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Sesmic Comparitive Analysis for Isolated RCC Trapezoidal Footing Resting over Black Cotton Soil

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Abstract:During earthquake soil deforms under influence of incident seismic waves and dynamically carries with it foundation and support structures. There are various types of soil and various types of footing Thus it becomes important to study the behaviour of footing during earthquake in different soil The main objective of the study is to understand the effect of sesmic forces on Isolated RCC Trapezoidal Footing resting over Black Cotton soil. Also from various literature review study shows the point which are helpful to overcome damage in footing construction by showing different method, loading combination, sesmic effect, footing stability, etc.
Keywords: Sesmic, Footing, Soil, Earthquake, Trapezoidal

I. INTRODUCTION

A. Aim
To Study Seismic comparitive analysis for Isolated RCC Trapezoidal footing resting over Black Cotton soil.

B. Objective
1) To Study various Soil condition**.**
2) To Study construction property of Black Cotton Soil.
3) To Study Types and function of footing.
4) To study Indian Seismology.
5) To Study effect of earthquake on RCC structures.

C. Need
Earthquake is one of the most destructive of natural hazards. It is the sudden movement of earth cause due to the release of strain energy. It may causes various damages to buildings, earth surface, environment and life of common man. Thus, to minimize the effect of earthquake, foundation of structure is considered as more strongest element of overall building. There can be different types of foundation failure on soil due to movement and settlement which can cause building collapse & stability of foundation is depend upon the soil type available at foundation site. Hence, it is necessary to study the seismic stability of footing on various underlying soil and provide the safety as well.

II. LITREATURE REVIEW

Sneharika S. Shirbhate, et. al (1) Studied about the behavior of building components during earthquake over hilly terrain area and seismic characteristics such as displacement, storey drift, time period, base shear, etc. In addition to this twisting, torsion, short column effect are also studied. Generally, 27 degree sloping ground is more suitable & provide better stability on hilly terrain as compared to other building types.

Nagaraju, et. al (2) Analyzing and designing the RC building with various load combination under very high seismic zone(i.e. zone 5) and also make the comparison between manual method & software method to find which method is more suitable to increase the design quality, accuracy and strength

S. Balachandar, et. al (3) Studied over analysis of self wt. of footing with reference to safe bearing capacity, analysis of depth v/s reinforcement & comparative analysis of concentric square footing, eccentric one way square footing, eccentric both ways square footing and concluded that, self wt. of footing & depth of footing is depend on safe bearing capacity of soil. If depth of footing increases the reinforcement is decreases and all the footings which were design having the same data but reinforcement is gradually increased.

Prof. S.C. Gupta et al. (4), studied the behavior of flexible foundation using STAAD. Pro software. The study was done using a real life foundation problem of a G+3 storey school building. This paper shows a comparison of plate raft and the beam-slab raft by method of subgrade reaction of flexible foundation

Tarun Tiwari, (5) Studied on the effect of soil type for evaluating the seismic performance of footing. By using software STAAD PRO, finding the better technique to make the sensitivity of footing rested on different soil type and finally stated that, soil type which are available at foundation site effects the stability of foundation when subjected to earthquake waves

III. DETAILED STUDY

A. What is Soil

Soil can be defined as the organic and inorganic materials on the surface of the earth that provide the medium for plant growth. For the formation of soil, it takes around hundreds to thousands of years. The soil is usually generated when rocks break up into their constituent parts. When a range of different forces acts on the rocks, they break into smaller parts to form the soil. These forces also include the impact of wind, water and the reaction from salts. Soil develops slowly over the time. It varies due to its structure and composition.

1) Classification of Soils a) Organic Soil: Come from living material such as plant and animal remains. b) Mineral Soil: Come from rocks and other non-living materials.
2) Functions of Soils a) Soils serve as media for growth of all kinds of plants. b) Soils modify the atmosphere by absorbing gases (carbon dioxide, methane, water vapor, and the like) and dust. c) Soils absorb, hold, release, alter, and purify most of the water in terrestrial systems. d) Soils serve as engineering media for construction of foundations, roadways, dams and buildings, and preserve or destroy artifacts of human endeavors. e) Soils act as a living filter to clean water before it moves into an aquifer.

