Analysis of An Intake Well Treatment Plant Unit Using Analysis Tool A Review

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ABSTRACT

Liquid storage tanks are one of the many important structures that demand greater safety against natural disasters like earthquakes. Specific concentration must be paid while designing the water tank to avoid the potential damage associated with the failure of storage tanks and water treatment plants.

In India at least, most of the components of water treatment plant like clariflocculator, aeration tank, disinfection tank etc. are composed in RCC. Pre-stressed concrete is not economical for small structures. But this construction can be efficient for water treatment plant. The pre-stressed steel strands distribute loads uniformly around the tank circumference efficiently. In pre-stressed concrete, compressive stresses are applied to the concrete prior to loading. The entire cross section is essentially in compression under service loads, which takes advantage of concrete's considerable compressive strength but minimal tensile strength. Since concrete deforms under sustained loads (creep), pre-stressed concrete was not practical until the advent of high strength pre-stressing bars and strands.

In this paper presenting review of literatures

Keywords : Analysis, Stress, Forces, Deflection, Staad.Pro

I. INTRODUCTION

Wastewater treatment plants (WWTPs) are well known facilities located at the end of sewage systems and used to remove contaminants from wastewaters in order to avoid water pollution and consequently damages to the environment and public health.

India debts for 2.45% of land region and 4% of water assets of the sector however represents 16% of the sector populace. With the existing populace growth-rate (1.nine according to cent according to year), the populace is anticipated to pass the 1.five billion mark through 2050. The Planning Commission, Government of India has anticipated the water call for boom from 710 BCM (Billion Cubic Meters) in

2010 to nearly 1180 BCM in 2050 with home and commercial water intake anticipated to boom nearly 2.five times. The use of pre-pressured concrete may be very uncommon for creation of water preserving systems because it calls for professional labour, heavy machineries & eager supervision. But this creation may be most cost-efficient for water preserving systems of huge capacity. The overdue Eugene Freyssinet, a outstanding French engineer commonly seemed as the daddy of pre-pressured concrete, changed into the primary to apprehend the want to apply steels of excessive fine and power, pressured to fantastically excessive levels, so as to triumph over the unfavourable outcomes of concrete creep and shrinkage.

In the early 1950s, following strategies used efficiently in Europe for some of years, numerous round pre-pressured concrete tanks have been built withinside the United States the use of post-tensioned excessive tensile-power cord tendons embedded withinside the tank partitions. The posttensioned tendons in maximum early "tendon tanks" have been grouted with a Portland cement-water aggregate after stressing to assist shield them towards corrosion and to bond the tendons to the concrete tank partitions. Others have been unbounded- paper-wrapped person cord or strand tendons that relied on a grease coating and the castin-region concrete for his or her corrosion protection. Later, the usage of unbounded tendons with corrosion-inhibiting grease coatings and plastic sheaths have become extra not unusualplace. Most of the early tendon tanks built with inside the U.S. observed the not unusual place European exercise of vertically pre- stressing the tank partitions to dispose of or manage horizontal cracking. This crack manage helped save you leakage of the contents and corrosion of the pre-stressing metallic. The pre-stressing of concrete has numerous blessings in comparison to conventional bolstered concrete (RC) with out pre-stressing.

Water treatment plant is very necessary for supplying water with purity to the people. This mainly helps to avoid spreading of water borne diseases and to keep the heath of the people in good condition. The project should also be economical and for that the implementation of technologies like Ozone Generation System and Euglena Biofiltration System helps. This chapter explains the process of deciding the treatment that has to be done for the water from the source. The literature review for the new technologies was dealt in this chapter along with analyzing the water treatments plants considering wind load and seismic loads.

II. REVIEW OF LITERATURE SURVEY

Anand Khune et.al (2023) objective of the research paper was to analyze the circular UG water well's 1004.8 cubic meter capacity first (10lakh liter) using analytical application STAAD.Pro. M25 grade concrete and Fe 500 steel was used as design components and water pressure, earth pressure, surcharge, and saturated soil pressure was investigated and the results stated that the structure was found stable.

