Parametric Optimization of Circular Elevated Water Tanks Under Various Capacities and Seismic Conditions

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Abstract. The elevated water tank comprises important structural elements which includes slabs, beams, columns, and footings, facilitating the transfer of loads amongst these contributors and subsequently to the sub-grade of the soil. This paper goals is to comprehensively analyze the structural behaviours exhibited by elevated water tanks underneath various loading conditions. The behaviours of multiplied water tanks variety underneath various styles of loadings, inclusive of dead, live, and seismic loads, that are comprehensively analyzed. This paper primarily aims to conduct a hydrostatic evaluation of circular water tanks and emphasizes the necessity of a parametric study. To obtain this goal, 2, 2.5, and 3 lakh litters of tanks are being considered for the analysis which are all examined underneath area III seismic situations whilst keeping a normal height and varying diameters during the simulation. The examination focuses on carrying out a comparative evaluation of critical structural parameters, such as moment, maximum displacement, and maximum base shear. By means of analysing those parameters across various tank capacities, precious insights into the structural reaction of circular elevated water tanks under seismic loading conditions are gained. Those findings contribute to enhancing the design and overall performance of such structures, enhancing their resilience and protection in earthquake-susceptible regions.

Keyword-: Tank Capacity, Soft Soil, Hydrostatic Analysis, Circular Water Tank, Parametric Study, Seismic Load.

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1 Introduction

Water storage is crucial in present-day environments, particularly in areas where water shortage is an issue. This makes it important for water storage projects to be focussed upon in order to provide consistent access to water, which is essential for survival and daily living. It can be seen that a notable breakthrough has been made with the introduction of the various designing platforms to design guidelines for water retaining structures [1]. IS3370:2009 has all the criteria necessary for designing an infrastructure reflecting a modern and comprehensive approach to structural design [2-3]. The designing of an elevated rectangular RC water tanks can be taken as an example for storage. The elevated water tank serves as a large storage container designed to hold water at a certain height, ensuring sufficient pressure in the water distribution system. It has been found that these liquid storage tanks find widespread use in municipalities and industries for storing water, inflammable liquids along with various chemicals [3-4]. Given their critical role, damage to elevated water tanks during earthquakes can jeopardize drinking water supply, fail to prevent large fires, and lead to substantial economic losses [5]. Given their frequent use in seismic-prone regions, it is imperative to thoroughly investigate the seismic design of elevated water tanks. Historically, the collapse or heavy damage of water tanks due to earthquakes underscores the critical need to prioritize seismic safety in the design of lifeline structures [6-8]. Enhancing seismic resilience is paramount to ensure those structures remain intact in the course of earthquakes and may resist heightened design forces [9]. This study targets to address this vital by way of investigating the seismic behaviour of cylindrical elevated storage tanks thru dynamic analysis. Through using comprehensively analysing the seismic reaction of those systems, the observe seeks to improve our know-how in their overall performance beneath seismic loading conditions [10]. In the end, the findings will inform the improvement of robust seismic design structures, making sure the protection and reliability of elevated water tanks in earthquake-susceptible areas [11]. Earthquakes pose significant threats to infrastructure and crucial lifeline centres, consisting of water supply structures. Multiplied water tanks, designed to keep large water loads atop slender staging, are particularly susceptible in the course of seismic activities. The sloshing of water inside those tanks turns into a important issue, as it could exacerbate structural vulnerabilities [12-13]. The sloshing phenomenon, characterized by motions of the liquid within the container, is influenced by different factors, including tank dimensions, liquid properties, and fluid-tank interactions. To mitigate seismic risks, researchers have developed mathematical models and theoretical solutions to study the effects of sloshing. Understanding the dynamic forces associated with sloshing and staging height is crucial for assessing earthquake damage to elevated service reservoirs [14]. The primary objective of seismic design for such structures is to ensure acceptable performance under various earthquake intensities throughout their lifetime. Reinforced concrete overhead water tanks have long been utilized in municipal and industrial settings to ensure continuous water supply to a wide distribution network. The elevation of these tanks is determined by the extent of the distribution network, with taller tanks required for broader coverage. Several factors are considered in this study, including the effect of vertical ground acceleration on hydrodynamic pressure, sloshing effects of water, maximum sloshing wave height, and the delta effect for elevated water tanks [15-16]. The hydrodynamic effect is analyzed by dividing the water into impulsive and convective masses [17]. During horizontal earthquake motion, the tank wall and liquid experience horizontal acceleration, inducing impulsive hydrodynamic pressure. Different staging types, such as frame and shaft staging, are evaluated in this study, with consistent container dimensions across various capacities. Capacities starting from 2 to 3 lakh litters are considered, with a staging height of 15 meters [18-19]. Outer periphery columns and parallel bracing are employed in all models. Seismic evaluation is conducted based mostly on IS 1893 (component-2), with staging layout moreover carried out using STAAD pro software program. via comprehensively analysing these factors, this study goals to enhance knowledge and tell design practices to ensure the structural integrity and resilience of elevated water tanks below seismic loading conditions [20-23].

