JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Literature Review on Seismic Analysis of RCC Building with different aspect ratio and different soil types with zones III

Ratnakala Borkar[1], Dr.V.D.Vaidya[2]
[1]M.Tech Students in structural engineering, Department of civil engineering,
K. D. K. College of engineering, Nagpur, Maharashtra, India
[2] Assistant Professor Department of civil engineering
K. D. K. College of engineering, Nagpur, Maharashtra, India

ABTRACT: As per the previous records of earthquake there is an increase in the demand of use of earthquake resisting structures. So it is necessary to design and analysis the structure by considering seismic effect. The present paper gives an overview of different research works to be done regarding the study of multi-storey RCC building with different aspect ratio and different soil types with zones. After study all research paper we gave the conclusion in this paper of the different aspect ratio of the RCC building with different soil types in seismic zone the help. This paper presents overview of literature related to the effect of soil structure interaction. The review includes literature based on software analysis and experimental results.This literature review delves into the seismic analysis of reinforced concrete (RCC) buildings, considering variations in soil types and aspect ratios. Seismic performance is influenced by numerous factors, including soil characteristics and building geometry. Understanding how these variables interact is crucial for designing resilient structures in seismic prone regions. This paper aims to synthesize existing research on the effects of soil types and aspect ratios on the seismic response of RCC buildings. By examining various studies this review highlights the methodologies employed, key findings, and areas for further investigation. Insights gleaned from this review can inform engineers and researchers in optimizing the seismic performance of RCC building across diverse geological and structural conditions.

KEYWORDS: seismic analysis, RCC buildings, soil types, aspect ratio, seismic performance, literature review

INTRODUCTION:

Reinforced concrete (RCC) buildings are vital components of urban infrastructure worldwide, providing shelter, workspace and essential services to millions of people. However in regions prone to seismic activity, the structural integrity of these buildings is continually challenged. Seismic event can induce significant forces and deformations, leading to damage or even collapse if structures are not adequately designed and constructed to withstands such forces

The seismic performance of RCC buildings is influenced by various factors, including soil types and building aspect ratio. Soils conditions beneath a structure play a crucial role in transmitting seismic forces to the foundation, affecting the building's dynamic response during an earthquake. Likewise, the aspect ratio, defined as the ratio of building height to its base dimension, influences the distribution of mass and stiffness within the structure, thereby impacting its seismic behaviour.

Understanding the interplay between soil types, aspect ratios, and seismic response is essential for designing resilient RCC buildings. Researchers and engineers are conducted numerous studies to investigate these relationships, employing analytical, numerical, and experimental approaches. By synthesizing and analysing existing literature, this review aims to provide insights into the currents understanding of seismic analysis concerning different soils types and aspect ratios in RCC buildings. Additionally, it seeks to identify gaps in knowledge and area for future research to enhance the seismic performance of RCC structures in diverse geological and structural contexts

LITURATURE REVIEW:

1. ***Abhay Guleria. (2014)*** This paper presents a case study focusing on the structural behavior of a multi-storey building with different plan configurations, including rectangular, C, L, and I-shapes. The study involves modeling a 15-storey reinforced concrete (R.C.C.) framed building using ETABS software for analysis. Following the structural analysis, key parameters such as maximum shear forces, bending moments, and maximum storey displacement are computed and compared across all analyzed cases. The objective is to assess how varying plan configurations impact the structural response of the building under seismic loads. The findings offer valuable insights into the effectiveness of different building shapes in mitigating seismic forces and guiding structural design decisions for improved resilience against seismic events.
2. ***Amir Hassan, Shilpa Pal (2018).*** The study involves modeling using ETABS software for analysis, aiming to assess the impact of varying plan configurations on key parameters such as maximum shear forces, bending moments, and maximum storey displacement under seismic loads. Through post-analysis comparison, insights into the effectiveness of different building shapes in mitigating seismic forces and guiding structural design decisions are provided to enhance resilience against seismic events**.**
3. ***Arun Babu M, Ajisha R (2018).*** This paper investigates the effect of high-rise buildings in varied seismic zones and soil conditions, focusing on G+10 storey structures. Using ETABS software, three-dimensional modeling and analysis are performed to assess structural performance. The study compares story displacement and base shear to identify which building demonstrates superior resilience against earthquakes. The findings offer insights for optimizing structural design and mitigating seismic risks in diverse geological settings.

