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Optimization of Circular RC Frame Structure by using Shear Wall at a Different Location in the Structure

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Abstract - *The goal of this article is to determine the seismic variation in a circular shape building by placing a shear wall at a different location within a reinforced concrete structure. The first model shear wall is supplied at the building's exterior wall, the second model shear wall is provided in the middle of the building, and the third model shear wall is provided at the building's inner wall in this article. The programme used to analyse all of these models is Etabs, and the method utilised to analyse them is dynamic analysis (time history analysis). IS(Indian Standard) 1893 part-1: 2016 was utilised for this dynamic study, and all models are in seismic zone four. After assessing all models, we will compare the seismic parameter values (lateral storey force, storey displacement, periods and frequency, storey stiffness) for all models to see which one is the most stable in comparison to the other two.*

Key Words: Dynamic analysis, time history, RC building, Shear Wall, Circular building, Etabs

1. INTRODUCTION

Nowadays, every RCC building is designed to be earthquake-resistant because the height of the building is increasing day by day, increasing the overturning moment, causing the building to fail in the overturning. If the height of the building is low, the value of the overturning moment and base shear is low, because the value of the base shear and overturning moment is dependent on the structure's self-weight.

The fundamental reason for employing a circle form structure is to reduce the impact of dynamic forces (wind and seismic) on the structure, and we placed the shear wall in a different location in this circular shape structure. We know that the circular-shaped structure uses 15 to 18 percent less material than the rectangular-shaped construction. Making a junction between a circle column and a rectangular beam is not difficult in a circular form construction. Because Courtyards circular building gave open space inside, all models of this article fall under it.

2. METHODOLOGY

We employed Dynamic Analysis, Etabs Software, and Indian Standard code 1893 part-1:2016 for the analysis of these three models. According to the IS code 1893 part-1: 2016, clause 7.7, dynamic analysis is a technique of structural analysis where the load fluctuation over time is greater. 3 dynamic analysis is divided into two categories:

i. Time History Method
ii. Response Spectrum Method

2.1.Response Spectrum Method

The structural reaction to brief, nondeterministic, transient dynamic events is estimated using response spectrum analysis. Earthquakes and shocks are examples of such phenomena. It's difficult to undertake a time-dependent analysis since the load's exact temporal history is unknown.

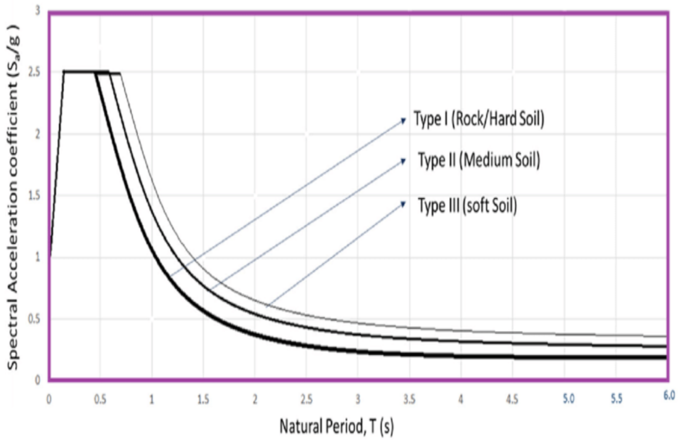

Figure-01: Response Spectrum Method

2.2. Time History Method

The time history approach must be based on adequate ground motion and executed using the acknowledged concept of earthquake structural dynamics, according to clause 7.7.4 of IS code 1893 part-1: 2016. "EL CENTRO" provided the data for the time history. When the variation of the lateral force with respect to time is greatest, the time history technique belongs to dynamic analysis; if the

variation of the lateral force with respect to time is little, the static analysis method should be used.
Etabs software is developed by the CSI company and is used for both analysis and designing of the structure.

3. MODELLING

In this paper, there are three models in the first model (Model-01) shear wall provided on the outer side of the building, in the model second (Model-02) shear wall provided at the mid-wall of the building, in the third model (Model-03) shear wall provided at the inner wall of the building.

All parameter (material, building configuration, seismic) of this circular shape building is given below in detail:

3.1 Material Parameter

In this parameter, we give the details about the material which is used in this RCC circular building and the material parameter is given below in the table:

Table -1: Material Parameter.