Types of soil:- Soil is a natural resource that can be categorized into different soil types.

1)Alluvial soil 2) Red soil 3) Black cotton soil 4) Marshy soil 5) Loam soil

Properties of Soil

Type of soil	Sand	Silt	Clay
Properties			
1. Color	Light Brown	Beige to Black	White to dull grey
2. Size	0.05-2.0 mm	0.002- 0.05 mm	Less than 0.002 mm
3. Specific Gravity	2.65-2.67	2.67-2.70	2.70-2.80
4. Cohesive Strength	0.5-2 Kn/m^2	75 Kn/m^2	10-100 Kn/m^2
5. Angle of internal Friction	30-40	26-35	20
6. Density	1800 kg/m^3	2100 kg/m^3	1900 kg/m^3
7. Porosity	20-35 %	35-50 %	33-60 %
8. Permeability	5.0 cm/hr	0.25 cm/hr	0.05 cm/hr
9. Unit Weight	13-16 kN/m^3	14-18 kN/m^3	14-21 kN/m^3
10. Bearing Capacity	100-300 Kn/m^2	Less than 75 Kn/m^2	75-180 Kn/m^2

B. Bearing Capacity of Soil

The load carrying capacity of foundation soil or rock which enables it to bear and transmit loads from structure.Bearing capacity is the power of foundation soil to hold the forces from the superstructure without undergoing shear failure or excessive settlement. Foundation soil is that portion of ground which is subjected to additional stresses when foundation and superstructure are constructed on the ground. The following are a few important terminologies related to bearing capacity of soil.

Ultimate Bearing Capacity (q_f) : It is the maximum pressure that a foundation soil can withstand without undergoing shear failure.

$$q_f = cN_c + \gamma DN_q + 0.5\gamma BN_\gamma$$

Gross bearing capacity :-The bearing capacity inclusive of the pressure exered by the weight of the soil standing on foundation or the surcharge pressure.

Net ultimate Bearing Capacity (q_n) : It is the maximum extra pressure (in addition to initial overburden pressure) that a foundation soil can withstand without undergoing shear failure.

$Q_n = q_f - q_o$

$$q_n = cN_c + \gamma DN_q + 0.5\gamma BN_\gamma - \gamma D$$

Here, q_o represents the overburden pressure at foundation level and is equal to γD for level ground without surcharge where γ is the unit weight of soil and D is the depth to foundation bottom from Ground Level.
Safe Bearing Capacity (q_s) : It is the safe extra load the foundation soil is subjected to in addition to initial overburden pressure.

$$q_s = \frac{q_n}{F} + q_o$$

$$q_s = \left[cN_c + \gamma D(N_q - 1) + 0.5\gamma BN_\gamma\right]\frac{1}{F} + \gamma D$$

Here. F represents the factor of safety.
Allowable Bearing Pressure (q_a) : It is the maximum pressure the foundation soil is subjected to considering both shear failure and settlement.

C. Study of Black Cotton Soil

Black cotton soil and other expansive soils have typical characteristics of shrinkage and swelling due to moisture movement through them due to rainy seasons moisture penetrates into these soil due to which they swell .Expansive soils are mostly found in the arid and semi-arid regions and it covers very large area of the world. It covers nearly 20% of the landmass in India and includes almost the entire Deccan plateau, Western Madhya Pradesh, parts of Gujarat, Andhra Pradesh, Uttar Pradesh, Karanataka, and Maharastra. The swelling soils are commonly known by the name of Black Cotton Soils. For swelling to occur, these soils must be initially unsaturated at some water content. If the unsaturated soil gains water content, it swells. On the other hand, if a decrease in water content occurs the soil shrinks. The presence of montmorillonite clay in these soils imparts them high swell–shrink potentials. Expansive soil will also exert pressure on the vertical face of a foundation, basement or retaining wall resulting in lateral movement. Shrink-swell soils which have expanded due to high ground moisture experience a loss of soil strength or “capacity” and the resulting instability can result in various forms of foundation problems and slope failure. Expansive soil should always be a suspect when there is evidence of active foundation movement. In order to expansive soil to cause foundation problems, there must be fluctuations in the amount of moisture containedin the foundation soils. If the moisture content of the foundation soils can be stabilized, foundation problems can often be avoided.

