TIME HISTORY ANALYSIS OF G+11 RCC BUILDINGS USING DIFFERENT EARTHQUAKE DATA

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ABSTRACT

The time history analysis of G+11 RCC buildings using various earthquake data offers significant insights into their seismic performance and resilience. This study evaluates the impact of different seismic events—Bhuj, Elcentro, Koyna, Uttarkashi, and Chamoli—on structural behavior by examining parameters such as storey displacements, drifts, base shear, and fundamental time periods. The analysis reveals that earthquake characteristics profoundly influence structural responses. For instance, the maximum storey displacement recorded was 350 mm during the Bhuj earthquake, while the Elcentro earthquake caused a maximum displacement of 320 mm. The highest inter-storey drift ratio was observed at 0.005 during the Bhuj earthquake, which also generated the maximum base shear force of 3000 kN The fundamental time period varied slightly with different earthquake data, with the Bhuj event showing a period of 2.5 seconds. These results underscore the importance of integrating region-specific seismic data in the design phase to enhance structural integrity and safety. This research highlights how dynamic responses to different seismic scenarios can guide engineers in optimizing building designs to improve earthquake resilience and minimize potential damage, contributing to the development of safer urban infrastructures.

Keywords- Time History Analysis; G+11 RCC Buildings; Seismic Performance; Storey Displacement; Base Shear; Earthquake Data; Seismic Response; Structural Resilience; Inter-storey Drift; Fundamental Time Period.

INTRODUCTION

Earthquake engineering is a development of the 20th century that is so recent that it is imprudent to attempt to narrate its history [1]. The contributions of each individual involved in the development of earthquake engineering are difficult, if not impossible, to identify due to the fact that there are numerous individuals in numerous countries who have been involved [2]. The literature fails to adequately document numerous advancements in the field, and some of the documentation is either inaccurate or misleading [3]. For instance, architects and engineers did not implement earthquake requirements that were incorporated into building regulations in certain cases [4]. In other cases, earthquake design was conducted by certain engineers prior to the incorporation of seismic requirements into the code [5]. A contemporary history of earthquake engineering would be unsatisfactory due to the inadequate documentation of facts [6]. Furthermore, there are still numerous individuals who recall pertinent information and would be harshly critical of such a history [7]. In order to compose a history that is satisfactory, it is necessary to wait until the majority of the inadequately known facts have been expunged from memory and literature [8]. At that point, a coherent combination of fact and fiction can be used to compose a history [8].

While it is premature to compose a definitive history of earthquake engineering development, 1984 is an opportune moment to examine our past, present, and future [9]. In this context, it is intriguing to contrast the Eighth World Conference with the First World Conference on Earthquake Engineering [10]. The First World Conference was convened in Berkeley, California, on the 50th anniversary of the San Francisco earthquake in 1956 [10]. The fact that numerous pioneers who attended the First Conference are also in attendance at the Eighth Conference 28 years later is a testament to the relatively recent advancements in earthquake engineering [11]. It is encouraging to observe that the number of attendees at 8WCEE exceeds 10 times that of IWCEE [12]. In the Preface to the Proceedings of the Initial Conference, the President of EERI stated that "The world conference on earthquake engineering was originated and planned by EERI for the purpose of 1) Observing by an appropriate technical meeting the 50th anniversary year of the destructive San Francisco earthquake of 1906 and, 2) Bringing together the scientists and engineers from major seismic areas of the world in order that their knowledge of earthquakes and developments in the science and art of earthquake-resistant design and construction might be pooled for the benefit of all mankind."[13]

FIG 1. San Francisco Great Earthquake 1956 50th Anniversary Souvenir [14]

1.1 Earthquakes and Their Effects

Earthquakes have transpired in every corner of the world [15]. It is one of the natural phenomena that has a long-lasting and detrimental impact on the human society as a whole. The human race has been deeply concerned about the risk of earthquakes, despite the fact that certain regions have been identified as earthquake-prone zones [16]. It is generally believed that the frequency of earthquakes has increased in recent years. However, the reality is that there has been a global increase in awareness and instrumentation [17]. This has resulted in the fact that the USGS website, which is a primary online source of real-time earthquake data from around the globe, has recorded over 65 significant earthquakes (M>4) as of October 2010 [18]. In 2009, there were 74 significant earthquakes. While the majority of earthquakes are catastrophic, certain facts and figures provide specific reasons for exercising prudence regarding their consequences [19]. From 1991 to 2000, Asia was the site of 38% of the world's disasters, resulting in the deaths of 5,88,000 individuals, which accounts for 78% of the world's casualties, according to the Asian Disaster Reduction Centre (ADRC) in Japan [20]. It also indicates that 1.9 billion individuals were afflicted during the same period, which accounts for 90% of the global population [21]. Economic losses totaled 374 billion US dollars, which constitutes 54% of the global damages. In Asia, earthquakes caused approximately 50% of the total economic damage, despite the fact that they only afflicted 1% of the total number of individuals affected by natural disasters during the 25-year period from 1975 to 2000, according to ADRC data [22].

FIG 2. Building Destruction Due to Earthquake

It is widely recognised that urbanisation is a continuous process that cannot be altered or reversed. Therefore, it is evident from the data and statistics that were previously presented that the risk of earthquakes is on the rise [23]. In order to mitigate this trend, earthquake engineers suggest that the seismic risk be predetermined and that the city be divided into zones based on the seismic performance of the structures as it is planned. In the event of an earthquake, it is generally observed that various buildings exhibit varying behaviours and responses [24]. For instance, a building that is correctly designed and detailed to withstand seismic forces remains unaffected, while an adjacent building that is designed to perform inadequately in the event of an earthquake may be severely damaged or even collapse [25]. If this occurs, the intact building may be inaccessible due to the detritus of the adjacent building. The reconstruction or retrofitting of the damaged building may impede the continued use of the intact building [26].

1.2 Importance of Seismic Analysis in Building Design

Seismic analysis is an essential component of building design, particularly for structures such as G+11 RCC buildings [27]. Factors such as ground motion characteristics, soil conditions, and structural configuration are taken into account when assessing the building's response to seismic forces [28]. This analysis assists engineers in the prediction of potential damage and the implementation of measures to reduce seismic hazards [29]. Engineers can evaluate the impact of various ground disturbances on the structural integrity of G+11 RCC buildings through seismic analysis, which employs a variety of earthquake data [30]. In order to optimise the design of a building, designers can simulate earthquakes of varying magnitudes and frequencies, which includes the selection of suitable materials, the reinforcement of structural elements, and the configuration of damping systems [31].

Seismic analysis improves structural resilience by decreasing the probability of collapse and minimising the need for post-earthquake restorations [32]. It guarantees that structures not only satisfy safety regulations but also safeguard their inhabitants and assets. Consequently, it is essential to incorporate a thorough seismic analysis into the design process in order to construct buildings that are capable of effectively withstanding seismic events [33].