4. ***Gourav Sachdeva, Vinamra Bhushan Sharma (2017).*** This paper explores the effect of high-rise buildings in varied seismic zones and soil conditions, focusing on G+10 storey structures. Through three-dimensional modeling and analysis using ETABS software, the study evaluates structural performance by comparing story displacement and base shear. The findings provide valuable insights for optimizing structural design and mitigating seismic risks across diverse geological settings.
5. ***W. Bourouaiah (2019).*** The study focuses on modeling the interaction between concrete walls and soil under seismic loading. Its purpose is to assess the effects of soil properties and soil-structure interaction on the seismic response of the structure. The findings demonstrate that soil properties significantly influence the seismic behavior of a structure. Additionally, Arnold and Reitherman (1982) addressed several seismic design considerations.
6. ***Arnold and Reitherman (1982)*** .The study aims to analyze the interaction between concrete walls and soil under seismic loading, intending to evaluate the impact of soil properties and soil-structure interaction on the structure's seismic response. Results indicate a substantial influence of soil properties on seismic behavior.
7. ***C.V.R.Murty (2005)*** In "Multi-Dimensional Building Planning for Safer Tomorrow," emphasis is placed on the significant advantage in seismic performance that arises from timely collaboration between architects and structural engineers. It is noted that a building with poor configuration will never withstand a damaging earthquake effectively.
8. ***Snigdha A. Sanyal (2008)*** In "Multi-Dimensional Building Planning for Safer Tomorrow," emphasis is placed on the significant advantage in seismic performance that arises from timely collaboration between architects and structural engineers. It is noted that a building with poor configuration will never withstand a damaging earthquake effectively.
9. ***Pawan Pandey & Dilip Kumar (2014)*** studied in Seismic load Effect on Building Configuration, that the behavior of building during Earthquake depends critically on its overall shape, size and geometry. The Seismic performance of building and new design methods should account for the building ability to dissipate energy and the effect of the lateral deformation.
10. ***Sanjay Kumar Sadhu and Dr. Umesh Pendharkar***. In their study on the effect of aspect ratio and plan configurations on the seismic performance of multi-storeyed regular R.C.C. buildings, it was observed that seismic parameters escalate with an increase in the number of bays and stores. Additionally, they concluded that a square configuration (horizontal aspect ratio=1) yields superior performance, and it is advisable to maintain a vertical aspect ratio of less than 4.
11. ***Dileshwar Rana, Prof. Juned Raheem (2015)***. The project demonstrates the performance and behavior of regular and vertically geometric irregular RCC framed structures under seismic motion. Five types of building geometries are considered: one regular frame and four irregular frames. A comparative study is conducted among these building configurations based on height and bay-wise variations. Changes in different seismic responses are observed across different heights, providing insights into the structural response under seismic loading.