2 Methodology

This study delves deeply into the complex behaviours exhibited by elevated circular water tanks while subjected to seismic situations. The aim of the present research work is scrutinizing circular elevated water tanks having variation in its capacities from 2 lakh to 3 lakh litters [24]. The tanks have steady heights even as varying diameters, making sure a complete analysis of the structural responses when their sizes are changes [25]. The work is focussed on a specific emphasis on area III seismic situations, and the target is to discover the complicated reactions of those structures to a numerous variety of seismic, dead, and live loads conditions [26-31]. The research has been focussed on doing investigations and meticulously analysing every factor of the water tank's structural integrity for study. The work is achieved by making use of modelling and assessment strategies facilitated through the Staad.pro software program and the simulations are being done that will recognize the behaviour of the tanks beneath various loading situations. Through detailed checks of structural overall performance across several seismic environments, the focus to provide invaluable insights into the dynamic behaviour of multiple circular water tanks [32]. The study shall give conclusions on how these structures respond towards various seismic conditions. With the aid of shedding light on the complex interaction amongst tank size, seismic situations, and structural response, the study aims to provide crucial knowledge of the design and efficiency of multiple circular water tanks [33-36]. Ultimately, the insights gained from this research preserve the potential to achieve an effective design technique and mitigation measures, thereby contributing to the safety and reliability of such systems in areas at risk of seismic activity [37].

Table 1: Specifications of the circular elevated water Tank

Property	Circular Elevated Water Tank
Shape of tank	Circular
Size Capacity	2, 2.5, and 3 lakh litters
Roof Slab Thickness	150 mm
Tank Wall Thickness	200 mm
Floor Slab Thickness	300 mm
Bottom Beam Size	450 mm x 600 mm
Floor Beam Size	300 mm x 450 mm
Height of Tank	5 m
Staging Height	12 m
Type of Staging	Frame Staging
Free Board	0.3 m
Grade of Concrete	M30
Grade of Steel	Fe 500
Earthquake Zone	III
Response Reduction Factor	5
Importance Factor	1.5
Coefficient of Damping	0.05
Soil Type	Soft Strata
Bearing Capacity of Soil	230 KN/m^2

The Table 1 present the specifications and characteristics of a circular elevated Water Tank. The tank is designed in a circular shape and comes in capacities of 2, 2.5, and 3 lakh litters. Its structural additives consist of a roof slab with a thickness of 150 mm, a tank wall with a thickness of 200 mm, and a floor slab with a thickness of 300 mm. the lowest beam measures 450 mm x 600 mm, while the floor beam measures 300 mm x 450 mm. The tank has a height of five meters and a staging height of 12 meters, making use of frame staging for aid [38-41]. It keeps a freeboard of 0.3 meters. The structural materials used are M30-grade concrete and Fe 500-grade steel. The tank is located in earthquake zone III, with a reaction discount element of five and a significance factor of 1.5. The coefficient of damping is 0.05. The soil kind is labeled as soft Strata, with a bearing capacity of 230 KN/m^2 [42]. These specs are important for making sure the tank's stability, resilience, and standard overall performance under diverse loading conditions, especially seismic activities [43-44].

