Seismic Vulnerability Assessment of Existing RC Buildings in Vijayawada City

Thesis submitted in partial fulfillment
of the requirements for the degree of

Master of Science in **Civil Engineering** by Research

by

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February 2024

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CERTIFICATE

This is to certify that the thesis entitled "*Seismic Vulnerability Assessment of Existing RC Buildings in Vijayawada City*" submitted by *S. L. N. Sastry (*Roll No. 200850051) to the International Institute of Information Technology Hyderabad, for the award of the degree of Master of Science in Civil Engineering by Research is a bonafide record of the research work done by him under my supervision. The contents of this report, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

Date

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Acknowledgements

I express my gratitude to my Thesis Guide Dr. Pradeep Kumar Ramancharla, for his support and guidance throughout the work. He was always available for advice and discussions. His willingness to provide necessary resources and materials whenever needed is highly appreciated.

I am also grateful to Professors Venkateshwarlu M, of EERC, for enriching my technical learning through the courses he taught. His encouragement and motivation helped me during the progress of the thesis work.

I extend my sincere thanks to Dr. Aniket Bhalkikar, for his continuous support for my thesis work. I cherish the lighter moments I had with Bharat Prakke, S. Saranya and Dharmil Baldev that helped me for the smooth thesis work ride!

I am thankful to my research centre colleagues Velani Pulkit. D, Raghu Nandan Vyas Pammi, Lakshmi Supriya Yerramsetty, and Niharika Talyan without their support my work could not have been completed.

My special thanks to Sri V. Ramudu, Director of Town & Country Planning, Govt. of AP for his support in arranging all the building plans required for my thesis purpose.

My thanks to G. Prabhakar, Driver of VC & MD, TSIIC, who helped me in taking Rebound Hammer Test readings for RC members of all buildings I surveyed in Vijayawada.

My wife, Sarada Salaka who has the understanding of my passion to conduct this thesis & supported me in every way possible.

Finally, I am thankful to Almighty, who has bestowed me with countless blessings that helped me complete this thesis.

Yours truly,
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Abstract

About 57% of the land area in India lies within the moderate-to-severe seismic zone, where approximately 80% of the population resides. Consequently, a substantial proportion of India's buildings are at risk due to seismic hazard and building stock in seismically active regions. The pre-earthquake safety assessment of the built environment plays a crucial role in mitigating damage and losses by identifying structures that are susceptible to earthquakes and implementing suitable measures to minimize their impact. The process of rapid visual screening (RVS) plays a vital role in evaluating the seismic vulnerability and potential risks of existing buildings in urban areas. The preservation and safety of existing buildings assume greater significance as urban areas undergo continuous growth and expansion. The Rapid Visual Survey (RVS) is a crucial instrument used to identify structures that necessitate more comprehensive assessment and potential retrofitting in order to improve their ability to withstand seismic activity.

In the present study, a total of 15 reinforced concrete framed buildings of above 10 m. Height were selected randomly from nearly 6 different locations in Vijayawada city falling in Seismic Zone III. Studies for Rapid Visual Assessments as well as detailed assessment were conducted and the results of both assessments are discussed. The study finds: (i) the construction practices in India must be checked regularly and also must evaluated regularly; (ii) there is urgent need to spread the awareness among engineers and builders about the seismic code provisions and municipal guidelines.

NOMENCLATURE

E - Edge point of column at specified level and direction

M - Midpoint of column at specified level and direction

FFL - Finished Floor Level

Ah - Horizontal seismic co-efficient.

I - Importance factor

Z - Zone factor

R - Response reduction factor

s_a/g - Average response acceleration coefficient.

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Chapter 1

Introduction

1.1 Background

Reinforced concrete (RC) buildings are widely used in construction due to their strength, durability, and versatility [1]. However, ensuring their seismic performance is of paramount importance in earthquake-prone regions. During an earthquake, RC buildings undergo complex dynamic responses that can be influenced by various factors, including building configuration, structural system, material properties, and design detailing [2, 3]. The seismic performance of RC buildings is influenced by two main considerations: (a) lateral load resistance and (b) ductility and energy dissipation [4].