12. ***Dr D.P.Joshi*** The paper focuses on studying various cases of aspect ratios of buildings under wind and earthquake forces. It examines the analysis and design of a G+30 storey building with different aspect ratios. By considering different aspect ratios, the study aims to draw concluding remarks based on the results obtained from the analysis. The research aims to provide insights into how aspect ratio influences the structural response to wind and earthquake forces, ultimately informing optimal design practices for high-rise buildings to ensure structural integrity and safety.
13. ***Mahadeva et al. (2014)***. The paper you've described focuses on the criteria for earthquake-resistant design of structures, particularly emphasizing the importance of understanding soil-structure interaction and employing appropriate foundation systems. It employs spectrum analysis to assess seismic response for different soil types and considers the structure and soil as a single continuum model. By analyzing 3D frames using SAP 2000 V14 software, the study evaluates the effectiveness of various foundation systems, including raft foundations, in mitigating seismic forces. Additionally, the paper delves into the energy transfer mechanism from substructure to superstructure during earthquakes, highlighting its significance in designing earthquake-resistant structures and renovating existing ones. Given the increasing importance of soil-structure interaction, further research in this area is deemed crucial for advancing earthquake engineering practices.
14. ***M. Yousuf, P.M. shimpale (2013).*** The paper you mentioned aims to minimize structural damage during earthquakes by dynamically analyzing reinforced concrete structures with plan irregularities. It investigates four models of G+5 buildings, including one with a symmetric plan and the others with irregular plans. Using ETABS 9.5 software, the study assesses various responses such as lateral forces, base shear, storey drift, and storey shear. Additionally, the effectiveness of different cross-sections in columns in resisting lateral forces is examined to enhance structural stability and seismic performance. This analysis provides valuable insights into optimizing structural design to mitigate earthquake-induced damage and improve overall structural resilience
15. ***Bhalchandra P. Alone, Dr. Ganesh Awchat (2017).*** The paper discusses a case study on the seismic analysis of a high-rise building system consisting of a ground floor, three basements, and fifty storeys of reinforced concrete construction. It utilizes STAAD PRO V8i software and incorporates relevant provisions from the Indian Standard (IS) codes. The study focuses on comparing the seismic performance of different models based on parameters such as storey drift, base shear, story deflection, and time period. By analysing these factors, the research aims to evaluate the structural response to seismic forces and assess the effectiveness of various design approaches in ensuring seismic resilience and safety parameters considered in this study are to compare the seismic performance of different models based on storey drift, base shear, story deflection and time period.
16. ***K Venu Manikanta , Dr. Dumpa venkenteswarlu (2016).*** The study aims to conduct a detailed analysis of simulation tools ETABS and STAAD PRO for the design and analysis of multi-storey buildings with rectangular plans, comparing regular and geometrically irregular configurations. The primary focus is to highlight the advantages of using ETABS over the current practice of using

STAAD PRO versions. It identifies ETABS as more user-friendly, accurate, and compatible for analysis and design results compared to STAAD PRO. Additionally, the study aims to discuss various advantages of ETABS and potential drawbacks of both software platforms. The author considered four shapes of the same area to facilitate a comprehensive comparison between the two software tools.

17. ***Kale, S. A. Rasal*** .The author considered four shapes of the same area multi-storey model and analysed them using the guidelines provided by IS -875-part 3 & IS 1893-2002 part 1. The behaviour of buildings with 15, 30, and 45 storeys was studied, focusing on parameters such as story displacement, drift, base shear, overturning moment, acceleration, and time period. The study aimed to draw conclusions regarding the convenience of different structural sections and determine whether seismic or wind effects are more critical in influencing the building's behaviour. By comparing the performance of various structural configurations under different loading conditions, the research aimed to provide insights into optimizing structural design for enhanced safety and performance against both seismic and wind forces.
18. ***Lekhraj k pandit, swapnil jadhav (2017).*** The analysis and design of a G+9 storey building with various aspect ratios, all having the same area of 2000 square meters, were considered in the study. It was observed that as the aspect ratio increases, the storey displacement also increases. Particularly, the displacement in the x-direction was found to be significantly greater than the displacement in the y-direction when subjected to earthquake loads. This observation underscores the importance of considering aspect ratio in structural design to accurately assess and mitigate potential displacement and deformation under seismic forces, ensuring the structural integrity and safety of the building.
19. ***Philip Mckeen, Alan S. Fung (2014).*** The study focuses on analyzing the energy consumption of multi-unit residential buildings in Canadian cities, considering varying aspect ratios. The aspect ratio of a building plays a crucial role in determining its energy efficiency by influencing heat transfer between the interior and exterior environment and the amount of building area subject to solar gain. The paper evaluates how the relationship between building geometry and location impacts energy efficiency, aiming to identify a design vernacular for energy-efficient buildings across Canada. By examining how different aspect ratios interact with climatic conditions, the study provides valuable insights into optimizing building design to reduce energy consumption and enhance sustainability in diverse Canadian urban environments.
20. ***Shmuel wimer, D.J.L. Kennedy March 1989.*** The paper presents a practical algorithm aimed at determining building blocks in a way that minimizes the area occupied by the building. This algorithm takes into account the variance of building blocks' dimensions, which can influence how blocks are assigned to different levels of a tree-like structure. By considering both the minimization of area and the variance of building block dimensions, the algorithm aims to optimize the layout and design of buildings, potentially leading to more efficient land use and construction practices.
21. ***S .Mahesh, B. Panduranga Rao (2014).*** The multi-storey building with both regular and irregular configurations under earthquake and wind loads. Using ETABS and STAAD PRO V8i software,

linear static and dynamic analyses are performed assuming linear material properties. The study considers various seismic zones and assesses the building's behaviour for each zone using three different types of soils: hard, medium, and soft. Different responses such as story drift, displacement, and base shear are plotted for each zone and soil type. By analysing these responses, the paper aims to provide insights into the structural performance of the building under combined earthquake and wind loads, considering different soil conditions and seismic zones.

