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Analysis of Top Rectangular Water Tank Worked as a Tuned Liquid Damper for Earthquake Vibration Controlling in the CR Tower Buildings

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ABSTRACT

Many multi-storey structures in India have open first floors. This is often used for first-floor parking or reception lobbies. Total seismic base shear during an earthquake depends on the building's natural period, while seismic force distribution depends on stiffness and mass throughout the height. A building's earthquake response relies on its design, size, geometry, and how seismic forces are transmitted to the ground. Different floor levels in a structure must transmit earthquake forces along the shortest route to the ground. Any deviation or discontinuity in this load transfer path might cause damage. Building underperforms Current building trends call for higher, lighter, more flexible structures with reduced damping values. This raises failure and serviceability risks. TLD is a novel approach to decrease structural vibration. The tuned liquid damper (TLD) employs liquid sloshing to dampen a structure's vibrations. Cost-effective, low-maintenance dynamic vibration absorbers utilized in flexible, gently damped constructions.

Keywords: Top Rectangular Water Tank as Damper, Base Shear, TLD, Seismic Effect, Building Structure

1. INTRODUCTION

An earthquake is a strong surface vibration caused by a release of energy in the earth's crust. This energy may be created by an abrupt crustal displacement, volcanic eruption, or manufactured explosion. Most damaging earthquakes are crustal. The crust may deform before the forces destroy the rocks. Breaking causes seismic waves. These waves travel from the earthquake's source along the surface and into the ground at varied rates. Waves may trigger surface calamities. No construction on Earth is completely earthquake-proof; only its resistance to earthquakes may be enhanced. Depending on the zone in which a certain place is situated, a specific treatment must be administered. Recent earthquakes have prompted us to consider catastrophe management and have prompted the emergence of a number of new concerns. From the design phase through the construction phase of a building, it has become crucial to think rationally in order to prevent failure and limit property damage.

2. REVIEW OF THE LITERATURE

Baldev D. Prajapati investigated the analysis and design process used to calculate the height of a symmetric high-rise multi-story structure (G+30) under the influence of EQ and wind forces. The shear wall of a R.C.C., Steel, or Composite structure is regarded to be a lateral force resisting system.Wind-induced vibrations of two actual tall towers, Nagasaki Airport Tower (height 42 m) and Yokohama Marine Tower (height 101 m), were reduced to about half by installing wind-induced vibrations of two actual tall towers at Nagasaki Airport Tower (height 42 m) and Yokohama Marine Tower (height 101 m), according to Fujii. TLD was successfully predicted using an analytical model based on shallow water wave theory, which proved to be highly useful. They added two empirical parameters to their model to account for the influence of breaking waves, which they discovered experimentally.

Wakahara conducted theoretical and practical investigations to build an optimal TLD, which he then validated by applying it to a high-rise hotel in Yokohama called the "Shin Yokohama Prince (SYP) Hotel." They used the Boundary Element Method (BEM) to simulate liquid movements in a TLD container in their interaction model. The TLD installation on the building has the potential to cut the wind-induced reaction in half.

Banarjistudied the efficiency of a rectangular TLD in lowering the seismic response of buildings for different values of natural time periods and structural damping ratios using the formulation proposed by. Furthermore, an effort is made to establish TLD design criteria that are useful in managing a structure's seismic reaction. These parameters include the tuning ratio, which is the ratio of linear sloshing and structure natural frequencies, the mass ratio, which is the ratio of water and structure masses, and the depth ratio, which is the ratio of water depth to TLD tank-length ratio.

3. OBJECTIVE OF STUDY

1) As a liquid damper, a 1 lakh lighted water tank is created on the top most level to analyze the behavior of the building.

2) The purpose of this research is to investigate the use of a liquid damper to regulate the vibration of buildings in response to different dynamic forces.

3) The sloshing kind of tuneable liquid dampers is the subject of this research. Inside the Liquid Damper, water is treated like a liquid.

4) Based on shallow water wave theory, a nonlinear model of a liquid damper exposed to horizontal motion is developed, with wave breaking taken into account and the structural behavior assumed to be linear.

4. METHODOLOGY

Columns, beams, and slabs make up the structure. Manually analyzing the structure is done. The study takes into account the dead load, live load, and seismic load.

