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RESPONSE ANALYSIS OF EFFECTIVE LOCATION AND POSITIONG OF WASTE WATER TREATMENT PLANT IN HIGH-RISE STRUCTURE

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ABSTRACT

Construction of high rise structure has got a boost in recent years, but on the other hand the issue of scarcity of water in these buildings has been encountered. Provision of On-site waste water treatment plant in a high rise structure at proposed refuge floor, is proving a better solution both Hydraulically and Environmentally. The positioning of these waste water treatment plant and the modeling of this heavy structure is carried out using STAAD Pro. Also the response of the structure after positioning of the treatment plant in the structure, in case of a seismic activity is checked and studied analytically. Time history analysis of the structure with an already available earthquake data is carried out primarily for three building models, and the comparative study to see feasibility of these models.

KEYWORDS: Environmental Floor, STAAD Pro., Storey Drift, Time History.

I. INTRODUCTION

Scarcity of water in today's world is hampering human civilization in more ways than one, there is an immediate need to find solutions to resolve this issue in various sectors. In India the three main sources of domestic supply of water are taps, water tankers and local water selling outlets. The supply via the taps is usually through the water reservoirs in the buildings or housing societies. While the water tankers are called upon when these reservoirs go dry, thus this source acts as an emergency supply source. While the local water selling bodies in the urban areas are not that effective in spite of being the costliest source amongst the others. Dealing with the scarcity of water in urban areas in India is a way more complicated and major issue than many think of it.

While on the other hand the untreated wastewater is causing its own set of adverse consequences on human habitat. In India an appealing 70% of sewage generated is not treated and directly dumped into rivers, lakes and various other water bodies. When we are already dealing with a greater issue of scarcity of water, this kind of solutions are just worsening the situation. So now we have not one but two major issues to deal with before we have a better provision of water. So to end at the right destination we need to start in a right direction. To achieve global water provision, we need to start right from our homes and societies, thus the plan of provision of wastewater treatment plant in a high-rise building is being suggested.

Study of feasibility of these system in context of an urban environment and further design and analysis of the structure is the basis of this project. The Project studies installation of the wastewater treatment methods developed by Dr. Mapuskar in a multi-storey residential building and to study the response of the structure during a seismic activity and design of the high rise structure and its analysis in both experimental and analytical aspects.

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II. DOSIWAM System

DOSIWAM stands for Decentralized Onsite Integrated Waste Management system. In 1981, Dr. S. V. Mapuskar developed an innovative design 'MALAPRABHA BIOGAS PLANT' for recovering biogas from anaerobically digested human nigh soil. While developing this design, he had taken into consideration the relevant hygiene factors along with the parameters for biomethanation of human night soil. The relevant social factors and convenient latrine use also were considered.

Since 1981, hundreds of Malaprabha biogas plants have been constructed. The results have been very good. The plants have been designed from 1 m^3 capacity to 30 m^3 capacity. In Dehu alone 80 Malaprabha plants are functioning satisfactorily.

The DOSIWAM system aims in treatment of the wastewater incurred from the Water Closets, Bathrooms, Basins and Showers on site using non-mechanized technique. It aims in producing well treated water in purest of the forms possible to be used for flushing and fire fighting purposes primarily, but which can also be used for gardening, car wash, and numerous secondary purposes. The installation of these wastewater treatment units is considerably an easy job benefitting at numerous levels. The primary units in a DOSIWAM system include a Stabilization tank and a Digester.

III. METHODOLOGY

Non Linear Dynamic Analysis:

When the evaluated structural response is nonlinear it is called Nonlinear Dynamic Analysis. This method has proven to be most effective in structural analysis. The nonlinear dynamic analysis is carried out using Time History Analysis. This method uses the already available time history of a representative earthquake for the structure to be evaluated. This is a step-by-step analysis of the dynamic response of a structure to a specified loading that varies with time. This method is used for seismic analysis of a structure under dynamic loading of representative earthquake.