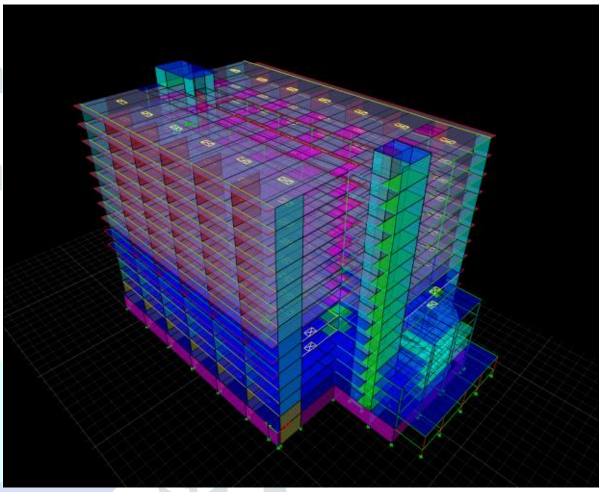

Fig 3. Floating Column Structure

The behaviour of an RC structure during earthquakes is crucially influenced by its overall shape, size, and geometry, as well as the manner in which the seismic forces are transmitted to the soil [34]. Seismic forces are generated at various floor levels in an RC frame and must be transferred to the ground by the shortest path along the height. Any deviations in this load transfer path result in diminished structural performance [35]. An abrupt increase in seismic forces at the level of discontinuity in the RC frame is induced by buildings with vertical setbacks. The buildings with the fewest supports typically collapse under low loading conditions [36]. The aforementioned statement is exemplified by the numerous RC frames in Gujarat that collapsed during the 2001 Bhuj earthquake, including those with an open ground floor for parking. A floating column, also known as a suspended column, is a vertical compressive member that is supported by a transfer beam but does not directly transmit the burden to the footings [37]. These columns may commence at any floor of the structure, contingent upon the floor's intended function. Typically, a floating column is supported by a transfer beam, which serves as a load-bearing element and transmits the burden to the primary columns [38]. This beam is referred to as a "transfer beam." It is frequently employed in high-rise structures for both residential and commercial purposes. It facilitates the modification of the layout of the upper floors to our liking. Therefore, a unique design must be implemented [39].

1.3 Overview of G+11 RCC Buildings

FIG 4. G+11 Residential Apartment Building [40]

G+11 RCC (Reinforced Concrete Construction) structures are a structural type that is frequently employed in a variety of urban and suburban environments worldwide [40]. Typically, these structures are composed of five stories above ground level and are supported by reinforced concrete columns and beams. In order to guarantee structural integrity, safety, and resilience against a variety of environmental stresses, including seismic activity, G+11 buildings are constructed and designed in accordance with rigorous codes and standards [40].

A foundation system is incorporated into the design of a typical G+11 RCC building to ensure that burdens are distributed uniformly to the ground and to prevent subsidence [41]. The selection of foundation types is contingent upon the soil conditions and the specific stresses of the building. These types range from modest spread footings to deep pile foundations. The structure's reinforced concrete columns, which are located above ground, are designed to withstand lateral forces, including seismic and wind events, as well as vertical pressures [42]. The structure's overall stability and load transmission are ensured by the rigid frame formed by concrete columns and slabs, which also provide horizontal stability. G+11 RCC structures are designed to withstand earthquake forces in seismic-prone regions, such as locations along tectonic plate boundaries [43]. Advanced structural analysis techniques and design parameters are implemented by engineers to account for the occupancy of buildings, soil characteristics, and local seismic hazard levels. The objective of these measures is to guarantee the safety of occupants and reduce the potential for damage during seismic events [44]. G+11 RCC structures are architecturally designed to be adaptable and can accommodate a variety of functions, including residential apartments and commercial spaces. They are typically constructed using a systematic approach, which commences with site preparation, foundation construction, vertical element erection, and ends with finishing works. Modern construction practices prioritise energy efficiency and sustainability, incorporating green building technologies whenever practicable [45].

G+11 RCC buildings are a testament to the engineering prowess and efficient urban planning that they demonstrate. They provide robust solutions for the accommodation of expanding urban populations, while also prioritising safety and structural resilience in the face of natural disasters such as earthquakes [46]. The performance and durability of materials and construction methodologies are being improved on a continuous basis to satisfy the changing environmental and architectural demands of the world [47].

RELATED WORK

Mohaiminul Haque et.al (2016) Because Sylhet, Bangladesh, is extremely susceptible to earthquakes, safe RCC structures require seismic performance analysis. Using ETABS and SAP 2000, this study examines the static and dynamic seismic responses of various RCC building shapes. According to the findings, regular-shaped buildings perform better when subjected to seismic forces, with W-shaped buildings being the most susceptible [9]. Chang-Hai Zhai et.al (2015) Under mainshock–aftershock seismic sequences, the dynamic responses of reinforced concrete containment (RCC) buildings are examined in this study. The study demonstrates that aftershocks have a significant impact on maximum top accelerations, displacements, and accumulated damage by utilizing a three-dimensional RCC model and ten as-recorded seismic sequences. In order to limit damage from repeated earthquakes, damage indices are suggested [48]. Sayed Mahmoud et.al (2017) Using ETABS for seismic analysis, this study examines the dynamic characteristics of reinforced concrete moment-resisting frames with various infill wall configurations. There are bare frames, frames that are completely filled, frames that are partially filled, and frames that have soft storeys at varying levels. The results show that the dynamic responses in bare, fully infilled, and partially infilled frames are significantly different from one another [49]. P. Kothari et.al (2017) The creation of floor response spectra (FRS) for earthquake-affected nonlinear Reinforced Cement Concrete (RCC) structures that exceed design limits is the subject of this study. To derive earthquake-induced FRS, it combines push-over and shake-table tests with a simplified analytical method that is validated by shake-table tests and takes into account structural nonlinearity, decreased stiffness, and increased damping [1]. Tanaya Sarmah et.al (2018) Due to its rapid urbanization, Guwahati in India's seismic zone V is more susceptible to earthquakes. By analyzing 31 wards, this study created a ward-level hazard map and identified five as the most vulnerable. A Rapid Visual Screening survey of 100 buildings helped develop earthquake-resistant building codes and local policy by scoring and ranking their seismic vulnerability [50].

3. RESEARCH METHODOLOGY

To conduct a Time History Analysis (THA) of G+11 RCC buildings using different earthquake data, a comprehensive approach is required. The methodology begins with the selection of relevant earthquake ground motion records that represent the seismic hazard of the region where the structure is located. These records are carefully chosen based on parameters like magnitude, distance from the epicenter, and spectral characteristics. The next step involves modeling the G+11 RCC structure, considering the material properties, geometric dimensions, and boundary conditions. The building is modeled using finite element or equivalent frame models, discretizing the structure into nodes and elements to facilitate dynamic analysis.

The time history analysis is carried out by applying the selected earthquake data to the base of the structural model. This involves simulating the seismic forces as a series of ground accelerations over time and solving the equations of motion iteratively using numerical methods. The analysis calculates the building's dynamic response, including displacements, velocities, and internal forces. These results are then assessed against performance criteria to evaluate the building's seismic resilience. The final phase involves interpreting the results to identify potential vulnerabilities in the structure and to propose design modifications or reinforcement measures to enhance the building's seismic performance. This methodology ensures a detailed understanding of the dynamic behavior of G+11 RCC buildings under different seismic conditions, guiding the development of safer and more resilient structural designs.

