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Design and analysis of high rise building under different types of soil condition with and without shear wall using ETABs software

[1] Omkar P. Patil ,[2]prof . S .M . Kazi

[1]P.G. STUDENT , DEPARTMENT OF CIVIL ENGINNERING, KJEI's TRINITY COLLEGE OF ENGINNRING AND RESEARCH, PUNE , MAHARASTRA, INDIA

[2]ASSOCIATEPROFESSOR , DEPARTMENT OF CIVIL ENGINNERING, KJEI's TRINITY COLLEGE OF ENGINNRING AND RESEARCH, PUNE , MAHARASTRA, INDIA

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ABSTRACT - Most earthquakes are caused by sudden energy release at a dislocation or rupture in crustal plates occurs due to natural or artificial reason. So, soil types and earthquake parameter are very much important while planning, constructing and designing any structure. Most of the structural failures occurred in the structure due to inadequate stiffness, strength and irregularities present in it. In this project work, behavior of regular and vertically irregular high rise G+50 story building in seismic zone V for soft, medium and hard strata is studied. Regular and vertically irregular building frames are modelled &analysed in ETABS software. The results are tabulated and graphs are plotted for base shear, time period, displacement and drift. The seismic analysis is done according to IS 1893:2002 part 1 by using the dynamic analysis method. For seismic zone V & soft, medium and hard soil strata are taken for comparative study.In Our Project contains a brief description and analysis of Symmetrical frame having 25storey building with shear wall and without shear wall with different types of soil condition for highly seismic area i.e. zone-5, thoroughly discussed structural analysis of a building to explain the application of shear wall. The design analysis of the multi storied building in our project is done through software ETABs.

KeyWords: Seismiceffect,windeffect,damageprobabilities,storydisplacement,storydrift, BASE SHEAR , modal time period.

I. INTRODUCTION

Reinforced concrete framed buildings are adequate for resisting both vertical and the horizontal loads acting on them. When the buildings are tall say more than 10 storey's or so, beam and column sizes work out large reinforcement at beam-column junctions works out quite heavy, so that there is a lot of congestion at these joints and it is difficult to place and vibrate concrete at these places, which fact, does not contribute to the safety of buildings. These practical difficulties call for introduction of shear wall in multi-story buildings. A shear wall is a structural element used to resist lateral/horizontal/shear force parallel to the plane of wall is called shear wall.

- Shear wall resist the lateral or horizontal force by cantilever action for slender wall where bending deformation is dominant.
- Shear wall resist the lateral or horizontal force by truss action for short wall where shear deformation is dominant.

1.1 StagesinStructuralDesign

Everystructurefollowsaspecificpathfromitsinitiation toultimatedesignasfollows:

1) Structuralplanningofthebuilding.
2) Calculationofappliedloads.
3) Structuralanalysisofthebuilding
4) Designofthebuildingasperanalysis.
5) Drawinganddetailingofthestructuralmembers.
6) Preparationoftablesandgraphs.
7) It is the responsibility of the structural engineer toconstruct the building structurally good, consideringall the loads acting on the building. There are so manymethodsofconductingthesedesignweuseE-tabsoftware.

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1.2 IntroductiontoE-tab

For nearly 30 years, ETABS has been recognized as theindustrystandardforBuildingAnalysisandDesign Software. Today, continuing in the same tradition, ETABShas evolved into a completely Integrated Building AnalysisandDesignEnvironment.TheSystembuiltaroundaphysical object based graphical user interface, powered bytargeted new special purpose algorithms for analysis anddesign, with interfaces for drafting and manufacturing, isredefiningstandardsofintegration,productivityandtechnicalinnovation.Theintegratedmodelcaninclude MomentResistingFrames,BracedFrames,Staggered TrussSystems,Frames withReducedBeamSectionsor Side Plates, Rigid and Flexible Floors, Sloped Roofs, Rampsand Parking Structures, Mezzanine Floors, Multiple TowerBuildings and Stepped Diaphragm Systems with ComplexConcrete, Composite or Steel Joist Floor Framing Systems.SolutionstocomplexproblemssuchasPanel ZoneDeformations,DiaphragmShearStresses,andConstruction Sequence Loading are now at your fingertips.ForBuildings,ETABSprovidestheautomationandspecialized options needed to make the process of modelcreation, analysis and design fast and convenient. Tools forlaying out floor framing, columns, and frames and walls, inconcreteorsteel,aswellastechniquesforquicklygenerating gravity and lateral loads offer many advantagesnotavailablefrommostgeneralpurposefiniteelementprograms.Seismicandwindloadsaregeneratedautomaticallyaccordingtotherequirementsoftheselectedbuilding code. All of these modeling and analysis optionsare completely integrated with a wide range of steel andconcrete design features. Full dynamic analysis, includingnonlineartime-historycapabilitiesforseismicbaseisolation and viscous dampers, along with static nonlinearpushover features offer state of the art technology to theengineer doing performance design. Powerful features fortheselectionsandoptimizationofverticalframingmembers as well as the identification of key elements forlateral drift control provide significant time savings in thedesigncycle.