22. ***Bharkha verma, prince wanjari, bhavika baghel (Jan 2022).*** The paper presents findings indicating that the storey displacement is greatest in a building with two spans (square configuration) and lowest in a building with twenty spans (rectangular configuration). This suggests that the structural response to seismic or wind loads varies depending on the building's span configuration. The results highlight the importance of considering building geometry and span configuration in structural design to optimize performance and mitigate displacement under various loading conditions.
23. ***Mohammed Rizwan Sultan, D.Gouse Peera (August 2015)*** .The paper indicates that irregularly shaped buildings are severely affected during earthquakes, particularly in high seismic zones. These buildings experience more deformation compared to regular-shaped buildings, emphasizing the importance of preferring regular-shaped structures in seismic design. The results of the study demonstrate that C-shaped buildings are more vulnerable compared to other shapes, highlighting the need for careful consideration of building geometry in earthquake-resistant design to enhance structural resilience and minimize damage during seismic events
24. ***Himanshu Krishna and Prince Yadav (2022)***. The research aimed to analyze the seismic performance of multi-story G+4 buildings with rectangular columns compared to buildings with unique-shaped columns. The study conducted comparable static analyses for buildings located in zone III soil a condition, following IS Code 1893 (part 1):2016 guidelines. The models were analyzed using ETABS software. The findings indicate that buildings with unique columns experience fewer deflections, drifts, and shear forces compared to buildings with standard rectangular columns. Moreover, buildings with unique columns demonstrate higher rigidity than those with standard columns. The research suggests that utilizing customized columns in construction could potentially enhance safety compared to using conventional rectangular columns.
25. ***Mylonakis et al. (2010)***. The paper analyzes the impact of soil-structure interaction (SSI) on the seismic response of structures. It begins by discussing how current seismic provisions address SSI effects. Specifically, it explores how response spectrum specifications in building codes, coupled with increased fundamental period and effective damping due to SSI, tend to reduce base shear in structures. However, in certain seismic and soil conditions, the increase in fundamental natural period caused by SSI may have adverse effects on seismic demand.

    Additionally, the paper examines the seismic response of an inelastic bridge pier, a commonly used structural model for assessing SSI effects. Through theoretical and numerical analysis, the paper demonstrates that inaccuracies in applying ductility concepts and geometric relations can lead to erroneous conclusions regarding seismic performance. The paper presents numerical examples to highlight critical issues related to SSI, providing insights into the complexities of the problem and emphasizing the importance of accurate modeling and analysis techniques in assessing seismic response

26. ***Anand et al (2010)***. The study analyzed the seismic behavior of RCC buildings with and without shear walls under various soil conditions. One to fifteen-story space frames were modeled and analyzed using ETABS software for different soil conditions (hard, medium, soft). The study compared values of base shear, axial force, lateral displacement, and moment in the column between frames with and without shear walls.

    The findings indicate that lateral displacement, base shear, axial force, and moment in the column increase when the soil changes from hard to medium and from medium to soft for all building frames. This suggests that soil conditions significantly influence the seismic response of structures. The study emphasizes the importance of considering soil-structure interaction in the design of frames to withstand seismic forces effectively. Incorporating soil-structure interaction in seismic design is crucial for ensuring the structural integrity and safety of buildings under earthquake loading.

27. ***Matinmanesha et al. (2011)*** .The paper presents an idealized two-dimensional plane strain finite element seismic soil-structure interaction analysis conducted using the Abacus V.6.8 program. The study records ground motion from low, intermediate, and high-frequency content earthquakes. By including soil-structure effects in the analysis, the results demonstrate that sandy soil amplifies seismic waves at the soil-structure interface. During earthquakes, seismic waves propagate from the bedrock through various soil layers beneath, leading to damage to the superstructure. The effects of strong ground motion are particularly crucial for mitigating earthquake disasters and ensuring earthquake-resistant design in local building construction. This study provides insights into the behavior of soil-structure interaction during seismic events, contributing to the development of effective strategies for earthquake disaster mitigation and resilient building design.