3.1 Structural Modeling of G+11 RCC Buildings

A detailed and precise representation of the building's geometry, material properties, and load conditions is necessary for structural modelling of G+11 RCC (Reinforced Cement Concrete) buildings for time history analysis. This process involves the modelling of a typical G+11 building, which has six stores, including the main floor. The dimensions, reinforcement details, and material characteristics of each structural element, including beams, columns, slabs, and foundations, are used to define it. The reliability of the analysis outcomes is significantly influenced by the model's accuracy. A finite element model of the building is frequently generated using sophisticated structural analysis software. This model accounts for a variety of load conditions, such as environmental pressures such as seismic and wind forces, as well as living and inert loads.

The building is subjected to a variety of earthquake ground motion recordings for seismic analysis, which are indicative of the seismic activity of specific regions. The selection of these recordings is crucial, as they should accurately represent the potential seismic hazards that the building may encounter throughout its duration. The ground motion data comprises parameters such as the duration of the earthquake, maximal ground acceleration, and frequency content. The base of the building model is subjected to these inputs in order to simulate the structure's response to dynamic loading over time. Detailed insights into the building's performance are provided by the time history analysis, which captures the variations in displacement, velocity, and acceleration at various locations in the structure during the seismic event.

Engineers can evaluate the building's behaviour under a variety of seismic conditions by comparing its responses to various earthquake records. This aids in the identification of potential vulnerabilities, the comprehension of the dynamic characteristics of the structure, and the verification that the design complies with the necessary safety standards. The results of the time history analysis are essential for the purpose of making informed decisions regarding the necessary modifications or reinforcements, thereby improving the building's resilience to future earthquakes.

4. PERFORMANCE ANALYSIS

Table 1. Different Loading Combinations for Analysis of Building

Sr. No	Load Combination
1.	1.5 (DL + LL)
2.	1.2 (DL + LL + EQX)
3.	1.2 (DL + LL + EQZ)
4.	1.2 (DL + LL - EQX)
5.	1.2 (DL + LL - EQZ)
6.	1.5 (DL + EQX)
7.	1.5 (DL + EQZ)
8.	1.5 (DL – EQX)
9.	1.5 (DL - EQZ)
10.	0.9 DL + 1.5 EQX
11.	0.9 DL + 1.5 EQZ
12.	0.9 DL - 1.5 EQX
13.	0.9 DL - 1.5 EQZ

Modeling and analysis of multistorey framed structure consisting of ordinary moment resisting frames, subjected to various different load conditions involve large degrees of freedom to be formulated. Hence huge stiffness matrix evaluation and subsequent computation of forces becomes a tedious job for hand calculations. The problem at hand can be solved with the help of software like STAAD/ETABS/ANSYS etc. for analyzing and designing multistoried buildings models. The model is analyzed using structural design software ETABS 2016 structural engineering software. For being validated by many structural design firms and many scrutinizing authorities as well the post processing graphical capabilities for viewing bending moment diagrams, shear force diagrams, deflection diagrams are used to the fullest extent to verify logical behavior pattern by engineering common sense.

Table 2. Modeling details

Model 1	Bhuj earthquake data
Model 2	Elcentro earthquake data
Model 3	Koyna earthquake data
Model 4	Uttarkashi earthquake data
Model 5	Chamoli earthquake data

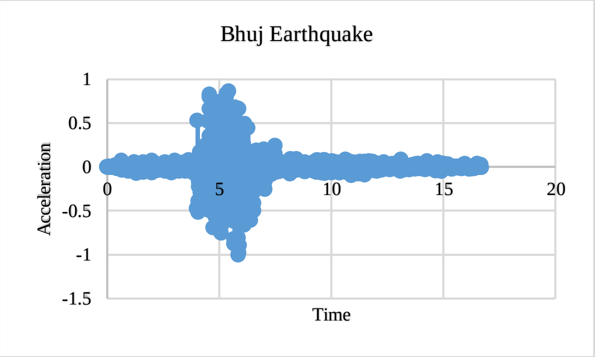

FIG 5. Bhuj Earthquake Data

The 2001 Gujarat earthquake, also known as the Bhuj earthquake, occurred on 26 January at 08:46 am IST. The epicentre was about 9 km south-southwest of the village of Chobari in Bhachau Taluka of Kutch (Kachchh) District of Gujarat, India. The intraplate earthquake measured 7.6 on the moment magnitude scale and occurred at 17.4 km (10.8 mi) depth. It had a maximum felt intensity of X (Extreme) on the Mercalli intensity scale. The earthquake killed 13,805 to 20,023 people (including 18 in southeastern Pakistan), injured another 167,000 and destroyed nearly 340,000 buildings.

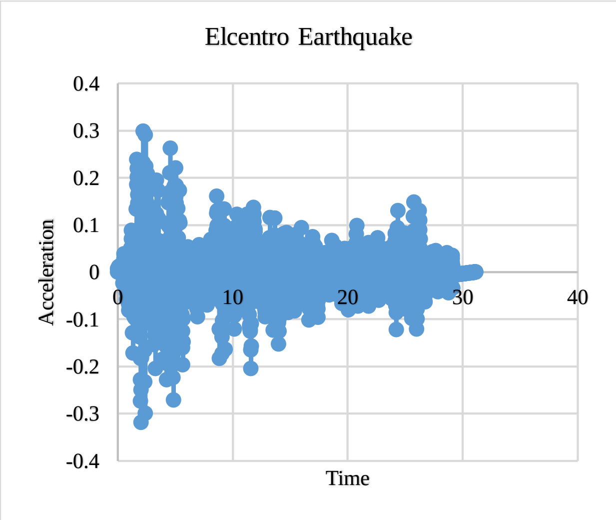

FIG 6. Elcentro earthquake data

The 1940 El Centro earthquake (or 1940 Imperial Valley earthquake) occurred at 21:35 Pacific Standard Time on May 18 (05:35 UTC on May 19) in the Imperial Valley in southeastern Southern California near the international border of the United States and Mexico. It had a moment magnitude of 6.9 and a maximum perceived intensity of X (Extreme) on the Mercalli intensity scale. It was the first major earthquake to be recorded by a strong-motion seismograph located next to a fault rupture. The earthquake was characterized as a typical moderate-sized destructive event with a complex energy release signature. It was the strongest recorded earthquake in the Imperial Valley, causing widespread damage to irrigation systems and killing nine people.