1.3 GettingStarted

Thispaperincludesdetailedinformationonthemethodologyto analyze and design ahighrise structureon E-tab software. Model generation, fixation of supports,loadanalysisandfinallybuildingdesign.Step bystepprocedure has been explained with the help of diagrams.Nexttothat,loadcalculationshavebeenexplainedindepthandeffectofseismicandwindcalculationshavebeen undertaken.

II. LITERATURE REVIEW

Xiao–Weizheng,Hong-NanLi,Yeong–BinYang,GangLi,(2019)(1)In this paper they studied about multihazardbased framework to access the damage risk of high risebuildingsubjectedtoearthquakeandwindhazardseparately and simultaneously .Numerical values indicatethatthedamageprobabilityandcontributionofeachhazardconditionsaresensitivetodamageseverity. theextensive application highlight the necessity of examiningtheresponsesofhighrisebuildingssubjectedtomultihazard.

FerraretoA.Johann (2018)(2) In this paper they studiedaboutaccessingtallbuildingoscillationsdueto wind–inducedmotionisamultidisciplinarytaskthatinvolveknowledgefromseveralfieldsofstudy,includingstructural engineering ,wind engineering ,reliability ,andevenhumanphysiology .

Alfonso Vulcano ,(1998)(3)this paper presented a studyaboutbasedisolationisaveryeffectivetechnicfor reducing the seismic forces trough a de coupling of thestructure option from that of the soil. With regard to theearthquake, the insertion of very flexible based isolationsystem is generally favorable, particularly for reducing theductilitydemand.mainpurposeofthispaperistoconclude the dynamic response of base isolated structuressubjected to strongearthquakesand wind loads in ordertoachieveanoptimaldesign ofthebaseisolationsystem.

Siu-KuiAu,Feng-Liangzhang,pingTo,(2011)(4)Thispaperdescribesobservationontheidentifiedmodelproperties of two tall buildings using ambient vibrationdata collected during strong wind moments. The approachviews model identification as an inference problem whereprobability is used as a measure for the relative possibilityofoutcomegiveninamodelofthestructureandmeasureddata.identificationoftheidentifiednatural frequencies and damping ratios verses the model root –mean-squarevalueindicateasignificanttrendthatisstatistically repeatableacrossevents.

DatDuthinh1andEmilSimiu2,(2010)(5)Inaccordancewith the ASCE Standard 7-05, in regions subjected to windandearthquakes,structuresaredesignedforloadsinduced by wind and, separately, by earthquakes, and thefinal design is based on the more demanding of these twoloading conditions. Implicit in this approach is the beliefthatthestandardassuresrisksofexceedanceofthe specified limit states that are essentially identical to therisksinherentintheprovisionsforregionswhereonlywindorearthquakesoccur.Wedrawtheattentionofdesigners, code writers, and insurers to the fact that thisbeliefis,ingeneral,unwarranted,andthatASCE7provisionsarenotriskconsistent,i.e.,inregionswithsignificant wind and seismic hazards, risks of exceedanceoflimitstatescanbeuptotwiceashighasthoseforregionswhereonehazarddominates.

AzlanAdnan,SuhanaSuradi,(2008)(6)Thisstudyaddressestheperformanceofreinforcedconcretebuildings with the comparison on the effect of earthquakeand wind loads for existing buildings in Malaysia, so thatthe adequacy of the design capacity can be checked. Thisstudy investigated seven existing buildings from West andEast Malaysia. The buildings were categorized as mediumandhigh-risereinforcedconcretemomentresistingframes.

Sanchitahirde (et.al) (7) The paper presented a study onthe severity of earthquake verses against wind forces ormulty story RCC building the main aim is to analyze themultistoriedstructuresituatedinwindzoneviandcompareitsperformancetothebuildingssituatedinzonev the analysis is carried out using the software ETABS .heobservedthattheeffectofbothearthquakeforcesand wind forces on multistory building increases with increaseinheightofabuilding.