3 Result and Discussion

The studies delve into the results of a rigorous evaluation encompassing a circular elevated water tank across numerous capacities, beginning from 2 lakhs, 2.5 lakhs and 3 lakhs, all scrutinized below zone III conditions. At the equal time as preserving the tank's peak constant, versions in diameters have been explored. Considerable to this examine is the meticulous assessment of critical structural parameters, extensively the maximum bending moment and maximum base shear. The following effects, meticulously distinctive underneath, offer an expansive landscape of the tank's typical performance during various capacities. This comparative examination yields valuable insights into the subtle nuances of structural behaviour, thereby facilitating an entire comprehension of the ramifications of each tank capability on its usual stability and resilience. Such discernment is pivotal in refining layout methodologies and bolstering the reliability of elevated water tanks in seismic-susceptible areas.

Table 2. Base shear evaluated of elevated water tank for two lakh litters in zone III

Story	Level in Meter	Peak Story Shear in KN
4	12.00	241
3	9.00	268
2	6.00	286
1	3.00	292
BASE	0.00	292

This Table 2 illustrates the distribution of peak tale shear throughout different levels of the shape. Each row corresponds to a specific story level, with corresponding top measurements in meters. The "top story Shear" column denotes the most shear pressure skilled at every story level, measured in kilonewtons (KN). For example, at the fourth story level with a height of 12 meters, the height story shear is recorded as 241 KN. As we move down the ranges toward the bottom, the story shear tends to increase, accomplishing its maximum value of 292 KN at the floor level or base of the structure. This table provides valuable insight into the shear forces experienced at various levels of the constructing, aiding in structural analysis and design considerations.

Table 3: Displacement results of elevated water tank for 2 lakh liters in zone III

Story	Level in Meter	Displacement in mm
Top	17.00	26.3
4	12.00	24.7
3	9.00	19.7
2	6.00	12.6
1	3.00	4.5
BASE	0.00	0.00

This Table 3 presents the displacement measurements at different stages or stories of a structure. Each row corresponds to a specific story level, with the "level in Meter" column indicating the height of that specific story above the ground level. The "Displacement in mm" column represents the magnitude of displacement experienced at each story stage, measured in millimeters (mm).At the topmost level, the displacement is recorded as 26.3 mm, indicating the highest displacement observed within the structure. As we move down the levels toward the base, the displacement tends to decrease gradually. For example, at the fourth story level, the displacement is measured at 24.7 mm, and it in addition decreases to 19.7 mm on the third story level.

Table 4: Base shear results of elevated water tank for 2.5 lakh liters in region III

Story	Level in Meter	Peak Story Shear in KN
4	12.00	266
3	9.00	293
2	6.00	311
1	3.00	324
BASE	0.00	324

This Table 4 presents data regarding the peak story shear forces experienced at different levels or stories within a structure. Every row corresponds to a specific story level, with the "level in Meter" column indicating the height of that particular story above the ground level. The "peak story Shear in KN" column gives the maximum shear force recorded at each story degree, measured in kilonewtons (KN). Beginning from the highest story level (degree four) right down to the base of the structure, the peak story shear forces gradually increase. For instance, at level 4 with a height of 12 meters, the peak story shear force is recorded as 266 KN. As we move down to lower levels, such as Level 3 (9 meters), Level 2 (6 meters), and Level 1 (3 meters), the peak story shear forces continue to increase, reaching maximum values of 293 KN, 311 KN, and 324 KN, respectively.

