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To Analysis Of Optimization Of Building Frames With Various Plans With Various Positions Of Shear Wall

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Abstract

Shear wall provide large strength and stiffness to buildings in the direction of their orientation, which reduces sway of the building significantly and thereby reduces damage to the structure. When walls are situated in advantageous positions in a building, they may be very efficient in resisting lateral loads originating from wind or earthquakes. A framework is proposed to obtain the optimum location of shear wall for the 'C' shaped structure such that the torsional effect arising in the structure due to its plan irregularity is minimized. The proposal is based on the selection of optimum location that converges to the optimum structural and engineering demand parameters for a 'C' shaped structure with a fixed length of shear wall. A G + 15 story structure is considered for an illustrative example of the framework considering fourteen models of shear wall location for a 'C' shaped structure with a fixed length of shear wall (14.5% wall to floor area ratio). The analytical results of each model have been compared with that of bare frame model in terms of base shear, peak story displacement, peak story drift, static eccentricity, time period and torsional moment, and the optimum model is reported. The proposed framework as well as the presented example is expected to serve as the guideline for deciding the optimum location of shear walls for the 'C' shaped structure.

Keywords: Optimum location, C' Shaped Stucture, Torsional Moment.

INTRODUCTION

Reinforced concrete (RC) buildings often have vertical plate-like RC walls called Shear Walls in addition to slabs, beams and columns. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along both length and width of buildings. Shear walls are like vertically-oriented wide beams that carryearthquake loads downwards to the foundation.

Properly designed and detailed buildings with shear walls have shown very good performance in past earthquakes. The overwhelming success of buildings with shear walls in resisting strongearthquakes is summarized in the quote: "We cannot afford to build concrete buildings meant to resist severe earthquakes without shear walls. Mark Fintel, a noted consulting engineer in USA Shear walls in high seismic regions require special detailing. However, in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse. Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and nonstructural elements (like glass windows and building contents)

Most RC buildings with shear walls also have columns; these columns primarily carry gravityloads (i.e., those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Thus, design of their foundations requires special attention. Shear walls should be provided along preferably both length and width. However, if they are provided along only one direction, a proper grid of beams and columns in the vertical plane (called a moment-resistant frame) must be provided along the other direction to resist strong earthquake effects. Door or window openings can be provided in shear walls, but their size must be small to ensure least interruption to force flow through walls. Moreover, openings should be symmetrically located. Special design checks are required to ensure that the net cross-sectional area of a wall at an opening is sufficient to carry the horizontal earthquake force. Shear walls in buildings must

Be symmetrically located in plan to reduce ill-effects of twist in buildings. They could be placed symmetrically along one or both directions in plan. Shear walls are more effective when located along exterior perimeter of the building – such a layout increases resistance of thebuilding to twisting.

Aim:

To Analysis of Optimization of building frames with various plans with various positions of shear wall.

Research Objective:

After exclusive study of literature carried by various researchers, the unfocused area is identified as problem for proposed dissertation to analysis structures for Optimization of building frames with various plans with various positions of shear wall proposed to carried out using following points, Dynamic analysis of building frames various plans and various positions.

Comparison of various parameters of building frames without and with shear walls for various position.

Finding out optimum percentage of shear wall and also finding suitable location of shear wall in various plan.

Scope of the Project Work

In India, very few buildings are designed properly by structural engineers. Proper analysis and design of building structures that are subjected to static and dynamic loads is very important. Another important factor in the analysis of these systems is obtaining acceptable accuracy in the results. The object of this study is to model and analyze shear wall-frame structures having regular and irregular shear wall in the structure and we will also discuss various factor considered in model analysis.

LITERATURE REVIEW

Mr. K. LovaRaju [Jan-2015] Conducted non-linear analysis of frames to identify Effective position of shear wall in multi- story building. An earthquake load was applied to an eight-story structure of four models with shear wall at different location in all seismic zones using ETABS. Push over curves were developed and has been found the structure with shear wall at appropriate location is more important while considering displacement and base shear.

Syed. M. Katami [May-2018] presented the results of time history analysis which addressed the Effect of openings in shear walls near- fault ground motions. A Complete shear walls, shear walls with square opening in the center and shear wall with opening at right end side were considered. From the results it was observed that shear walls with openings experienced a decrease in terms of strength.