Problem Statement:

A 30 floor building (G+29) with a plan area of 1575 m^2 as shown in figure 1 with a cross-section of (45 m x 35 m) accommodating a waste water treatment unit on its environmental floors. The waste water treatment unit to be accommodated is a DOSIWAM system usually facilitated in rural areas as described earlier. The system primarily includes a digester, a stabilization tank and a water reservoir. Since the system follows a non-mechanized pattern for treatment of waste water in the building there is no need of any mechanical equipment adding to the weight on the building and further complications. The analysis result of the building with these waste water treatment units was compared with a building of same physical properties, but just without the waste water treatment units and a another building model with waste water treatment unit and provided with base isolation, to check the feasibility of the structure for earthquake responses. Time history analysis was carried out for these building models, using the El Centro data for time vs. acceleration.

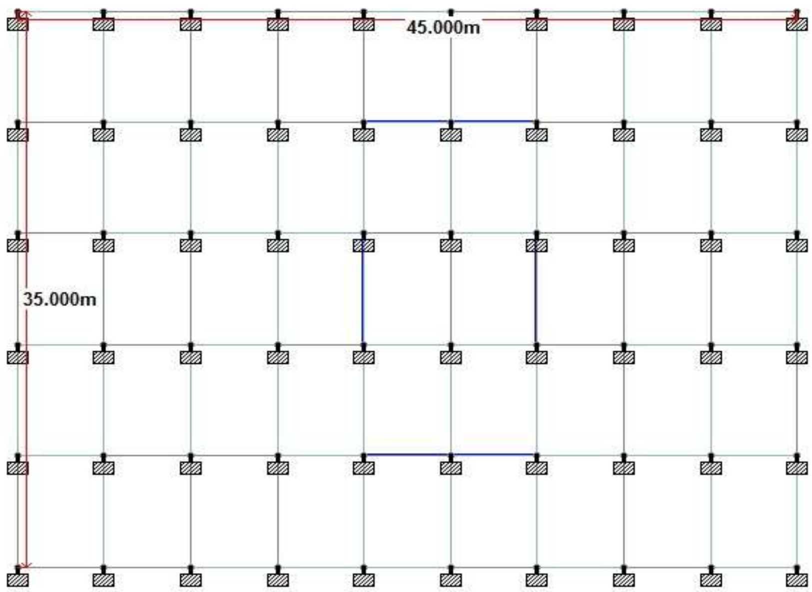

Figure 1 Plan of the building to be analyzed.

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Analysis assumptions:	Live Load on Typical floors – 3 kN/m^2 ;	Live Load on Terrace – 1.5 kN/m^2
	Column Size – 0.5 m x 0.5 m;	Beams Size – 0.23 m x 0.45 m
	Slab Thickness – 0.15 m	Brick Wall Thickness – 0.23 m
	Density of Concrete – 25 kN/m^3	Density of Brick wall – 18 kN/m^3