D. Foundation

Any part of a structure that serves to transmit the load to the earth or rock can be called foundation .The higher and heavier the building is to be, the wider and deeper the supports of footings for the foundation. The important purpose of foundation are as follows;
1)To transfer forces from superstructure to firm soil below.2) To distribute stresses evenly on foundation soil such that foundation soil neither fails nor experiences excessive settlement. 3) To develop an anchor for stability against overturning. 4)To provide an even surface for smooth construction of superstructure.
Foundations are mainly of two types:1) Shallow 2)Deep foundations.
(1) Shallow foundations :-Shallow foundations are used when the soil has sufficient strength within a short depth below the ground level These heavy loads are sustained by the reinforced concrete columns or walls (either of bricks or reinforced concrete) of much less areas of cross-section due to high strength of bricks or reinforced concrete when compared to that of soil The strength of the soil, expressed as the safe bearing capacity of the soil as,is normally supplied by the geotechnical experts to the structural engineer. Shallow foundations are also designated as footings.
(2)Deep foundations. In case the strata of good bearing capacity is not available near the ground ,the foundation of the structure has to be taken deep with the purpose of attaining a bearing stratum which is suitable in all respect. In addition there may be many other conditions which may require deep foundation for ensuring stability and durability of a structure .
Types of Shallow Foundations:a)Isolated footing,b)Combined Footing,c)Mat/Raft Footing,d)Strap footing,e)Strip footing
a)Isolated footing :-An isolated footing is used to support the load on a single column, It is usually either squarer or rectangular in plan .It represent the simplest ,most economical type and most widely used footong.Whenever possible ,square footing are provided so as to reduce the bending moment and shearing forces at their critical section 1) SBC is generally high 2) Columns are far apart 3)Loads on footings are less .The isolated footings can have different shapes in plan. Generally it depends on the shape of column cross section Some of the popular shapes of footings are; Square,Rectangular ,Circular

b)Combined Footing It supports two columns as shown in figure below. It is used when the two column are so close to each other that their individual footings would overlap. A combined footing is also provided when the property line is so close to one column that a spread footing would be eccentrically loaded when kept entirely within the property line. Combined footings are provided when:-1)SBC is generally less,2)Columns are closely spaced ,3)Footings are heavily loaded

c)Strap Footing An alternate way of providing combined footing located close to property line is the strap footing. In strap footing, independent slabs below columns are provided which are then connected by a strap beam. The strap beam does not remain in contact with the soil and does not transfer any pressure to the soil. Generally it is used to combine the footing of the outer column to the adjacent one so that the footing does not extend in the adjoining property.

d)Mat/Raft Footing It is a large slab supporting a number of columns and walls under entire structure or a large part of the structure. A mat is required when the allowable soil pressure is low or where the columns and walls are so close that individual footings would overlap or nearly touch each otherIt is normally provided when 1) Soil pressure is low ,2)Loads are very heavy ,3)Spread footings cover > 50% area e) Strip footing A strip footing is another type of spread footing which is provided for a load bearing wall. A strip footing can also be provided for a row of columns which are so closely spaced that their spread footings overlap or nearly touch each other. In such cases, it is more economical to provide a strip footing than to provide a number of spread footings in one line. A strip footing is also known as continuous footing.

E. Codal provision for Design of footings as per IS 456 : 2000

The important guidelines given in IS 456 : 2000 for the design of isolated footings are as follows: Footings is designed to sustain the applied loads, moments and forces and the induced reactions and to ensure that any settlement which may occur is as nearly uniform as possible, and the safe bearing capacity of the soil is not exceeded (see IS 1904).In sloped or stepped footings the effective cross-section in compression is limited by the area above the neutral plane, and the angle of slope or depth and location of steps is provided such that the design requirements are satisfied at every section. Sloped and stepped footings that are designed as a unit shall be constructed to assure action as a unit. (a) Minimum nominal cover (Clause. 26.4.2.2 of IS 456) The minimum nominal cover for the footings should be more than that of other structural elements of the superstructure as the footings are in direct contact with the soil. Clause 26.4.2.2 of IS 456 prescribes a minimum cover of 50 mm for footings. However, the actual cover may be even more depending on the presence of harmful chemicals or minerals, water table etc. Thickness at the Edge of Footing(cls. 34.1.2 and 34.1.3 of IS 456)