Bijapure Shifa Arif et.al (2022) in the research paper, circular components of water treatment plant resting on ground was analysed and designed considering reinforced cement concrete and prestressed concrete using IS codes. STAAD PRO software was used to cross check the manual design moments. Estimation on the basis of design was carried out for both RCC and PSC components. Using MS EXCEL, spread sheets was prepared for RCC design of components, PSC design of components and estimation of the respective components.

Considering the construction cost for small capacity tanks up to 1000 m3 RCC construction is economical compared to PSC construction. But as the capacity of

the tank goes on increasing, PSC construction becomes economical. For larger capacity tanks PSC construction is economical than RCC construction by 17 % for M40 grade concrete and 15.75 % for M50 grade concrete on average. Prestressed concrete is more durable compared to reinforced cement concrete; therefore, PSC construction requires less maintenance than RCC construction.

Boggula Rajesh and G. Sreekanth (2022) in the research paper, seismic analysis of improved square water tank was achieved according with IS: 1893-1984 (i.e. Lumped mass version) and IS: 1893-2002 (Part-2) draft code (i.e. Two mass version). The structures are analysed with different simulated soft ware's Staad-pro and E-tabs.The process comprises the simulation of a 100m3 -liter water tank. These overhead water tanks are analyzed at staging heights of 15m, 25m accordingly. I'm observing a wind speed of 44 m/s. It is done using the Staad.Pro software for wind load dynamic analysis. The design of the water tank must be able to endure earthquake loads, which increases as the seismic zones increase

Results stated that when the tank is full, the wall of the tank has the maximum and smallest nodal deformations. Comprehensive and empty water tanks are subjected to higher shear and bending moments due to the zone factor, response reduction factor, etc., in seismic analysis. In a full tank, the shear force and bending moment are slightly larger than in an empty tank because of the lack of water or hydrostatic pressure. Base shear in perfect working order the tank is slightly higher than an empty tank because to pressure difference or the absence of water.

Vaishnavi Bahale and S.P. Tak (2022) objective of the research paper was to evaluate the response of steel elevated water tank with or without base isolation by Performing Non-Linear dynamic time history analysis using analytical application ETABS. Elevated steel water tank was isolated with Laminated lead rubber bearing and two different isolating position were considered namely between Superstructure-Substructure and Between Staging- tank. Steel water tank was designed as per the Indian code IS: 805-1968 (Reaffirmed 2006).

The performance of the elevated steel water tank with Laminated rubber bearing isolator is found to be effective in reducing the Base shear by 55 - 75 % as compared to non-isolated tanks. Convective motion of the liquid can play major role in the failure of tanks. To reduce the convective mode base isolation techniques can be applied to the actual tanks, it is observed that tank deformation is reduced up to 60 – 70 % as compared to the non-isolated tank. Bracing Structures gives more resistance to lateral deflection and it is also suitable in earthquake prone areas. Comparison with staging pattern shows that performance of X Braced frame shows better seismic response as compared to the Inverted V braces frame.

V I Rimshin et.al (2020) author presented the main reasons of destruction and damage to building structures in various water treatment and wastewater disposal facilities and provided the most effective ways for eliminating these damages. The calculation substantiation of the supporting structures reinforcement namely reinforced concrete slabs in water treatment structures was conducted. The characteristic features of water treatment and sanitation facilities were taken into account.

Results stated that estimated reinforcement does not exceed the actual one. The calculation results do not ensure compliance with the requirements for strength and deformation of both the system as a whole and individual elements. It was necessary to carry out work on strengthening reinforced concrete slabs.

Vaishnavi S. Sarode et.al (2020) The research paper highlighted the work administered on construction of Jackwell with Overhead Pump House. The Paper includes the provision of Design of a water treatment

scheme for the area in order to supply the treated water to the houses. Jackwell and Pump House has been analyzed by using STAAD PRO vi8 software under seismic condition.