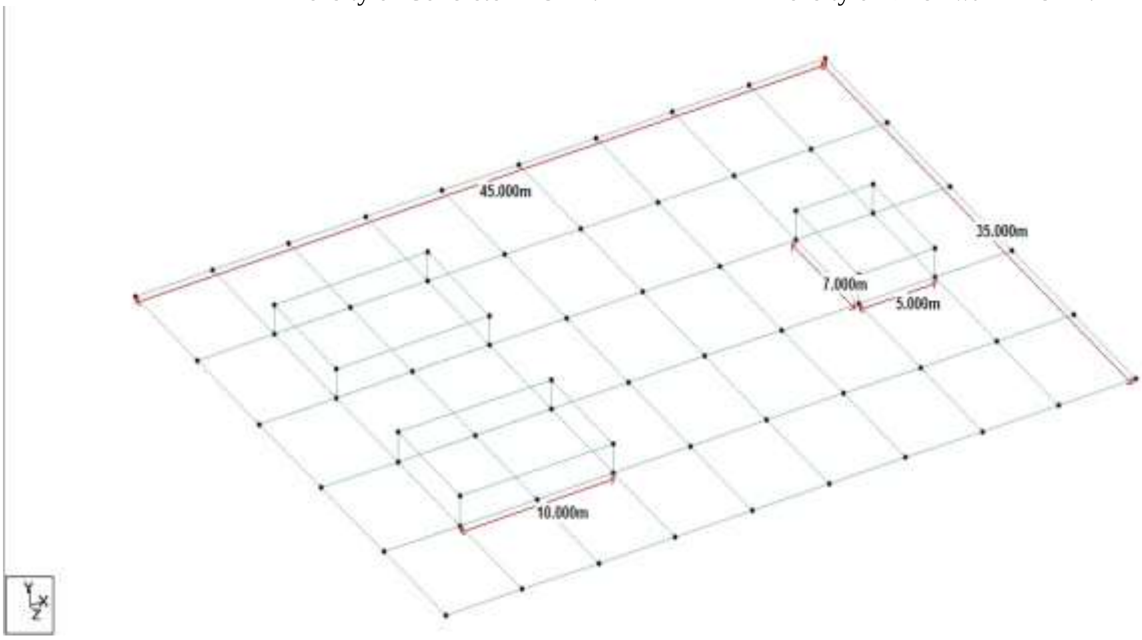

Figure 2 Position of Waste Water Treatment Plant.

IV. RESULTS AND DISCUSSION

Storey drift is the drift of one level of a multi-storey building relative to the level below. Inter storey drift is the difference between the roof and floor displacement of any given storey as the building sways during the earthquake, normalized by the storey height.

The variation in the storey drift of these models will help us understand the difference in storey drift between them. Thus suggesting the change or difference in consequences of these buildings aftermath of an earthquake. The storey drift mainly accounts for the X and Z direction of these building models. All the values accounting are in mm and the positive and negative signs define the directions of the displacement in respective axial directions.

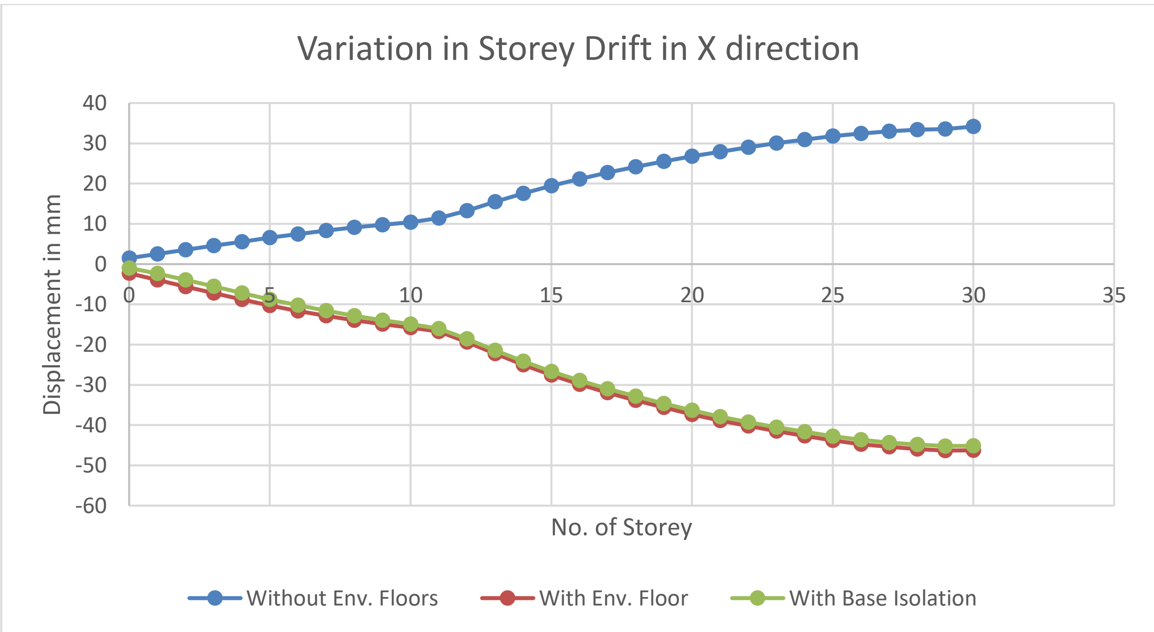

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Figure 3 Variation in storey drift in X direction for all models.