III. OBJECTIVES

The main objective of this paper is to undergo lateral loadanalysis and design of high rise building subjected strongwind and earthquake on E-Tab. The objectives have beenspecifiedasfollows:

1. Modelling of 24 -storey building and application of different loads on ETABs.
2. The main objective is to check Seismic response on shapes of buildings via rectangular shape, and square shape in different Zones of India and design earthquake resistant multistoried building on that basis using ETABs software.
3. Seismic analysis of multi-storied building before construction work using ETABs software
4. Study of reactions, shear forces, axial force, bending moment, seismic forces and node displacement during assigning process and restrained them by applying suitable property and material in different zones.
5. Modelling of 25 storey building and application of different loads on ETABS load calculations due to different loading combinations analysis and design of structure on ETABS.
6. To anaylsis the building using IS code 1893 (part 1): 2002 for seismic analysis.
7. Compare the results coming from shear wall design and column design with seismic analysis.

IV. METHODOLOGY TO UNDERTAKE ANALYSIS AND DESIGN OF G+15 BUILDIN GONE-TAB.

The analysis and design is undertaken as per IS 456:2000.M25 concrete and FE500 is used as design parameters.Percentage steel of 4% has been specified as per IS Codestandards and the design parameters have been assignedto respective beam and column. After the final design ofthe structure, the output file is generated containing thestructuraldesignofeveryindividualbeamandcolumnmember.

ANALYSISOFG+25BUILDING

Linear static method of analysis is selected for the givenstructure. This approach defines a series offorces actingonthebuildingtorepresenttheeffectofearthquakegroundmotionandstronglateralforcessuchaswind,typically defined by a seismic design response spectrum. Itconsidersthatthebuildingvibratesinitsfundamental mode. Forthis to be true, thebuildingmustbe low-riseand must not twist significantly when the ground movesandincaseofstrongwind.Theseismiczoningmapof India is given below categorizing every zone as zone II, IIIandIV,V

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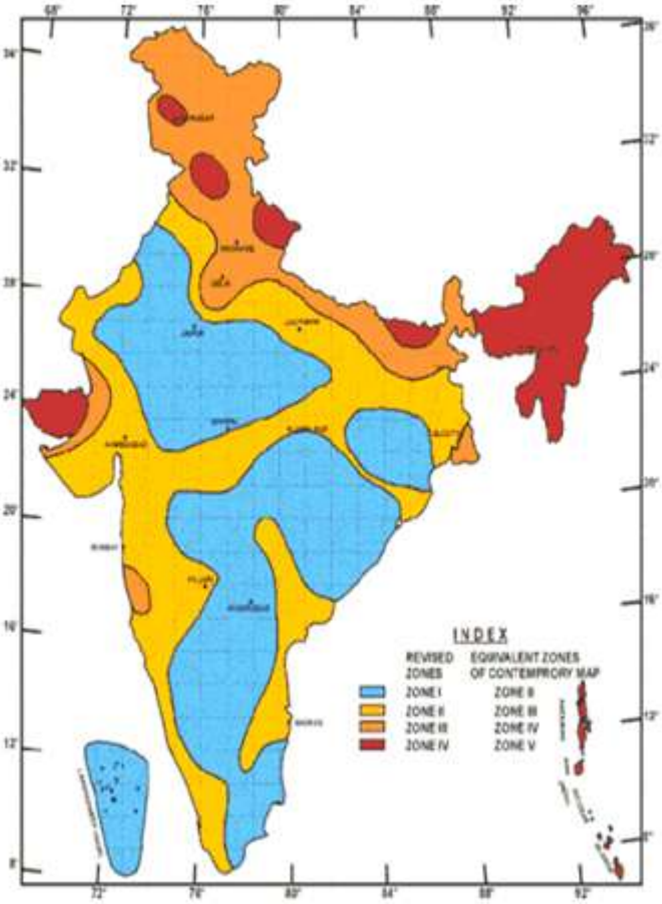

Fig.no.1: SeismicZoningMapofIndia

Response Spectrum

Theresponsespectrumcoefficientconsideredasper IndianStandardsforthepurposeofdesign,whichisshown in the figure shown below for different soil typebasedon suitablenaturalperiods and dampingratioofthe structure. The spectral acceleration coefficient (Sa/g)consideredasper IS 1893(Part1):2002isgivenbelow