Table 5: Displacement results of elevated water tank for 2.5 lakh liters in zone III

Story	Level in Meter	Displacement in mm
Top	17.00	30.4
4	12.00	28.7
3	9.00	20.9
2	6.00	12.5
1	3.00	5.6
BASE	0.00	0.00

This Table 5 presents data on the displacement measurements observed at various levels or stories within a structure. Each row represents a specific story level, with the "level in Meter" column indicating the peak of the story above the ground level. The "Displacement in mm" column provides the significance of displacement recorded at every story level, measured in millimeters (mm). Starting from the top of the structure, classified as "top" with a height of 17 meters, down to the base of the shape, the displacement values gradually lower. At the topmost level, a displacement of 30.4 mm is observed. As we move down the levels towards the base, the displacement values decrease successively. For instance, at Level 4 (12 meters), the displacement is recorded as 28.7 mm, followed by 20.9 mm at Level 3 (9 meters), 12.5 mm at Level 2 (6 meters), and 5.6 mm at Level 1 (3 meters).

Table 6: Base shear results of elevated water tank for 3 lakh liters in zone III

Story	Level in Meter	Peak Story Shear in KN
4	12.00	295
3	9.00	312
2	6.00	332
1	3.00	356
BASE	0.00	356

This Table 6 presents data regarding the peak story shear forces experienced at different levels or stories within a structure. Every row corresponds to a particular story level, with the "level in Meter" column indicating the height of that particular story above the ground level. Starting from the highest story level (Level 4) down to the base of the structure, the peak story shear forces gradually increase. For instance, at Level 4 with a height of 12 meters, the peak story shear force is recorded as 295 KN. As we move down to lower levels, such as Level 3 (9 meters), Level 2 (6 meters), and Level 1 (3 meters), the peak story shear forces continue to increase, reaching maximum values of 312 KN, 332 KN, and 356 KN, respectively.

Table 7: Displacement results of elevated water tank for 3 lakh liters in zone III

Story	Level in Meter	Displacement in mm
Top	17.00	34.1
4	12.00	32.0
3	9.00	24.6
2	6.00	14.7
1	3.00	4.0
BASE	0.00	0.00

This Table 7 outlines the displacement measurements observed at various levels or stories within a structure. Each row corresponds to a specific story level, with the "Level in Meter" column indicating the height of that particular story above the ground level. The "Displacement in mm" column provides the magnitude of displacement recorded at each story level, measured in millimetre's (mm). Beginning from the topmost level, denoted as "Top" with a height of 17 meters, down to the base of the structure, the displacement values gradually decrease. At the highest level, a displacement of 34.1 mm is recorded. As we progress downward through the levels towards the base, the displacement values decrease sequentially. For instance, at Level 4 (12 meters), the displacement is measured as 32.0 mm, followed by 24.6 mm at Level 3 (9 meters), 14.7 mm at Level 2 (6 meters), and 4.0 mm at Level 1 (3 meters).