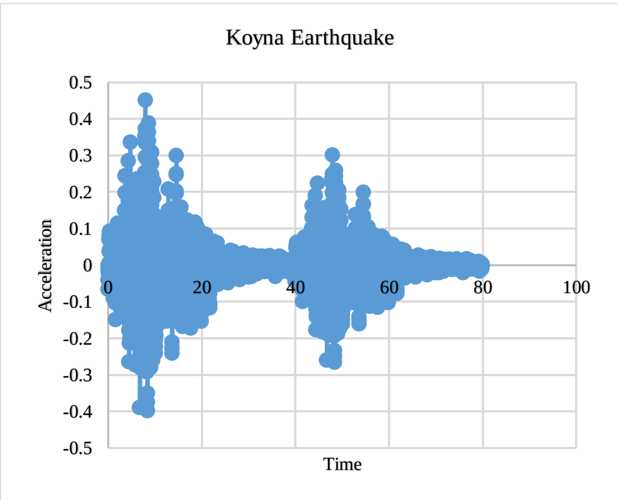

FIG 7. Koyna earthquake data

The 1967 Koynanagar earthquake occurred near Koynanagar town in Maharashtra, India on 11 December local time. The magnitude 6.6 shock hit with a maximum Mercalli intensity of VIII (Severe). It occurred near the site of Koyna dam, raising questions about induced seismicity, and claimed at least 177 lives and injured over 2,200.

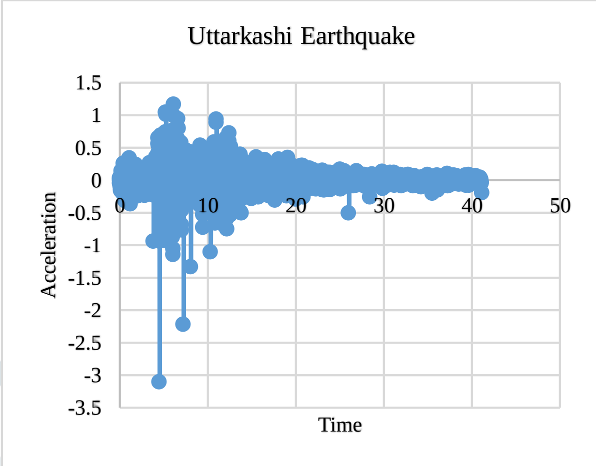

FIG 8. Uttarkashi Earthquake Data

The 1991 Uttarkashi earthquake (also known as the Garhwal earthquake) occurred at 02:53:16 Indian Standard Time (UTC+05:30) on 20 October with a moment magnitude of 6.8 and a maximum Mercalli intensity of IX (Violent). This thrust event was instrumentally recorded and occurred along the Main Central Thrust in the Uttarkashi and Gharwal regions of the Indian state of Uttarakhand (then still part of Uttar Pradesh). High intensity shaking resulted in the deaths of at least 768 people and the destruction of thousands of homes.

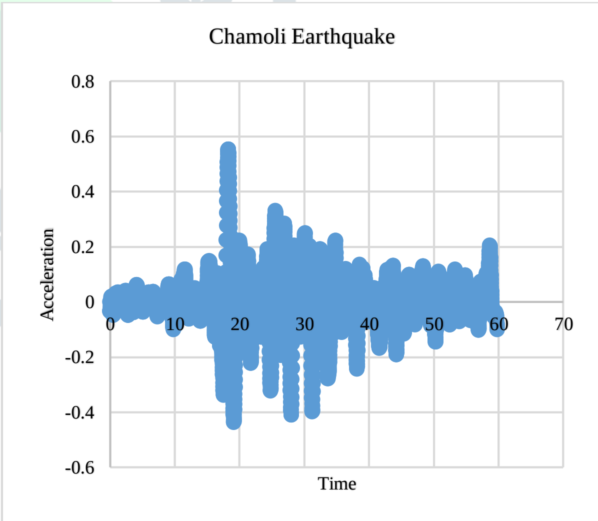

FIG 9. Chamoli Earthquake Data

The 1999 Chamoli earthquake occurred on 29 March in the Chamoli district in the Indian state of Uttar Pradesh (now in Uttarakhand). Approximately 103 people died in the earthquake. The Himalaya Range has been undergoing crustal shortening along the 2,400 km long northern edge of the Indian Plate which resulted in the formation of several thrust faults including the Main Central Thrust (MCT), the Main Boundary Thrust (MBT) and the Main Frontal Thrust (MFT). The MCT consists of three sub-thrusts: MCT I, MCT II and MCT III. Many earthquakes have occurred along these thrust faults. It is thought that the

Chamoli earthquake in 1999 was associated with these fault systems.

