Analysis of CR TOWER G+6 Buildings Having Top Rectangular Water Tank Work as a Liquid Damper Situated in Ambikapur Chhattisgarh

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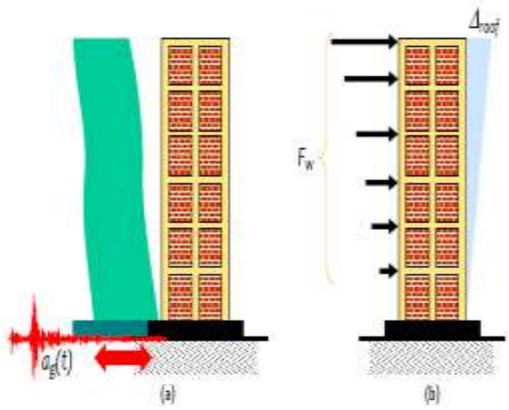
Abstract - *Many urban multistorey buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storey. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height. The behavior of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. The earthquake forces developed at different floor levels in a building need to be brought down along the height to the ground by the shortest path; any deviation or discontinuity in this load transfer path results in poor performance of the building. In the present trends in the construction industry demands taller and lighter structures, which are also more flexible and having quite a low damping value. This increases failure possibilities and also, problems from the serviceability point of view. Several techniques are available today to minimize the vibration of the structure, out of which concept of using of TLD is a newer one. The tuned liquid damper (TLD) is a liquid filled tank which uses liquid sloshing action to dampen the oscillations of a structure. They are cost effective and low maintenance dynamic vibration absorbers that are being used in flexible and lightly damped structures. A total of five loading conditions was applied at the base of the structure. First one was a sinusoidal loading corresponding to the resonance condition with the fundamental frequency of the structure, second one was corresponding to compatible time history as per spectra of IS-1893 (Part -1): 2002 for 5% damping at rocky soil and rest three were corresponding to time histories of past earthquake such as El Centro Earthquake record, Sanfranscisco Earthquake and Colianga Earthquake.*

Key Words**: CR tower G+6 building, available in top rectangular water tank as damper, base shear**

1. INTRODUCTION

An earthquake is the vibration, sometimes violent to the earth's surface that follows a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of segments of the crust, by a volcanic eruption or even by a manmade explosion. The dislocation of the crust causes most destructive earthquakes. The crust may first bend and then the stresses exceed the strength of rocks, they break. In the process of breaking, vibrations called seismic waves are generated. These waves travel outward from the source of the earthquake along the surface and through the earth at varying speeds depending on the material through which they move. These waves can cause disasters on the earth's surface.



Nature of temporal variations of design actions:

(a) Earthquake Ground Motion – zero mean, cyclic

(b) Wind Pressure – non-zero mean, oscillatory

No structure on the planet can be constructed 100% earthquake proof; only its resistance to earthquake can be increased. Treatment is required to be given depending on the zone in which the particular site is located. Earthquake occurred in the recent past have raised various issues and have forced us to think about the disaster management. It has become essential to think right from planning stage to completion stage of a structure to avoid failure or to minimize the loss of property.

1.1 Seismic Protection Systems in earthquake

Three categories of seismic protection systems have been implemented:-

1.1.1 Conventional Systems

These systems are based on traditional concepts and use of stable inelastic hysteresis to dissipate energy. This mechanism can be reached by plastic hinging of columns, beams or walls, during the axial behavior of brace elements by yielding in tension or buckling in compression or through the shear hinging of steel members.

1.1.2 Isolation Systems

Isolation systems are usually employed between the foundation and base elements of the buildings and between the deck and the piers of bridges. These systems are designed to have less amount of lateral stiffness relative to the main structure in order to absorb more of the earthquake energy. A supplemental damping system could be attached to the isolation system to reduce the displacement of the isolated structure as a whole.

1.1.3 Supplemental Damping Systems

The supplemental damping system can be categorized in three groups as passive, active and semi-active systems. These dampers are activated by the movement of the structure and decrease the structural displacements by dissipating energy via different mechanisms.

2. LITERATURE REVIEW

Baldev D. Prajapati *has study that the analysis & design procedure adopted for the calculation of symmetric high rise multi-storey building (G+30) under effect of EQ and Wind forces. The R.C.C., Steel, & Composite building with shear wall is considered to resist lateral forces resisting system*.