1) In reinforced and plain concrete footings, the thickness at the edge shall be not less than 150 mm for footings on soils, nor less than 300 mm above the tops of piles for footings on piles.2. In the case of plain concrete pedestals, the angle between the plane passing through the bottom edge of the pedestal and the corresponding junction edge of the column with pedestal and the horizontal plane (see Fig. 20) shall be governed by the expression:(Clause.34.1.3 of IS 456)

$$\tan\alpha \; <\neq 0.9 * \sqrt{(100q_0/f_{ck}) + 1}$$

Where,*qa*= calculated maximum bearing pressure at the base of the pedestal in N/mm^2,f_{ck} = characteristic strength of concrete at 28 days in N/mm^2.

2) Moments and Forces

a) In the case of footings on piles, computation for moments and shears may be based on the assumption that the reaction from any pile is concentrated at the centre of the pile.

b) For the purpose of computing stresses in footings which support a round or octagonal concrete column or pedestal, the face of the column or pedestal shall be taken as the side of a square inscribed within the perimeter of the round or octagonal column or pedestal.

c) Bending Moment(Clause. 34.2 of IS 456) The bending moment at any section shall be determined by passing through the section a vertical plane which extends completely across the footing, and computing the moment of the forces acting over the entire area of the footing on one side of the said plane. The greatest bending moment to be used in the design of an isolated concrete footing which supports a column, pedestal or wall, shall be the moment computed in the manner prescribed above at sections located as follows:a) At the face of the column, pedestal or wall, for footings supporting a concrete column, pedestal or wall;b) Halfway between the centre-line and the edge of the wall, for footings under masonry walls; This is stipulated in Clause.34.2.3.2 of IS 456.c) Halfway between the face of the column or pedestal and the edge of the gussetted base, for footings under gussetted bases.

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d) Shear and Bond(Clause. 31.6 and 34.2.4 of IS 456) a) The footing acting essentially as a wide beam, with a potential diagonal crack extending in a plane across the entire width; the critical section for this condition shall be assumed as a vertical section located from the face of the column, pedestal or wall at a distance equal to the effective depth of footing for footings on piles. b) Two-way action of the footing, with potential diagonal cracking along the surface of truncated cone or pyramid around the concentrated load; in this case, the footing shall be designed for shear in accordance with appropriate provisions The critical section for checking the development length in a footing shall be assumed at the same planes as those described for bending moment and also at all other vertical planes where abrupt changes of section occur. If reinforcement is curtailed, the anchorage requirements shall be checked in accordance with 26.2.3 of IS456: 2000.

e) Tensile Reinforcement(Clause.34.3 of IS 456) The total tensile reinforcement at any section shall provide a moment of resistance at least equal to the bending moment on the section.Total tensile reinforcement shall be distributed across the corresponding resisting section as given below:a) In one-way reinforced footing, the-reinforcement extending in each direction shall be distributed uniformly across the full width of the footing;b) In two-way reinforced square footing, the reinforcement extending in each direction shall be distributed uniformly across the full width of the footing;c) In two-way reinforced rectangular footing, the reinforcement in the long direction shall be distributed uniformly across the full width of the footing. For reinforcement in the short direction, a central band equal to the width of the footing shall be marked along the length of the footing and portion of the reinforcement determined in accordance with the equation given below shall be uniformly distributed across the central band

$$\frac{Reinforced\ in\ central\ band\ width}{Total\ reinforced\ in\ short\ direction} = \frac{2}{\beta + 1}$$

.where ,$\beta$is the ratio of the long side to the short side of the footing. The remainder of the reinforcement shall be uniformly distributed in the outer portions of the footing.

f) Transfer of Load at the Base of Column the compressive stress in concrete at the base of a column or pedestal should be considered as being transferred by bearing to the top of the supporting pedestal or footing. The bearing pressure on the loaded area shall not exceed the permissible bearing stress in direct compression multiplied by a value equal to

$$\frac{\sqrt{A_1}}{\sqrt{A_2}}$$

but not greater than 2, where A_1 =supporting area for bearing of footing, which in sloped or stepped footing may be taken as the area of the lower base of the largest frustum of a pyramid or cone contained wholly within the footing and having for its upper base, the area actually loaded and having side slope of one vertical to two horizontal; andA_2= loaded area at the column base.

