Seismic Analysis of Inclined Structure with Core

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Abstract— The various factors have to be taken into consideration before commencing the actual work of designing a building, which is carried out before the construction work. The type of building and its design depends on the purpose for which it is built. This study aims in designing, which is not only innovative but also endeavors to explore a new facet of civil engineering. The design process involves determining the size of the different components of the building and checking the stability of the building for various external forces to which it is subjected. The study comprises of RCC building having G+15 floors which have been elevated as inclined structure. The proposed building is a commercial building. The shear wall will act as a single core. The shear wall will be connected to each other with a network of beams/ slabs with the slabs acting as in plane rigid diaphragms for each of the floors. . As the structure is resisting only on a single core the shear wall will be provided in such a way to control deflections and resist lateral forces. Shear wall will be provided in such a way to control deflections and resist lateral forces. Provision is done in design in such a way that services can be laid without major obstructions and maximum headroom is achieved.

Keywords: Seismic Analysis, Structure Design, Core Type Shear Wall, ETABS 2016

I. INTRODUCTION

The rapid increase in population and scarcity of land tends to the development of construction technology and high-rise commercial structures. A structure is said to be stable when it satisfies all stability requirements. Structures will be more stable when all the sides of the structure are supported and there is no eccentric loading. A normal building has a number of columns. What sets this building apart is that is consists of just one core. For aesthetic appearance we create our building supported by a single core. Modular planning of this building would also be very simple, as the interior walls have no longer any hindrances. Satisfying the requirement of the stability conditions for a single core structure will be complicated one, compared with the structures supported in all sides depending upon their configuration. Single core structure is a critical one when it is subjected to unsymmetrical and eccentric loading conditions. Eccentric loading will cause the structure to twist in any direction and may cause failure of structure. This study will describes planning, structural analysis and design of the single core building. The building consists of a square central core which transfers the load of the super structure to the ground surface. Since a single core is supporting the whole structure, all the other members will act as cantilevers. The structure is analyzed and designed using E-TABS software which is based on finite element method and it is analyzed and designed for the critical condition. The initiation of software usage in the engineering industry has remarkably reduced the complexities of different facet in the analysis and design of projects, as well as reducing the amount of time necessary to complete the designs.

II. SHEAR WALL AND ITS PROPERTIES

Shearwall is a structural member positioned at different places in a building from foundation level to top parapet level, used to resist lateral forces i.e. parallel to the plane of the wall. When lateral displacement is large in a building with moment frames only, structural walls, often commonly called shearwalls, can be introduced to help reduce overall displacement of buildings, because these vertical plate-like structural elements have large in-plane stiffness and strength. Shear walls resist lateral forces through combined axial-flexure-shear action. Earthquake resistant buildings should possess, at least a minimum lateral stiffness, so that they do not swing too much during small levels of shaking.

A. Advantages of Shear Walls in RCC Buildings

Properly designed and detailed buildings with shear walls have shown very good performance in past earthquakes. The overwhelming success of buildings with shearwalls in resisting strong earthquakes is summarized in the quote: "We cannot afford to build concrete buildings meant to resist severe earthquakes without shear walls." Following are the advantages of providing shear walls.

- Shear wall resist horizontal lateral force and provide earthquake resistance.
- It possesses very large in-plane stiffness which resist lateral load.
- Shear walls are helpful in controlling deflection.
- RCC shear walls are easy to construct– reinforcement detailing.
- It minimizes earthquake damage to structural damage and non-structural damages.
- Well-designed shearwalls not only provide adequate safety but also provide great measure of protection against costly non-structural damage during moderate seismic damages.