Fujii *have found by installing wind-induced vibrations of two actual tall towers, at Nagasaki Airport Tower (height 42 m) and Yokohama Marine Tower (height 101 m), were reduced to about half Successfully developed an analytical model for TLD, based on shallow water wave theory, which proved to be very effective. They extended this model to account for effect of breaking waves by introducing two empirical coefficients identified experimentally.*

Wakahara*, Carried out theoretical and experimental studies to design an optimum TLD and verified the TLD with an actual application to a high-rise hotel the "Shin Yokohama Prince (SYP) Hotel" in Yokohama. The interaction model considered by them was based on the Boundary Element Method (BEM) for simulating liquid motion in a TLD container. The TLD installation on the building could reduce the wind-induced response to half of the original value.*

Banarji *used the formulation suggested by in order to study the effectiveness of a rectangular TLD in reducing the earthquake response of structures for various values of natural time periods and structural damping ratios. Furthermore, an attempt is made to define appropriate design parameters of the TLD that is effective in controlling the earthquake response of a structure. These parameters include the ratio of the linear sloshing and structure natural frequencies, henceforth called the tuning ratio, the ratio of the masses of water and structure, henceforth called the mass ratio, and the water depth to the TLD tank-length ratio, henceforth called the depth ratio.*

Ikeda & Ibrahim *analyzed an elastic structure carrying a cylindrical tank partially filled with liquid where the structure is vertically subjected to a narrow-band random excitation. They derived the modal equations taking into account the liquid nonlinear inertia forces. Nonlinear coupling between liquid modes and structure modes results in 2:1 internal resonance, i.e., when the natural frequencies of the structure and the first anti-symmetric sloshing mode were commensurable. They solved the modal equations numerically using Monte Carlo simulation, and estimated the system response statistics*

3. OBJECTIVES

1. *To study the behavior of structure available water water tank of capacity* ***1 lakh lit*** *is constructed on the top most floor as a* ***liquid damper****.*
2. *The objective of this work is to study the application of Liquid* ***damper*** *to control the vibration of buildings under various dynamic actions.*
3. *This study focuses on the sloshing type of tune liquid dampers. Water is considered as liquid inside the* ***Liquid Damper****.*
4. *A nonlinear model of* ***Liquid damper*** *subjected to horizontal motion is proposed on the basis of shallow water wave theory taking wave breaking into consideration and the structural behavior is assumed to be linear.*

4. METHODOLOGY

The structure consists of columns, beams and slabs. Analysis of the structure is done manually. Dead load, live load and earthquake load are considered for analysis.

4.1.1 Material use & properties in CR Tower building

Height of building = 21 m

Safe bearing capacity of soil = 23 tones

Grade of steel for base = Fe-500

Grade of steel above base/floor = Fe-415

Grade of concerte = M-20

Young's modulus of concrete = 25000Mpa

Young's modulus of steel =200000Mpa

Unit weight of steel = 78.0KN/m3

Unit weight of concrete = 25 KN/m3

Unit weight of masonry = 20 KN/m3

4.1.2 Structural properties Detail in CR Tower building

Total area of plot= 4007.8 sqm

Area for developed= 557.24sqm

Builtup 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

4.1.3 Earthquake Load consider in CR tower building

The earthquake load is considered as per the IS 1893-2002(Part 1). The factors considered are for the CR Tower building

- *Zone factors = 0.10(zone 2)*
- *Response reduction factor = 1.0*
- *Importance factor = 1.5*
- *Soil condition = Medium soil*

4.1.4 Consider of Earthquake loads

The earthquake load, dead load & live load including floor finish is considered as per IS 875-1987 (Part I-Dead loads). The imposed load is considered as per IS 875-1987 (Part II-Imposed loads.

