International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 22
November 2018

Analysis and Design of High Rise Commercial Building (C+S+15 Storey) On Low Bearing Capacity Soil in Seismic Zones II, III, IV and V by Using Etabs

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ABSTRACT

Earthquake load is turning into an extraordinary worry in our nation as on the grounds that not a solitary zone can be assigned as earthquake safe zone. A standout amongst the most critical viewpoints is to develop a building structure, which can oppose the seismic power productively. Study is made on the structure in all zones on low bearing soil to discover the most upgraded answer for create an effective safe earthquake safe building.

The essential standards of structure for vertical and horizontal loads(wind &seismic)are the equivalent for low, medium or high ascent building. Be that as it may, a building gets high both vertical and sidelong loads wind up controlling components. The vertical loads increment in direct extent to the floor zone and number of floors. As opposed to this, the impact of horizontal loads on a building isn't direct and increment quickly with increment in tallness. Because of these parallel loads, minutes on steel segments will be high.

In the present analysis(static and reaction range investigation), a business shopping complex working with C+S+15 floors is broke down at various areas were for the 4 cases that implies on ZONE – II , ZONE-III, ZONE – IV and ZONE – V in low bearing limit Soil(Loose Soil) by utilizing ETABS(Extended Three Dimensional Analysis of Building System). This procedure is structured according to Indian codes that implies IS 1893(PART 1):2016 for Earthquake Design and IS 875(PART 3):1987 for Wind Design and IS 456:2000 for Plain and Reinforced Concrete Design. In this we look at Story Drift, Story Shear and Story Displacement for various load mixes. Heap is planned physically dependent on IS 2911(PART 1):2010.

A business bundle ETABS has been used for breaking down high ascent working for various zones. Commonplace arrangement and section positions and bar confining every one of these illustrations are attracted AUTOCAD. The outcome has been contrasted utilizing tables and diagram with discover most enhanced arrangement. Finishing up comment has been made based on this investigation and correlation tables.

1. INTRODUCTION

1.1 GENERAL

Essential to the building procedure is the target to create, plan and develop to satisfy a given arrangement of execution necessities.

A portion of the target criteria in this staggered procedure are completely levelheaded and quantitative, however others must remain non-quantifiable in light of either their huge diagnostic unpredictability or on the grounds that they include components of taste or style.

The essential point in managing sane target criteria is to locate the best or ideal answer for the current issue. In a building improvement issue the, best arrangements are those that fulfill the prerequisites of capacity and respectability for the base capital and working expenses and the greatest income salary while staying inside the stylish limits forced by the planner.

High-Rise structures are an indispensable piece of modem urban conditions, and there are two crucial contrasts between planning t sew and building tasks of a littler scale: 1) the outcomes of structure choices are all the more exorbitant; and 2) the ecological innovation of a tall building is more intricate. High-ascent structures speak to tremendous private and open speculation and, in particular, they are extensive buyers of assets as work and construction materials (Forwood)- Because of this huge venture, investigate exertion has for quite some time been dedicated throughout the years to creating enhancement methods that decrease the utilization of assets for building ventures (New check and Rosen blueth , Cohn et al . McDermott etaI , Iyengar , Cohn).

Like all plans, the structure of a high-Rise building includes the improvement of the physical portrayal of an antiquity subject to an arrangement of given requirements and determinations. There are three stages in the structure of a high-Rise building; 1) applied, 2) starter, and 3) definite plan. Applied plan manages the distinguishing proof of various ideas and the determination of in general best subsystems and their arrangements. The fundamental plan organize includes the underlying advancement of one or a couple of calculated models. At last, the point by point configuration organize characterizes an entire answer for al1 subsystems, and results in definite illustrations for building, auxiliary, electrical and mechanical frameworks.

Expanding quantities of high-ascent structures are created every year for business utilize. Nonetheless, most plan methodology are backhanded, in that a structure idea is proposed and after that progressively investigated, assessed, adjusted and reanalyzed unti1 the last outcomes satisfy the fashioners' requests. The accomplishment of such a structure procedure depends particularly on the underlying plan idea proposed and on the assessments, judgments and experience of the planners. All things considered, the comparing configuration process is regularly generally incapable since the auxiliary kind and game plan, structural format and electrical/mechanical gear are frequently just formulated and replicated from past structures. Since extraordinary quantities of such structures will be required to satisfy the quickening requests of urban trade, it is indispensable to set up complete technique for the plan of high-Rise structures. This examination will center specifically after distinguishing "best idea" plans. Similarly noteworthy will be its attention on the advancement of a general methodology by which such plans might be accomplished.

1.2 DESIGN OF HIGHRISE BUILDING

Generally, the modeler was the ace manufacturer with command over the whole plan and building process. Notwithstanding, in time, industrialization and progressively complex ventures have expected planners to forsake territories of action that are ideally serviced by master engineers. Such zones in building plan and construction incorporate those identified with auxiliary, mechanical, electrical and construction designing. Likewise, the administrations of specialists in value building and fund are additionally regularly required (Holgate).

The structure of a task is the consequence of a steadily advancing idea beginning from an underlying plan produced by the structure group and the proprietor. Introductory ideas are affected by the required usefulness of the undertaking. Assist fundamental improvement of ideas representing site conditions, zoning laws and accounts, auxiliary, mechanical and electrical frameworks, and also the feel highlights of the task, in the long run prompt schematic illustrations. At this stage, upon endorsement from urban experts, more point by point configuration is produced. With the contribution of designers from various orders, the major electrical, mechanical and basic subsystems are adequately point by point for each colleague to have data in regards to the others necessities and duties, along these lines empowering everybody to finish their individual subsystem. This point by point organize is facilitated by intermittent gathering among the diverse orders of the structure group and includes critical correspondence of illustrations and records.

1.3 CONCEPTUAL DESIGN

Applied plan is the soonest period of the building configuration process and begins with an arrangement of beginning ideas. Remembering that there is no single arrangement with ideal execution as for al1 prerequisites because of the reality there are clashing target criteria, originators must assess distinctive contending criteria with the view to accomplish a decent trade off structure. That is, the choice of a reasonable arrangement includes making emotional bargains between clashing target criteria.