B. Classification of Shearwalls:

- Simple rectangular types and flanged walls (bar bell type)
- Coupled shear walls
- Rigid frame shearwalls
- Framed walls with in filled frames
- Column supported shearwalls
- Core type shearwalls

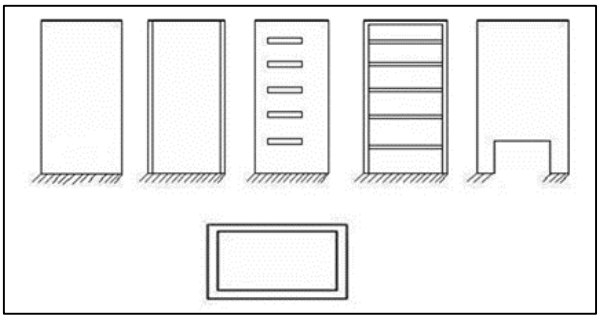


Fig. 2.2.1: Classification of shearwall.

III. METHOD OF ANALYSIS

Code based Procedure for Seismic Analysis (IS 1893:2016)

A. Equivalent Lateral Force

Seismic analysis of most of the structures is still carried out on the basis of lateral force assumed to be equivalent to the actual loading. The base shear which is the total horizontal force on the structure is calculated on the basis of structure mass and fundamental period of vibration and corresponding mode shape. The base shear is distributed along the height of structures in terms of lateral force according to code formula. This method is conservative for low to medium height buildings with regular conformation.

B. Response Spectrum Analysis

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 (MDOF) system is expressed as the superposition of modal response, each modal response being determined from the spectral analysis of single -degree-of-freedom (SDOF) system, which is then combined to compute total response. Modal analysis leads to the response history of the structure to a specified ground motion; however, the method is usually used in conjunction with a response spectrum. A response spectrum is simply a plot of the peak or steady-state response (displacement velocity or acceleration) of a series of oscillators of varying natural frequency that are forced into motion by the same base vibration or shock.

C. Time History Analysis

A linear time history analysis overcomes all the disadvantages of modal response spectrum analysis, provided non-linear behavior is not involved. This method requires greater computational efforts for calculating the response at discreet time's .One interesting advantage of such procedure is that the relative signs of response quantities are preserved in the response histories. This is important when interaction effects are considered in design among stress resultants. Although this is too simplistic to apply to a real structure, the Heaviside Step Function is a reasonable model for the application of many real loads, such as the sudden addition of a piece of furniture, or the removal of a prop to a newly cast concrete floor.

IV. ANALYSIS AND DESIGN

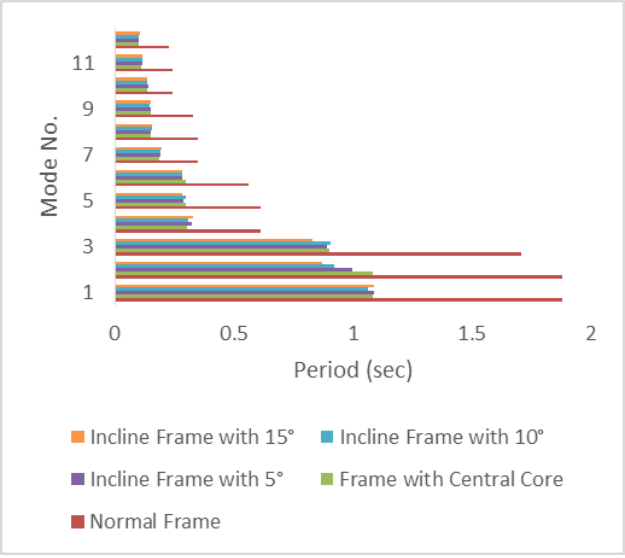
A. Consideration for analysis and design

The building is analyzed is G+15RCC framed building of symmetrical plan configuration. Complete analysis is carried out for dead load, live load& seismic load using ETAB 2016. Response Spectrum Method of seismic analysis is used. All combinations are considered as per IS 1893:2016.