RC buildings resist lateral loads primarily through their structural systems, including shear walls, moment frames, and their combinations. Shear walls provide the primary lateral load resistance, while moment frames enhance the building's overall stiffness and ductility. The interaction between these elements determines the overall response of the building under seismic forces. Moreover, RC buildings must exhibit ductile behavior during earthquakes [5]. Ductility refers to the ability of the structure to undergo large deformations without losing its load-carrying capacity. This is achieved through proper detailing of reinforcement, adequate concrete strength, and confinement measures. Ductile behavior allows the structure to absorb and dissipate seismic energy, reducing the potential for catastrophic failure [2, 4].

However, the seismic performance of an RC building becomes more complex if any irregularities are present in the building. Irregularities in the design and construction of reinforced concrete (RC) buildings can significantly impact their structural performance. It can severely affect the building's response to lateral loads. Irregularities in RC buildings can occur in various forms, affecting different aspects of the structure. Some common types of irregularities include:

1. Vertical Irregularities: Vertical irregularities involve variations in the height or stiffness along the vertical axis of the building. Examples include setback or step-back configurations, soft stories (floors that are significantly less stiff or strong than the floors above), and extreme changes in floor height.
2. Horizontal Irregularities: Horizontal irregularities refer to variations in the distribution of mass, stiffness, or strength along the horizontal plane of the building. Examples include torsional irregularities (asymmetric mass or stiffness distribution causing torsional effects), discontinuous vertical elements (such as columns or shear walls), and irregular floor plans.
3. Plan Irregularities: Plan irregularities occur when the building's shape or layout deviates from regular geometric forms, such as rectangular or symmetrical shapes. Examples include L-shaped or T-shaped buildings, buildings with reentrant corners, and complex architectural features.

The most commonly observed implications of irregularities on seismic performance of RC buildings are: (a) increase in seismic demand; (b) non-uniform response; and (c) loss of strength and stiffness. Irregularities lead to concentration of forces which results in localized areas experiencing higher seismic demands. This leads to higher stresses and potential failure modes in specific regions of the structure. Further, it even induces uneven distribution of forces, causing non-uniform response and torsional effects which results in amplified displacement demands, increased inter-story drifts, and potential damage concentration [6]. Some irregularities such as discontinuities or changes in structural elements can compromise the load path and reduce the ability of the building to resist lateral loads effectively. Understanding the implications of irregularities and implementing appropriate mitigation strategies are essential for enhancing the safety and resilience of RC structures. But ensuring the safety of existing buildings remains a challenging task.

1.2 Motivation

A study on the Indian subcontinent shows that about 60% of the country's land area, which is having nearly 78% of the country's population, is under the threat of moderate-to-severe seismic shaking [7]. Moreover, construction as per the owner's choice without any engineering inputs is a common construction practice followed in many parts of India [8]. In such cases, the building becomes an irregular building causing often unexpected behavior, leading to severe damage or even sometimes collapse of the building [9]. Lack of awareness about the earthquake resistant design guidelines is another reason for this. As a result, the engineers face a critical question that must be answered immediately: which buildings are safe, and which must be strengthened or demolished?

For decades researchers have been studying and developing seismic vulnerability assessment procedures to overcome this problem. These vulnerability assessment procedures can be categorized into three types based on the level of complexity involved while performing [10-12]. The first level of seismic assessment procedures is known as the screening phase (also known as rapid visual screening). This very first level of the assessment procedure is the quickest and a street survey that involves the ranking of buildings in building stock. The typical parameters used in this type of assessment procedure are the number of storeys, age of the building, vertical irregularities, plan irregularities, location etc.

The assessment method in which more detailed and reliable information is needed falls in the second category, the preliminary evaluation phase. The information required for this phase is like the screening phase with some more additional data such as building plan, sizes of structural members (slab, beam, column, and shear wall), their orientation and material property etc. The information collected is used to find the structural capacity and checked against expected demand, and finally, from comparison, the performance of the building is predicted. When a more in-depth evaluation is carried out by collecting comprehensive information about the building, which assessment method falls into the third category, i.e., the detailed evaluation phase. The data is collected from the structural drawings and the as-built features, including the geometrical properties of structural components, mechanical properties of materials, and reinforcement detailing of the structural components [13]. Upon collecting all the information, the building is modeled in some sophisticated software, and nonlinear analysis is performed to check the building behavior for seismic actions. Later, the behavior of buildings is compared with some standard accepted values to decide the expected building performance. Though the latter two assessment procedures are perfectly capable of identifying the deficit buildings but are costly, time-consuming and involve much more workforce. Compared to these procedures, the first procedure, i.e., rapid visual screening procedure, is the best alternative that requires significantly less time and serves the purpose.