S. No	Material	Grade
1.0	Concrete	M30 & M25
2.0	Longitudinal Bar	Fe415
3.0	Stirrup Bar	Fe250

3.2 Building Parameter

In this parameter, we provide the information about structure parameter such as size of beam, column, shear wall and slab is given below in table:

Table -2: Building Parameter

S.No	Building Parameter	Value
01.	Beam	0.250 mX0.400 m
02.	Column	0.400 m diameter
03.	Slab	0.160 m
04.	Span of Beam	4000 mm
05.	Height of building	33000 mm
06.	Floor height	3000 mm
07.	Ground storey	3000 mm
08.	Shear Wall	0.23.0 m
09.	External Diameter	72000 mm
10.	Internal Diameter	32000 mm
11.	Area	4380 m^2

3.3 Seismic Parameter

In this factor, we were given the factor of the seismic where the model is assumed to construct such as seismic zone factor, Importance factor, etc

Table -3: Seismic Parameter

S.No	Seismic Parameter	Value
01.	Seismic Zone Factor (Z)	0.24 (Forth Zone)
02.	Response Reduction Factor (R)	5.0
03.	Importance factor (I)	1.20
04.	Soil type	2nd
05.	Eccentric ratio	0.05

3.4 Load Parameter

The load which is acting on the model such as Imposed load is given in the table:

Table -4: Load Parameter

S.No	Load Parameter	Value
01.	Live load	3.0KN/m^2
02.	Partition wall	7.0KN/m
03.	Load distribution wall	14.0KN/m

3.5 Shear Wall at Outer wall on Structure (Model-01)

The plan, elevation and three-dimensional view of the model-01(where the shear wall is provided at the outer wall of the building) are given below:

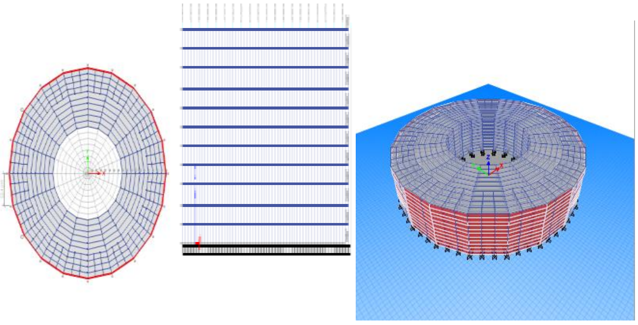

Figure -02: Plan, Elevation and 3D View of Model-01

3.6 Shear Wall at Mid wall on Structure (Model-02)

The plan, elevation and three-dimensional view of the model-02(where a shear wall is provided at the mid-wall of the building) are given below, the elevation of the model-02 is the same as model-01.

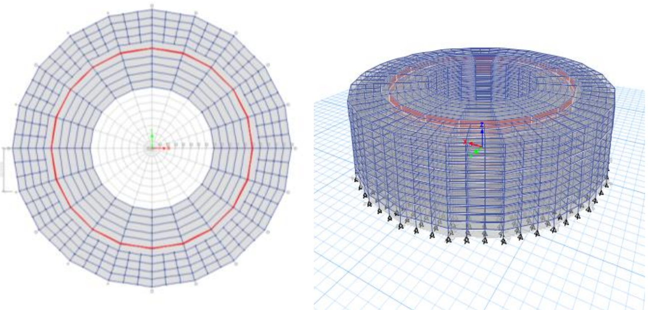

Figure -03: Plan and 3D View of Model-02

3.7 Shear Wall at Inner wall on Structure (Model-03)

The plan, elevation and three-dimensional view of the model-03(where the shear wall is provided at the inner wall of the building) are given below, the elevation of the model-03 is the same as model-01.

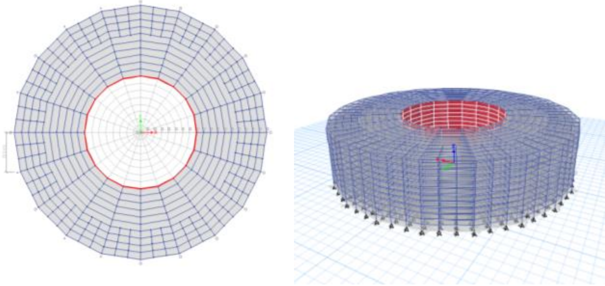

Figure -04: Plan and 3D View of Model-03

4. CALCULATION AND ANALYSIS

After analyzing all these three model, there are following result come out and we have taken some parameter to compare the value of these three models, such parameter is the natural period, base shear, storey stiffness, storey drift, and maximum storey displacement.