4.2 About the structure detail of CR Tower

Fig 01 Plan of CR tower building

In the CR Tower building 4 type of building design are constructed these are given below:-

Fig 02 Plan of building in CR tower 2BHK

Fig 03 Plan of building in CR tower 2BHK & 3BHK

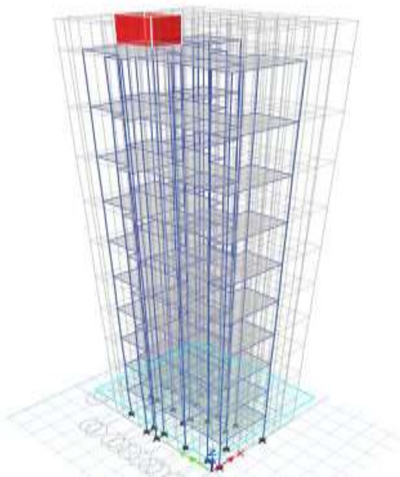


Fig 04 CR tower building with water tank capacity 1 lakh lit water depth 2.5m

5. CONCLUSIONS

- *In our study, we used the seismic data for CR Tower building to analyze the behavior of **6 levels** building. We find that the seismic shear forces and lateral forces can reach **5833KN** and **KN** respectively.*
- *Behavior of **Liquid Damper** with water tank depths is more efficient to reduce structural vibration.*
- *The present study leads to the conclusion that it is reasonable to implement tuned liquid damper for mitigation of structural response under dynamic action.*
- *The calculation of Base shear **VB** is same as in case of considering stiffness of infill walls, the storey lateral forces and shear forces are same as in the previous case. Therefore, Lateral and Shear Force distribution along the height of the structure is valid.*
- *Selection of sites for construction are selected in terms of frequency of occurrence and the likely severity of ground shaking and failure of ground.*
- *During the study several excitation frequency rates varying from **0.5 to 1.5** were considerable where excitation frequency is units.*
- *The performance of liquid damper is observed to be effective in reducing the response of structure the liquid damper was ineffective in dissipating the energy for other excitation frequency ratio as the inertial the liquid damper interface force interfaces each other.*
- *The design of **RC Tower building** elements and joint should be implemented is occurrence with the analysis that is duality design.*
- *To provide symmetry & regularity in the distribution of mass and stiffness in plan and in elevation, spatial solution should be applied.*
- *In case of the higher water depth ratio no significant reduction in response amplitude is observed for higher depth ratios .The energy absorbed and dissipated by liquid damper depends mostly on the sloshing and wave breaking. The liquid damper having a higher water depth ratio does not slosh as much as that for low water depth ratios.*
- *From this study, it can be concluded that properly designed TLD with efficient design parameters such as tuning ratio, depth ratio and mass ratio is considered to be a very effective device to reduce the structural response.*

6. Scope for future work

- Study may further be extended for different seismic zones.
- *The structural model considered in this study is linear one which provides a further scope to study the problem using a nonlinear model for the structure.*
- *The study can be further extended by introducing obstacles like baffles, screens and floating particles in the tank to obtain changed control performance.*
- *The structure and damper model considered here is two-dimensional, which can be further studied to include 3-dimensional structure model as well as a damper liquid model.*
- *Analysis shall be carried out for different in fills.*
- *Analysis shall be carried out using time history method.*

REFERENCES

*[1] **Frandsen, J.B,** "Numerical predictions of tuned liquid tank structural systems "Journal of Fluids and Structures, volume 75 (2), (2005).*

*[2] **Hong-Nan Li, Ying Jia, Su-yan Wang.,** "Theoretical and experimental studies on reduction for multi-modal seismic responses of high rise structures by tuned liquid dampers" Journal of Earth and environmental science,volume143,2004.*

*[3] **Kim Young-Moon, You Ki-Pyo, Cho Ji-Eun, and Hong Dong-Pyo**."The Vibration Performance Experiment Of Tuned Liquid Damper and Tuned Liquid Column" Journal of Mechanical Science and Technology, Vol. 20, No. 6, (2006).*

*[4] **Modi V.J. and Seto M.L.,** "Suppression of flow induced oscillations using sloshing liquid dampers" Journal of Wind Engineering, volume 67-68, April-june1997*

*[5] **IS 456:2000,** "Plain and Reinforced concrete" – Code of practice.*

*[6] **P.C.Varghese,** "Limit state design of reinforced concrete"*

*[7] **N.Krishnaraju."** Reinforced concrete design"*

*[8] **Srinivasau.A, Dr.Panduranga Rao.B.** Non –linear static analysis of multi storeyed building.*

*[9] **Dolce.M & Ponzo.F.c** Non –linear seismic response of EC-8 designed RC building structures.*

*[10] **Mahesh suresh kumawat & kalurkar.L.G .**Static & dynamic analysis of multi sotrey building using composite structures.*

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