The reasonable structure stage includes settling on choices that can have the greatest effect on the last plan and undertaking cost. One investigation proposed that as much as 80% of the aggregate assets required to develop a building are submitted by the choices made in the primary 10% of the structure procedure (Deiman and Platt). Though, creators regularly will in general invest the vast majority of their working energy in the point by point configuration stage, where the degree for huge enhancement is significantly less. They frequently just produce a solitary structure idea, or at most a not many that fulfill the plan criteria, on the grounds that conventional plan practice places serious requirements on time and configuration costs. Broad age and assessment of choices is just conceivable with the assistance of PC based strategies. All things considered, such PC strategies for reasonable plan are not yet accessible to fashioners practically speaking. One explanation behind this circumstance is that reasonable structure has not yet advanced into an all around characterized technique.

A general perspective of the structure procedure and the plan itself is required when performing calculated plan. The originators at the beginning times must comprehend the numerous components influencing the building being planned. Such a worldwide way to deal with high-Rise building configuration ought to incorporate record for basic proficiency, erection cost. Mechanical and electrical prerequisites, working cost, nature of room and solace and rental income. One should add to this rundown such things as introductory land cost, enthusiasm on obtained cash and support cost. Noteworthy multifaceted nature originates from the need to decide the general advantages of al1 of these different amounts and characteristics (Rush).

Investigations of high-ascent structures comprise of numerous stages and factors and to assess these are past the extent of the Master's proposal. For concrete, no impacts from wet blanket, shrinkage or temperature impacts have been examined. The concrete have additionally been viewed as un split. Moreover, no structure of component cross-areas has been made and the accelerations of the building are figured by Indian Standards.

Earthquake is the most awful because of its capriciousness and tremendous intensity of pulverization. Earthquakes themselves don't murder individuals, rather the gigantic loss of human lives and properties happen because of the devastation of structures. Building structures crumple amid serious earthquakes, and cause coordinate loss of human lives. Various research works have been guided worldwide in most recent couple of decades to explore the reason for disappointment of various sorts of structures under extreme seismic excitations. Gigantic annihilation of high-rise and low-ascent structures in late destroying earthquake demonstrates that in creating provinces like India, such examination is the need of great importance. Henceforth, seismic conduct of deviated constructing structures has turned into a theme of overall dynamic research. Numerous Investigations have been directed on flexible and inelastic seismic conduct of unbalanced frameworks to discover the reason for seismic powerlessness of such structures. The reason for the paper is to perform direct static examination of medium stature RC structures and research the progressions in basic conduct because of thought of various plane shapes.

An essential component in building arrangement is its normality and symmetry in the plane and rise. Structures on slope slant are highly unpredictable and unbalanced in plan and rise. One of the significant supporters of auxiliary harm amid solid earthquake is the discontinuities and abnormalities in the heap way or load exchange.

The parallel load, for example, earthquake is to be delegated live flat power following up on the structure contingent upon the building's geographic area, stature, shape and basic materials. A working with a sporadic setup might be intended to meet all code necessities however it won't perform well when contrasted with a working with a standard arrangement.

1.4 OBJECTIVES OF THE STUDY

The principle target of this work is to add to the advancement of the structure direction for high ascent structures in connection to various states of working to control wind excitation and earthquake stack as a kind of perspective for designers, architects, engineers, and understudies. In this examination, the idea of high ascent building, which incorporate the definition, essential plan contemplations, and sidelong loads; shape adjustments of tall structures, are considered. At that point the outcomes for various conditions are translated and ends are made with respect to which molded structures out of four taken in the thought is generally steady. Additionally work should likewise be possible on more convoluted states of structures and arrive at resolution with respect to which is most steady and practical shapes under given condition for wind and earthquake loads.

1.5MODELING AND ANALYSIS METHOD

3D demonstrating for investigations utilizing ETABS. The building models are pushed along positive symmetrical headings and the building is examined by wind loads and additionally seismic loads. Parametric Studies the impacts of various state of expanding on the general conduct of the structure when oppressed powers are analyzed.

ETABS Software is utilized in displaying of building outlines. ETABS Stands for Structural investigation and configuration Program and it is broadly useful programming for playing out the examination and plan of a wide assortment of structures. The fundamental exercises which are to be done to accomplish this objective:

a. Geometry of the structure

b. Giving material and part properties

c. Applying loads and bolster conditions

Programming ETABS has been utilized to think about the progressions of the Structural conduct for various states of High Rise R.C Building under the parallel load impact, for example, earthquake stack, According to IS 1893:2002;the fundamental contrasts between the two techniques are in the size and circulation of the horizontal load over the tallness of the building.

1.6 OUTLINE OF THESIS

The present part portrays the target and extent of the present investigation and furthermore gives a concise depiction of the request in which the sections are sorted out in the postulation. The section likewise depicts the significance of the investigation. The second part entitled Review of Literature portrays in detail the different works led by the analysts to comprehend the conduct of brick work infill outlines and their impact on strength prerequisites, for various kind of working in the seismic examination. The third section entitled Methods of Analysis of structure. It clarifies every one of the techniques accessible for the horizontal load examination of structures and methodology to do the equivalent. The fourth section entitled Modeling in ETABS portrays the different building models embraced in the investigation and their properties. It additionally depicts diverse examination performed on the structures utilizing ETABS investigation bundle. The fifth part portrays the Numerical displaying . The outcomes acquired from the examination are exhibited in the 6th section entitled Results and Discussions. The section displays the outcomes in the frame charts and tables for the model structures considered and it likewise gives a discourse on the outcomes got. The seventh section portray the heap establishments. The last section entitled Summary and Conclusions gives the ends that can be drawn dependent on the examination led. It likewise gives the extension for future work in the examination.

3.6 LOADS CONSIDERED:

Loads on a structure are by and large two sorts.

1. Gravity loads and

2. Lateral loads

3.6.1 Gravity loads:

Gravity loads are the vertical powers that follow up on a structure. The heaviness of the structure, human inhabitance and snow are a wide range of loads that need an entire load way to the ground..

