Impact of Dynamic Analysis of High Rise Structure with Dual System under Different type of Soil Conditions, Different type of RC Shear Wall & Different Load Combination, Load Cases

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Abstract

The current research work analyzes thirty storey building in India with C, Box ,E ,I shape and new shape of RC Shear walls Plus shape, at the center in Concrete Frame Structure with fixed support conditions under different type of soil (Hard, Medium soft soil) for earthquake zone V as per IS 1893 (part 1) :2002. This design also uses software ETABS by Dynamic analysis (Response Spectrum method). All the analyses have been carried out as per the Indian Standard code books. This work aims to explore the behavior of new shape of RC Shear walls plus shape in high rise structure with dual system with different type of RC Shear under different type of soil condition and different load combination for seismic loading. Estimation of structural response such as lateral load, stiffness, storey drift, storey moment, storey shear, storey displacements, time period , frequency, mode shape, Pier forces and column forces is carried out. It was found that the building which is in box shape shear walls provided at the center core showed better performance in terms of maximum storey displacements, time period, frequency and mode shape. The time period is not influenced by the type of soil. The displacement is influenced by type and location of the shear wall and also by changing soil conditions. The better performance for model with soft soil can be attributed to low displacement and drift. Storey drifts are found within the limit, according to Indian standards. It was found that the behavior of new shape (plus shape) of RC shear wall are not more different with I and box shape and also there is no more difference between 1.5 (DL + EL) and 1.2 (DL + IL ± EL) combination load. Moreover, the Axial force and Moment in the column increases when the type of soil changes from hard to medium and medium to soft. Since the column moment increases as the soil type changes, soil structure interaction must be considered suitable while designing frames for seismic force.

Index terms— dynamic analysis, structural response, soil condition, rc shear walls, software etabs

he usefulness of shear walls in the framing of buildings has long been recognized. Walls situated in advantageous positions in a building can form an efficient lateral-force-resisting system, simultaneously fulfilling other functional requirements. Shear Wall is a structural element used to resist lateral, horizontal, and shear forces parallel to the plane of the wall by: cantilever action for slender walls where the bending deformation is dominant .Truss action for squat/short walls where the shear deformation is dominant. Shear walls are analyzed to resist two types of forces: shear forces and uplift forces. b) Necessity of Shear Walls Shear wall system has two distinct advantages over a frame system.

It provides adequate strength to resist large lateral loads without excessive additional cost. It provides adequate stiffness to resist lateral displacements to permissible limits, thus reducing risk of non-structural damage.

1 c) Earthquake Load

The seismic weight of building is the sum of seismic weight of all the floors. The seismic weight of each floor is its full dead load plus appropriate amount of imposed load, the latter being that part of the imposed loads that may reasonably be expected to be attached to the structure at the time of earthquake shaking. It includes the weight of permanent and movable partitions, permanent equipment, a part of the live load, etc. Earthquake forces experienced by a building result from ground motions (accelerations) which are both fluctuating and sometimes dynamic in nature; in fact they reverse directions somewhat chaotically. In theory and practice, the lateral force that a building experiences from an earthquake increases in direct proportion with the acceleration of ground motion at the building site and the mass of the building (i.e., a doubling in ground motion acceleration or building mass will double the load). As the ground accelerates back and forth during an earthquake it imparts backand-forth (cyclic) forces to a building through its foundation which is forced to move with the ground.

2 II. Methodology

Earthquake motion causes vibration of the structure leading to inertia forces. Thus a structure must be able to safely transmit the horizontal and the vertical inertia forces generated in the super structure through the foundation to the ground. Hence, for most of the ordinary structures, earthquake-resistant design requires ensuring that the structure has adequate lateral load carrying capacity.

Quite a few methods are available for the earthquake analysis of buildings; two of them are presented here:

1. Equivalent Static Lateral Force Method (pseudo static method). 2. Dynamic analysis.

i. Response spectrum method.

ii. Time history method.

a) Response Spectrum Method Dynamic analysis should be performed to obtain the design seismic force, and its distribution to different levels along the height of the building and to various lateral load resisting elements, for the following buildings:

Regular buildings-Those are greater than 40 m in height in zone IV, V and those are greater than 90 m height in zones II,III, and Irregular buildings-All framed buildings higher than 12 m in zone IV and V, and those are greater than 40 m in height in zone II and III. Dynamic analysis may be performed either by time history method or by the response spectrum method. However in either method, the design base shear V B shall be compared with a base shear V B calculated using a fundamental period Ta. When V B is less than V B all the response quantities shall be multiplied by V B / Vb, The values of damping for a building may be taken as 2 and 5 percent of the critical, for the purpose Of dynamic analysis of steel and reinforced concrete buildings, respectively. Therefore, analysis in practice typically uses linear elastic procedures based on the response spectrum method. The response spectrum analysis is the preferred method because it is easier to use. This method is also known as model method or mode superposition method. It is based on the idea that the response of a building is the superposition of the responses of individual modes of vibration, each mode responding with its own particular deformed shape, its own frequency, and with its own model damping.