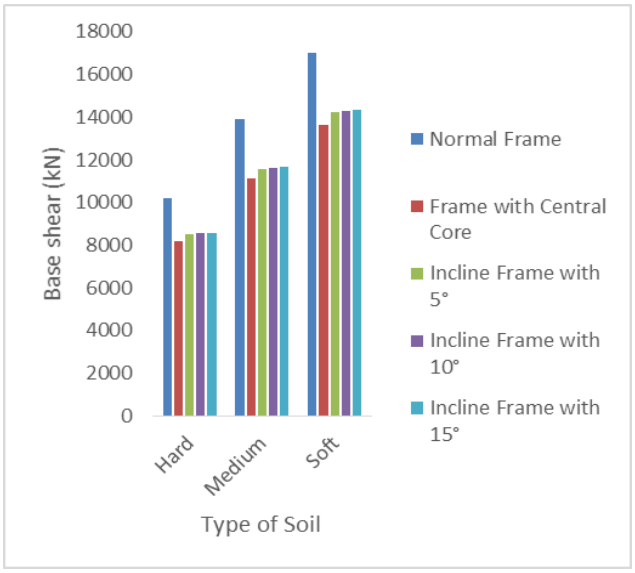
B. Preliminary Data for G+15 RCC framed building.

1.	Type of building	Public building
2.	Number of story	G+15
3.	Plan Dimensions	28.8X28.8 m
4.	Floor To Floor Height	3.5m
5.	No. Of Stories	16
6.	Total height of building	52m
7.	Slab thickness	150 mm
8.	Shearwall Thickness	250 mm
9.	Brickwall Thickness	230 mm
10.	Size of column	300X600 mm
11.	Size of Beam	300X400 mm
12.	Grade Of Concrete	M40
13.	Grade Of Steel	Fe500
14.	Zone IV	Soil Type 1- Hard Soil
		Soil Type 2- Medium Soil
		Soil Type 3- Soft Soil
15.	Loading On structure	
	Dead Load	self-weight of structure
	Brickwall Load	13.8 kN/m
	Live Load	
	Floor	4 kN/m²
	Roof	1.5kN/m²