Dr. B. Kameshwari [Oct 2011] Analyzed the influence of drift and inter story drift of the structure on various configuration of shear wall panels on high rise structures. The bare frame was compared with various configurations like i) Conventional shear wall ii) Alternate arrangement of shear wall iii) Diagonal arrangement of shear wall iv) Zig Zag arrangement of shear wall v) Influence of lift core shear wall.

From the study it was found that Zig Zag shear wall enhanced the strength and stiffness of structure compared to other types. In earthquake prone areas diagonal shear wall was found to be effective for structures.

Nanjma Nainan [May 2012] Conducted analytical study on dynamic response of seismo resistant building frames. The effects of change in height of shear wall on story displacement in the dynamic response of building frames were obtained. From the study it was concluded that it is sufficient to raise the shear wall up to mid height of building frames instead of raising up to entire height of the building.

Shahzad Jamil Sardar [Sep 2013] Modelled a 25-storey building zone V and analyzed by changing the location of shear wall to determine various parameters like story drift, story shear and displacement using ETABS. Both static and dynamic analysis was done to determine and compare the base shear. Compared to other models, when shear wall placed at center and four shear walls placed at outer edge parallel to X and Y direction model showed lesser displacement.

Eshan Salami Firoozabad [July 2021] determined the shear wall configuration on seismic performance of building. The top story displacements for different configurations were obtained using SAP 2000. From the study it was observed that the top story drift can bereduced by changing the location of shear wall and it was suggested that the quantity of shear wall could not influence the seismic behavior of buildings.

Varsha.R.Harne [May 2014] considered a six story RCC building which is subjected to Earthquake loading in zone II to determine the strength of RC wall by changing the location of shear wall using STAAD.Pro. Seismic coefficient method is used to calculate the earthquake load as per IS 1893 – 2002 (Part I). Four different models like structure without shear wall, structure with L type shear wall, structure with shear wall along periphery, structure with cross type shear wall were modeled for analysis. Compared to other models the shear force and bending moment, for structure with shear wall along the periphery is found to be maximum at the ground level and Wall provided along the periphery of the structure is found to be more efficient than all other types of shear wall.

Shahabodin. Zaregarizi [Oct. 2008] Conducted comparative investigation on using shear wall and infill to improve seismic performance of existing buildings. Static nonlinear analysis was done to compare the effectiveness of both methods. From the results, it was observed that concrete infills have considerable strength while brick one showed lower strength. On the contrary, brick infills accepted large displacement than concrete ones. It was concluded that the combination of brick and concrete infills reduced the negative effects when they both used individually.

Chun Ni [2021] described the performance of shear walls with diagonal or transverse lumber sheathing. A total of 16 full-scale shear walls were tested to determine the effects of hold-owns, vertical load and width of lumber sheathing on in-plane shear capacity. The in-plane shear capacities of shear walls with double diagonal lumber sheathing are 2-3 times higher than that of shear walls with single diagonal lumber sheathing.

Michael R. Dupuis [May 2018] analyzed seismic performance of shear wall buildings with gravity- induced lateral demands using Open Sees software. The inelastic response of concrete shear wall buildings was investigated. From the result, it was demonstrated that a seismic ratcheting effect can develop and amplify inelastic displacement demands. But the effect is more prevalent in coupled shear walls than cantilevered shear walls.

Prof. Swati Ghuge and Prof. Monika T Zope [Feb. 2019] Multistory buildings with open (soft story) the ground floor are inherently vulnerable to collapse due to seismic loads, their constructions is still widespread in develop nations. Auxiliary outline and examination delivers the ability of opposing all the connected loads without failure amid its expected life. The plan of high rise structures is administered by lateral loads predominantly because of the earthquake. The inside basic framework or outside auxiliary framework gives the protection from lateral loads in the structure. They examination and outline of high rise structure with Single Moment Resisting Frame (SMRF) for 14 story building with up to a 45m height. In this paper we will define first the reinforcement details by using manual design under IS-Codes and then it will be analyzed in ETABs 2017 Version for the most important like Story Drift and Location of the Shear Wall. We will investigate these results for 3 main types of the shear wall which Rectangular, Core Type and the Column Supported Shear Wall.