Results stated that Design of economical and efficient water supply scheme of Jhagarpur and adjoining villages (Mining Affected) under Rajgangpur Dist-Sundargarh, Odisha. Improvement in supply of potable water to various sections of villages in accordance with their demand and requirement. Fulfill the all water demand of domestic, industrial and commercial area of Jhagarpur and adjoining villages (Mining Affected) under Rajgangpur Dist-Sundargarh, Odisha.

Arun Ahirwar and M.C.Paliwal (2019) research paper described water tank constructed in same regions having different soil condition and columns. The cost of water tank was evaluated on basis of the soil condition, columns and different size of water tank and taking account of seismic and wind effect on the water tank evolved using by working stress method and Esr-Gsr software.

The results showed that the quantity of material is more for soft soil as compared to black cotton and ordinary soil. The amount of reinforcement and concrete increase in 2000 m3 capacity. The influence of seismic effect is more than compared to wind effect on the different member of circular water tank. The geometrical data of superstructure are same while the volume of concrete and quantity of steel in superstructure are varying with variation in the no. of columns, seismic zone and wind zone.

Sagar T.Mane and Prashant M. Kulkarni (2019) in the research paper, time history analysis of rectangular and circular elevated water storage tank were analyzed using SAP 2000 software. The concrete baffle wall was used to reduce the sloshing effect of the water tank. The tank responses such as maximum nodal displacement, base shear and result were compared for empty and full tank water fill condition. From IS 11682:1985 provision when seismic loading is considered only two cases may be taken one is tank empty condition and other is tank full condition.

Results stated that baffle wall was less displacement and more base shear as compared to the without baffle wall simple water tank in rectangular and circular water tank for empty and full tank condition. The time period increases with baffle wall as compared to the without baffle wall in rectangular and circular water tank due to the increase in mass of the tank. The convective time period remains constant in both circular and rectangular water tank. This implies that the convective mode doesn't depend on staging and eventually depends on the size of the tank. The time period varies in tank empty condition and tank full condition, this is due to the sloshing effect and hydrodynamic pressure

Manoj Nallanathel et.al (2018) author analyzed the design of water tanks of both overhead and underground tanks of rectangular, square and circular shapes was designed and analysed using Staad pro.

The analysis results concluded about the influence of shape factor in design loads and how shapes of the tanks play predominant role in the design and in stress distribution and overall economy.

S. Ninan and Afia S Hameed (2018) research paper presented seismic analysis of rectangular and circular elevated water tanks using SAP 2000.

Results concluded that primary mode shape of rectangular tank was translation and that of circular tank is torsion which needs to be eliminated. To eliminate the torsional mode shape in circular elevated water tank, orientations of columns was modified. Shear and moment values increases for braced structures. This is due to the increase in mass due to bracings. Element size required for rectangular tank is more when compared to circular tank. So circular tank is more economical.

Ayub Patel and Sourabh Dashore (2017) objective of the research paper was to compare the seismic behaviour of elevated square and circular RCC water tanks having different capacities of storage. Square and circular elevated water tanks of capacities 1 lakhs and 2 lakhs was considered to analyse under seismic forces. Heights of staging considered are 12m, 18m and 24m for square and circular tanks for both the capacities. All the models were analysed for zone III, zone IV and zone V using Staad.Pro v8i software and the seismic behavior of both the tanks the response parameters selected were lateral displacement and base shear.

Results stated that the provision of circular water tank was more flexible for seismic loadings as compared to square water tank. From the analysis result parameters deflection and base shear of the water tanks increases from lower to higher zones because the magnitude of intensity will be more for higher zones.