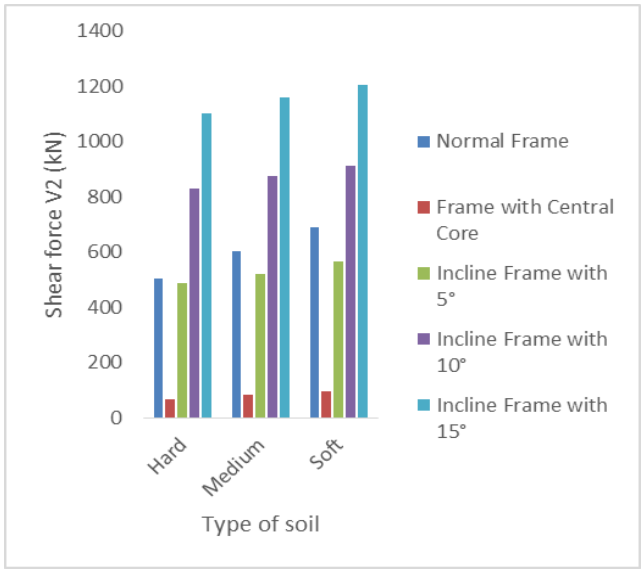
V. COMPARISON OF ANALYSIS RESULTS



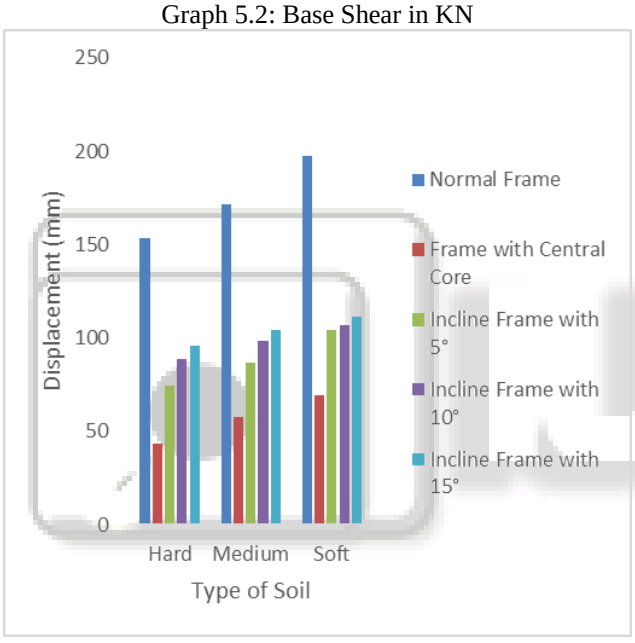
Graph 5.1: Modal Time period in Sec



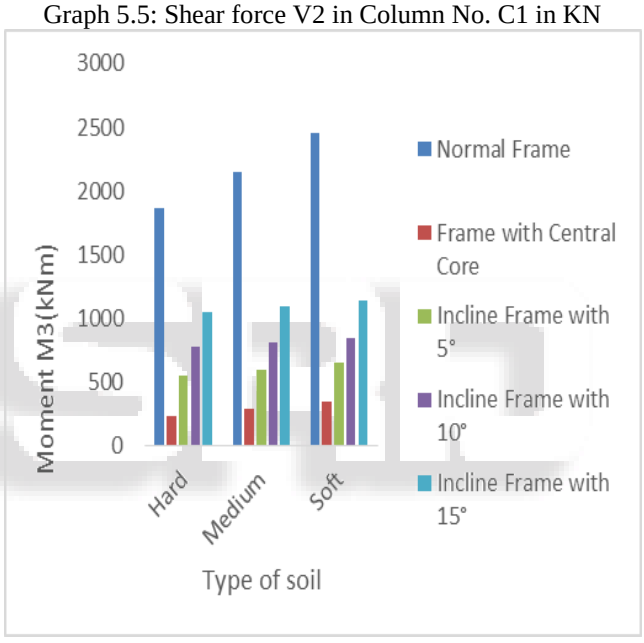
Graph 5.2: Base Shear in KN



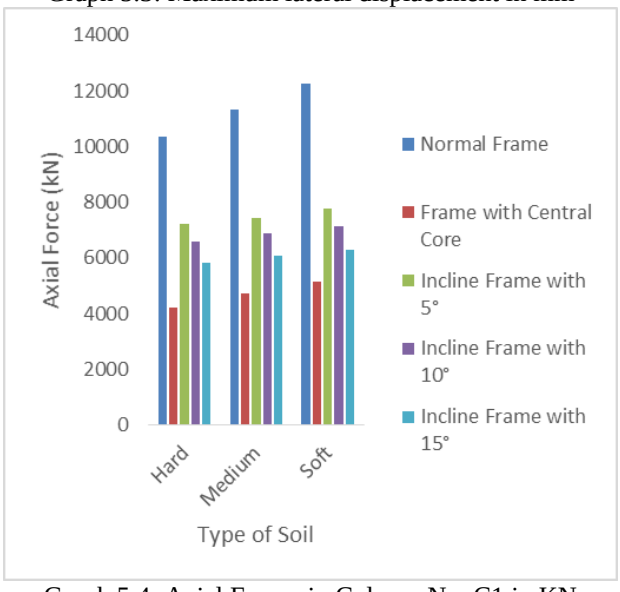
Graph 5.5: Shear force V2 in Column No. C1 in KN



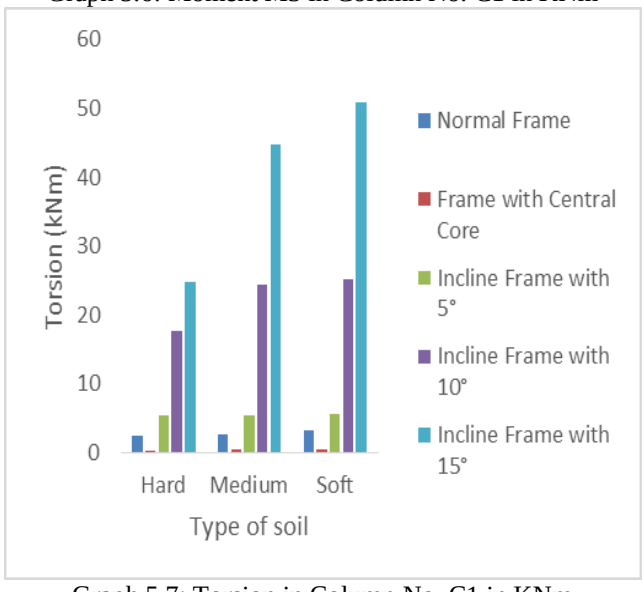
Graph 5.3: Maximum lateral displacement in mm