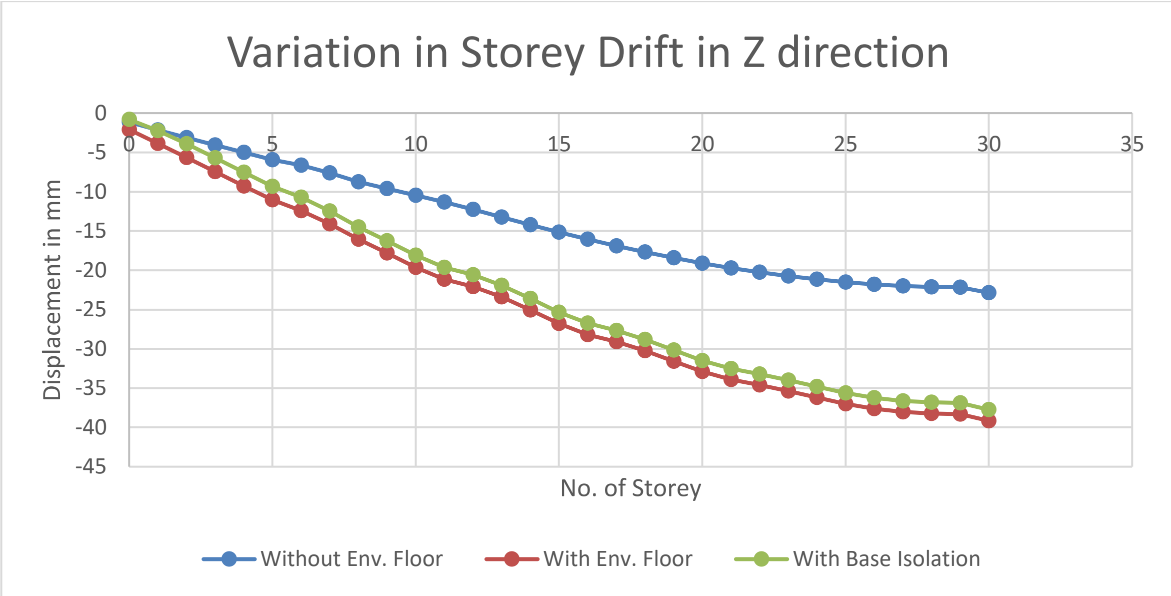

Figure 4 Variation in storey drift in Z direction for all models.

The variation in the storey drift of the three models in both X and Z direction can be seen in the graphs plotted above. The maximum change in value for model 1 to 2 in X direction is 13 mm and in Z direction is 12 mm, which helps us understand though there is increase in storey drift for model 1 and model 2, the increment is not considerably large. Thus there is no harm to the structure when water treatment plant is located in structure at the above mentioned position. While the decrease in model 2 and model 3 in X direction is maximum of 2 mm while in Z direction the decrease is 3 mm. Thus stating that there is no additional requirement of provision of Base Isolation to the structure. The requirement of the shear walls and proper location and positioning of waste water treatment unit in this building can be beneficial in its behavior during an earthquake.

V. CONCLUSION

1. The variation in the storey drift of the three models in both X and Z direction can be seen in the graphs plotted above. The maximum change in value for model 1 to 2 in X direction is 13 mm and in Z direction is 12 mm, which helps us understand though there is increase in storey drift for model 1 and model 2, the increment is not considerably large.
2. Thus there is no harm to the structure when water treatment plant is located in structure at the above mentioned position.
3. The decrease in model 2 and model 3 in X direction is maximum of 2 mm while in Z direction the decrease is 3 mm.
4. Thus stating that there is no additional requirement of provision of Base Isolation to the structure.
5. The requirement of the shear walls and proper location and positioning of waste water treatment unit in this building can be beneficial in its behavior during an earthquake.

VI. FUTURE SCOPE

In the future scope of this study, further researchers may do their work considering irregular building models and varying storey number and increasing the capacity of the treatment plant to be positioned in the buildings. It will also be beneficial to study and decrease the sizes of structural elements where the additional load due to water treatment plants is not considerably large.

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