3.6.1.1 Dead Loads:

Every lasting construction of the structure frame the dead loads. The dead load involves the weights of dividers, allotments floor completes, false roofs, false floors and the other changeless constructions in the structures. The dead load loads might be ascertained from the measurements of different individuals and their unit weights. the unit weights of plain concrete and fortified concrete made with sand and rock or squashed common stone total might be taken as 24 kN/m3 and 25 kN/m3 separately.

3.6.1.2 Imposed Loads:

Every single changeless construction of the structure frame the dead loads. The dead load includes the weights of dividers, allotments floor completes, false roofs, false floors and the other changeless constructions in the structures. The dead load loads might be ascertained from the measurements of different individuals and their unit weights. the unit weights of plain concrete and strengthened concrete made with sand and rock or pulverized common stone total might be taken as 24 kN/m3 and 25 kN/m3 individually.

Live loads are taken as 2kN/m.

3.6.2 Lateral Loads:

Parallel loads are the level powers that are follow up on a structure. Wind loads and earthquake loads are the principle horizontal loads follow up on structures.

3.6.2.1 Wind Loads

Fundamental wind speed zones in India are named six zones according to IS 875 section - 3-1987.

Table – 3.1: Zone Wise Basic Wind Speeds in m/sec

Zone	Basic wind speed (m/sec)
I	33
II	39
III	44
IV	47
V	50
VI	55

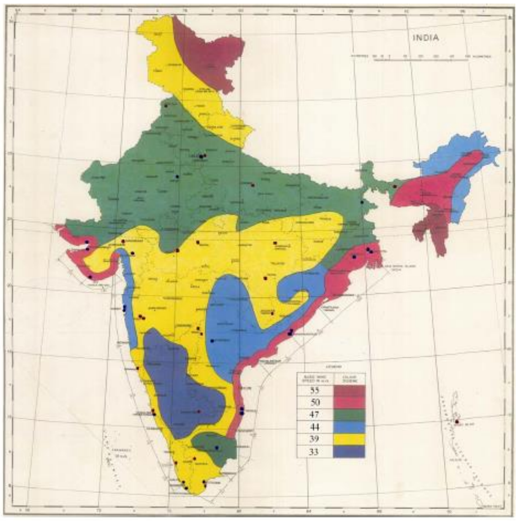

Figure - 3.6: Basic wind speed zone map in India

Wind is air in movement in respect to the surface of the earth. The essential driver of wind is followed to earth's revolution and contrasts in earthbound radiation. The radiation impacts are principally in charge of convection either upwards or downwards. The wind by and large blows flat to the ground at high wind speeds. Since vertical segments of climatic movement are generally little, the term 'wind' means only the flat wind, vertical winds are constantly distinguished in that capacity. The wind speeds are evaluated with the guide of anemometers or anemographs which are introduced at meteorological observatories at statures for the most part shifting from 10 to 30 meters over the ground.

3.2.2.2 Design Wind Speed (V,)

The essential wind speed (Vh) for any site will be gotten from and will be changed to incorporate the accompanying impacts to get configuration wind speed at any stature (Vh) for the picked structure:

A) Risk level;

B) Terrain harshness, stature and size of structure; and

C) Local geography.

It very well may be numerically communicated as pursues: Where:

V = Vb X kl X k2X k3

Vb = configuration wind speed at any stature z in m/s;

kl = likelihood factor (chance coefficient)

k2= landscape, tallness and structure measure factor

k3 = geography factor

Hazard Coefficient (k1 Factor): Gives fundamental wind speeds for landscape Category 2 as pertinent at10 m over the ground level dependent on 50 years mean return period. In the plan all things considered and structures, a local fundamental wind speed having a mean return time of 50 years will be utilized.

Territory, Height and Structure Size Factor (k2, Factor):

Territory - Selection of landscape classifications will be made with due respect to the impact of checks which comprise the ground surface unpleasantness. The landscape class utilized in the plan of a structure may differ contingent upon the bearing of wind under thought. Wherever adequate meteorological data is accessible about the idea of wind bearing, the introduction of any building or structure might be appropriately arranged.

Geography (k3 Factor) - The essential wind speed Vb assesses the general level of site above ocean level. This does not take into consideration neighborhood topographic highlights, for example, slopes, valleys, precipices, ledges, or edges which can essentially influence wind speed in their region. The impact of geography is to quicken wind close to the summits of slopes or peaks of precipices, ledges or edges and decelerate the wind in valleys or close to the foot of bluff, soak slopes, or edges.

Wind Pressures and Forces On Buildings/Structures:

The wind stack on a building will be computed for:

a) The working overall,

b) Individual auxiliary components as rooftops and dividers, and

c) Individual cladding units including coating and their fixings.

Pressure Coefficients - The pressure coefficients are constantly given for a specific surface or part of the surface of a building. The wind stack acting typical to a surface is gotten by duplicating the zone of that surface or its proper bit by the pressure coefficient (C,) and the plan wind pressure at the tallness of the surface starting from the earliest stage. The normal values of these pressure coefficients for some building shapes Average values of pressure coefficients are given for basic wind headings in at least one quadrants. With the end goal to decide the most extreme wind stack on the building, the aggregate load ought to be figured for every one of the basic bearings appeared from all quadrants. Where extensive variety of pressure happens over a surface, it has been subdivided and mean pressure coefficients given for every one of its few sections. At that point the wind stack, F, acting toward a path typical to the individual auxiliary component or Cladding unit is:

F= (Cpe – Cpi) A Pd

Where,

Cpe = outer pressure coefficient,

Cpi = inside pressure-coefficient,

A = surface zone of basic or cladding unit, and

Pd = configuration wind pressure component

Wind loads are connected on the structure according to IS 875-1987.i.e wind stack in x-course WLx and wind stack in y-bearing WLy.

3.6.2 Seismic Loads:

3.6.2.1design Lateral Force

The structure sidelong power will initially be registered for the working in general. This structure parallel power will then be circulated to the different floor levels. The general structure seismic power hence acquired at each floor level will at that point be disseminated to singular horizontal load opposing components relying upon the floor stomach activity.