In the field of structural engineering and risk assessment, the rapid visual screening (RVS) of existing buildings plays a crucial role in identifying potential vulnerabilities and assessing the overall seismic performance of structures [14]. This proactive approach enables engineers, architects, and decision-makers to prioritize resources and take appropriate actions for ensuring the safety and resilience of buildings in the face of potential earthquakes or other hazards. This write-up aims to provide an introductory overview of RVS, its purpose, methodology, and benefits.

The primary purpose of RVS is to quickly assess the seismic vulnerability of existing buildings, particularly in regions prone to earthquakes. The process involves a visual inspection of the building's exterior and interior to identify key factors that contribute to its structural performance and potential weaknesses. RVS helps professionals identify high-risk structures that require further evaluation and prioritize them for detailed assessments or retrofitting measures. Rapid visual screening typically follows a systematic procedure that involves the following key steps:

1. Pre-screening: Initial data collection, including building characteristics, occupancy, construction type, and historical records, helps determine the overall risk level and prioritize the screening process.
2. Visual inspection: Qualified personnel conduct a visual examination of the building's exterior and interior components, including the foundation, walls, floors, and roof. They look for signs of distress, damage, inadequate construction, or potential structural weaknesses.
3. Screening forms: Specific screening forms or checklists are utilized to document observations, note deficiencies, and assign a rating or score based on predefined criteria. These criteria may include building age, construction quality, foundation type, structural system, and others.
4. Vulnerability assessment: The collected data is evaluated to estimate the building's seismic vulnerability. This assessment can involve comparing the observed conditions with established building codes, standards, and guidelines. The vulnerability rating provides an indication of the level of risk associated with the structure.

This rapid visual screening method utilizes a scoring system with a checklist of building irregularities (i.e., vulnerable parameters) and score values. The results of this procedure can be used in identifying buildings that require preliminary or detailed assessment[15]. However, preliminary, and detailed assessments on sample Bldgs. should be used for benchmarking the scores with damage levels. Later, rapid visual screening methods can be used for understanding the vulnerability of large Bldgs. stocks. Rapid visual screening offers several benefits for building owners, engineers, and communities, includes:

1. Cost and time efficiency: RVS allows for a quick assessment of multiple buildings, enabling efficient allocation of resources by identifying structures that require further evaluation or prioritized retrofitting measures.
2. Early identification of vulnerabilities: By identifying potential weaknesses, RVS enables early intervention, enhancing the safety and resilience of existing buildings against seismic events.
3. Prioritization of mitigation measures: RVS helps decision-makers prioritize buildings for further evaluation or retrofitting based on their level of vulnerability, ensuring that limited resources are allocated effectively.
4. Public safety and risk reduction: By identifying high-risk structures, RVS supports proactive measures to mitigate risks, thereby reducing potential casualties and property damage during earthquakes or other hazards [16].

Rapid visual screening plays a crucial role in the initial assessment of existing buildings' seismic vulnerability. This proactive approach aids in identifying high-risk structures and prioritizing resources for further evaluation or retrofitting measures. By enhancing the safety and resilience of buildings, RVS contributes to the overall resilience and well-being of communities in seismic-prone regions. As research and advancements continue in this field, RVS techniques and methodologies will further evolve, leading to improved risk assessment and mitigation strategies.

1.3 Objective and Scope of Study

As the determination of seismic safety of existing buildings is a time-consuming process, many rapid visual screening methods were developed. The present study makes use of one of available rapid visual screening method to assess the safety of reinforced concrete buildings in the Vijayawada city. The reason for selecting the Vijayawada city for present study it its topography. The city is located on banks of Krishna River; it is also located on foot hills and surrounded by hills of Eastern Ghats. Moreover, the city is falls in seismic zone III. Therefore, the decision was taken to focus on the seismic safety assessment of existing reinforced concrete buildings in Vijayawada city.

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Chapter 2

Review of Literature

2.1 Literature Survey

The rapid visual screening (RVS) of existing buildings is a crucial process for assessing their seismic vulnerability and potential risks in urban areas. As cities continue to grow and expand, the preservation and safety of existing buildings become increasingly important. RVS is an essential tool for identifying buildings that may require further detailed evaluation and potential retrofitting to enhance their seismic resilience [17].