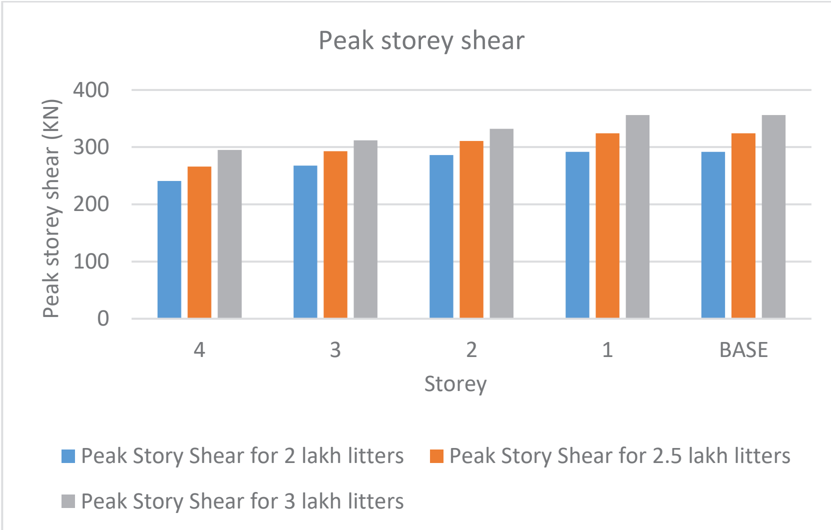

Fig. 1: Comparative Analysis of Peak Story Shear for Tanks with Capacities of 2, 2.5, and 3 Lakh Liters in Zone III

The provided figure offers a comparative examination of the peak story shear forces encountered by circular elevated water tanks, ranging in capacities from 2 lakh to 3 lakh litters, under Zone III seismic conditions. For each story level, the Fig. 1 illustrates the peak story shear force values across the various tank capacities. Consistently, larger tank capacities are associated with higher peak story shear forces across all story levels, elucidating a clear pattern. This comparison underscores the substantial impact of tank capacity on the distribution of shear forces within circular elevated water tanks.

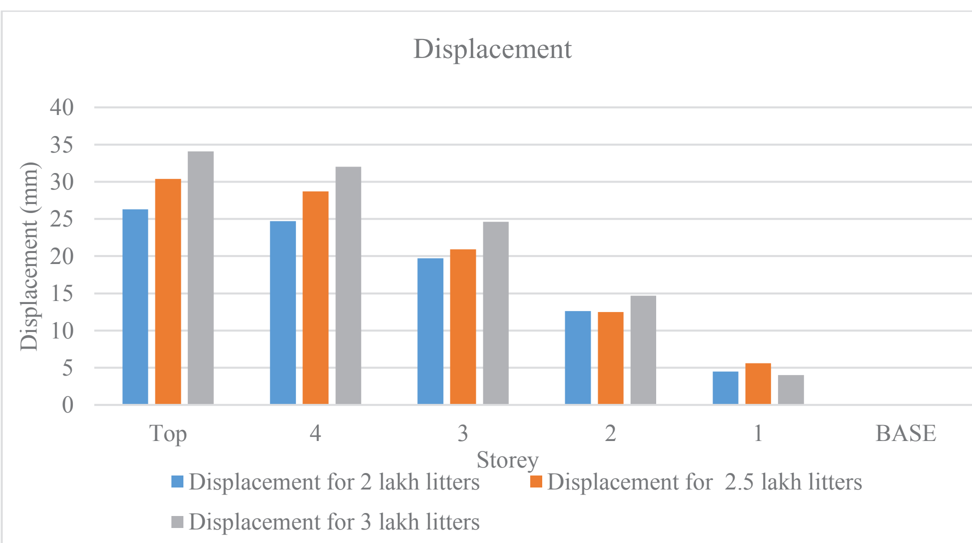

Fig. 2: Comparative Analysis of displacement for Tanks with Capacities of 2, 2.5, and 3 Lakh Liters in Zone III

The provided Fig. 2 offers the displacements observed at different story levels within circular elevated water tanks, ranging in capacities from 2 lakh to 3 lakh litters, under Zone III seismic conditions. This comparative evaluation illuminates the variability in displacements inside the circular elevated water tanks throughout different capacities. Extensively, the figure demonstrates a consistent trend large tank capacities generally tend to yield better displacements. This commentary underscores the significance of accounting for capability even as comparing the structural behavior and response of such tanks below seismic loading situations. Through recognizing the influence of tank capacity on displacements, engineers can make informed selections to make certain the structural integrity and resilience of round accelerated water tanks in seismic-prone regions.