3 III. Numerical Analysis a) Modeling of Building

A symmetrical building of plan 38.5m X 35.5m located with location in zone V, India is considered. Four baysof length 7.5m& one bays of length 8.5m along Xdirection and Four bays of length 7.5m& one bays of length 5.5m along Y -direction are provided. Shear Wall is provided at the center core of building model.

Structure 1: This model building with 30 storeysis modeled as a (Dual frame system with shear wall (Plus Shape).The shear wall acts as vertical cantilever at the center of building.

Structure 2: This model building with 30 storeys is modeled as (Dual frame system with shear wall (Box Shape) the shear wall acts as vertical cantilever at the center of building.

Structure 3: This model building with 30 storeys is modeled as (Dual frame system with shear wall (C-Shape).The shear wall acts as vertical cantilever at the center of building.

Structure 4: This model building with 30 storeys is modeled as (Dual frame system with shear wall (E-Shape) the shear wall acts as vertical cantilever at the center of building.

Structure 5: This model building with 30 storeys is modeled as (Dual frame system with shear wall (I-Shape). The shear wall acts as vertical cantilever at the center of building.

4 b) Load Combinations

As per IS 1893 (Part 1): 2002 Clause no. 6.3.1.2, the following load cases have to be considered for analysis:

1.5 (DL + IL) 1.2 (DL + IL ± EL) 1.5 (DL ± EL) 0.9 DL ± 1.5 EL Earthquake load must be considered for +X, -X, +Y and -Y directions.

For the purpose of determining the design seismic forces, the country (India) is classified into four seismic zones (II, III, IV, and V). IV.

5 Discussion on Results

When a structure is subjected to earthquake, it manifests in the form of vibration. An example force can be resolved into three mutually perpendicular directionstwo horizontal directions (X and Y directions) and the vertical direction (Z). This motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. All the structures are primarily designed for gravity loads-force equal to gravity of mass time in the vertical direction. This can be accounted to the inherent factor used in the design specifications as most structures tend to be adequately protected against vertical shaking. Vertical acceleration should also be considered in structures with large spans those in which stability for design, or for overall stability analysis of structures. The basic intent of design theory for earthquake resistant structures is that buildings should be able to resist minor earthquakes without damage, resist moderate earthquakes without structural damage but with some non-structural damage. To avoid collapse during a major earthquake, members must be ductile enough to absorb and dissipate energy by post elastic deformation. Redundancy in the structural system permits redistribution of internal forces in the event of the failure of key elements. When the primary element or system yields or fails, the lateral force can be redistributed to a secondary system to prevent progressive failure.

The structural prototype is prepared and lots of data is been collected from the prototype. All the aspects such as safety of structure in shear, moment and in story drift have been collected. So, In order to check the safety of the structure with established shear walls and all construction of core wall in the center, the graphical values of structure with the shear wall and a simple rigid frame structure need to be compared.

6 IS 1893 Part1Codal Provisions For Storey Drift Limitations:

The storey drift in any storey due to the minimum specified design lateral force, with partial load factor of 1.0, shall not exceed 0.004 times the storey height For the purposes of displacement requirements only, it is permissible to use seismic force obtained from the computed fundamental period (T) of the building without the lower bound limit on design seismic force specified in dynamic analysis.

The result obtained from the analysis models will be discussed and compared as follows: It is observed that

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? The maximum storey drift in X-direction occurred at storey 11 th for structure 3 in hard, medium and soft soil. ? The maximum storey drift in X-direction occurred at storey 11 th for structure 4 in hard, medium and soft soil. ? The maximum storey drift in X-direction occurred at storey 14 th for structure 5 in hard, medium and soft soil. ? The time period is 6.298 Sec for structure1 and it is same for different type of soil. ? The Frequency is 0.159cyc/sec for structure1 and it is same for different type of soil. ? The time period is 5.785 Sec for structure2 and it is same for different type of soil. ? The Frequency is 0.173cyc/sec for structure2 and it is same for different type of soil. ? The time period is 6.415 Sec for structure3 and it is same for different type of soil. ? The Frequency is 0.156cyc/sec for structure3 and it is same for different type of soil. ? The time period is 6.375Sec for structure4 and it is same for different type of soil. ? The Frequency is 0.157cyc/sec for structure4 and it is same for different type of soil. ? The time period is 6.382 Sec for structure5 and it is same for different type of soil. ? The Frequency is 0.157cyc/sec for structure5 and it is same for different type of soil.