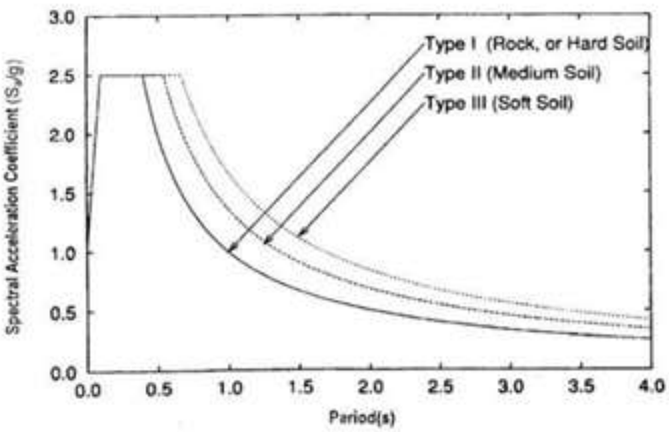

Fig.no.2:Responsespectrafor5%damping

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Project Statement
A structure considered here is a residential building with plandimension.ForwindloadIS875(1987)part-3isused andIS:1893(part-1)2002isusedforseismic loading.

Tableno1:Specificationofbuildingmodel

Total height of building	72.3 m		
Height of each story	3m		
Thickness of slab	125mm		
Grade of reinforcing steel	Fe500		
Density of concrete	25 KN/m3		
Grade of concrete for beam ,coulumn and shear wall	M25		
Seismic zone	V		
Seismic zone factor	0.36		
Soil condition	Hard	Medium	Soft
Soil interaction factor	1	2	3
Response reduction factor	4		
Importance factor	1.2		
Damping ratio	0.05		
Column size RCC	Ht 0 m to 30 m	700 m X 700 m	
	Ht 30m to 60 m	600 m X 600 m	
	Ht 60 m to 90 m	400m X400m	
Thickness of shear wall	300mm (Ht 0m to 27m)		
	250mm (Ht 27m to 60m)		
	150 mm (Ht 60 to 90 m)		

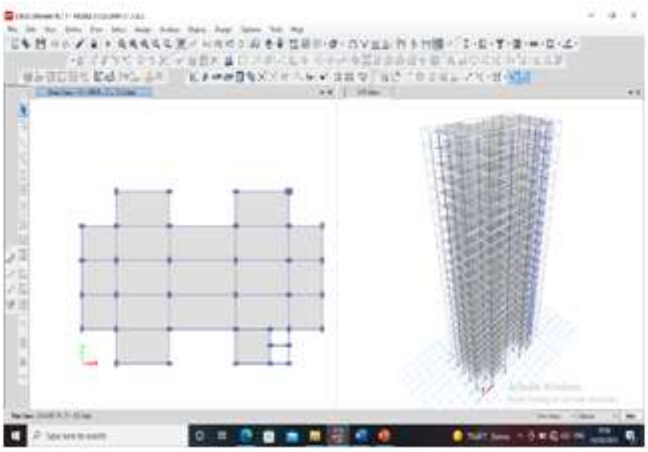

Fig.no.3:PlanviewofG+25RCbuilding.

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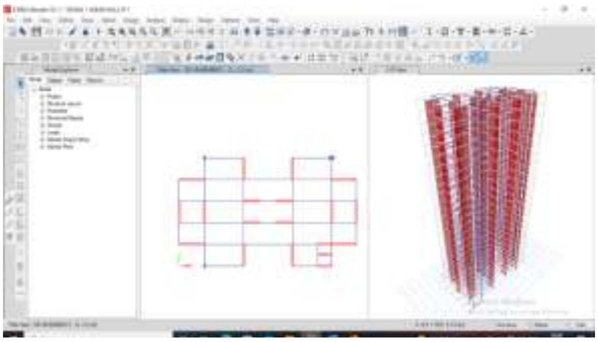


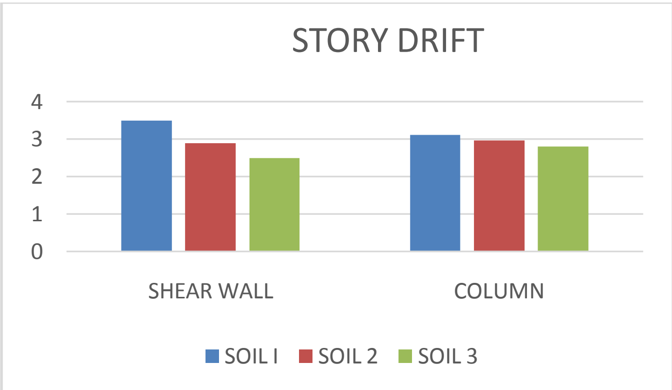
Fig.no.4: plan view of shear wall building G+25

V. RESULTS AND DISCUSSION

STORY DRIFT: Story Drift is the lateral displacementof one level relative to the level above or below. StoryDriftRatioisthestorydriftdividedbythestoryheight.
Values of drift at different story is given in following tableandshownbygraph.