28. ***Pandey et al. (2011)***. The paper presents static pushover analysis and Response Spectrum Analysis (RSA) of five different building configurations, including three step-back buildings and two step-backset-back buildings with varying support conditions. These configurations are analyzed for different soil conditions (hard, medium, and soft soils), idealized by equivalent springs.

    The response spectra parameters, including total base shear (V), displacement from pushover analysis, displacement from response spectra method, and response correction factor are studied with respect to fixed base analysis to compare the effect of flexible soil springs.

    In general, the study finds that the response reduction factor decreases with increasing time period, but it is expected to be constant beyond a certain value of the time period. This analysis provides valuable insights into the behavior of different building configurations under seismic loads and the impact of soil flexibility on structural response, aiding in the development of more resilient building designs.

29. ***Priyanka et al. (2012)***. The study investigated the effect of soil-structure interaction on multi-storied buildings with various foundation systems. Dynamic properties of soil can alter seismic waves as

they propagate through soil layers, influencing the response of structures during earthquakes. When a building is subjected to seismic excitation, its interaction with the foundation and soil modifies ground motion, ultimately affecting the response of the entire structure-ground system.

The research aimed to study the response of multi-storied buildings with fixed and flexible support under seismic forces, considering different soil conditions such as hard, medium, and soft. The buildings were analyzed using the Response Spectrum Method in STAAD Pro software. The study presented the response of building frames, including lateral deflection, storey drift, base shear, axial force, and column moment values for all building frames. By analyzing these parameters under different soil conditions and foundation types, the research aimed to provide insights into optimizing building design for enhanced seismic performance and resilience.

30. ***Mahadeva et al. (2014)***. The paper focuses on the criteria for earthquake-resistant design of structures, considering spectrum analysis for different types of soil conditions (hard, medium, and soft) and soil-structure interaction with various foundation systems. The analysis is conducted using SAP 2000 V14 software, treating the soil and structure as a single continuum model. The study also explores the response of buildings subjected to seismic forces with raft foundations, analyzed using the response spectrum method in SAP 2000.

    Furthermore, the paper delves into the analysis of energy transfer mechanisms from the substructure to the superstructure during earthquakes, which is a critical criterion for designing earthquake-resistant structures and renovating existing ones. The study underscores the increasing importance of researching soil-structure interaction problems to enhance the resilience and safety of structures in seismic-prone regions.

31. ***Kuladeepu et al. (2015)***. In the analysis, the soil under the raft slab was replaced with a true soil model, considering it as homogeneous, isotropic, and elastic half-space. Dynamic shear modulus and Poisson's ratio were used as inputs for the elastic continuum model of the soil.

    The study examined the influence of various parameters such as the number of stories, soil types, and height ratio for seismic zone-V. Building responses were evaluated for bare frames with and without incorporating soil flexibility. Result parameters such as lateral natural period, seismic base shear, and lateral displacement (story drift) were assessed to understand the seismic behavior of the building frames under different conditions.

32. ***Kumar et al. (2016)***. The study investigated the seismic performance of superstructures considering the interaction between the substructure and superstructures. This involved comparing the dynamic responses of structures with fixed bases to those with dynamic bases. To address this, Finite Element Method was employed to model soil-structure interaction analysis of raft foundation-supported framed structures using SAP 2000 V14 software.

    The results were obtained by considering parameters such as time period, lateral displacement, and storey drift, bending moment in X-X and Y-Y directions. Time history analysis was conducted, and parameters such as base shear and rooftop displacement of the building frames resting over the raft foundation and soil media were studied.

The study found that soil-structure interaction significantly influences various parameters, including time period, bending moment in X-X and Y-Y directions, lateral displacement, and base shear. As the flexibility of the soil increases, the bending moment also increases, highlighting the importance of considering soil-structure interaction in seismic analysis for accurate assessment of structural response and performance.

