Analysis of CR TOWER G+5 Buildings Having Top Rectangular Water Tank Work as a Liquid Damper Situated in Ambikapur Chhattisgarh

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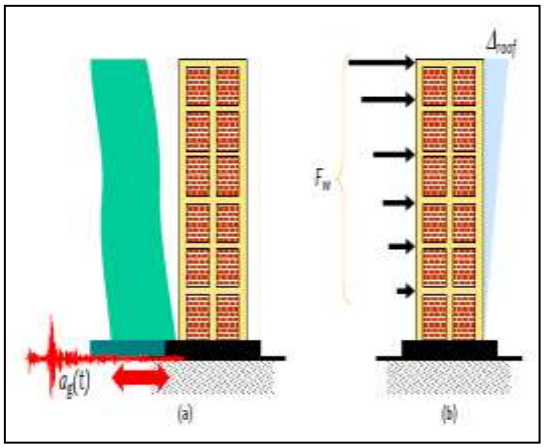
Abstract— Many urban multistorey buildings in India today have open first storey as an unavoidable feature. This is primarily being adopted to accommodate parking or reception lobbies in the first storey. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent 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.

Keywords: CR Tower G+5 Building, Available In Top Rectangular Water Tank as Damper, Base Shear

I. 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:

1) Earthquake Ground Motion – zero mean, cyclic
2) 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.

A. Seismic Protection Systems in earthquake

Three categories of seismic protection systems have been implemented:-

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.

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.

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.

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II. 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

III. 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.

IV. 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.

A. Material use & properties in CR Tower building

Assume Live load = 3.5KN/m^2
Floor finish load = 1 KN
Type of Soil = Type II, Medium as per IS: 1893
Location = ambikapur city
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/M^2
Assume Unit Weight of Masonary = 20 KN/M^2

B. 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

C. 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 = 0.16(zone 2)
Response reduction factor = 3.0
Importance factor = 1.5
Soil condition = Medium soil
Consider of Earthquake loads

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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.

D. About the structure detail of CR Tower

Fig. 1: Plan of CR tower building

V. 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 6913KN and KN respectively.
- Behavior of Liquid Damper with water tank depths is more efficient to reduce structural vibration.
- From the response of the analytical models it can be noticed that displacement of the structure depends on the type of the soil, seismic zone and height of the buildings. It can be observed that maximum displacement will be higher in structure without tank and lower displacement in structure having tank Displacement goes on increasing with the storey height.
- It can be noted that base shear will be higher in structure without tank and lower displacement in structure without tank. The value increases corresponds to its soil types with different types of models.
- high quality of construction to be provided conforming to related IS codes such as IS 1893 , IS 13920 to ensure good performance during future earthquakes.

VI. 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.
- Analysis shall be carried out for different in fills.
- The CR Tower building 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.

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