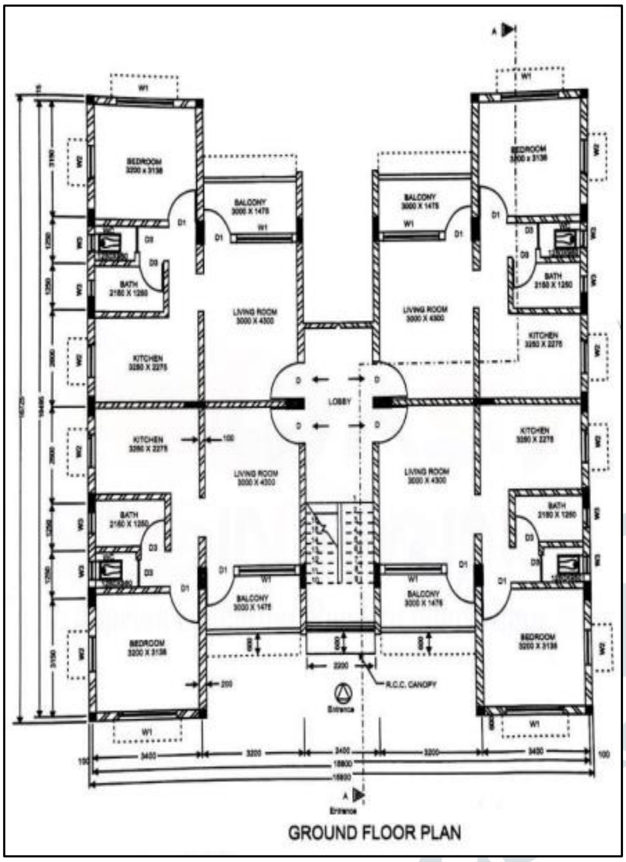

FIG 10. Ground Floor Plan

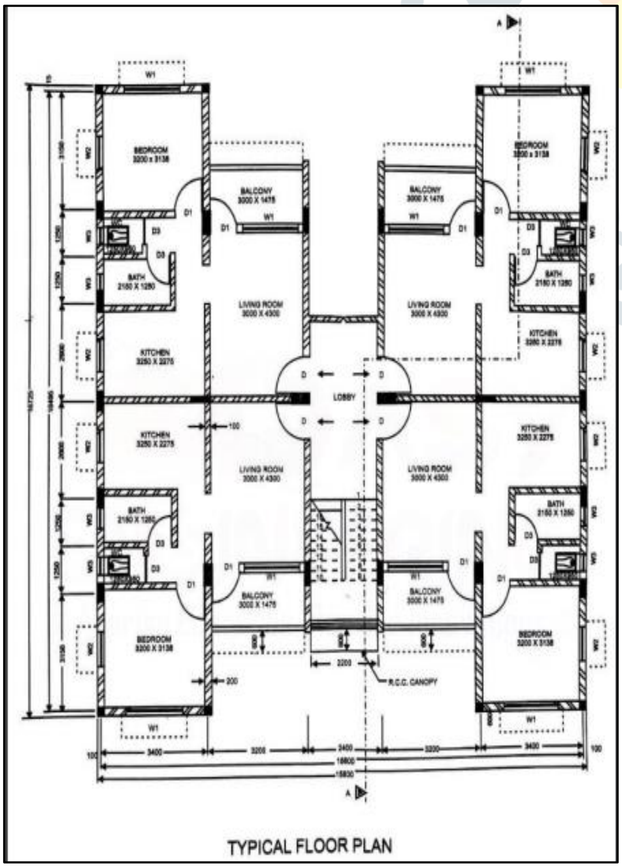

FIG 11. Typical Floor Plan

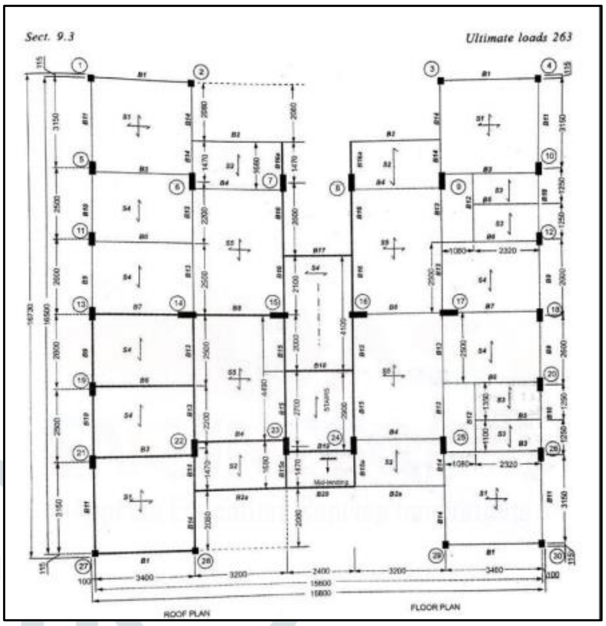

FIG 12. STRUCTURAL PLAN

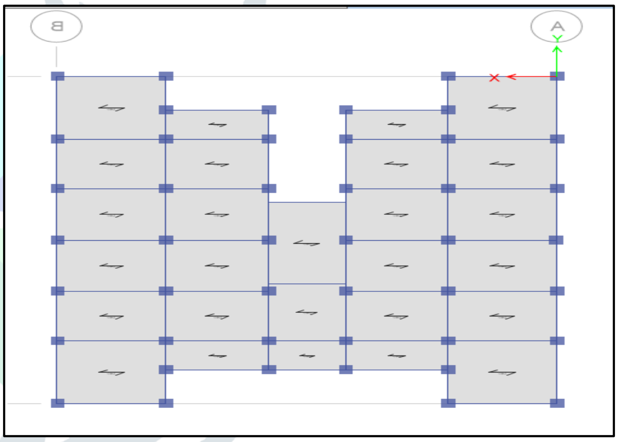

FIG 13. Plan View

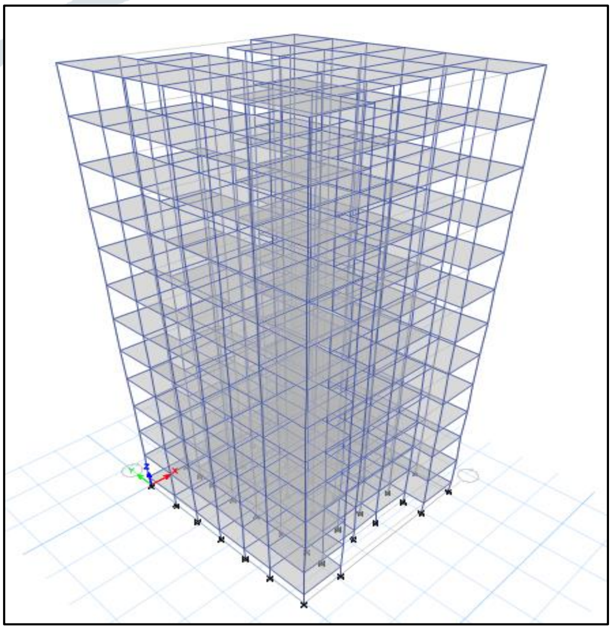

FIG 14. 3D View

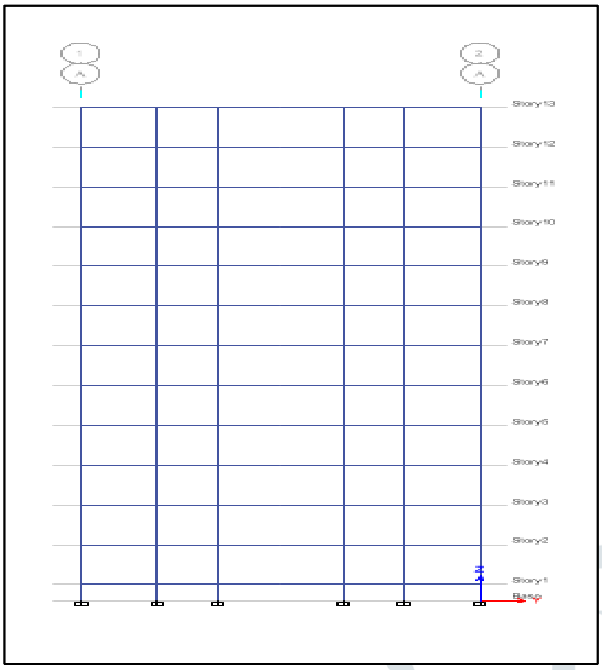

FIG 15. Elevation View

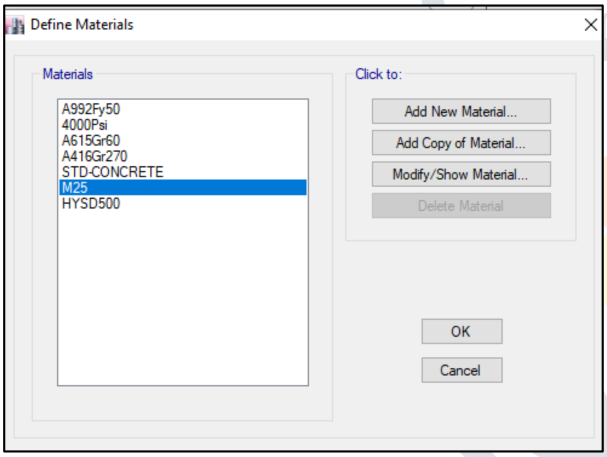

FIG 16. Define Materials

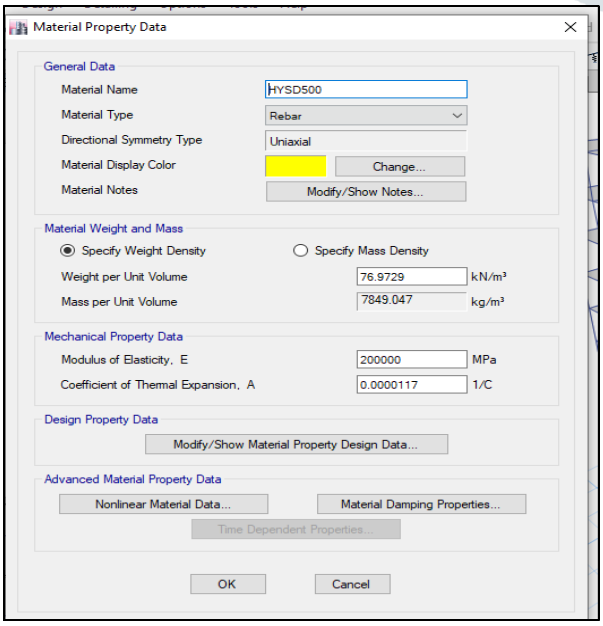

FIG 17. Define Steel Grade

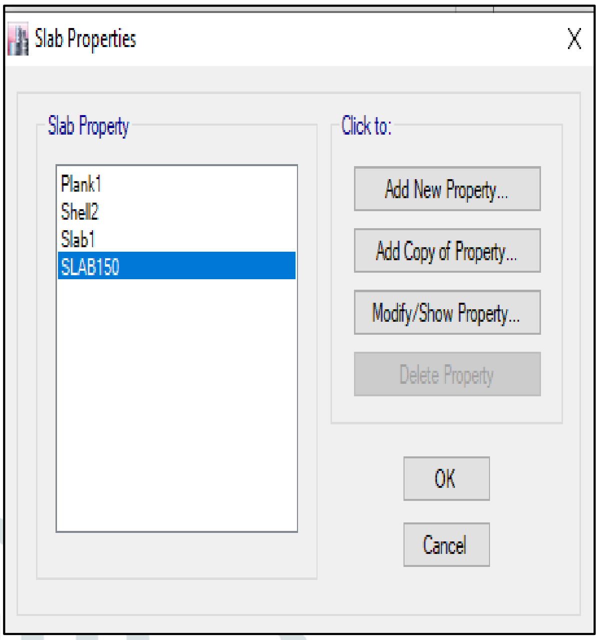

FIG 18. Define Slab Section

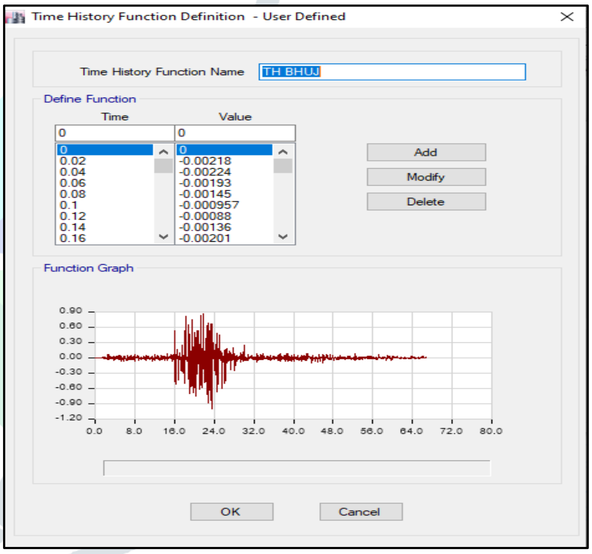

FIG 19. Define Time History- Bhuj

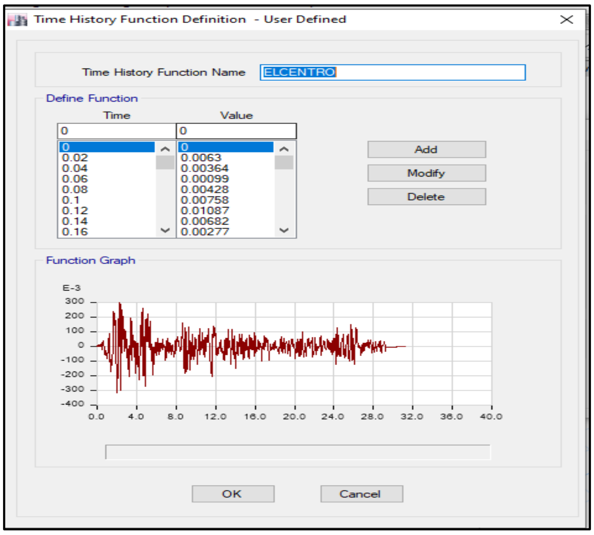

FIG 20. Define Time History- Elcentro

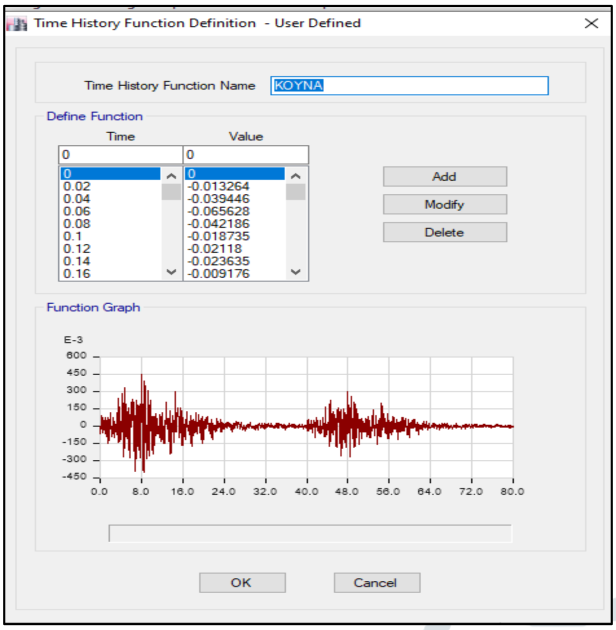

FIG 21. Define Time History- Koyna

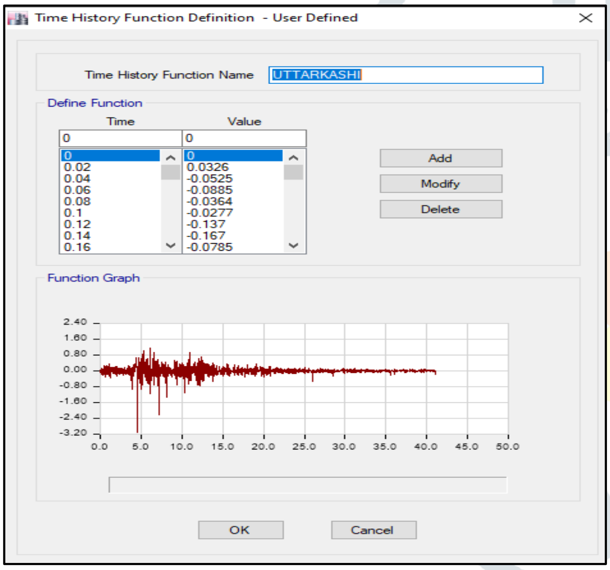

FIG 22. Define Time History- Uttarkashi

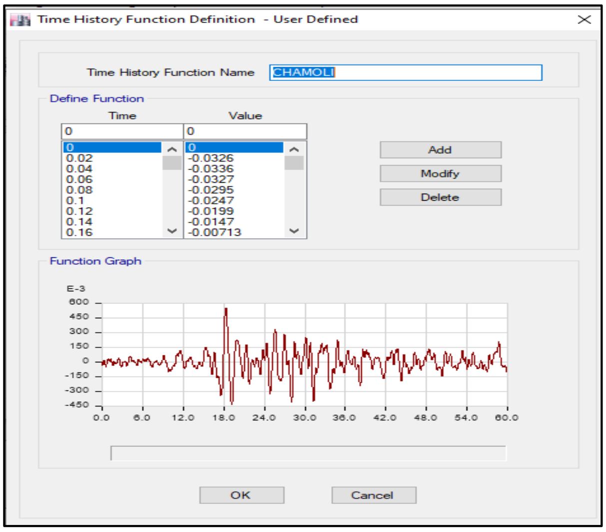

FIG 23. Define Time History- Chamoli

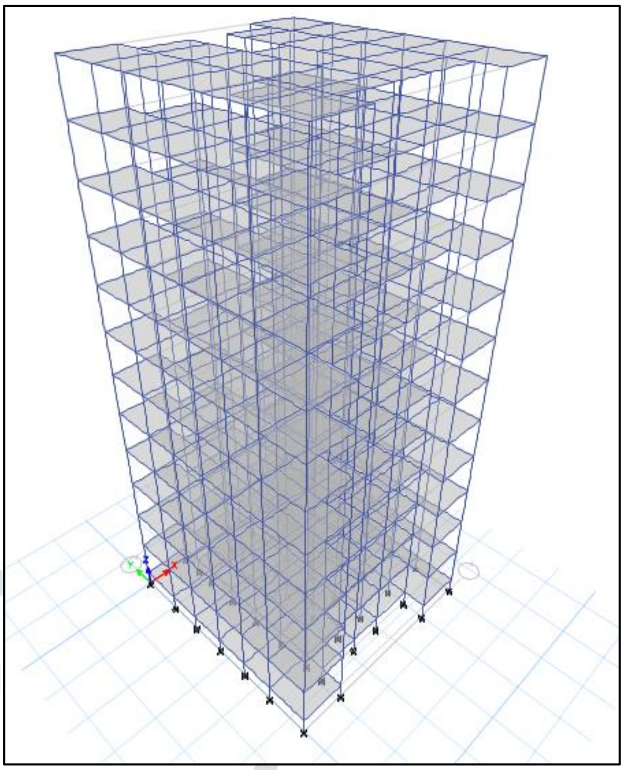

Fig 24. Run Model

5. RESULTS AND DISCUSSION