Earthquake loads are connected according to IS 1893-2002 in earthquake x-heading, y-bearing Positive x-course, negative x-course, positive y-heading and negative y-course. What's more, stack mixes are considered according to IS 1893-2002.

3.6.2.2 Design Seismic Base Shear

The aggregate structure sidelong power or plan seismic base shear (Vb) along any essential heading will be controlled by the accompanying articulation:

Vb = Ah W

Where,

Ok = flat acceleration range

W = seismic weight of all the floor

Major Natural Period

The inexact principal common time of vibration (T,), in a flash, of a minute opposing edge working without block in the boards might be evaluated by the exact articulation:

Ta=0.075 h0.75 for RC outline building

Ta=0.085h0.75 for steel outline building Where,

H = Height of working, in m. This bars the storm cellar stories, where cellar dividers are associated with the ground floor deck or fitted between the building sections. However, it incorporates the cellar stories, when they are not all that associated. The surmised principal common time of vibration (T,), in short order, of every single other building, including minute opposing casing structures with block lintel boards, might be evaluated by the experimental Expression:

T=.09H/√D

Where,

H= Height of building

D= Base measurement of the working at the plinth level, in m, along the thought about course of the sidelong power.

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p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 12
August 2016

Vertical Distribution of Base Shear to Different Floor Level

The structure base shear (V) will be dispersed along the tallness of the working according to the accompanying articulation:

Qi=Design parallel power at floor I,

Wi= Seismic weight of floor I,

Hi=Height of floor I quantified from base, and

n=Number of stores in the building is the quantity of levels at which the majority are found. Dispersion of Horizontal Design Lateral Force to Different Lateral Force Resisting Elements if there should arise an occurrence of structures whose floors are equipped for giving inflexible even stomach activity, the aggregate shear in any level plane will be circulated to the different vertical components of parallel power opposing framework, accepting the floors to be boundlessly unbending in the flat plane. If there should arise an occurrence of building whose floor stomachs can't be treated as interminably unbending in their own plane, the parallel shear at each floor will be circulated to the vertical components opposing the horizontal powers, considering the in-plane adaptability of the outline.

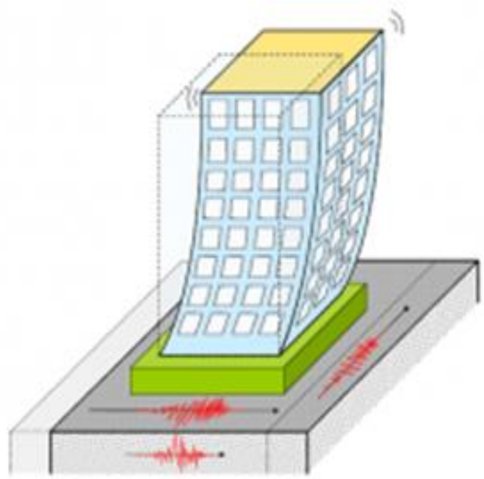

Figure – 3.8: Behavior of building under earth quake

RESULTS AND DISCUSSION

6.1 RESULTS:

Table-6.1: Vertical Displacement

S. no	Storey ID	Point Displacement (m)			
		Zone-II	Zone-III	Zone-IV	Zone-V
1	Base	0	0	0	0
2	Storey-1	0.0026	0.0027	0.0029	0.0032
3	Storey-2	0.0057	0.0059	0.0062	0.0066
4	Storey-3	0.0068	0.0071	0.0074	0.0079
5	Storey-4	0.0080	0.0083	0.0087	0.0093
6	Storey-5	0.0091	0.0094	0.0098	0.0105
7	Storey-6	0.0136	0.0104	0.0109	0.0115
8	Storey-7	0.0110	0.0114	0.0118	0.0125
9	Storey-8	0.0131	0.0134	0.0138	0.0144
10	Storey-9	0.0147	0.0151	0.0156	0.0162
11	Storey-10	0.0163	0.0166	0.0171	0.0178
12	Storey-11	0.0176	0.0180	0.0185	0.0192
13	Storey-12	0.0189	0.0193	0.0197	0.0204
14	Storey-13	0.0210	0.0213	0.0217	0.0223
15	Storey-14	0.0225	0.0228	0.0232	0.0239
16	Storey-15	0.0237	0.0240	0.0244	0.0251
17	Storey-16	0.0246	0.0249	0.0254	0.0261
18	Storey-17	0.0250	0.0254	0.0259	0.0265
19	Storey-18	0.0262	0.0265	0.0269	0.0276

Table-6.2: Storey Drift along X- Axis

S.no	Storey ID	Storey Drift-X (m)			
		Zone-II	Zone-III	Zone-IV	Zone-V
1	Base	0	0	0	0
2	Storey-1	0.000320	0.000510	0.000763	0.001143
3	Storey-2	0.000603	0.000965	0.001447	0.002169
4	Storey-3	0.000710	0.001135	0.001703	0.002554
5	Storey-4	0.000753	0.001205	0.001808	0.002711
6	Storey-5	0.000773	0.001237	0.001856	0.002784
7	Storey-6	0.000782	0.001251	0.001877	0.002815
8	Storey-7	0.000794	0.001268	0.001899	0.002846

9	Storey-8	0.001028	0.001642	0.002462	0.003692
10	Storey-9	0.001009	0.001614	0.002421	0.003631
11	Storey-10	0.000975	0.001560	0.002340	0.003510
12	Storey-11	0.000933	0.001493	0.002239	0.003358
13	Storey-12	0.000895	0.001426	0.002134	0.003197
14	Storey-13	0.001274	0.002034	0.003048	0.004569
15	Storey-14	0.001136	0.001817	0.002725	0.004087
16	Storey-15	0.000977	0.001563	0.002344	0.003516
17	Storey-16	0.000796	0.001274	0.001911	0.002866
18	Storey-17	0.000593	0.000974	0.001420	0.002130
19	Storey-18	0.000383	0.000601	0.000893	0.001330

