terrain in which a specific structure stands shall be assessed as being one of the following terrain categories:

Category 1 - Exposed open terrain with few or no obstructions and in which the average height of any object surrounding the structure is less than 1.5 m.

NOTE - This category includes open sea-coasts and flat treeless plains.

Category 2 - Open terrain with well scattered obstructions having heights generally between 1.5 to 10 m.

NOTE - This is the criterion for measurement of regional basic wind speeds and includes airfields, open parklands and undeveloped sparsely built-up outskirts of towns and suburbs. Open land adjacent to sea coast may also be classified as Category 2 due to roughness of large sea waves at high winds.

Category 3 - Terrain with numerous closely spaced obstructions having the size of building structures up to 10 m in height with or without a few isolated tall structures.

NOTE 1 - This category includes well wooded areas, and shrubs, towns and industrial areas full or partially developed.

NOTE 2 - It is likely that the next higher category than this will not exist in most design situations and that selection of a more severe category will be deliberate.

NOTE 3 - Particular attention must be given to performance of obstructions in areas affected by fully developed tropical cyclones. Vegetation which is likely to be blown down or defoliated cannot be relied upon to maintain Category 3 conditions. Where such situation may exist, either an intermediate category with velocity multipliers midway between the values for Category 2 and 3 given in Table 2, or Category 2 should be selected having due regard to local conditions.

Category 4 - Terrain with numerous large high closely spaced obstructions. NOTE - This category includes large city centers, generally with obstructions above 25 m and well-developed industrial complexes. Variation of wind speed with height for different sizes of structures in different terrains (K2 factor) –

Table 2 in IS 875 (Part3) gives multiplying factors (K2) by which the basic wind speed given in Fig. 1 in IS 875 (Part3) shall be multiplied to obtain the wind speed at different heights, in each terrain category for different sizes of buildings/structures. The buildings/structures are classified into the following three different classes depending upon their size:

Class A - Structures and/or their components such as cladding, glazing, roofing, etc, having maximum dimension (greatest horizontal or vertical dimension) less than 20m.

Class B - Structures and/or their components such as cladding, glazing, roofing, etc, having maximum dimension‟ (greatest horizontal or vertical dimension) between 20 and 50 m.

Class C - Structures and/or their components such as cladding, glazing, roofing, etc, having maximum dimension (greatest horizontal or vertical dimension) greater than 50 m.

- **Topography (K3 Factor) –**

The basic wind speed Vb given in Fig. 1 in IS 875 (Part3) takes account of the general level of site above sea level. This does not allow for local topographic features such as hills, valleys, cliffs, escarpments, or ridges which can significantly affect wind speed in their vicinity.

The effect of topography is to accelerate wind near the summits of hills or crests of cliffs, escarpments or ridges and decelerate the wind in valleys or near the foot of cliffs, steep escarpments, or ridges

- **Importance Factor for Cyclonic Region (K4 Factor)-**

Cyclonic storms usually occur on the east coast of the country in addition to the Gujarat coast on the west. Studies of wind speed and damage to buildings and structures point to the fact that the speeds given in the basic wind speed map are often exceeded during the cyclones. The effect of cyclonic storms is largely felt in a belt of approximately 60 km width at the coast. In order to ensure greater safety of structures in this region (60 km wide on the east coast as well as on the Gujarat coast), the following values of k4 are stipulated, as applicable according to the importance of the structure:

Structures of post–cyclone importance 1.30

Industrial structures 1.15

All other structures 1.00

4.1.3.1 WIND LOAD ANALYSIS

- **Nature of wind in atmosphere**

In general, wind speed in the atmospheric boundary layer increases with height from zero at ground level to a maximum at a height. The variation with height depends primarily on the terrain conditions.

- **Basic wind speed (Vb)**

IS 875 (Part 3) gives basic wind speed map of India, as applicable to 10 m height above mean ground level for different zones of the country. Basic wind speed is based on peak gust velocity averaged over a short time interval of about 3 seconds and corresponds to mean heights above ground level in an open terrain **(Category 3).** Basic wind speeds have been worked out for a **100-year return period**. Basic wind speed for some important.