F. Design Steps for Isolated Footing

Following are the steps which are adopt to design the effective and durable isolated footing-

1) Calculation for loads.
2) Proportioning of base slab (i.e. dimensions of footing L & B).
3) To calculate net upward pressure intensity and projection.
4) To calculate moment (along X-X span & along Y-Y span).
5) To calculate depth of footing (from moment along X-X and Y-Y consideration).
6) Design of reinforcement (R/F along X-X, R/F along Y-Y, R/F in central band, R/F in remaining portion).
7) Check for two way shear.
8) Check for one way shear.
9) Make the reinforcement detail (show the no. of bars which are used with their size).

G. Seismological map of India

Earthquakes are the shaking, rolling or sudden shock of the earth's surface. These are the natural means of releasing stress. There are about 20 plates along the Earth's surface and these plates moves continuously and slowly past each other, towards each other & away from each other thus causing different phenomenon on Earth's surface. India lies at the northwestern end of the Indo Australian Plate, which encompasses India, Australia, a major portion of the Indian ocean and other smaller countries. This plate is colliding against the huge Eurasian plate and going under the Eurasian Plate.

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This process of one tectonic plate getting under another is responsible for making India a earthquake prone country. A number of significant earthquakes occurred in and around India over the past century. Some of these occurred in populated and urbanized areas and hence caused great damage. The varying geology at different locations in the country implies that the likelihood of damaging earthquakes taking place at different locations is different. Thus, a seismic zone map is required to identify these regions.Every nation carries out mapping of its territory based on all natural disasters like earthquake, cyclone, flood and volcano etc.. This mapping is done on the basis of past history and factors responsible for such disaster of present in that area. This mapping helps people to design their home and other infrastructure so that they don't become the victim of such disaster and can withstand disasters with as minimum as possible loss of life and property. Code of practice of all nations for design of buildings and other structure recommended design guidelines based on such mapping or zoning. In India, the country has been divided into 4 zones. Earlier there were 5 zones however after Bhuj Earthquake of 2001, the zone I have been eliminated. Each country in the world has such zoning for all such natural disasters. India is divided into 4 seismic zones i.e. Zones II, III, IV and V. These zones are divided on the basis of Maximum Considered Earthquake and service life of structure in each seismic zone.

Fig. 1 Seismological map of India

As per Bureau of Indian Standards {IS 1893(part 1) : 2002}, grouped out the India into four seismic zones such as zone V, IV III and II.

Seismic zone have been categorized as follows:

Zone V: The areas of this zone have the highest risk of effects by an earthquake. The earthquake intensity for this zone is MSK-IX or greater. The zone factor for this zone is 0.36, which is indicative of effective (zero period) level earthquake in this zone. This zone is called as Very High Damage Risk Zone. Some of the regions which fall under this zone are Rann of Kutch, Eastern regions etc.

Zone VI: The areas of this zone have the lesser risk to effects by an earthquake as compared to zone V. The earthquake intensity for this zone is between MSK VIII to MSK-IX. The zone factor for this zone is 0.24. This zone is called as High Damage Risk Zone. Some of the regions which fall under this zone are Northern regions, North Eastern regions, Delhi etc.

Zone III: The areas of this zone have the lesser risk by an earthquake. The earthquake intensity for this zone is MSK VII. The zone factor for this zone is 0.16. This zone is called as Moderate Damage Risk Zone. Some of the regions which fall under this zone are some parts of Gujarat & Maharashtra, Andaman Nicobar Islands etc.

Zone II: The areas of this zone have the least risk of an earthquake. The earthquake intensity for this zone is MSK VI. The zone factor for this zone is 0.10. This zone is called as Low Damage Risk Zone. Larger parts of India come under this zone. Out of all these zones. Zone II is seismically least active region, while zone V is the most. i.e. the damage and effect of earthquake would be higher.