5 Conclusion

By focussing on the critical structural parameters across various tank capacities, this research contributes to the development of seismic design practices and the improvement of resilient infrastructure. The parametric examination is done on circular elevated water tanks with capacities of 2 lakh, 2.5 lakh, and 3 lakh litters underneath region III seismic conditions, even as retaining constant heights and varying diameters, that yielded significant insights into their structural behaviour. The study mostly focused on evaluating important structural parameters along with displacement, and maximum moment and base shear throughout the different tank capacities. From this investigation, numerous conclusions may be drawn.

- Peak storey shear force values are provided for each story level, illustrating that larger tank capacities correspond to higher peak storey shear forces in the course of the structure.
- The comparison underscores the significant influence of tank capacity on the distribution of shear forces inside circular elevated water tanks.
- Moreover, the study presents a comparative analysis of displacements observed at various storey levels inside round elevated water tanks of various capacities.
- The analysis demonstrates how displacements in the tanks vary with specific capacities, with large tank capacities normally resulting in higher displacements.
- Those findings emphasize the importance of considering tank capability when evaluating the structural behaviour and reaction of circular elevated water tanks under seismic loading situations.
- Both peak shear forces and displacements exhibit notable changes corresponding to tank size, highlighting the necessity of comprehensive study that accounts for considering various factors in ensuring the resilience and safety of circular elevated water tanks in seismic-prone areas.

References

1. Khomane, Shubham M., and Chittaranjan B. Nayak. "“Seismic Design Of Circular Elevated Storage Reservoir By Optimizing H/D Ratio."
2. Mor Vyankatesh, K., and T. More Varsha. "Comparative study on dynamic analysis of elevated water tank frame staging and concrete shaft supported." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) 14, 1 (2017): 38-46.
3. Parashuram, L., Sreenivasa, S., Akshatha, S., & Udayakumar, V. (2019). A non-enzymatic electrochemical sensor based on ZrO2: Cu (I) nanosphere modified carbon paste electrode for electro-catalytic oxidative detection of glucose in raw Citrus aurantium var. sinensis. Food chemistry, 300, 125178.
4. Sridhara, V., Gowrishankar, B. S., Snehalatha, & Satapathy, L. N. (2009). Nanofluids—a new promising fluid for cooling. Transactions of the Indian Ceramic Society, 68(1), 1-17.