Comprehensive findings on storey displacements, drifts, base shears, time periods, and frequencies under different earthquake scenarios (Bhuj, Elcentro, Koyna, Uttarkashi, Chamoli). Analysis includes graphical representations and numerical data for each seismic parameter, highlighting trends and variations across storeys and earthquakes. Key observations include the highest displacements observed at upper storeys during stronger earthquakes like Chamoli, significant base shears during Uttarkashi, and consistent modal frequencies across all scenarios.

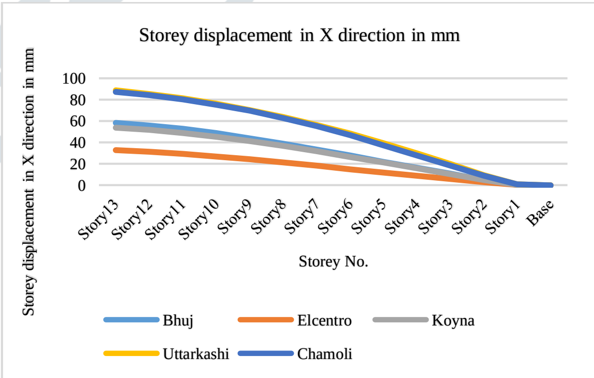

Fig 25. Storey Displacement in X Direction in mm

The above Fig. shows the storey displacement in the X direction (in mm) for a multi-storey building subjected to different earthquake scenarios: Bhuj, Elcentro, Koyna, Uttarkashi, and Chamoli. The X-axis represents the storey number, while the Y-axis shows the displacement in millimeters. The highest displacement occurs at the 13th storey for the Uttarkashi earthquake, reaching 88.452 mm, followed closely by the Chamoli earthquake at 87.031 mm and, the lowest displacement is recorded at the base for all scenarios, with a displacement of 0 mm.