4.1 Lateral Force on Storey

From clause 7.2.1 in Indian Standard code 1893 part-1: 2016, the base shear is defined as the lateral forces which act on every floor due to seismic effect on the structure. The following graph represents the base shear of all models in the X direction due to applying the seismic effect in the X direction:

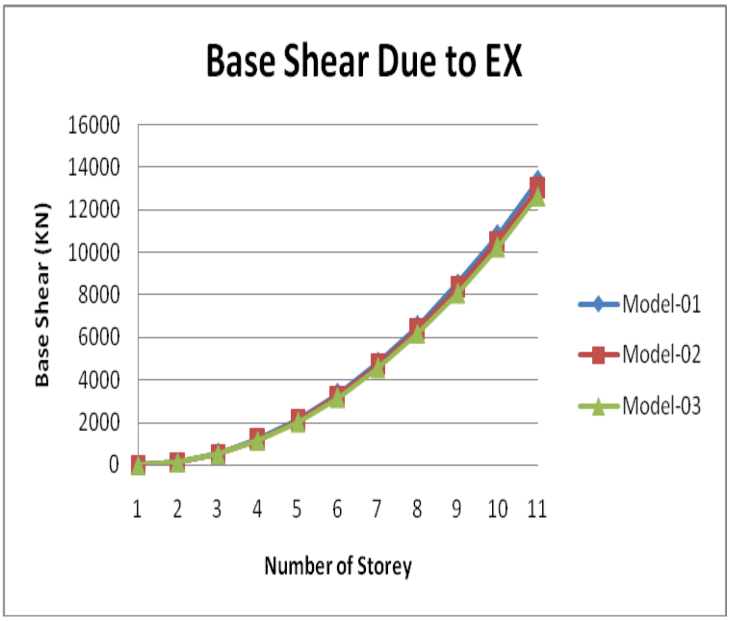

Chart -01: Base Shear due to EX

From the above graph, we can see that the value of the base shear is maximum in model-01. And the minimum value of the base shear in model-03(where the shear wall is provided at the inner wall of the circular RC building).

4.2 Storey Stiffness

Storey stiffness is defined as the ratio of the storey shear to the storey drift of the structure. The graph of the storey stiffness of all models is given below:

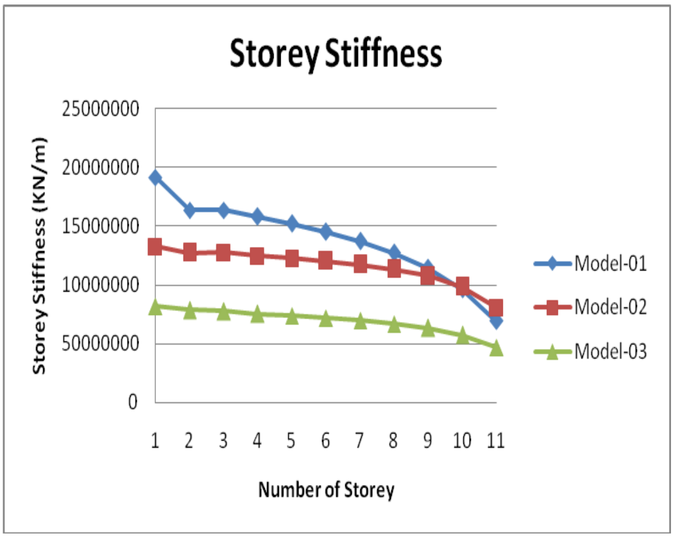

Chart -02: Storey Stiffness

From the above graph, we can see that the value of the storey stiffness is maximum in Model-01 (shear wall provided at the outer wall of the RC circular building).