Table-6.3: Storey Drift along Y- Axis

S.no	Storey ID	Storey Drift-Y (m)			
		Zone-II	Zone-III	Zone-IV	Zone-V
1	Base	0	0	0	0
2	Storey-1	0.000366	0.000585	0.000877	0.001315
3	Storey-2	0.000693	0.001100	0.001646	0.002465
4	Storey-3	0.000831	0.001326	0.001986	0.002976
5	Storey-4	0.000889	0.001419	0.002126	0.003186
6	Storey-5	0.000911	0.001454	0.002178	0.003265
7	Storey-6	0.000917	0.001463	0.002191	0.003283
8	Storey-7	0.000922	0.001467	0.002195	0.003287
9	Storey-8	0.001123	0.001788	0.002678	0.004013
10	Storey-9	0.001093	0.001743	0.002610	0.003911
11	Storey-10	0.001047	0.001672	0.002505	0.003755
12	Storey-11	0.000998	0.001591	0.002382	0.003569
13	Storey-12	0.000949	0.001508	0.002254	0.003374
14	Storey-13	0.001277	0.002034	0.003042	0.004558
15	Storey-14	0.001137	0.001814	0.002717	0.004071
16	Storey-15	0.000971	0.001550	0.002322	0.003480
17	Storey-16	0.000785	0.001252	0.001875	0.002809
18	Storey-17	0.000578	0.000917	0.001369	0.002047
19	Storey-18	0.000368	0.000567	0.000833	0.001231

Table-6.4: Storey Shear along X- Axis

S.no	Storey ID	Storey Shear-X (kN)			
		Zone-II	Zone-III	Zone-IV	Zone-V
1	Base	0	0	0	0
2	Storey-1	8226.28	13162.05	19743.08	29614.61
3	Storey-2	8224.59	13159.35	19739.02	29608.53
4	Storey-3	8206.33	13130.13	19695.91	29542.79
5	Storey-4	8168.29	13069.26	19603.89	29405.83
6	Storey-5	8100.65	12961.05	19441.57	29162.35
7	Storey-6	7994.98	12791.96	19187.94	28781.92
8	Storey-7	7842.80	12548.48	18822.72	28234.09
9	Storey-8	7642.92	12228.67	18343.00	27514.50
10	Storey-9	7389.33	11822.93	17734.40	26601.59
11	Storey-10	7068.39	11309.42	16964.13	25446.20
12	Storey-11	6672.16	10675.46	16013.19	24019.78
13	Storey-12	6192.73	9908.37	14862.55	22293.82
14	Storey-13	5629.61	9007.38	13511.07	20266.60
15	Storey-14	4974.87	7959.80	11939.70	17909.55
16	Storey-15	4215.53	6744.85	10117.28	15175.92
17	Storey-16	3343.84	5350.15	8025.22	12037.83
18	Storey-17	2352.05	3763.28	5644.92	8467.39
19	Storey-18	1232.41	1971.86	2957.79	4436.69

Table-6.5: Storey Shear along Y- Axis

S.no	Storey ID	Storey Shear-Y (kN)			
		Zone-II	Zone-III	Zone-IV	Zone-V
1	Base	0	0	0	0
2	Storey-1	7490.39	11984.63	17976.95	26965.42
3	Storey-2	7488.86	11982.17	17973.26	26959.89
4	Storey-3	7472.23	11955.57	17933.35	26900.02
5	Storey-4	7437.59	11900.14	17850.21	26775.32
6	Storey-5	7376.01	11801.61	17702.41	26553.62

7	Storey-6	7279.78	11647.65	17471.48	26207.21
8	Storey-7	7141.22	11425.95	17138.93	25708.39
9	Storey-8	6959.20	11134.74	16702.11	25053.17
10	Storey-9	6728.31	10765.30	16147.95	24221.93
11	Storey-10	6436.08	10297.73	15446.30	23169.89
12	Storey-11	6075.30	9720.48	14580.72	21871.08
13	Storey-12	5638.75	9022.01	13533.01	20299.52
14	Storey-13	5126.01	8201.62	12303.43	18453.64
15	Storey-14	4529.84	7247.75	10871.63	16307.44
16	Storey-15	3838.43	6141.49	9212.23	13818.35
17	Storey-16	3044.72	4871.55	7303.32	10960.98
18	Storey-17	2141.65	3426.64	5139.95	7709.93
19	Storey-18	1122.17	1795.47	2693.20	4039.8