Priyanka Kosare [July 2019] the primary purpose of all kinds of structural systems used in the building is to support gravity loads. The most common loads resulting from the effect of gravity are dead load, live load and snow load. Buildings are also subjected to lateral loads caused by wind, blasting or earthquake. The objective of this paper is to evaluate the response of shear walls placed in the buildings subjected to seismic loads and to study best possible location for positioning of shear wall to resist the seismic load efficiently. Shear wall is a structural member designed to counteract the lateral forces acting on a structure. These walls are more important in seismically active zones when shear forces on the structure increases due to earthquakes. Shear walls have more strength, stiffness and resist in-plane loads that are applied along its height. Buildings with shear walls which are properly designed and detailed have shown very good performance in past earthquakes. Various research studies have been conducted on the design of shear wall and its performance to seismic forces. This paper compiles the evaluation of seismic performance of shear wall.

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. Seismic codes will guide a designer to safely design the structure for its intended purpose.

Seismic codes are unique to a particular region or country, In India, IS 1893 is the main code that provides outline for calculating seismic design force, This force depends on the mass and seismic coefficient of the structure and the latter in turn depends on properties like seismic zone in which it rests, and its ductility. Part of IS1893:2016 deals with assessment of seismic loads on various structures and building. Whole the code centers on the calculation of base shear and its distribution over height. Depending on the height of the structure and zone to which it belongs, type of analysis i.e., static analysis or dynamic analysis is performed.

Response Spectrum Method

This method is applicable for those structures where modes other than the fundamental one affect significantly the response of the structure. In this method the response of multi degree of freedom system is expressed as the superposition of modal response, each modal response being determined from the spectral analysis of single degree of freedom system, which is then combined to compare the total response. Modal analysis of the response history of structure to specified ground motion; however, the method is usually used in conjunction with a response spectrum.

Shear Wall (Structural Wall)

It is a vertically oriented planar element that is primarily designed to resist lateral force effects (axial force, shear force and bending moment) in its own plane.

Special Shear Wall

It is a structural wall meeting special detailing requirements for ductile behavior.

THEORETICAL FORMATIONS

Introduction

In this title of parametric investigation, a detailed study and design of High rise framed structure using shear wall, IS codes has been presented. Study has been done on Reinforced concrete structure. Analysis of all the above mentioned structures has been carried out by using Indian Standard with Response Spectrum Method. Cost effectiveness of structures has also been studied only from material point of view.

Problem Formulation

G+15 Multi-storied Reinforced concrete building, moment resisting space frame have been analyzed using professional software. Model (G+15) of building frame with regular shear wall and percentage of shear wall is analyzed by response spectrum Method. The plan dimensions of buildings are shown in table below. The plan view of building, elevation of different frames is shown in figures below.