Tableno.2:StorydriftofG+25RCBuilding

STORY DRIFT	SOIL I	SOIL II	SOIL III
SHEAR WALL	0.000351	0.000296	0.000253
COLUMN	0.000312	0.000297	0.000280



Graphno.1-Max.StorydriftofG-25Building

StoryDisplacement:
It is defined as the displacement of a story with respect tothe base of a structure. Values of displacement of differentstoryisgivenbyfollowingtablesandgraphs:

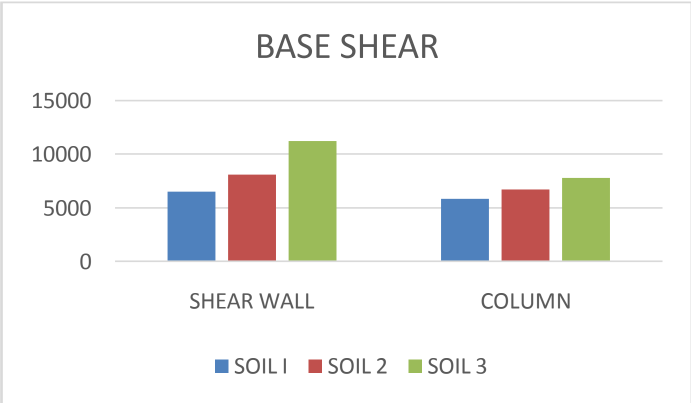
Tableno.3:StorydisplacementofG+25RCBuilding

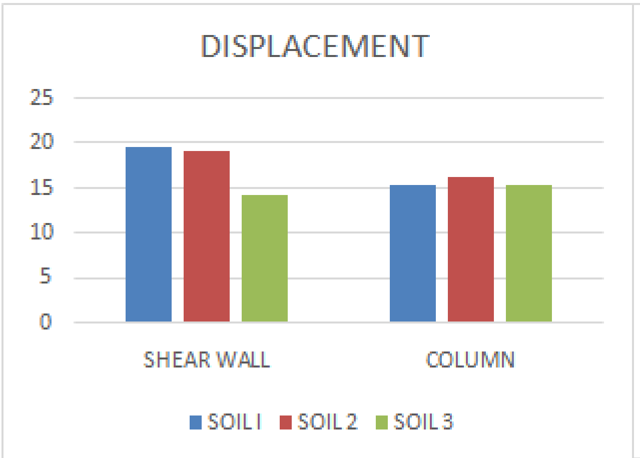
DISPLACEMENT	SOIL I	SOIL II	SOIL III
SHEAR WALL	19.37	18.97	14.16

COLUMN	15.19	16	15.11

BASE SHEAR VALUE:

Base Shear	SOIL I	SOIL II	SOIL III
SHEAR WALL	6545.48	8099	11250
COLUMN	5850	6719	7798





DISPLACEMENT For EARTHQUAKE AND RESPONSE SPECTRUM

VI. CONCLUSIONS

1. In building having no shear wall drift increases in initial 4 or 5 stories there after it remain constant about 2/3 of total height and then it decreases. A kink is observed where column sections are changed.
2. Irrespective of type of provision of shear wall. In case of 70m height building drift increases gradually up to ½ of total height and there after it is almost constant in all the cases. In all the cases it is well within permissible limit.
3. In case where full shear wall and Stepped shear wall show proper drift reduction factor upto 3/4 of total height.
4. Gradual reduction in thickness of shear wall has better drift control.

5. For soil condition hard and medium the drift reduction factor decrease drastically in above storey due to which shear wall acts negatively in drift control as compare to frame structure.
6. For soil condition soft stepped shear wall show proper drift control.
7. Gradual reduction shear wall maybe saved in investment without impairing structural strength.
8. For Different cases of 70m heighted building for different condition of soil in which the permissible drift exceed for soft soil condition especially where column section and Shear wall section are changes up kink sudden change observed.

VII. ACKNOWLEDGEMENT

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REFRANCES

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