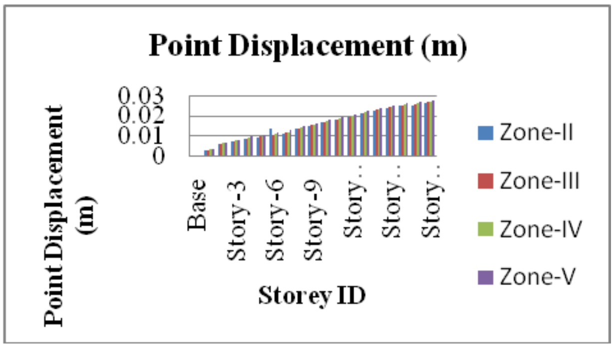

Fig-6.4: Point Displacement

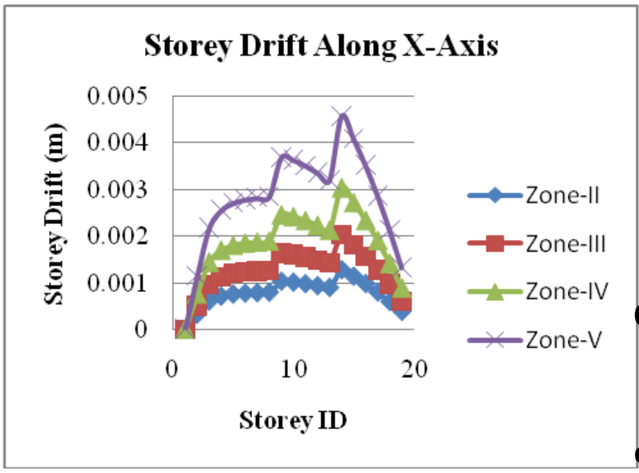

Fig-6.5 Storey Drift along X-Axis

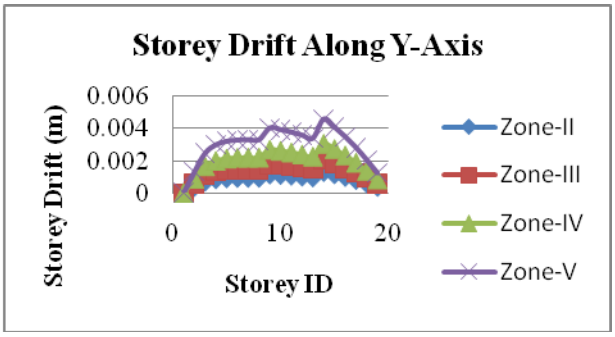

Fig-6.6 Storey Drift along Y-Axis

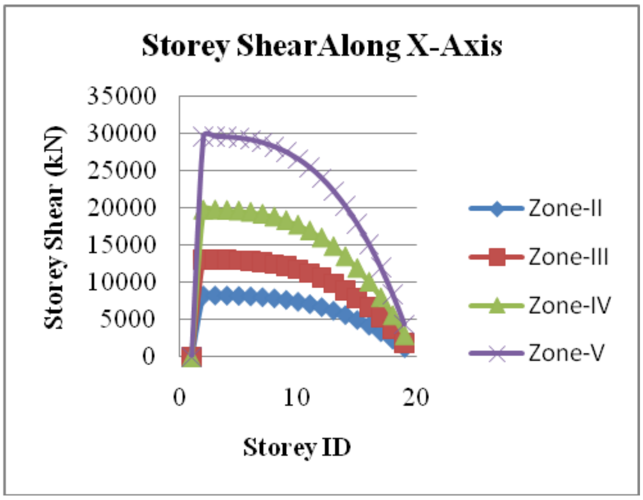

Fig-6.7 Storey Shear along X-Axis

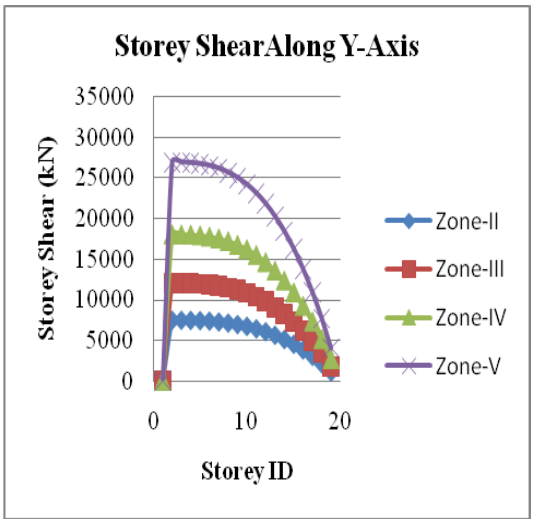

Fig-6.8 Storey Shear along Y-Axis

6.2 DISCUSSIONS:

Case -1

Variation of Point Displacement for different zones:

The point displacement is increases from base storey to top storey. By Comparing zones , the point displacement is increases from zone to zone. That means when zone increases, Zone II to Zone III like wise , point displacement increases.

Case-2

Variation of Drift from different zones :

In this case storey drift increases at some height of storey and decreases at some height of storey and at top storey it decreases . Compare to zones, as zone increases the drift also increases.

Case-3

Variation of Shear from different zones:

Shear is more in x-direction than in shear in y-direction. Compare to stories, the shear increases from top storey to bottom storey. By comparing zones, shear increases from zone to zone.

DESIGN OF PILES
Design of Pile:

PILE FOUNDATION DESIGN AS PER IS 2911--2010

Some of the important changes in the code are highlighted as follows:

1. Definitions of various terms have been modified as per the prevailing engineering practice.
2. Minimum grade of concrete to be used in pile foundations has been revised to M 25.
3. Design parameters with respect to adhesion factor, earth pressure coefficient, modulus of subgrade reaction, etc, have been revised to make them consistence with the outcome of modern research and construction practices.
4. Minimum dia of bored cat in situ pile have been changed as 450mm based on following parameters:

Clear cover over reinforcement Cl.6.11.4 50 x2 = 100mm

Dia of vertical bar minimum Cl. 6.11.4 12 x 2 = 24 mm

Helical reinforcement minimum dia cl. 6.11.4 8 x2 = 16 mm

Clearance for operation of Tremie Cl.6.11.4 4 x20 = 80 mm

Dia of Tremie pipe minimum Cl.8.4 (c) = 200 mm

Total dia of pile required = 420 mm say 450mm

5. Provisions for special use of large diameter bored cast in-situ reinforced cement concrete piles in marine structures have been added.
6. Procedures for calculation of bearing capacity, structural capacity, factor of safety, lateral load capacity, overloading, etc, have also been modified to bring them at par with the present practices.
7. Minimum time of curing before handling of precast piles has been modified.
8. Provision has been made for use of any established dynamic pile driving formulae, instead of recommending any specific formula, to control the pile driving at site, giving due consideration to limitations of various formulae.

Selection of pile foundation:

1. For Poor bearing soils such as Soft clay, Medium Clay or any clay etc. under reamed pile foundation with pile cap and grade beam or Bored cast in situ Pile foundation with pile cap may be adopted.
2. For clay soil with G+2F, G+3F, silt+3floors loads, under reamed piles with pile caps connected with grade beams is best suited. If the hard strata available is at 10m depth, End bearing/ Bored cast insitu piles with pile caps may be adopted. This type of foundation is also best suited for multi storeyed building also.
3. If the load on foundation is 500KN (say G+2Floor load), Under reamed pile foundation for a depth of 3.5m to 4.50m with pile caps shall be adopted.

If the load on foundation is in the range of 2000KN to 3000KN, Bored cast in ‘situ concrete piles with 6.0m to 20.0m depth with pile caps shall be adopted. This type is adopted in case of multi storied building.