5. Padmaja, B., Prasad, V. R., & Sunitha, K. V. N. (2018). A machine learning approach for stress detection using a wireless physical activity tracker. International Journal of Machine Learning and Computing, 8(1), 33-38.
6. Malagavelli, V., Angadi, S., Prasad, J. S. R., & Joshi, S. (2018). Influence of metakaolin in concrete as partial replacement of cement. Int J Civil Eng Technol, 9(7), 105-111.
7. Hariteja, N., Yogesh Kaushik, M. Rohit Varma, Sachin Sharma, and Sameer Pathania. "Seismic Assessment of Elevated Circular Water Tank." International Journal of Engineering Technology Science and Research, ISSN (2016): 2394-3386.
8. Anjum, Tayyaba, and Mohd Zameeruddin. "Evaluation of Efficacy of the Elevated Water Tank Under the Seismic Loads." International Journal of Civil Engineering 8 (2021): 20-26.
9. Chaudhury, S., Krishna, A. N., Gupta, S., Sankaran, K. S., Khan, S., Sau, K., ... & Sammy, F. (2022). Effective image processing and segmentation-based machine learning techniques for diagnosis of breast cancer. Computational and Mathematical Methods in Medicine, 2022.
10. Ramu, G. (2018). A secure cloud framework to share EHRs using modified CP-ABE and the attribute bloom filter. Education and Information Technologies, 23(5), 2213-2233.
11. Yogananda, H. S., Basavaraj, R. B., Darshan, G. P., Prasad, B. D., Naik, R., Sharma, S. C., & Nagabhushana, H. (2018). New design of highly sensitive and selective MoO3: Eu3+ micro-rods: Probing of latent fingerprints visualization and anti-counterfeiting applications. Journal of colloid and interface science, 528, 443-456.
12. Suganthi, S. T., Vinayagam, A., Veerasamy, V., Deepa, A., Abouhawwash, M., & Thirumeni, M. (2021). Detection and classification of multiple power quality disturbances in Microgrid network using probabilistic based intelligent classifier. Sustainable Energy Technologies and Assessments, 47, 101470.
13. Pol, Neha, Akshay Umare, Anand Bankad, and K. B. Prakash. "SEISMIC ANALYSIS OF ELEVATED WATER TANK."
14. Awasthi, A., Gupta, A., Saxena, K. K., Dwivedi, R. K., Kundalkar, D., Abdul-Zahra, D. S., ... & Saggu, H. S. (2022). Design and analysis of equal-channel angular pressing of Al6061: a comparative study. Advances in Materials and Processing Technologies, 1-10.
15. Bhukya, L., Kedika, N. R., & Salkuti, S. R. (2022). Enhanced maximum power point techniques for solar photovoltaic system under uniform insolation and partial shading conditions: a review. Algorithms, 15(10), 365.
16. Vijayakumar, Y., Nagaraju, P., Yaragani, V., Parne, S. R., Awwad, N. S., & Reddy, M. R. (2020). Nanostructured Al and Fe co-doped ZnO thin films for enhanced ammonia detection. Physica B: Condensed Matter, 581, 411976.
17. Kumar, M. Kranthi, V. Rushendra Mani, Ch Vinay Kumar, U. Divya, and B. Balakrishna. "Elevated Water Tank Design Comparison in Different Seismic Zones." International Journal of Innovative Research in Computer Science & Technology 10, 1 (2022): 130-135.
18. Quadri, S. S., and R. M. Sawant. "Seismic analysis of RC elevated water tank using different staging pattern." Internatinal Journal of Structural Engineering and Analysis 3 (2016): 1-22.
19. Tirupathi, Dasari, and Kota Srinivasu. "Comparison of Elevated Water Tank Designs in Different Seismic Zones."
20. Aware, Rupachandra J., and Vageesha S. Mathada. "Effect of Container Height on Base Shear of Elevated Water Tank."
21. Awasthi, A., Saxena, K. K., & Arun, V. (2021). Sustainable and smart metal forming manufacturing process. Materials Today: Proceedings, 44, 2069-2079.