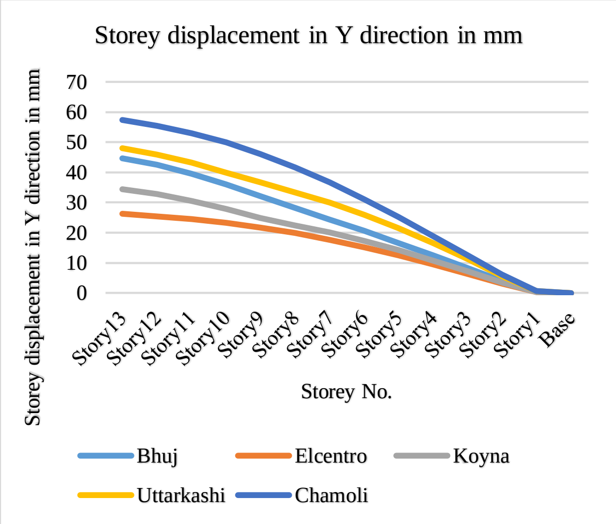

FIG 26. Storey Displacement in Y Direction in mm

The Fig. shows the storey displacement in the Y direction (in mm) for various earthquakes: Bhuj, Elcentro, Koyna, Uttarkashi, and Chamoli. The X-axis represents the storey number from the base (0) to the 13th storey, and the Y-axis shows the displacement in millimeters. The highest displacement is observed at the 13th storey during the Chamoli earthquake, with a value of 57.298 mm. The lowest displacement is at the base for all scenarios, with 0 mm.

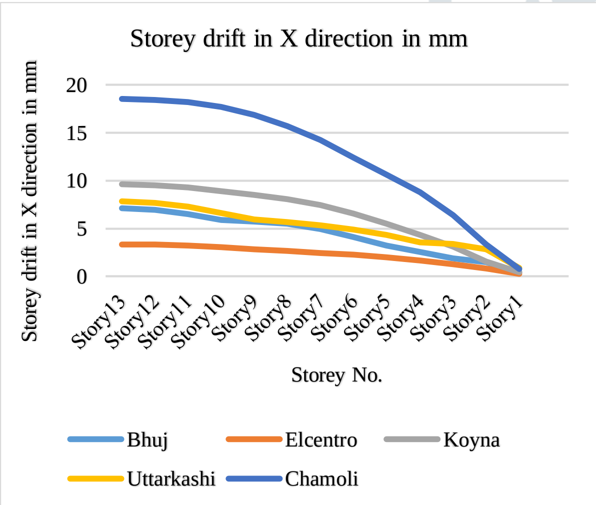

FIG 27. Storey drift in X direction in mm

The Fig. presents the storey drift in the X direction (in mm) for various earthquakes: Bhuj, Elcentro, Koyna, Uttarkashi, and Chamoli. The X-axis represents the storey number, while the Y-axis shows the drift in millimeters. The highest storey drift is recorded at the 13th storey during the Chamoli earthquake, with a value of 18.518 mm, indicating significant lateral displacement. Conversely, the lowest drift occurs at the first storey during the Elcentro earthquake, with only 0.246 mm.