H. Some important terms about soil that affects the design and placement of foundation:

Safe bearing capacity of soil ,Cohesiveness of soil ,Non-cohesive soil

1) *Safe bearing capacity of Soil:* The bearing capacity of soil is defined as the capacity of the soil to bear the loads coming from the foundation. The First test which one should be performed before construction is the safe bearing capacity of the soil. It's a preliminary test which it should be conducted before the construction of any structure. It is recommended that safe bearing capacity of soil should be tested at all the points of footings. In order to keep the structure safe, safe bearing capacity of a soil is calculated on the field at different points and the selection of footing is done accordingly. The maximum load per unit area which the soil can bear without any displacement or settlements is designated as the safe bearing capacity of soil. SBC of soil should be determined on the basis of soil test data or by performing some test.

Table: Safe bearing capacity (SBC) Values for different types of soils

Type of soil	SBC value
Soft or muddy clay	0.5Kg/cm^2
Black cotton soil	1.5Kg/cm^2
Loose gravel	2.5Kg/cm^2
Compacted clay	4.5Kg/cm^2
Soft rocks	4.5Kg/cm^2
Compacted gravel	4.5Kg/cm^2
Hard rocks (Granite)	33Kg/cm^2
Coarse sand	4.4Kg/cm^2
Medium sand	2.45Kg/cm^2
Fine sand	4.45Kg/cm^2

Following are the methods of determining the bearing capacity of soil.

- Analytical Method:-Terzaghis analysis,Skempton's Analysis,Mayerhoff's Analysis,Hansen's Analysis,Vesic's Analysis,IS code Methods
- Field Test:-Standard Penetration Test,Plate Load Test ,Static Cone Penetrometer Test

2) *Cohesiveness of Soil:* Cohesive soil is defined as sticky soil, and can be termed as clay or silty clay. The surface tension of capillary water exerts the capillary forces, which reduces the soil strength. Cohesive soils have shear strength. It is possible to make a vertical cut in silts and clays and it remain standing, unsupported, for some time. This cannot be done in dry sand. In clay and silts, therefore, some other factor must contribute to shear strength. This factor is called cohesion. It results from the mutual attraction, which exist between fine particles and tends to hold them together in a solid mass without the application of external forces. Clay consist of very fine microscopic particles which hold water to increase their volume, and release moisture to decrease their volume. Special precaution needs to be taken in the design of footings to resist or avoid the forces caused by shrinking and swelling.
3) *Non-Cohesive Soil:* Non-cohesive soil is any free-running type of soil, such as gravel or sand, whose strength depends on friction between soil particles. In this the soil particles lie side by side without bonding. Noncohesive soil like sand and gravel have no shear strength. An apparent cohesion in sand can be noticed when water is present. Sand grains stick together due to negative pore pressure (building sandcastles is an example). Sand stand in slopes when wet but will not stand when dry or saturated. Strength, bearing capacity and slope stability all derived from internal friction . for granular soils (sand & gravel) range from 30° to 45°. ϕ increases due to grading, packing density and grain angularity. Courser grained soils are more permeable to water and, unless saturated, may have very little water in their voids. If well consolidated and confined, they form a foundation that is almost as stable as rock. If loosely consolidated or with high percentage of organic matter, the site must be classified as a problem site.

I. Various Loads Acting on Structure Under Seismology and Their Combinations and Effects

Definition of loading: Loads or actions are not only the forces but also the deformations, or accelerations applied to the structural components. Loads cause stresses, deformations, and displacements in structures. Assessment of their effects is carried out by the methods of structural analysis. Excess load or overloading may cause structural failure, and hence such possibility should be either considered in the design or strictly controlled. Types of loads: In general the loads and forces that may act upon foundation directly or by the superstructures are going to be discussed below.