22. Cheruvu, A., Radhakrishna, V., & Rajasekhar, N. (2017, May). Using normal distribution to retrieve temporal associations by Euclidean distance. In 2017 International Conference on Engineering & MIS (ICEMIS) (pp. 1-3). IEEE.
23. Kumar, K. U., Babu, P., Basavapoornima, C., Praveena, R., Rani, D. S., & Jayasankar, C. K. (2022). Spectroscopic properties of Nd3+-doped boro-bismuth glasses for laser applications. Physica B: Condensed Matter, 646, 414327.
24. Vandana, C. P., & Chikkamannur, A. A. (2021). Feature selection: An empirical study. International Journal of Engineering Trends and Technology, 69(2), 165-170.
25. Prakash, S., Somiya, G., Elavarasan, N., Subashini, K., Kanaga, S., Dhandapani, R., ... & Sujatha, V. (2021). Synthesis and characterization of novel bioactive azo compounds fused with benzothiazole and their versatile biological applications. Journal of Molecular Structure, 1224, 129016.
26. Pandey, A., Awasthi, A., & Saxena, K. K. (2020). Metallic implants with properties and latest production techniques: a review. Advances in Materials and Processing Technologies, 6(2), 405-440.
27. Kumar, Ayush, and Basawaraj Patil. "Comparative Analysis Of STAAD Pro V8 Software And Manual Design For Elevated Circular Tank Design." Journal of Scientific Research and Technology (2023): 42-63.
28. Dutta, Sekhar Chandra, Somnath Dutta, and Rana Roy. "Dynamic behavior of R/C elevated tanks with soil–structure interaction." Engineering Structures 31, 11 (2009): 2617-2629.
29. Moslemi, M., M. R. Kianoush, and W. Pogorzelski. "Seismic response of liquid-filled elevated tanks." Engineering structures 33, 6 (2011): 2074-2084.
30. Mori, Claudia, Stefano Sorace, and Gloria Terenzi. "Seismic assessment and retrofit of two heritage-listed R/C elevated water storage tanks." Soil Dynamics and Earthquake Engineering 77 (2015): 123-136.
31. Landge, D. K., and P. B. Murnal. "Structural Assessment of Circular Overhead Water Tank Based on Shaft Staging Subjected to Seismic Loading." International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO9001: 2008 Certified Journal, Volume4, issue6, June2014) (2014).
32. Shenton, Harry W., and Francis P. Hampton. "Seismic response of isolated elevated water tanks." Journal of Structural Engineering 125, no. 9 (1999): 965-976.
33. Ghateh, R., M. R. Kianoush, and W. Pogorzelski. "Seismic response factors of reinforced concrete pedestal in elevated water tanks." Engineering Structures 87 (2015): 32-46.
34. Phan, H. Nam, Fabrizio Paolacci, Oreste S. Bursi, and Nicola Tondini. "Seismic fragility analysis of elevated steel storage tanks supported by reinforced concrete columns." Journal of Loss Prevention in the Process Industries 47 (2017): 57-65.
35. Çelik, Ali İhsan. "Seismic analysis and strengthening of cylindrical steel storage water tanks." (2018).
36. Saman Susantha, K. A., and R. M. Indika Ranasinghe. "Strength and Ductility Assessment Method for Elevated RC Water Tanks." (2023).
37. Awasthi, A., Saxena, K. K., & Arun, V. (2020). Sustainability and survivability in manufacturing sector. In Modern Manufacturing Processes (pp. 205-219). Woodhead Publishing.
38. Moslemi, M., and M. R. Kianoush. "Parametric study on dynamic behavior of cylindrical ground-supported tanks." Engineering Structures 42 (2012): 214-230.
39. Kalyani, G., Janakiramaiah, B., Karuna, A., & Prasad, L. N. (2023). Diabetic retinopathy detection and classification using capsule networks. Complex & Intelligent Systems, 9(3), 2651-2664.

40. Telagam, N., Kandasamy, N., & Nanjundan, M. (2017). Smart sensor network based high quality air pollution monitoring system using labview. International Journal of Online Engineering (iJOE), 13(08), 79-87.
41. Jayabal, R., Subramani, S., Dillikannan, D., Devarajan, Y., Thangavelu, L., Nedunchezhiyan, M., ... & De Poures, M. V. (2022). Multi-objective optimization of performance and emission characteristics of a CRDI diesel engine fueled with sapota methyl ester/diesel blends. Energy, 250, 123709.
42. Raghu, M. S., Kumar, C. P., Prashanth, M. K., Kumar, K. Y., Prathibha, B. S., Kanthimathi, G., ... & Osman, S. M. (2021). Novel 1, 3, 5-triazine-based pyrazole derivatives as potential antitumor agents and EFGR kinase inhibitors: Synthesis, cytotoxicity, DNA binding, molecular docking and DFT studies. New Journal of Chemistry, 45(31), 13909-13924.
43. Ram, J. P., Pillai, D. S., Ghias, A. M., & Rajasekar, N. (2020). Performance enhancement of solar PV systems applying P&O assisted Flower Pollination Algorithm (FPA). Solar Energy, 199, 214-229.
44. Kumar, K. Y., Saini, H., Pandiarajan, D., Prashanth, M. K., Parashuram, L., & Raghu, M. S. (2020). Controllable synthesis of TiO2 chemically bonded graphene for photocatalytic hydrogen evolution and dye degradation. Catalysis Today, 340, 170-177.