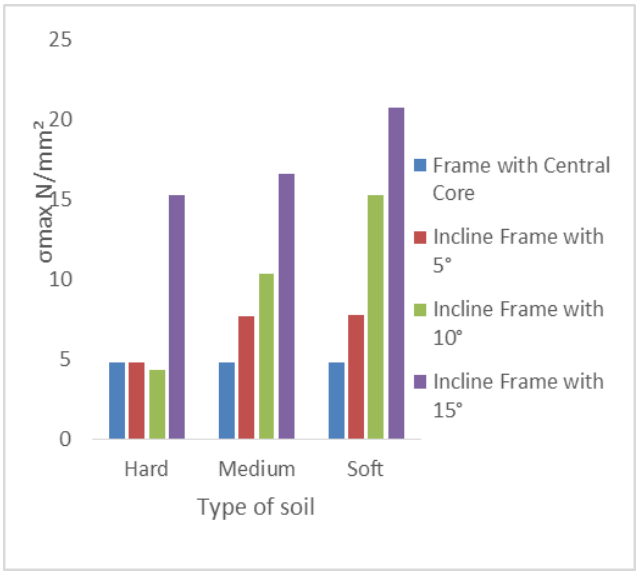
Graph 5.6: Moment M3 in Column No. C1 in KNm



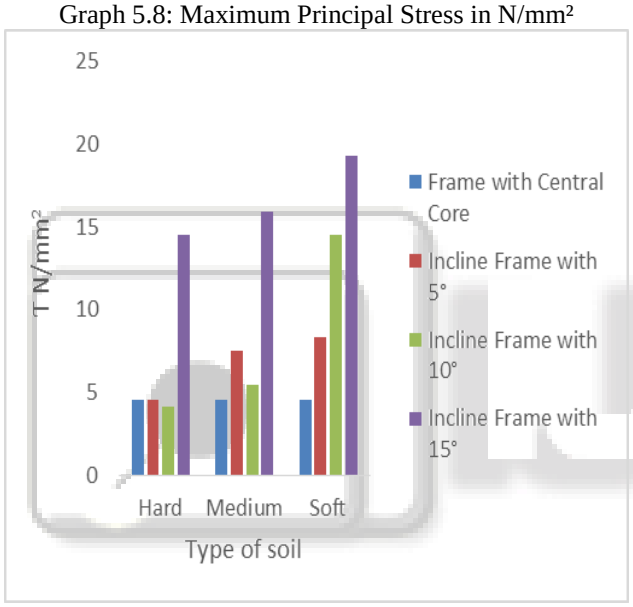
Graph 5.4: Axial Forces in Column No. C1 in KN



Graph 5.7: Torsion in Column No. C1 in KNm



Graph 5.8: Maximum Principal Stress in N/mm²



Graph 5.9: Shear stress in N/mm²

VI. CONCLUSIONS

Lateral response of normal building is studied by response spectrum analysis. Dynamic characteristics of the same building are compared with shear wall building and inclination with vertical plane. Change in axial force, shear force, bending moment, seismic base shear and building drift due to change in inclination and soil conditions are studied.

1) Base shear of building without core is more than the base shear in shear wall building for all types of soils.
2) Graphs clearly show that axial force of frame with inclination is more than as compared to frame with central core.
3) Graphs clearly show that shear force in columns of frame with inclination is more than as compared to frame with central core.
4) Moment in columns of building without core is more than as compared to with core building for column C1.
5) Torsion in columns of inclined building is more than as compared to with normal building for column C1.
6) Maximum principal stress and shear stress in shear wall of inclined frame is more than as compared to with central core building.

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