A. Materials Used

Assume Live load = 3.5KN/m2
Floor finish load = 1 KN
Type of Soil = Type II, Medium as per IS: 1893
Earthquake load = As per IS -1893 (part 1)-2002 Grade of steel use Fe-415
Type of footing =slope footing (2-1/2)
Total no. of column =104 NOS
Total area of plot = 4007.84sqm
Built up area =40.46m X 34.95m (1414.077sqm)
Safe bearing capacity of soil = 23tonne Storey height from base = 21m
Floors = G.F. + 5
Thickness of Wall = 200m
Thickness of Slab = 130mm Assume Unit Weight of Concrete = 25KN/M2
Assume Unit Weight of Masonary = 20 KN/M2

B. Structural properties Detail of CR Tower building

Total area of plot= 4007.8 sqm Area for developed= 557.24sqm
Built-up area (floor area deduct) = 1253.80sqm
Water tank constructed in top floor capacity= 1lakh lit Foundation depth below the ground surface= 6.096m
Total no. of column= 104nos
Type of footing= slope footing
Size of column (1) = 600x300mm, 23nos Size of column (2) = 300x600mm,
48nos Size of column (3) = 750x400mm,
31nos Size of column (4) = 750x500mm,
2nos Size of beam (1) = 200x600mm Size of beam (2) = 200x500mm Size of beam (3) = 300x600mm Size of beam (4) = 400x750mm Size of beam (5) = 200x400mm Thickness of wall = 200mm Thickness of slab = 130mm Diameter of bar use = 16 to 28mm, Use crusher broken aggregate for base= 40mm

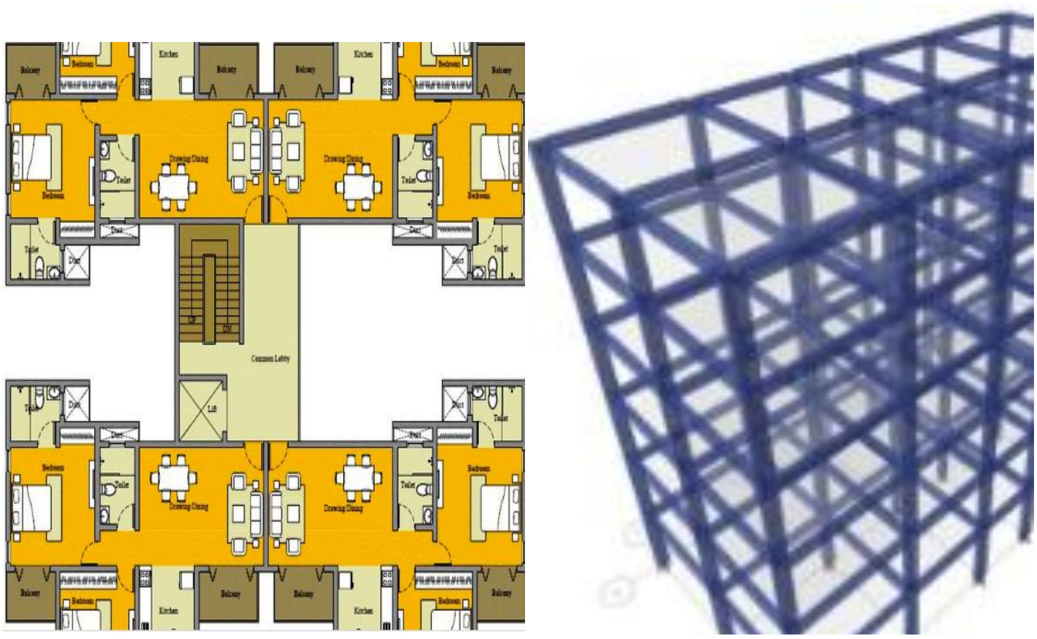

Fig 1: Plan and 3D model of CR Tower Structure

5. RESULT

5.1 Earthquake Dead load Calculation of CR Tower Structure(Part 1)

The seismic load is calculated according to IS 1893-2002. The criteria taken into account are for the construction of the CR Tower. 0.16 zone factors (zone 2) 3.0 Response Reduction Factor of importance = 1.5The soil is in a medium condition. Take into account the effects of earthquakes.

5.2 Earthquake Imposed Load Calculation of CR Tower Structure (Part II)

According to IS 875-1987, seismic load, dead load, and living load, including floor finish, are taken into account (Part I-Dead loads). IS 875-1987, Imposed loads is used to calculate.

6. CONCLUSION

1. In this work, we analyzed the behavior of a six-story structure using seismic data from the CR Tower. The seismic shear and lateral forces are found to be 6913KN and KN, respectively.

2. The Liquid Damper's behavior with different water tank depths is more effective in reducing structural vibration.

3. The displacement of the structure is dependent on the kind of soil, seismic zone, and building height, as shown by the analytical models' responses. It can be seen that the maximum displacement in a structure without a tank is larger, while the maximum displacement in a construction with a tank is smaller.

4. The displacement increases as the story height rises.

5. It should be noted that in a construction without a tank, base shear will be larger and displacement would be lower. With various sorts of models, the value rises in accordance with the soil types.

6. To guarantee excellent performance during future earthquakes, high-quality building must be given in accordance with applicable IS norms such as IS 1893 and IS 13920.

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