33. ***Magade et al. (2016)***. The analysis focused on the common design practice for dynamic loading, which typically assumes that buildings are fixed at their bases. The supporting soil medium allows for some movement due to its deformable properties. The flexibility of the foundation can decrease the stiffness of the structural system, resulting in an increase in the natural periods of the system. It is suggested that the soil-structure interaction effect be accounted for through the consideration of springs of specified stiffness. Therefore, the change in natural period due to the effect of soil-structure interaction may be an important issue from the viewpoint of design considerations. Accounting for soil-structure interaction in dynamic analysis is crucial for accurately assessing the response of structures to seismic forces and ensuring the safety and stability of buildings during earthquakes

CONCLUSION:

Based on the present literature review papers, the following conclusions can be drawn:

- The response of buildings is commonly analysed in terms of fundamental natural period, lateral displacement, storey drift, lateral deflection, and seismic base shear.
- Soil properties significantly influence the seismic behavior of buildings and should be considered in the design of earthquake-resistant structures.
- The aspect ratio of a building is a crucial factor in seismic analysis and design. Irregularly shaped buildings experience more deformation, highlighting the preference for regular-shaped structures.
- Seismic parameters such as base shear, storey overturning moment, storey drift, storey displacement, and model period of vibration increase with plan aspect ratio. Higher numbers of bays lead to excessively increased values of these parameters.
- Buildings with a square configuration, having an aspect ratio of 1, perform well seismically based on various seismic parameters and may be considered a suitable plan configuration option.
- Soil-structure interaction can lead to an increase in seismic base shear and time period of building frames. This effect is more pronounced in soft soils compared to hard soils with higher stiffness.
- The response of buildings is commonly analyzed in terms of fundamental natural period, lateral displacement, storey drift, lateral deflection, and seismic base shear.

These conclusions highlight the importance of considering soil properties, aspect ratio, and soil-structure interaction in seismic analysis and design to ensure the earthquake resistance of buildings.

REFERENCE:

1. Abhay Guleria , “Structural Analysis of a Multistoried Building using ETABS for different Plan Configurations”, International Journal of Engineering Research Technology (IJERT) Vol. 3Issue5,May-2014
2. Arnold,C., and Reitherman, R.,(1982), Building Configuration and Seismic Design, John Wiley & Sons, Inc., NY,USA
3. Murty, C.V.R.,(2005), IITK-BMTPC Earthquake Tips Learning Earthquake Design and Construction, National Information Center of Earthquake Engineering, IIT Kanpur, India
4. Snigdha A. Sanyal, Multi-Dimensional Building Planning for Safer Tomorrow, The 14th World Conference on Earthquake Engineering Oct. 12-17, 2008, Beijing, China.
5. IS-875-1987. (Part-1) For Indian standard code of practice for structural safety loadings standards Bureau of Indian Standards, New Delhi.
6. IS: 875-1987 (part-2) for Live Loads or Imposed Loads, code of practice of Design loads (other than earthquake) for buildings and structures.
7. Sanjay Kumar Sadhu and Dr. Umesh Pendharkar [3], “Effect of Aspect Ratio & Plan Configurations on Seismic Performance of Multi-storeyed Regular R.C.C. Buildings”: An Evaluation by Static Analysis. International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 1, January 2016).
8. Philip McKeen, Alan S. Fung, “The Effect of Building Aspect Ratio on Energy Efficiency: A Case Study for Multi-Unit Residential Building in Canada”, ISSN 2075-5309.
9. W.Bourouaiah. (2019). “Influence of the soil properties on the seismic response of structures”.IJASC.
10. Amar Hassan, Shilpa Pal. (2018). “Effect of soil condition on seismic response of isolated base buildings”. IJASC.
11. Arun Babu M, Ajisha R. (2018). “Analysis of Multistoried Building in Different Seismic Zones with Different Soil Conditions”.IJIRST
12. Bhalchandra p. Alone, Dr. Ganesh Awchat. (2017). “Study on seismic analysis of high-rise building by using software”. IJSDR
13. Gourav Sachdeva, Vinamra Bhushan Sharma. (2017).” Impact of Different Soils and Seismic Zones on Varying Height of Framed Structures”.IJIRST
14. M. Yousuf, P.M. shimpale, Dynamic analysis of reinforced concrete building with plan irregularities, Int J Emerg Techno Adv. Eng. 2013; 3(9).