J Visuvasam et.al (2017) in the research paper, the flexible base was provided as spring stiffness in order to consider the effect of soil properties on the seismic behaviour of water tanks. A linear time history earthquake analysis was performed using SAP2000. Parametric studies have been carried out based on various types of soils such as soft, medium and hard. The soil stiffness values highly influence the time period and base shear of the structure.

The ratios of time period of flexible to fixed base and base shear of flexible to fixed base were observed against capacities of water tank and the overall height of the system. The both responses are found to be increased as the flexibility of soil medium decreases. The ratio of the fundamental time period of flexible base (Tf) to fixed base (T) behaves linearly in case of all types of soils such as soft, medium and hard. There was not much variation with respect to capacity of water tanks. The soil structure interaction affects the Tf /T ratio by 20% and 10% for soft and medium type soils respectively.

Kangning Dang et.al (2017) in the research paper, numerical analysis for the seismic response of hydropower station intake tower in step-like ground based on artificial boundary theory. A L topography finite element model was established to verify the correctness of the proposed method of viscous elasticity boundary by consider inconsistent reflective surface. The method was applied to an intake tower, and the acceleration of bedrock was obtained by seismic inversion method, then the equivalent load of each node was calculated. Five different models were established as follow: massless foundation, consistent input viscous elasticity boundary, inconsistent input viscous elasticity boundary and whether set contact, then displacement and stress were compared, the results show that the proposed method with contact was minimal.

Results stated that when the ground surface has obvious hypermutation, viscoelastic artificial boundary should be applied to the calculation of sub-regional node load, this displacement is to be enlarged at the volley surface of highly abrupt, its value greater than the incident and reflected superposition value.

K. Srinivas Reddy et.al (2017) objective of the research paper was to conduct analysis and design of a rectangular clear water reservoir. The design is done mainly based on the storage capacity and supply, it may also includes choice of materials of construction, as well as the location, volume, purpose, hydraulic pressures , soil pressures , Wind and Earthquake design considerations etc. The goal of constructing the best, economical and safest design of an rectangular clear water reservoir the design is done by limit state method. The analysis and design of rectangular clear water reservoir taking different load cases like Dead load , Live Load, Seismic load in to consideration.

Conclusion stated that safe and economic design is required for effective maintenance of clear water reservoir taking safety and serviceability into consideration. Design of water tank was a tedious method, particularly the design of underground water tanks involves a lot of mathematical formulas and this project by designing clear water reservoir gives the solution for all those problems.

P. Mortazavi et.al (2017) author investigated the available Canadian Engineering Standards and compares them to the leading design codes in order to identify an industry accepted standard of analysis. The ACI 350.3-06 analysis methodology was adapted for a Canadian application and is applied in a case study. The case study consisted of the seismic retrofitting of large aeration tanks located on the second storey of an existing secondary clarifier designed and constructed in the 1970's. A dynamic analysis was performed considering the vibrational modes of the contained liquid while considering different fixity assumptions at the foundation. Energy dissipation was evaluated at the foundation level considering the effects of soil damping and base slab averaging.

Conclusion stated that the fixed base assumption is conservative. The reductions in the D/C ratios are small for this structure. However, the impact of this assumption would be more significant if the structural period was lengthened past the short period range (0.2s) and moved onto the descending branch of the seismic hazard curve. Due to the size of the structure the reduction factor for base slab averaging is approximately 0.84. The reduction factor for embedment was not as significant, at approximately 0.95. The increase in effective damping considering the effects of period elongation due to inertial soil structure interaction is approximately 40%, effective damping increased from 0.12 compared to 0.05.

Ankush N. Asati et.al (2016) in the research paper, the seismic behavioural effect of circular elevated water tank was analyzed for specific capacity of tank for various staging arrangements in plan, variation in number of periphery columns and variation in number of stages inelevation. Two mass idealizations suggested by Gujarat State Disaster Management Authority was considered here. Under earthquake loads; a complicated pattern of stresses is generated in the tanks. Total 36 combinations were analysed with SAP2000 using Response Spectrum Method (RSM) and results were presented.