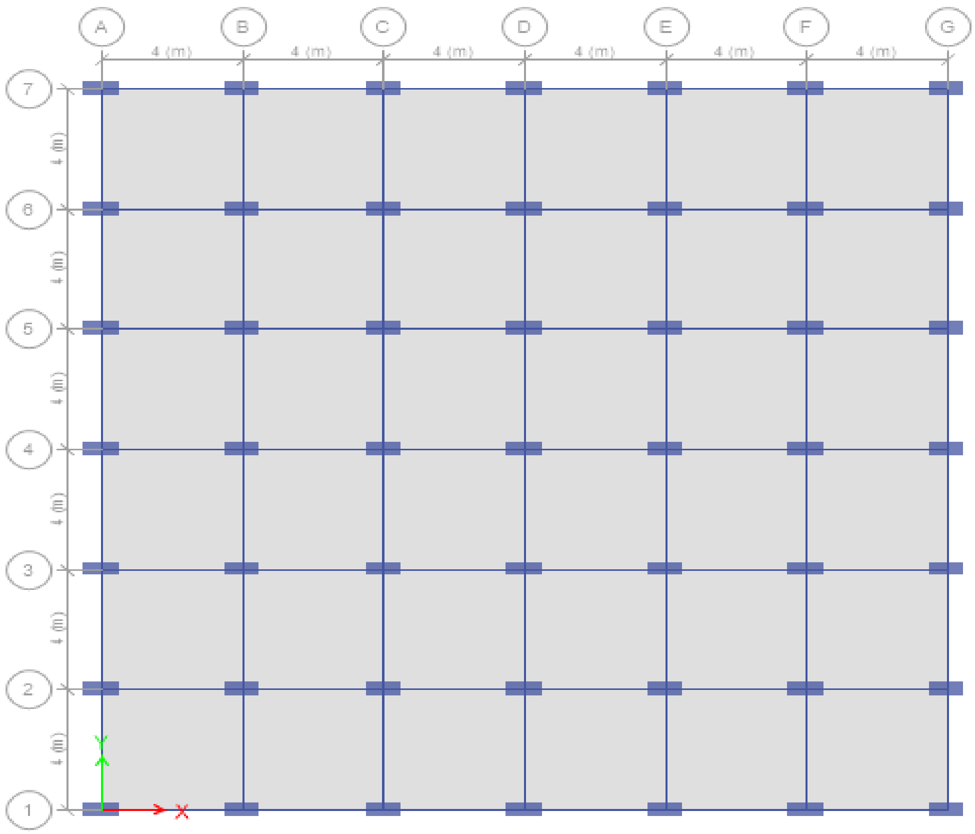
Table: Detail Features of Building

Sr. No.	Parameters	Values
1	Material used	Concrete-M25 and M30 Reinforcement Fe-415&500Mpa
2	Plan dimension	
3	Height of each Story	3.0m
4	Height of ground Story	2.0m
5	Density of concrete	$25KN/m^3$
6	Poisson ratio	0.2-concrete and 0.15-steel
7	Density of brick	$20KN/m^3$
9	Code of Practice adopted	IS456:2000 , IS1893:2016
10	Seismic zone for IS1893:2002	III
12	Importance factor	1
13	Response reduction factor	5
14	Foundation soil	Medium
15	Slab thickness	150mm
16	Wall thickness	150mm
17	Floor Finish	1KN/m2
18	Live load	3 KN/m2
19	Earthquake load	As per IS 1893-2016
20	Wind load	As per IS 875- 2015
21	Size of beam	450x230, 580mmx300mm and 600X230
22	Column size	530mmx300mm and 600X300, 680X300
23	Shear wall size	230mm

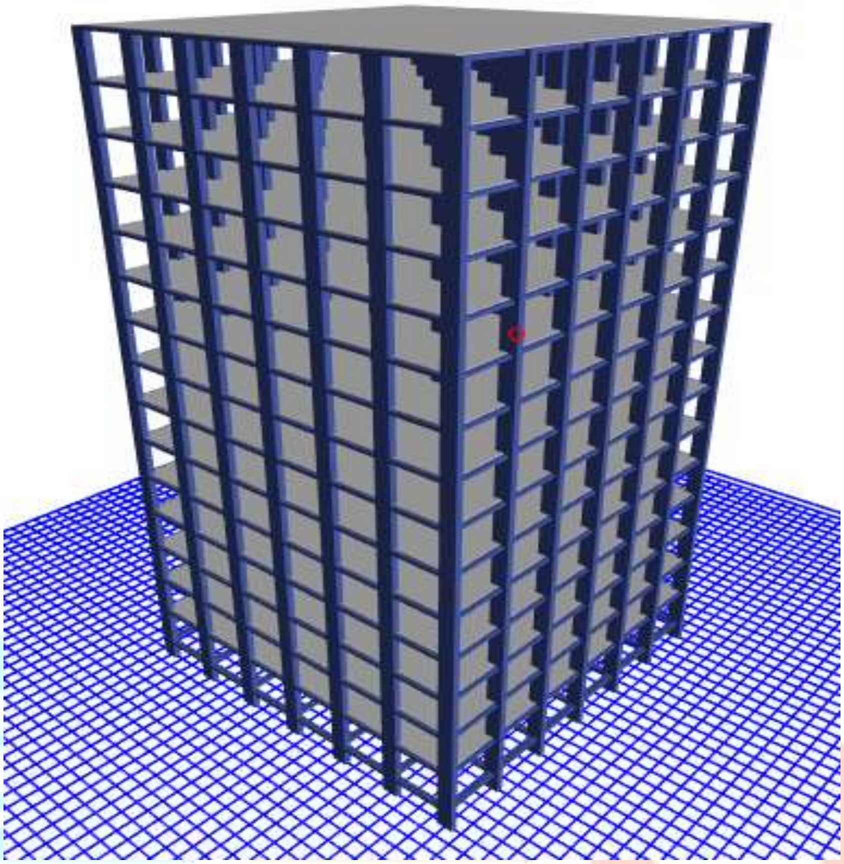
24	Model to be design	G+15
25	Ductility class	IS1893:2016 SMRF
27	Basic wind speed (Vb)	39 m/sec
28	Terrain category	2
29	Risk coefficient	1
30	Topography factor	1