V.

8 Conclusion

? Time period is a significant factor for the shear wall and its position ? This not only influenced by the type of soil but also by the low time period which is a very significant performance as shown in structure 2. ? Structure two indicates increase in the height of the building, hence there is increase in drift is observed and further reduction at top floor. ? For a better comparison story drift values are smaller values is noted for the center of the building which can be obtained for it shear wall at center. ? As per code, the actual drift is less than permissible drift. The parallel arrangement of shear wall in the center core and outer periphery is giving very good result in controlling drift in both the direction. The performance is better for all the structures with soft soil because it has low storey drift. ? The height of the each storey is 3.5 m. So, the drift limitation as per IS 1893 (part 1): 2002 is 0.004 X 3.5 m = 14 mm. The models show a similar behavior for storey drifts as shown in graph. ? According to Indian standards, storey drifts are found within the limit, IS 1893 (Part1): 2002.specification for earthquake resistant design of structures.

? There is reduction in displacement of shear wall which may increase in building stiffness. ? The displacement is influenced by accommodating shear wall and also by changing soil condition. The performance is better for model with soft soil because it has low displacement. ? For both X and Y directions, the behavior of the displacement graph is similar for all the structures in soil which is soft, Soil which is medium and Hard Soil. The order of maximum storey displacement in both the directions for the models is same. ? The value of the lateral loads in x-direction for all models observed reduction with enhancement of storey level. ? The value of the lateral loads in x-direction for all models in soft soil is less compared with the structure in medium soil and hard soil. ? Lateral loads in X-direction for all models in soft soil <Medium soil < hard soil. ? It is noted that the maximum column moment in ydirection is influenced by the type of soil and placing of shear wall. ? The Axial force and Moment in the column increases when the type of soil changes from hard to medium and medium to soft. Since the column moment increases as the soil type changes, soil structure interaction must be considered suitable while designing frames for seismic force. ? For severe lateral loads caused by wind load and or earthquake load, the reinforced shear wall is obvious because it produces less deflection and less bending moment in connecting beams under lateral loads than all others structural system. ? ETABS is the robust software which is utilized for analyzing any kind of multi building structures. It can easily analyze 40 floors building structures by its fast and accuracy. ? The shear force resisted by the column frame is decreasing by placing the shear wall and the shear force resisted by the shear wall is increasing. This can be concluded indirectly by observing the maximum column shear force and moment in both directions. ? It is observed that the value of storey moment inx & y-direction is same for the model with a different type of soil and placing shear wall. ? It is observed that the value of stiffness in x& ydirection is same for the model with a different type of soil and placing shear wall.