Results stated that increase in number of columns, does not assure the increase in the improvement of structural responses. Radial arrangement with six staging levels is found to be best for the number of columns used. To suggest the number of columns with suitable diameter cost optimization is done for the radial staging arrangement with six staging levels considering critical direction of seismic force, quantity of concrete and steel required. It is found that eight numbers of columns gives less cost as compared to six, ten and twelve with optimized diameter of 300mm.

Ravikumara H S (2015) objective of the research paper was to investigate the dynamic behavior of circular cylindrical intake towers. The soil-structure-interaction analysis is carried out to study its effect on the dynamic behavior of the intake towers. The computer software package, SAP2000, is used for developing finite element models of intake tower and soil using shell elements and solids respectively. Modal and Response Spectrum analyses are carried out to determine the dynamic characteristics and response of the tower to earthquake excitation for various geometrical parameters and submergence conditions.

Results stated that the presence of water inside and outside of the structure for a fully submerged tower increases the fundamental time period of the tower

due to the added mass. The fundamental time period increases as the slenderness of the tower increases. This is due to the increase in flexibility of the tower. As the thickness of the tower decreased, the time periods also decreased due to the decrease in self weight of the tower. Displacement at the top was much greater for the tower with base soil effect. Bending moment was lesser for soil model due to increased flexibility. Shear force at the base was increased for model with flexible base as the seismic weight due to the soil increases.

Antonio Panico et.al (2013) research paper dealt with the assessment of seismic vulnerability of wastewater treatment plants by analyzing the effects of past earthquakes and taking into account the following factors such as plant size (small, medium and large), typology of wastewaters treated (municipal and industrial), treatment level performed (primary, secondary and tertiary), main causes of damages (soil/structure dynamic interaction and inertial overload) and elements damaged (structural, e.g. tank walls and bottom, and non-structural, e.g sludge scrapers, baffles, aerators, mechanical mixers). Primary aim was to provide fragility curves and threshold values with respect to the main seismic intensity parameters and considering either the loss of control or the leak of wastewater in the ground from containment system. Once validated such curves could be successfully and easily used implemented into existing or new Quantitative Risk Analysis (QRA) tools or for land-use planning methodologies.

Municipal WWTPs result to be more vulnerable than industrial ones when earthquakes occur. The fragility curves shown in this paper and obtained by processing collected data are affected by scarcity of available data, therefore such curves need to be refined and this operation is possible only if more data concerning past and next earthquakes are systematically collected. However, they can be usefully adopted for preliminary structural analysis of

seismic resilience of WWTPs, in the framework of risk assessment tools and land use planning.

Vladimir Vukobratović and Đorđe Lađinović (2013) in the research paper, simple dynamic model for analysis of the seismic response of ground-supported concrete circular liquid storage tanks. The model can be applied in analysis of the total seismic response as well as for the determination of local response quantities. All of the obligatory provisions of Eurocode 8 were fully taken into account, while some of the informative ones were substituted with similar provisions defined by IITK GSDMA and ACI provisions. The effect of both the impulsive and the convective component was considered in the model and the influence of both horizontal and vertical seismic action was taken into account. A comparative analysis of the total seismic response of tanks with various geometrical properties was conducted through a parametric study.

The results showed that the impulsive period of vibrations, base shear force and overturning moments increase almost linearly with the increase of the ratio H/R, whereas the convective period of vibrations is practically a constant value for the H/R>1.5. It was therefore concluded that the seismic response of a tank structure mainly depends on the response in the impulsive mode. In addition, it should be noted that the increase of base shear force and overturning moments controlled by the increase of the ratio H/R directly influences the detailing demands.

CONCLUSION

The literature comprises the papers and books published on various techniques that are followed while designing a Treatment plant along with other problems that arises during the design. Literature review also consists of involvement of other departments in the water treatment process. Different aspects of Water Treatment plant had been studied well using the above mentioned literatures.

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