Software Plan and Model Screenshots

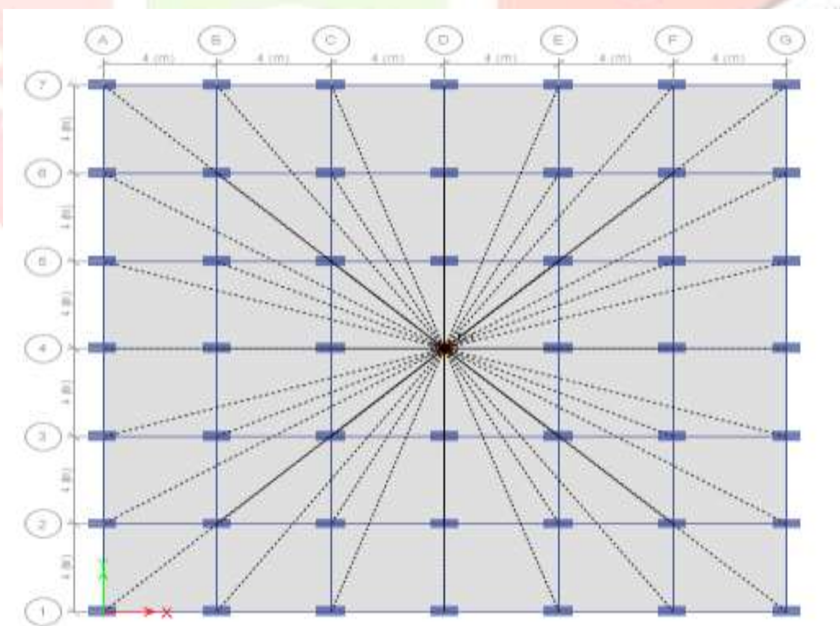
A. Software Plan



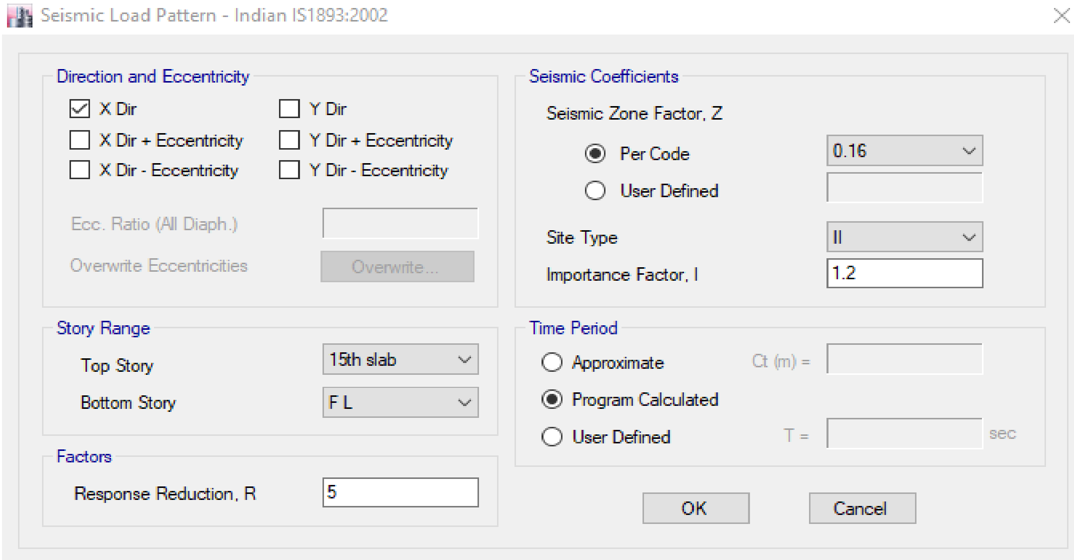
B. G+15 Story Without Shear Wall Software Model