Pile Cap Deisgn:

Size of Column =0.9 m x 0.9 m

Axial load at Column Base=13187kN

Bearing Capacity of soil = 15000kg/m^2= 150 kN/m^2

To find the Pile cap size assume the

Grade of concrete=M 35 i.e f_{ck} =35N/mm^2

Grade of steel=Fe415 i.e f_y=415N/mm^2

Step 1:

Finding the cross section dimensions of the pile cap

Area of pile cap=(10% of axial load+ Axial load)/Safe bearing capacity of soil

= (0.1 x 13187 + 13187)/150

=96.7 m^2

Assume one side of pile cap=8m

Then other side of pile cap=96.7/8=12.08 ~12.1

Take Area of pile cap=8 x 12.1=96.8 m^2

Step 2:

Soil reaction for the design load

As per IS code,

Qu= Pu/Area of Pile cap

where P_u(Design load) =1.5 x Axial load =1.5 x 13187 = 19780.5 kN

Q_u=19780.5/96.8=0.204 N/mm^2

Step 3: Finding the depth of pile cap

Depth of pile cap decides by the one way shear. In one way shear, the critical section at a distance 'd' from the column face across section x-x.

Soil Pressure (V_u) = Q_u x[((B-b)/2)-d]D

= 204.34 x [((8-0.9)/2)-d]12.1

= 2472.574(3.55-d)

Design shear strength of concrete:

Assumed grade of concrete= M35

Assumed percentage of steel=0.25%

As per IS 456:2000 Table 19 for for M35 grade of concrete and 0.25% of steel

The Permissible Shear stress(T_c)= 0.37 N/mm^2

We know that V_u= T_u x B xd

2472.574(3.55 –d) =(0.37 x 1000)x 8 xd

d =1.615 m

Hence we provide 1.615 m depth of pile cap.

Step 4: Check for Bending moment

Critical section at the face of the column across section x-x.

$M_{u,lim}$=0.138 f_{ck} B d^2

= 0.138 x 35 x 8000 x (1615)^2

= 100.78 x10^3 kN.m

M_u = Q_u B[(B-b)^2/8]

= 0.204 x 8000 x[(8000-900)^2/8]

= 10.283 kN.m

Check :$M_{u,lim}$> M_u (OK)

Hence, provide depth is sufficient.

Step 5: Check for two way shear

In two way shear, the critical section at distance 'd/2' from the column face in both directions.

Perimeter of the section(P)=2(a+b)

a=b=0.9+(d/2)=0.9+(1.615/2)=1.707 ~1.71

P= 2(1.71+1.71)=6.84 m

Area of concrete resisting two way shear (A)=P x d

= 6.84 x 1.615

A = 11.0466 m^2

Soil pressure(V_u) = Q_u [B x D – a xb]

= 204.34[8 x12.1 – 1.71 x 1.71]

= 19182.6 kN

As per IS code

V_u = T_c^1 x A

19182.6= T_c^1 x 11.0466

T_c^1= 1.736 N/mm^2

But Punching Shear 'T_p' as per IS code

T_p=k_s T_C

Where k_s=0.5 +s

s=B/D =8/12.1

k_s= 0.5 +(8/12.1) = 1.61

where T_c= 0.25 (f_{ck})$^{0.5}$

T_c= 0.25(35)$^{0.5}$=1.479

Then T_p= 1.61 x 1.479= 2.38

Check: T_p>T_c^1 (OK)

Step 6: Area of Reinforcement

As per IS code

International Journal of Research
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p-ISSN: 2348-6848
e-ISSN: 2348-795X
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$M_u = 0.87\ f_y\ A_{st}\ d[1-(f_y A_{st}/f_{ck}Bd)]$

$10.283 \times 10^9 = 0.87 \times 415 \times A_{st} \times 1615[1-(415A_{st}/(315 \times 8000 \times 1615)]$

$A_{st} = 17500\ mm^2$

Step 7:

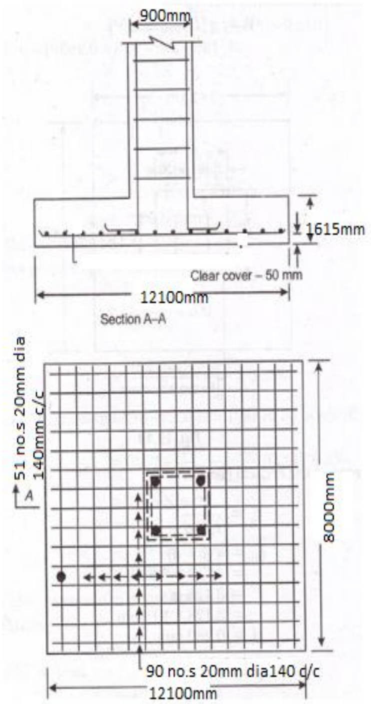
Assume 20 mm diameter bars

Spacing= (One bar area/area of steel) x B

$=[((3.14 \times 20^2)/4)/(17500)] \times 8000$

= 143.54 ~ 140mm c/c spacing

Hence, we provide 20 mm diameter bars @ 140 mm c/c spacing.



Plan showing the details of reinforcement

Design of Pile:

Total load = axial load + pile cap load

Pile cap load= volume of pile cap x unit weight of concrete

= 8 x12.1 x 1.615 x 25

= 3908.3 kN

Axial load = 13187 kN

Total load = 13187 kN + 3908.3kN

= 17095.3 kN

Assumption made on Soil charactrestics:

Unconfined compressive strength of clay(q_u)=150 kN/m^2

Adhesion factor(a)=0.6

Diameter of pile(d)=1m

Length of pile=20m

Factor of safety=2.5

N_c=9

Step 1: Cohesion= $q_u/2 = 75\ kN/m^2$

We know that for group failure

$Q_g = CN_c\ A_b + (a \times C \times A_s)$

$A_b = B \times B$

B= 3S+d

Spacing of pile(S)=2d=2 x1=2m

B=3 x2 +1=7m

Perimeter(P)=4 xB=4x 7=28m

$A_b = 7 \times 7 = 49m^2$

A_s= Perimeter x L=(4 x7) x 20= 560m^2

Then $Q_g = 75 \times 9 \times 49 + 0.6 \times 75 \times 560$

Q_g = 58725 kN ------------------------------(1)