1) *Dead Load:* Dead loads are in general the most important loads in foundation design particularly for the structures whose footings rest on soft cohesive soils. Dead loads being permanent forces action upon the structures may cause considerable settlements or dangerous shear failures. Dead loads is the weight of the structure and its permanent parts (such as weight of walls, floors, roofs etc.). The weight of the foundation itself and the weight of the soil on the footing are also dead loads
2) *Live Load:* The weight of the structure may be assumed as live loads if they act temporarily or intermittently during service life , For example , human occupancy , some partition walls , furniture , some stock material and mechanical equipment. It is also called super-imposed load. In general (with exception of some industrial buildings, silos, oil tanks etc. ..), live loads act for a short time during the service life of structure or they act intermittently or alternately. Floor slabs and beams will be designed for maximum live load and no reduction of live load is allowed more than 50% in any floor.
3) *Seismic Load:* Seismic loads are internal forces which act on the structure due to earthquake developed ground movements. Seismic loads are calculated by considering the following: Earthquake parameters at the building site, The type of materials used to create the structure. The construction quality of a structure. Seismic loads must be included in foundation design in countries where seismic shocks are probable. Earthquake motion results in lateral forces that may act on the structure in any horizontal direction, and all structures built in the earthquake zones must be designed to resist these lateral forces. The evaluation of the earthquake forces is difficult and it requires long time observation in the regions concerned.
4) *Wind Load:* Pressure applied due to the wind on a structure is called wind load. Wind loads are randomly applied dynamic loads. This load gets distributed throughout the surface area of structure (Wall, Roof, Inclined roof). The magnitude of this load increases as height of structure increases i.e. Taller structures has more effect due to the wind than shorter structures and the intensity of the wind pressure on the surface of a structure depends on wind velocity, air density, orientation of the structure, area of contact surface, and shape of the structure.**e)Snow Load:** Snow load should be considered in countries where winters are severe and long. Snow load is the downward force on a building's roof by the weight of accumulated snow and ice. The roof or the entire structure can fail if the snow load exceeds the weight the building was designed to shoulder or if the building was poorly designed or constructe

J. Loading Combinations

It's our duty to design a safe and serviceable structure and in order to do so we must predict the magnitudes of various loads that are likely to be applied to the substructure or superstructure over its lifetime. Hence to account for the probability of the simultaneous application of various load types, several load combinations are applied on the structure. These load combinations can be created by selecting the Indian code and also with the help of auto load combinations where they are generated by the software. Load combinations provide the basic set of building load conditions that should be considered by the designer.Load combinations are provided as per IS 456-2000

[1]1.5(DL+LL); [2]1.2(DL+LL+EQX); [3]1.2(DL+LL-EQX); [4]1.2(DL+LL+EQZ); [5]1.2(DL+LL-EQZ); [6]1.5(DL+EQX); [7]1.5(DL-EQX); [8]1.5(DL+EQZ) [9]1.5(DL-EQZ); [10]0.9DL+1.5EQX [11] 0.9DL-1.5EQX; [12] 0.9DL+1.5EQZ; [13]0.9DL-1.5EQZ

K. Steps for RC Structure Design

There are various steps to design the RC structure to make it durable and providing the safety against different failure.

1) Determining size of footing
2) Two way shear
3) Design of flexure
4) Check for one way shear
5) Check for development length

L. Seismic Consideration for Footing

Footings are an important part of foundation construction. They are typically made of concrete with rebar reinforcement that has been poured into an excavated trench. The purpose of footings is to support the foundation and prevent settling. Footings are especially important in areas with troublesome soils. The dimensions of footings are depend on the size and type of structure that will be built. Placement of footings is crucial to provide the proper support for the foundation and ultimately the structure. Concrete footings may also be needed for projects such as a deck, pergola, retaining wall or other types of construction. The choice of suitable type of footing for a structure depends on the depth at which the bearing strata lies, the soil condition, and the type of superstructure. Lateral loads or overturning moments result in a non-uniform soil bearing pressure under the footing, where the soil bearing pressure is larger on one side of the footing than the other. Nonuniform soil bearing can also be caused by a foundation pedestal not being located at the footing center of gravity. If the lateral loads and overturning moments are small in proportion to the vertical loads, then the entire bottom of the footing is in compression and a P/A ± M/S type of analysis is appropriate for calculating the soil bearing pressures. Due to earthquake or wind loading, the line of action of total load from the superstructure does not pass through the centre of gravity of the footing resulting in eccentric loading.So that, when only vertical load is their on footing i.e. when axial load is acted, the forces only in y direction is to be noticed but when their is lateral load and overturning moment along with vertical load acted at a time, the forces Fx, Fy, Fz and moments Mx, My, Mz is their on footing.