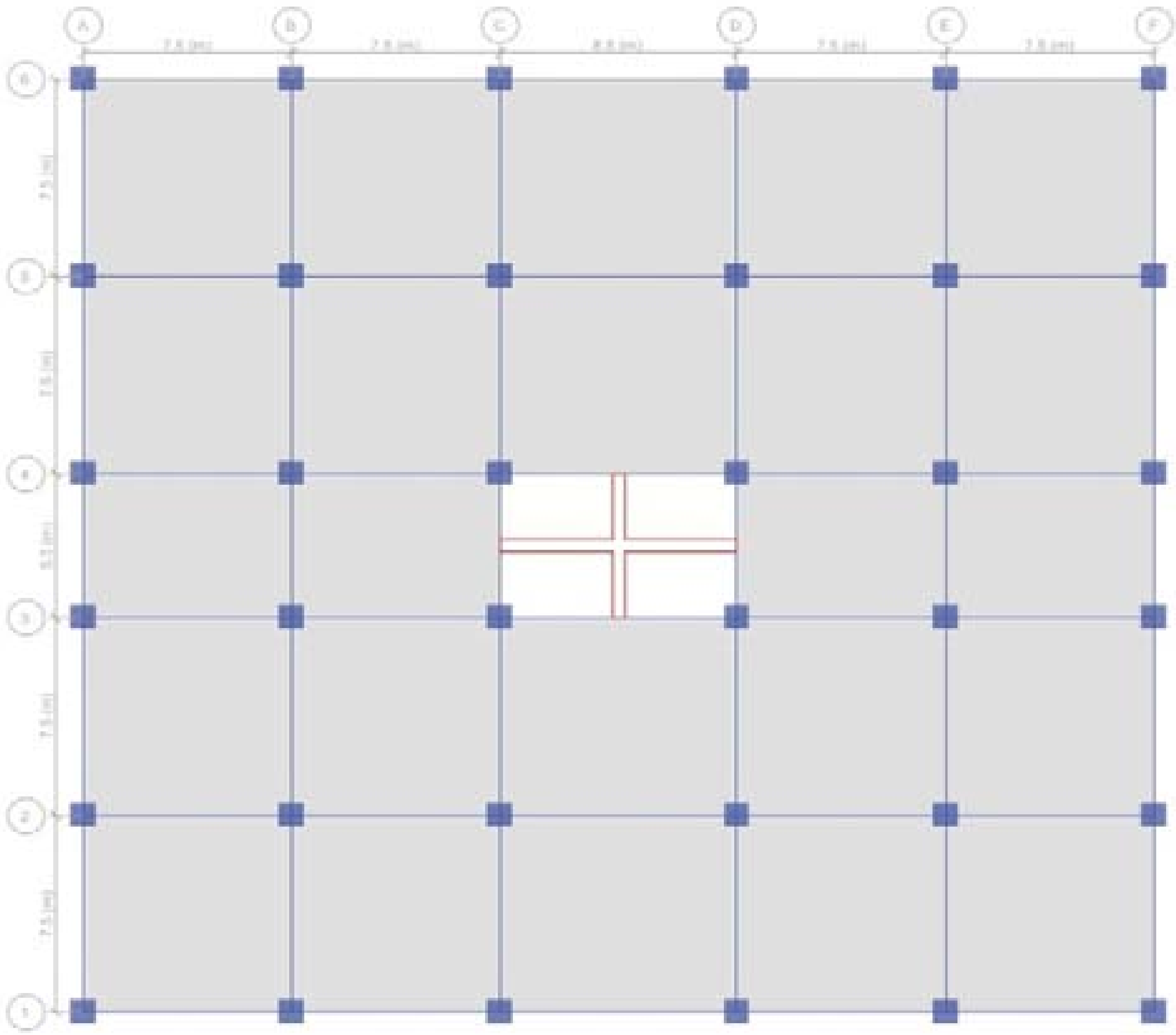

Figure 1:

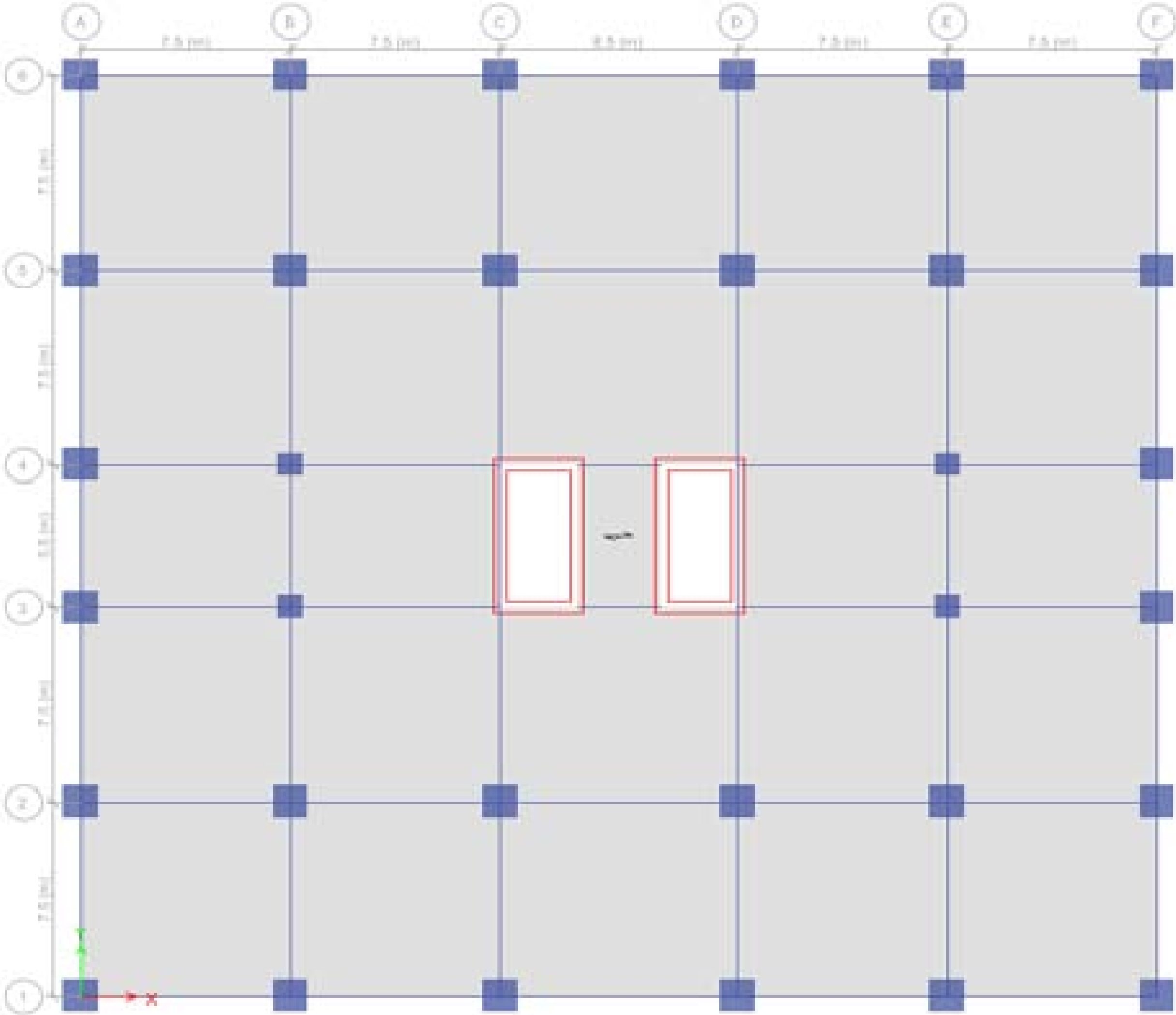

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Figure 2: Figure 1 : 2019 EFigure 2 :

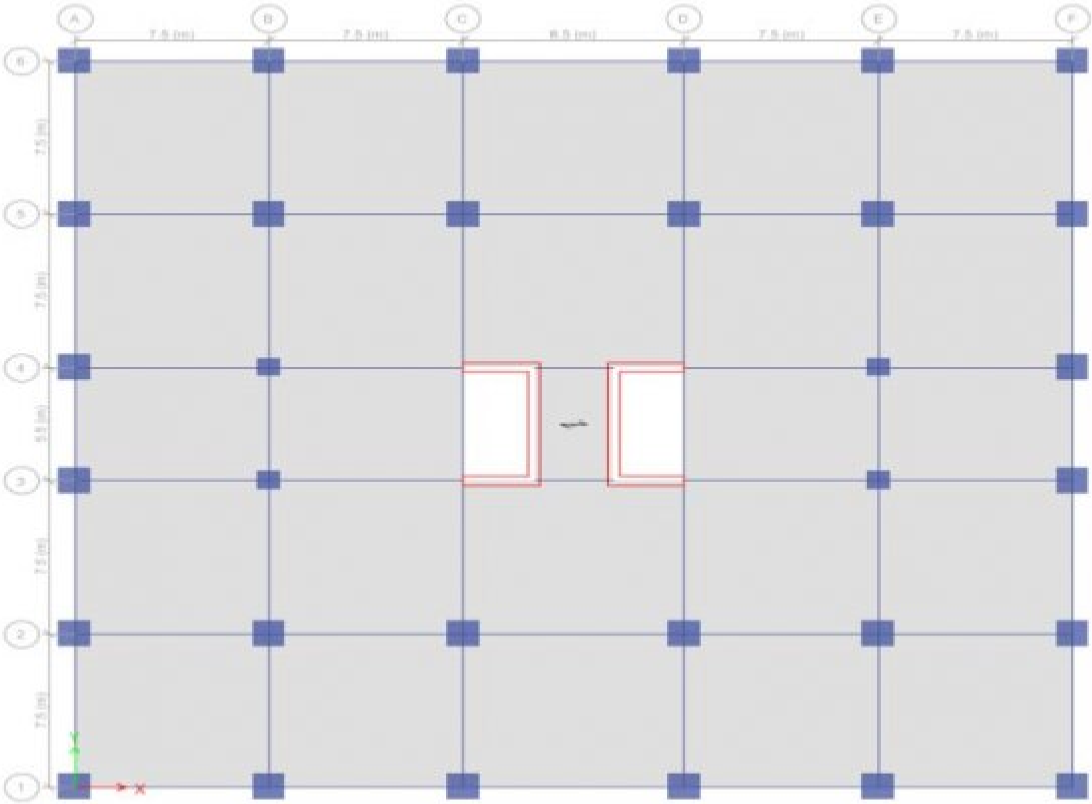

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Figure 3: Figure 3 :Figure 4 : 4 Figure 5 :

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Building Parameters	Details
Type of frame	Special RC moment resisting frame fixed at the base
Building plan	38.5m X 35.5m

Figure 4: Table 1 :

Figure 5: ?

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