4.1.3.2 DESIGN WIND PRESSURE

The design wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind velocity:

$$Pz = 0.6Vz2 \qquad (3.24)$$

Where, Pz = design wind pressure in N/m2 at height z, and
Vz = design wind velocity in m/s at height z

Risk coefficients for different types of structures in different wind speed is given in table 3.4 below (from IS 875 Part 3)

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4.1.4 TEMPERATURE

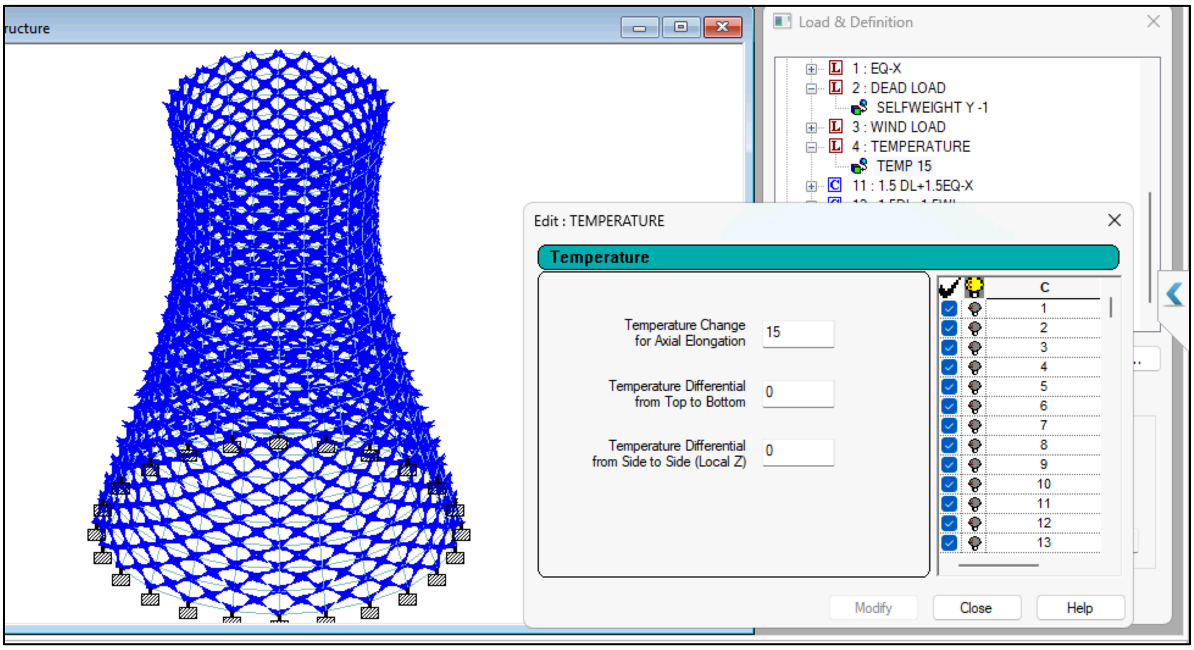
Location of Structure = Mumbai

Minimum temperature in location (t_1) = 10^0C

Maximum temperature in location (t_2) = 40^0C

Variation in temperature (t_2 - t_1) = 30^0C

Temperature definition will be added in Staad model.



4.2 LOAD COBMINATION

We Apply Following Load Combination in Staad Pro

1. 1.5 (DL + EQX)
2. 0.9 (DL + 1.5 EQX)
3. 1.5 (DL + WLX)
4. 0.9 DL + 1.5 WLX
5. 1.5 (DL + TL)
6. 1.2 (DL + EQX + TL)
7. 1.2 (DL + WLX + TL)

Above Load Combination will be added in Staad model.

CONCLUSION

To summarize, we gain knowledge of the cooling tower's numerous features and parts, as well as its production methods.

1. The cooling tower type is compared to other varieties, and its characteristics of requiring less equipment and energy consumption.
2. By evaluating the rates and calculating the values for the tower, we are able to lower the cost and reach the target that we set out to attain.

As a consequence, the information has been completed from all the sources and updated after the most recent version that is according to our research, the comparison to other cooling towers is cost-effective and may be adopted extensively in the nuclear, thermal, and chemical sectors.

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