IV. CONCLUSION

From the study done in the seminar and literature review it can be seen that, there is a variation in analysis and design of footing with change in soil type . Behavior of footing during seismicity are also studied in this seminar. Also various types of load and sesmic load combinarions are studied. Finally it can be concluded that design of footing depends on factors like type of soil, sesmic zone, etc. hence it is necessary to study the effect of soil and footing type for evaluating the seismic performance of footing.

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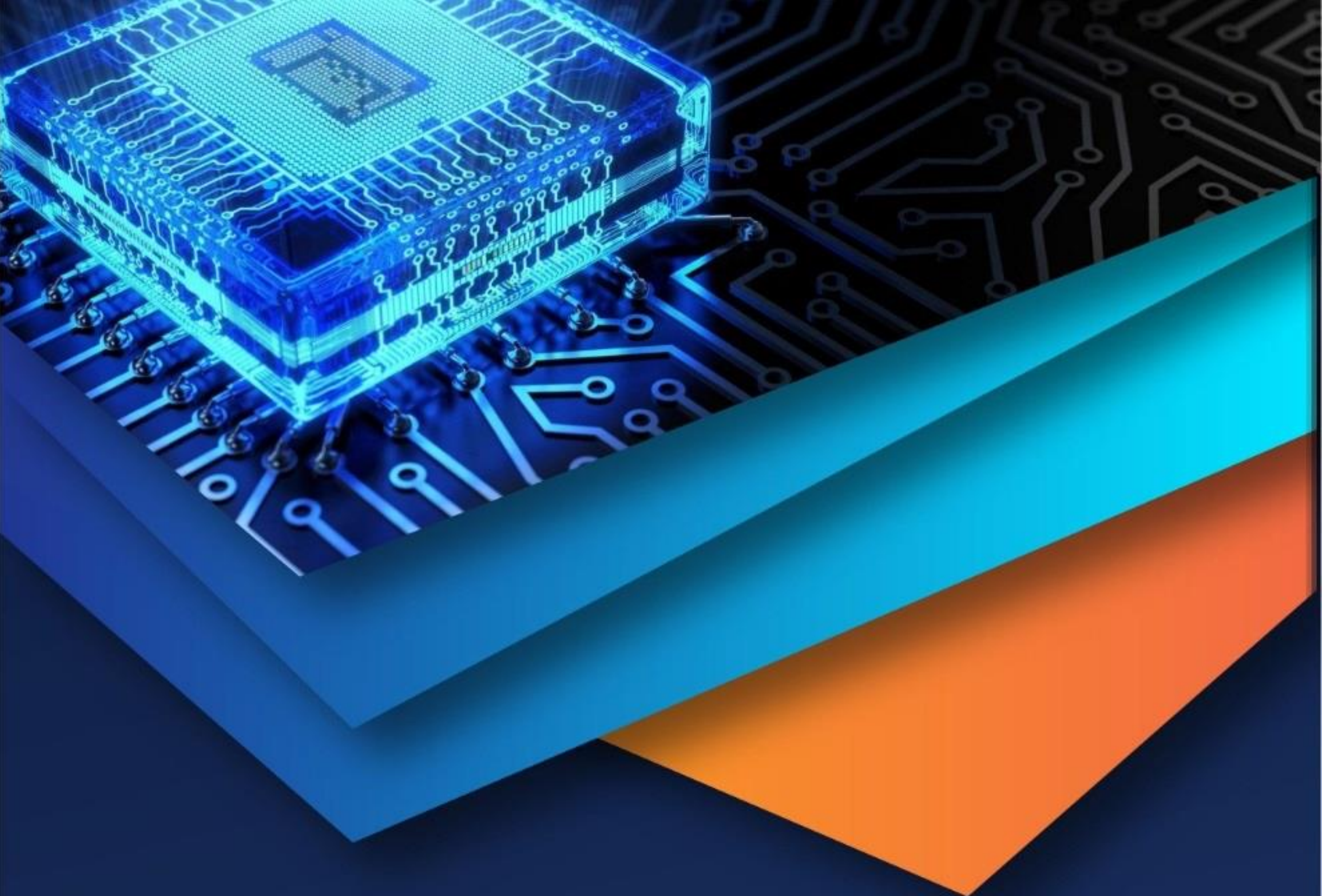

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