Rapid visual screening involves a preliminary evaluation of buildings based on visual observations and limited data collection. Various methodologies have been proposed to streamline and standardize this process. One such widely used method is the FEMA's (Federal Emergency Management Agency) "Rapid Visual Screening of Buildings for Potential Seismic Hazards" (FEMA 154) [18]. This method employs a set of building attributes, including construction type, age, and number of stories, and occupancy, to classify buildings into different seismic vulnerability categories. While FEMA 154 provides a useful starting point, researchers have acknowledged the need for further refinement to account for regional variations and building-specific characteristics. For instance, Mohanty and Gupta (2017) proposed a modified rapid visual screening method for reinforced buildings in India [19]. Their approach incorporates additional parameters such as the quality of construction, reinforcement details, and seismic design provisions to improve the accuracy of vulnerability assessments. The modified method offers a more refined classification of building vulnerability and assists in prioritizing retrofitting efforts [20].

Rapid visual screening (RVS) of existing buildings in urban areas is a crucial step in assessing their seismic vulnerability and mitigating potential risks. In India, where rapid urbanization is a significant phenomenon, the need to ensure the safety of existing buildings becomes even more critical [21-23]. Rapid visual screening of existing buildings in Indian cities faces unique challenges due to the country's diverse building stock, urban density, and data availability. One of the primary challenges is the lack of comprehensive building inventories and reliable data sources. Many Indian cities lack updated building records, and informal settlements often remain unaccounted for, leading to an incomplete assessment of the overall seismic risk [24]. Moreover, the varying construction practices across different regions in India necessitate localized RVS methodologies. Building materials, construction techniques, and architectural styles can significantly influence a building's seismic vulnerability. The socioeconomic aspects also play a vital role in RVS implementation. Retrofitting existing buildings can be costly, and building owners may be reluctant to invest in seismic upgrades. Identifying economically feasible retrofitting solutions and implementing incentive programs become crucial in promoting seismic resilience.

Gupta and Sharma (2015) developed a seismic risk assessment framework that combines building data with historical seismicity and local site conditions. Their approach incorporates rapid visual screening as an initial step to prioritize buildings for detailed evaluation and retrofitting [22]. This framework emphasizes the importance of collecting data on building materials, age, construction type, and occupancy. Sharma et al. (2019) presented a building typology-based seismic risk assessment method for Indian cities. Their methodology categorizes buildings into groups based on structural characteristics and vulnerability factors, enabling efficient RVS on a larger scale. This typology-based approach accounts for the diverse building stock present in Indian cities and is particularly useful in regions with mixed construction types [24].

The application of rapid visual screening for vulnerability assessment of existing reinforced buildings in India has gained traction in recent years. Several studies have been conducted in different regions to evaluate the seismic vulnerability of reinforced structures. Sharma et al. (2018) applied rapid visual screening to assess the vulnerability of residential reinforced buildings in Delhi. The study identified key deficiencies in building construction and provided valuable insights for seismic risk mitigation. Additionally, Das and Venkataramana (2019) conducted a city-wide rapid visual screening of existing reinforced buildings in Bengaluru. The study aimed to identify areas with a higher concentration of vulnerable buildings, helping urban planners and policymakers prioritize retrofitting strategies [25]. Luco et al. (2015) conducted a rapid visual screening survey in downtown San Francisco to assess the seismic risk of unreinforced masonry buildings. The study identified areas with a higher concentration of vulnerable buildings, providing valuable insights for targeted retrofitting strategies [26].

Despite its effectiveness, rapid visual screening for vulnerability assessment of existing reinforced buildings in India faces certain challenges and limitations. One significant challenge is related to the complex construction practices and variations in building codes and design standards across different regions of India. The diversity in building typologies and construction materials requires customized RVS methodologies that consider regional variations [24]. Moreover, the availability of trained personnel for conducting rapid visual screening is a limitation. Proper training and expertise are essential to ensure accurate and consistent assessments. Therefore, efforts to train engineers, architects, and building officials in RVS techniques are necessary to improve the quality of vulnerability assessments [21].

2.2 Observed Vulnerability

Seismic vulnerability assessment is a critical process that helps evaluate the potential susceptibility of structures to damage or failure during seismic events. It involves assessing various structural elements and systems to identify weaknesses and vulnerabilities. Here is the key vulnerability observed in the structures:

2.2.1 Horizontal Irregularities

Horizontal irregularities in reinforced concrete buildings can compromise the overall structural integrity and safety of the structure, particularly during seismic events. The following are the types of horizontal irregularities commonly observed in reinforced concrete buildings.