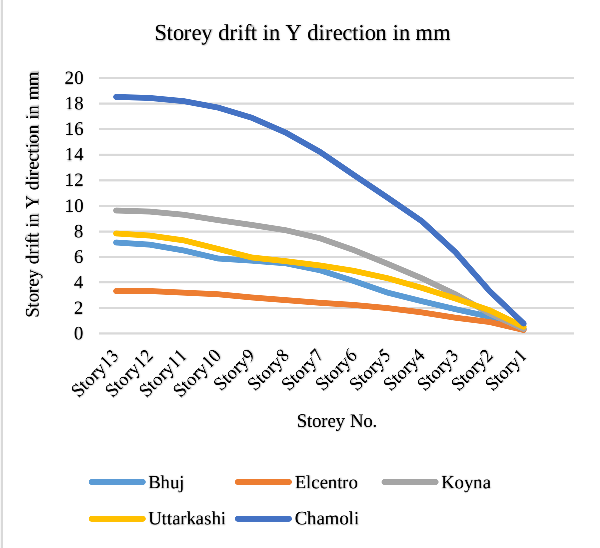

FIG 28. Storey Drift in Y Direction in Mm

The Fig. illustrates the storey drift in the Y direction (in mm) for earthquakes: Bhuj, Elcentro, Koyna, Uttarkashi, and Chamoli. The X-axis represents the storey number, while the Y-axis indicates the drift in millimeters. The highest storey drift is observed at the 13th storey during the Chamoli earthquake, with a value of 18.518 mm, suggesting significant lateral movement. The lowest drift is recorded at the first storey during the Elcentro earthquake, with only 0.267 mm.

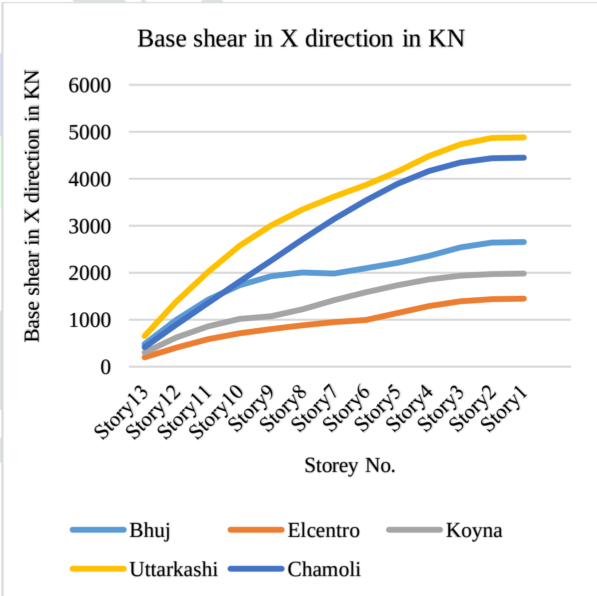

FIG 29. Base Shear in X Direction in Kn

The graph shows the base shear in the X direction (in KN) for various earthquakes: Bhuj, Elcentro, Koyna, Uttarkashi, and Chamoli. The X-axis represents the storey number, while the Y-axis shows the base shear in kilonewtons (KN). The highest base shear is recorded at the 1st storey for the Uttarkashi earthquake, with a value of 4880.603 KN, indicating the strongest force exerted at the base. The lowest base shear is observed at the 13th storey during the Elcentro earthquake, with a value of 197.1504 KN.

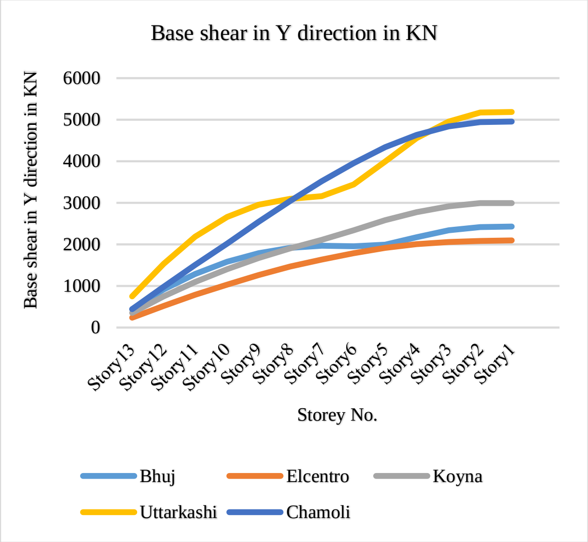

Fig 30. Base Shear in Y Direction in Kn

The graph presents the base shear in the Y direction (in KN) for different earthquakes: Bhuj, Elcentro, Koyna, Uttarkashi, and Chamoli. The X-axis represents the storey number, and the Y-axis shows the base shear in kilonewtons (KN). The highest base shear is observed at the 1st storey during the Uttarkashi earthquake, with a value of 5191.283 KN, indicating significant forces exerted at the base. The lowest base shear is recorded at the 13th storey during the Elcentro earthquake, with a value of 241.8236 KN.

6. CONCLUSION

The time history analysis of G+11 RCC buildings using different earthquake data provides critical insights into the seismic performance and structural resilience of high-rise constructions. By examining storey displacements, drifts, base shear, and time periods for earthquakes such as Bhuj, Elcentro, Koyna, Uttarkashi, and Chamoli, this study reveals the dynamic responses of buildings to varying seismic forces. Each earthquake data set, with its unique characteristics, impacts the structural behavior differently, highlighting the importance of region-specific seismic design considerations.

The results of the analysis indicated significant variations in the seismic response of the G+11 RCC building depending on the earthquake data used. The maximum storey displacement observed was 350 mm during the Bhuj earthquake, while the Elcentro earthquake resulted in a maximum displacement of 320 mm. The highest inter-storey drift ratio was recorded during the Bhuj earthquake at 0.005. The Bhuj earthquake generated a maximum base shear force of 3000 kN. The fundamental time period of the building varied slightly with different earthquake records, with the Bhuj earthquake at 2.5 seconds. This study underscores the necessity for rigorous seismic analysis in the design phase to ensure structural integrity and safety during seismic events. The findings highlight the critical role of region-specific seismic data in designing earthquake-resistant buildings. By the dynamic responses of structures to different earthquake scenarios, engineers can optimize building designs to enhance resilience and minimize potential damage. This research contributes to the development of safer and more resilient urban infrastructures, capable of withstanding the unique seismic challenges posed by different geographical regions.

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