4.3 Fundamental Period

From clause 3.18 the natural period in the mode of oscillation is defined as the time (in second) taken by the structure to complete one cycle of the oscillation in its natural mode of oscillation. The following graph represents the variation of the natural period:

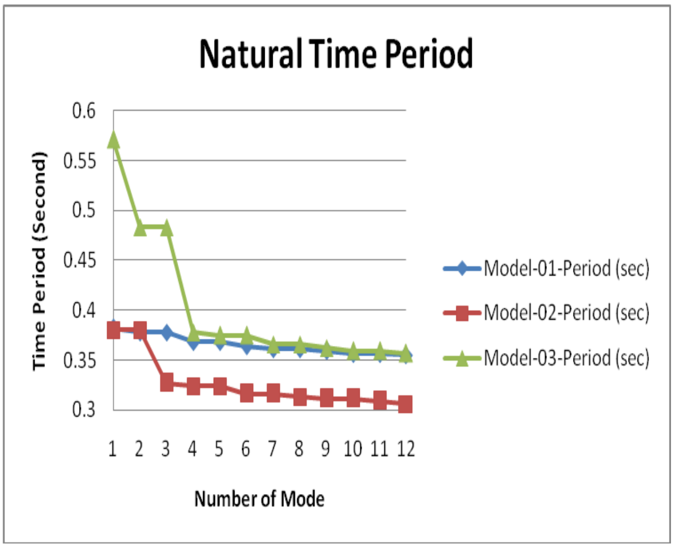

Chart -03: Natural period

From the Indian Institute of Technology Kanpur, earthquake tips number 10 gives the reference that "storey one to storey 20 storey buildings are usually in the range 0.05-2.00 sec." from this our model is in a safe condition.

4.4 Maximum Storey Displacement

Maximum storey displacement is defined as the maximum displacement of the floor from the ground surface due to lateral force which acts on the structure. The value of the maximum storey displacement does not measure floor level. The graph of displacement of all models is given below:

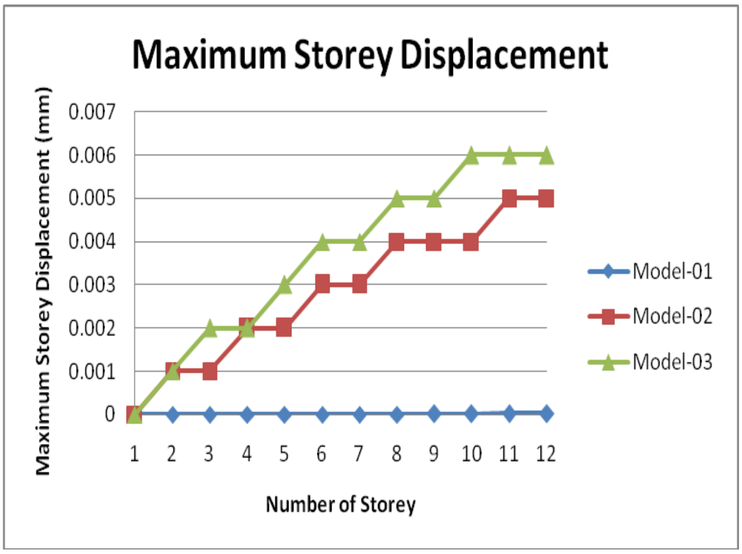

Chart -04: Maximum Storey Displacement

From the above graph, the value of the storey displacement in model-01 is very less as compared to the two models.

5. CONCLUSIONS

From the above dynamic analysis of all models, we have taken some seismic parameters to choose the stable model, and we found a few conclusions after analyzing all models, which are given below:

I. When we provide the shear wall at the mid-wall or centre wall of the Circular RC building then the value of the natural period is low as compared to the model when the shear wall is provided at the outer wall or inner in the circular building, and from the result, we can choose the Circular RC building by providing the shear wall at the centre wall in the building on the case to reduce the natural period.

II. The value of the lateral force due to applying seismic in the X direction is low in model-03 (where the shear wall is provided at the inner wall of the circular RC building) because the dead load of the

Model-03 is less as compared to the other two models.

III. The value o the maximum storey displacement in the model-01(where the shear wall is provided at the outer wall of the circular RC building) because the lateral force due to seismic is directly acting at the outer wall of the circular building and we provided shear wall at the outer wall of the circular RC building because the main purpose of the shear wall to reduce the effect of the lateral forces on the RC structure.

IV. In the model-03(where the shear wall provided at the inner wall of the circular RC building) the value storey stiffness is minimum as compared to the other two models, it's because of the value of the storey drift maximum and value of the base shear is low in the model-03.

V. From the above conclusion, we found that when the shear wall provided in the mid or centre of the building is more stable because the shear wall resists the outer forces and inner forces, but in model-02 the storey displacement is high as compared to the model-01.

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