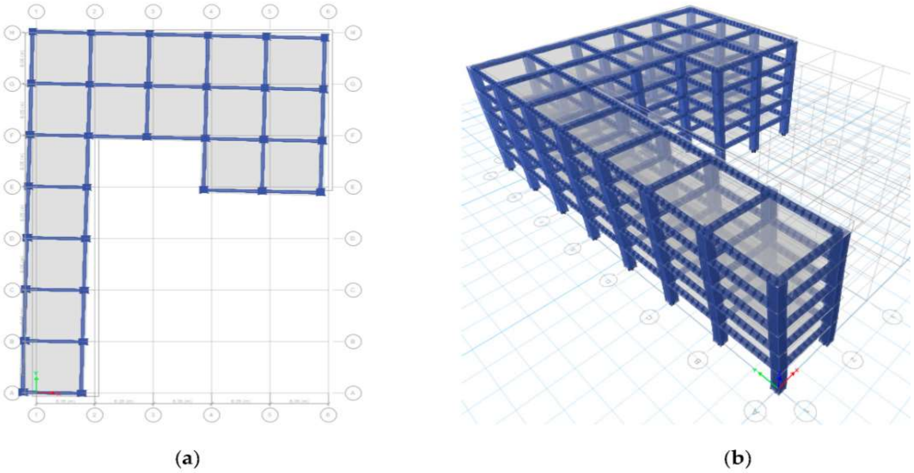

Fig. 2.1 Horizontal irregularity

2.2.2 Torsional Irregularity

Torsional irregularity occurs when there is a significant difference in stiffness or mass distribution along the building's perimeter. This irregularity creates an imbalance in resisting torsional forces during seismic events, leading to excessive twisting and rotational motions in the structure. The reasons of torsional irregularity are: (a) asymmetrical building shapes or floor plans; (b) Off-center or irregular placement of mass or vertical elements (columns and walls); and (c) Varied lateral stiffness between building wings.

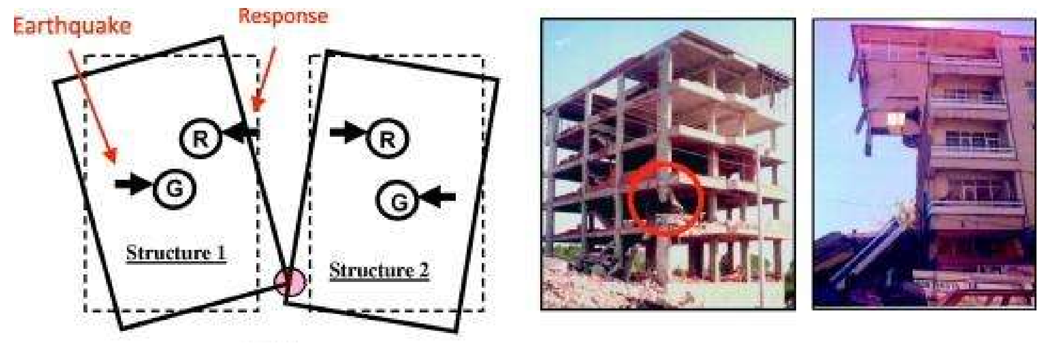

Fig. 2.2: Torsional irregularity

2.2.3 Mass Irregularity

Mass irregularity refers to uneven distribution of mass along the height or plan of the building. Buildings with significant variations in mass are prone to differential lateral movements during seismic events. The reasons for mass irregularity are: (a) inconsistent distribution of mass due to varying floor layouts or architectural design choices; and (b) changes in building function or occupancy at different levels.