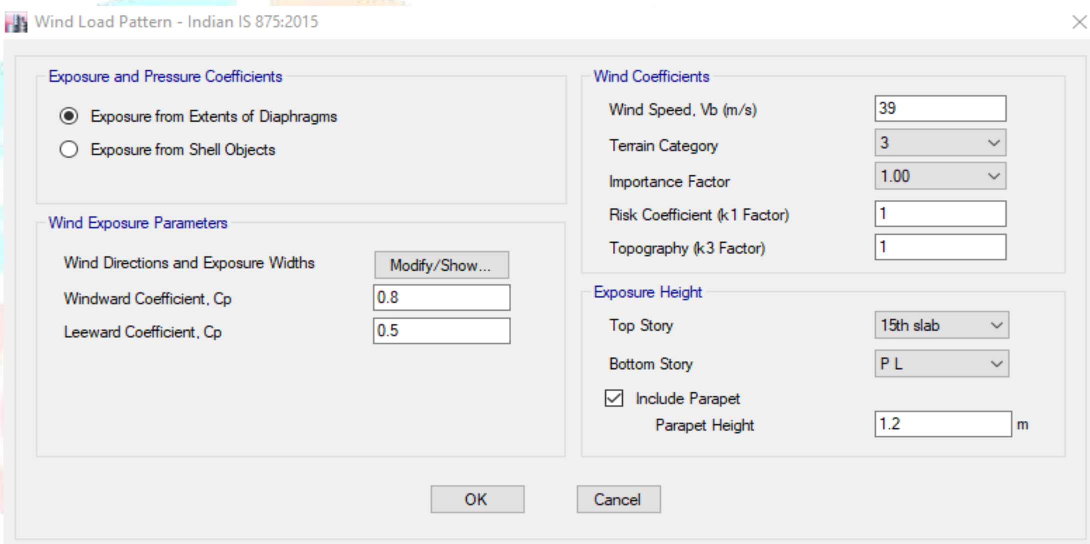
C. Diaphragms Assign



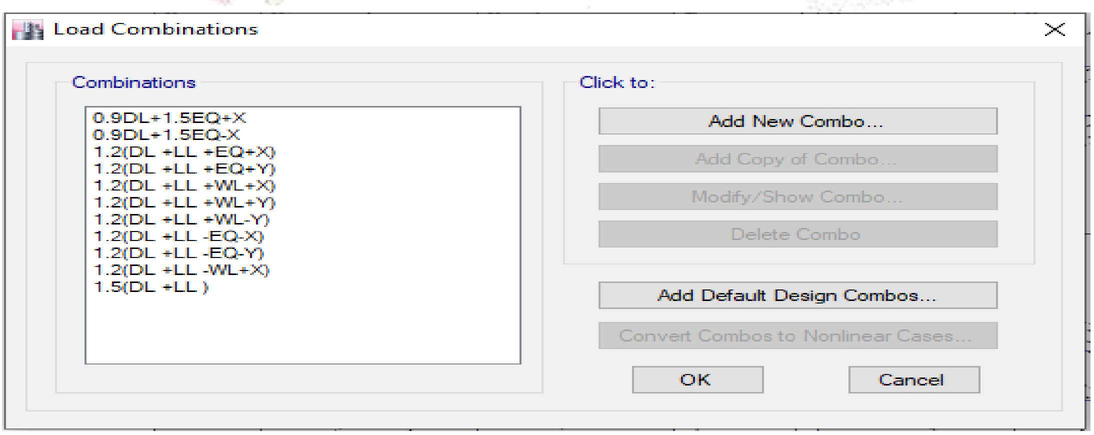
D. Earthquake Load Define



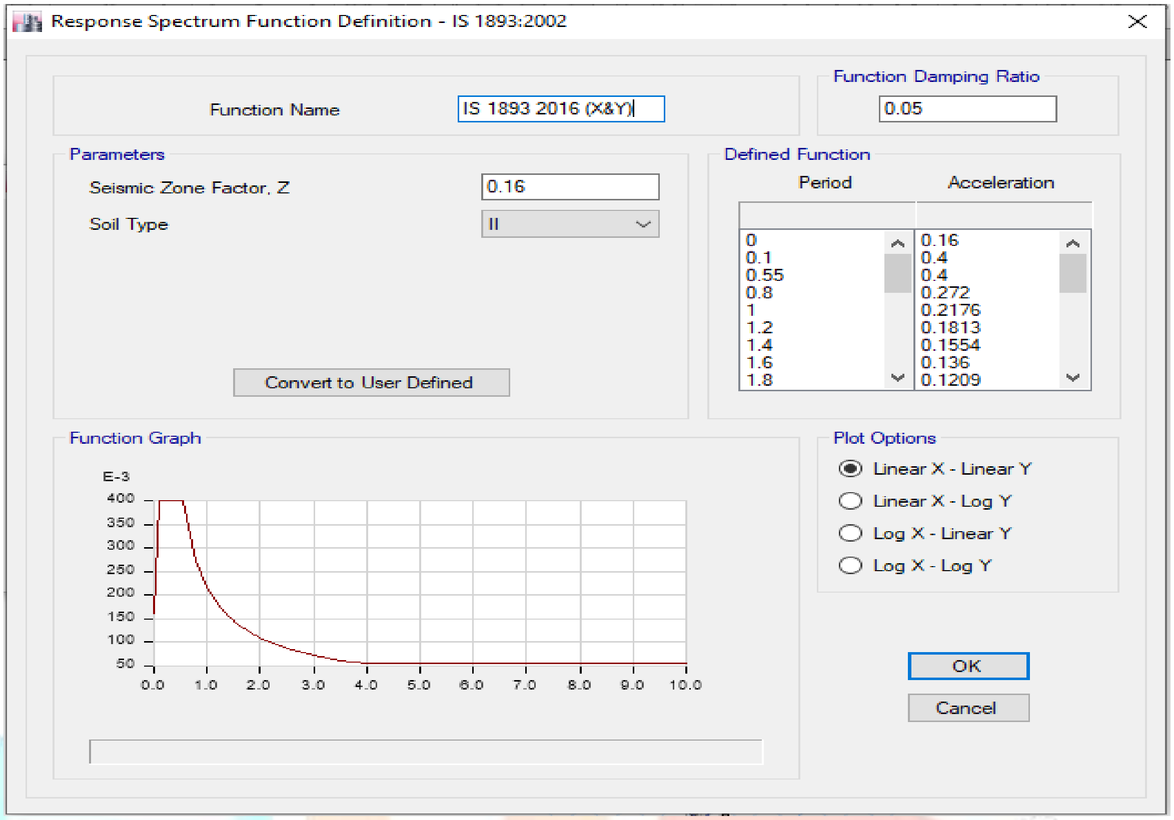
E. Wind Load Define



F. Load Combinations Define



G. Mass Source Define



CONCLUSIONS

In the present study, relative analysis of RCC Building G+15 Storey with different shape of building i.e. Square shape and Rectangular shape of building in medium soil is carried out. The structures are analysed for earthquake zone III with medium soil and results are compared. It has been made on different structural parameters viz. base shear, earthquake displacement, wind displacement, and storey drift etc. Grounded on the analysis results, following conclusions are drawn:

1. Analysis of RCC building with different shape of building i.e. Square shape and Rectangular shape of building with medium soil condition at zone II, the base shear in x- direction in periphery locations shear wall building, the base shear is increased 1.324 times as compared to corner locations of shear wall building. Also in longer span, mid span and short span locations of shear wall, base shear in X- direction, mid span locations of shear wall building, the base shear is increased 1.4 times as compared to longer and shorter span locations of shear wall building. Similarly, in Without shear wall building, 10% Shear wall, 15% shear wall, 20% Shear wall and 25% shear wall, base shear is increased by 56%, 26%, 16% and 7.5% respectively as compared to 25% shear wall

2. The Structure, corner locations of shear wall and periphery locations of shear wall also in longer span locations of shear wall, mid span locations of shear wall and short span locations of shear wall building with analysis for zone III with medium soil was carried out. But results indicate that

variation of base shear increases in Periphery locations of shear wall building and Mid span locations of shear wall building, as compared to different types of shear wall building, means self-weight of regular Shear wall structure is maximum hence Periphery locations of shear wall building and Mid span locations of shear wall building is economical as compared to other types of shear wall building

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