Step 2: Individual failure

Q_g= number of piles x Q_u

$Q_g = n \times Q_u$

Let us assume number of piles= 16

$Q_u = A_b\ C\ N_c + aCA_s$

$A_b = (3.14 \times d^2)/4$

$= (3.14 \times 1^2)/4$

$A_b = 0.785\ m^2$

$A_s = 3.14 \times d \times L = 3.14 \times 1 \times 20 = 62.8\ m^2$

Then $Q_g = 16[\ 0.785 \times 75 \times 9 + 0.6 \times 75 \times 62.8]$

Q_g = 53694 kN -----------------------------------(2)

Take lesser value from Equations 1 and 2, we get

Q_g=53694 kN

Safe Allowable load = Q_g/Factor of safety

= 53694/2.5

=21477.6 kN

Check: Whether Safe allowable load > Axial load

21477.6 kN >17095.3 (o.k)

Step 3: Finding the area of steel

Check: If L/D <30

L/D=20/1 = 20 <30 (OK)

Then the minimum percentage of steel=1.25% of gross area of pile

Area of steel (A_{st}) = $0.0125 \times A_p = 0.0125 \times 0.785 \times 10^6 = 9812.5\ mm^2$

International Journal of Research
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p-ISSN: 2348-6848
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Let assume , if we provide 25mm diameter of bar

Area of steel provided(a_{st})=[3.14 x(25)^2]/4=490.625 mm^2

Then number of bars=A_{st}/a_{st} =9812.5/490.625 = 20

Hence, we provide 20 number of bars with 25 mm diameter.

Step 5: Finding the spiral reinforcement

Assume a bar with 12mm diameter for ties

Clear cover=100mm

Volume of each tie= Perimeter x Area

= 3.14 x (1000-200) x [(3.14 x12x12)/4]

= 283956.48 mm^3

Volume of spiral reinforcement per length of pile=0.6 % of area of pile

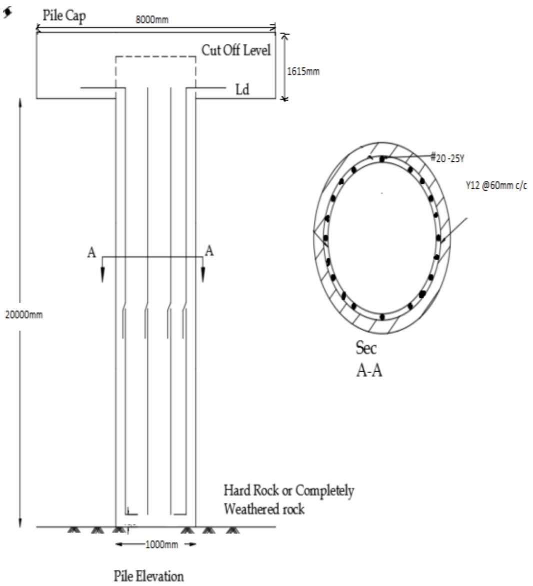
= (0.6/100) x ((3.14 x1000 x1000)/4)

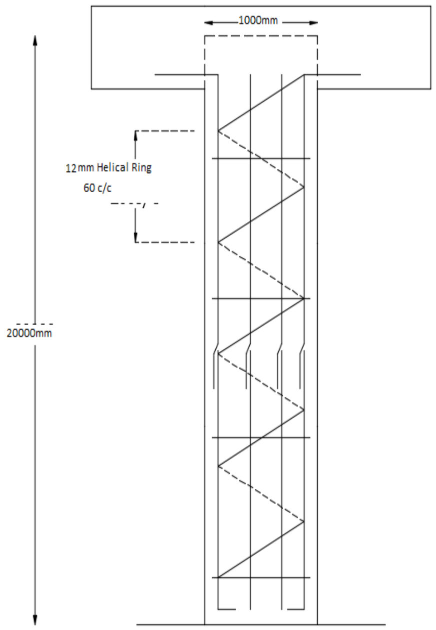
= 4710 mm^3

Spacing =Volume of each tie/Volume of each spiral reinforcement

= 283956.48/4710

= 60.28 ~ 60 mm c/c





CONCLUSIONS

- From the analysis results the storey shear was maximum at base of the structure.
- Point displacement at base of the storey is zero in all zones.
- Point displacement increases from base of the storey to top storey in all zones.
- Point displacement increased for zone place increased.
- Point displacement in Zone-II is less compare to Zone –III.
- Point displacement in Zone-III is less compare to Zone-IV.
- Point displacement in Zone-IV is less compare to Zone-V.
- Storey drift at base of the storey is zero in all zones.
- Storey drift increased from base storey to 8th storey. From 9th storey to 12th storey the storey drift decreased and from 13th storey to 18th storey the storey drift decreased. But increased from 12th storey to 13th storey.
- Storey drift more in Y-axis when compare to X-axis.
- Storey Drift increased for zone place increased.

- Storey shear decreased from top storey to bottom storey in all zones.
- Storey shear in Zone-II is less compare to Zone –III.
- Storey shear in Zone-III is less compare to Zone-IV.
- Storey shear in Zone-IV is less compare to Zone-V.
- Usage of ETABS software minimizes the time required for analysis and design.
- We go for Deep foundation for low bearing soil because it didn't support loads came from the structure.
- We adopt the Bored cast in-situ pile with pile cap for low bearing soil based on IS 2911(Part 2):2010.

Scope of future work:

Earthquake-resistant design of structures has grown into a true multi-disciplinary field of engineering wherein many exciting developments are possible in the near future.

Most notable among these are:

(a) a complete probabilistic analysis and design approach;

(b) performance-based design codes;

(c) multiple annual probability hazard maps for response spectral accelerations and peak ground accelerations with better characterization of site soils, topography, near-field effects;

(d) new structural systems and devices using non-traditional civil engineering materials and techniques; and

(e) new refined analytical tools for reliable prediction of structural response, including nonlinearity, strength and stiffness degradation due to cyclic loads, geometry effects and more importantly, effects of soil–structure interaction.

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