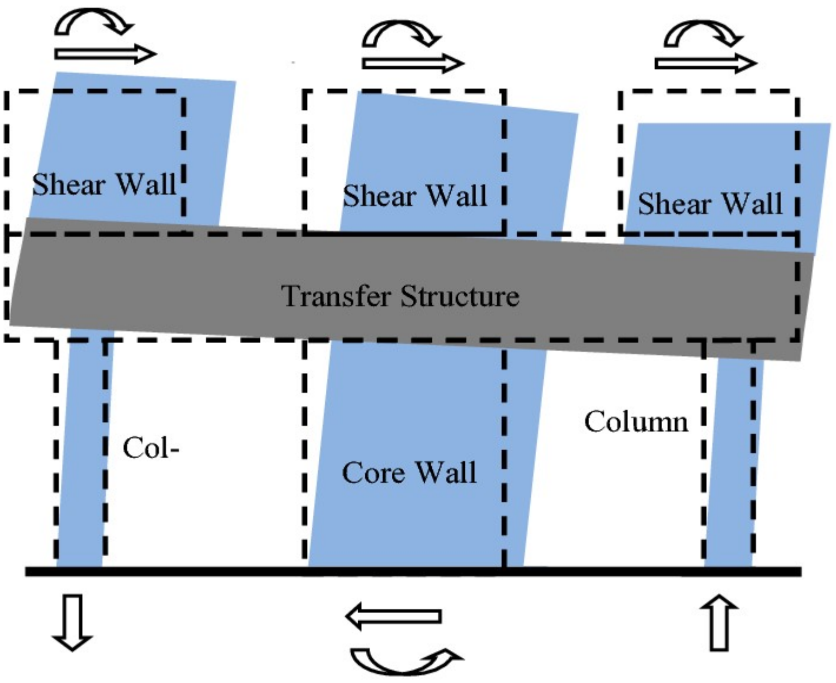

Fig. 2.3: Mass irregularity in horizontal direction

2.2.4 Diaphragm Discontinuity

Diaphragm discontinuity occurs when there is a lack of continuity or stiffness in the building's horizontal diaphragm, which is responsible for distributing lateral forces to the vertical elements. Irregular layout of floor slabs or inconsistent diaphragm materials causes diaphragm discontinuity.

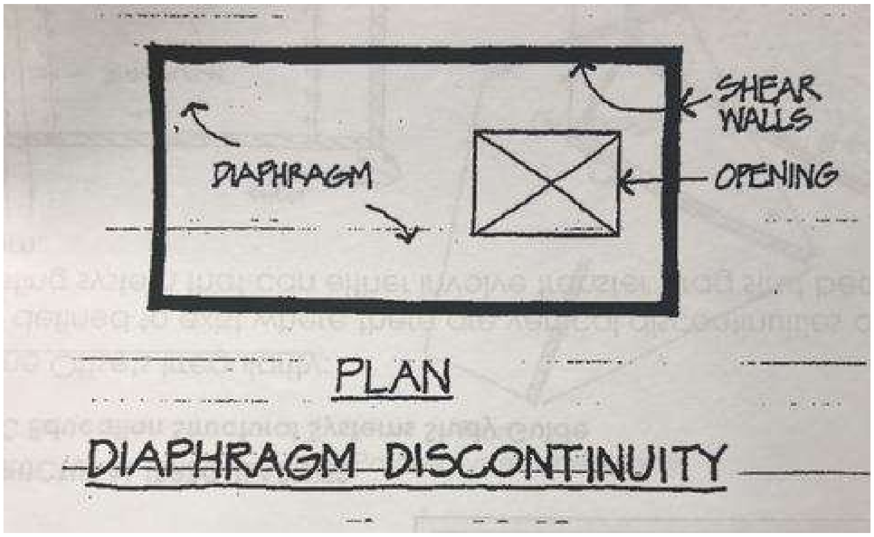

Fig. 2.4: Diaphragm discontinuity

2.2.5 Vertical Irregularities

Vertical irregularities in reinforced concrete buildings are deviations from standard design or construction practices that can significantly affect the building's structural integrity and performance during seismic events. Five types of vertical irregularities observed in reinforced concrete buildings, their causes, potential consequences, and effective mitigation strategies.

Fig. 2.5: Vertical irregularity

2.2.6 Soft Story Irregularity

A soft story irregularity refers to a significant difference in stiffness of two adjacent stories, usually found in buildings with an open ground floor (parking space) and residential or commercial spaces above. During an earthquake, the soft story can experience excessive lateral drift, leading to severe structural damage or even collapse. Inadequate lateral bracing or shear walls on the ground floor, removal or reduction of walls for parking space without appropriate compensation in lateral resistance are major reasons for causing soft storey irregularity.

Fig. 2.6: Buildings with soft storey

2.2.7 Setback Irregularity

Setback irregularity occurs when a building's mass is reduced at higher levels, creating setbacks. This design feature can lead to significant torsional effects during seismic events, causing uneven distribution of lateral forces and increasing structural vulnerability. The major reasons behind the setback irregularity are: architectural considerations that prioritize aesthetics over structural performance and use of cantilevered sections or varying floor layouts.

Fig. 2.7: Building with setback irregularity.

2.2.8 Re-entrant Corners

Re-entrant corners refer to a building's floor plan with inward projections or recesses, such as U or L shapes. These corners concentrate lateral forces, creating stress concentration points susceptible to damage during seismic events.

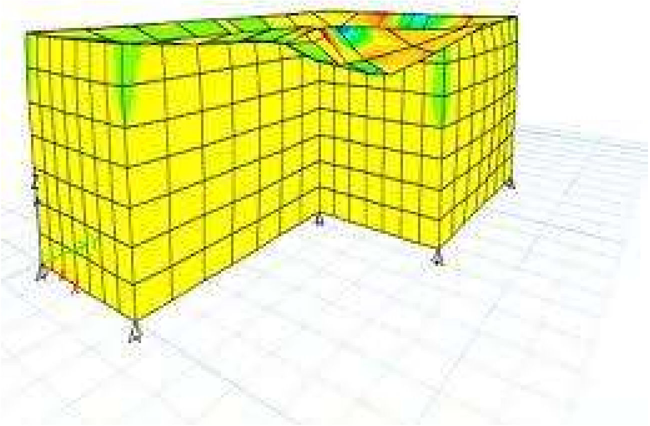

Fig. 2.8: Re-entrant corner

2.2.9 Mass Irregularity

Mass irregularity occurs when there are significant variations in mass distribution along the height of the building. This irregularity can lead to unequal distribution of seismic forces, resulting in differential drifts and increased structural vulnerability. Uneven distribution of mass due to design choices or construction errors, and changes in building function or occupancy at different levels leads to mass irregularity.

Fig. 2.9: Mass irregularity in vertical direction

2.2.10 Out-of-Plane Irregularity

Out-of-plane irregularity arises when a building's vertical elements, such as columns or walls, are not perfectly aligned vertically. This can lead to eccentricities and uneven distribution of lateral loads during seismic events. Construction errors or lack of proper alignment during building construction and foundation settlement or movement leads to the out of plane irregularity.

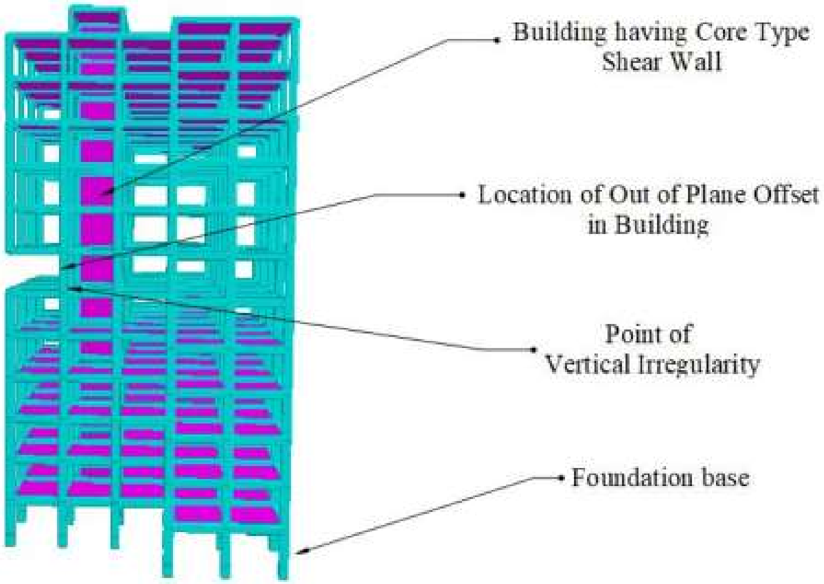

Fig. 2.10: Out of plate irregularity

2.3 Summary

Irregularities in reinforced concrete buildings can significantly influence their seismic performance. Vertical, horizontal, and plan irregularities can introduce complexities and vulnerabilities that impact the building's response to lateral loads. Understanding the implications of irregularities and implementing appropriate mitigation strategies are essential for enhancing the safety and resilience of reinforced concrete structures.

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Chapter 3

Seismic Assessment Methods

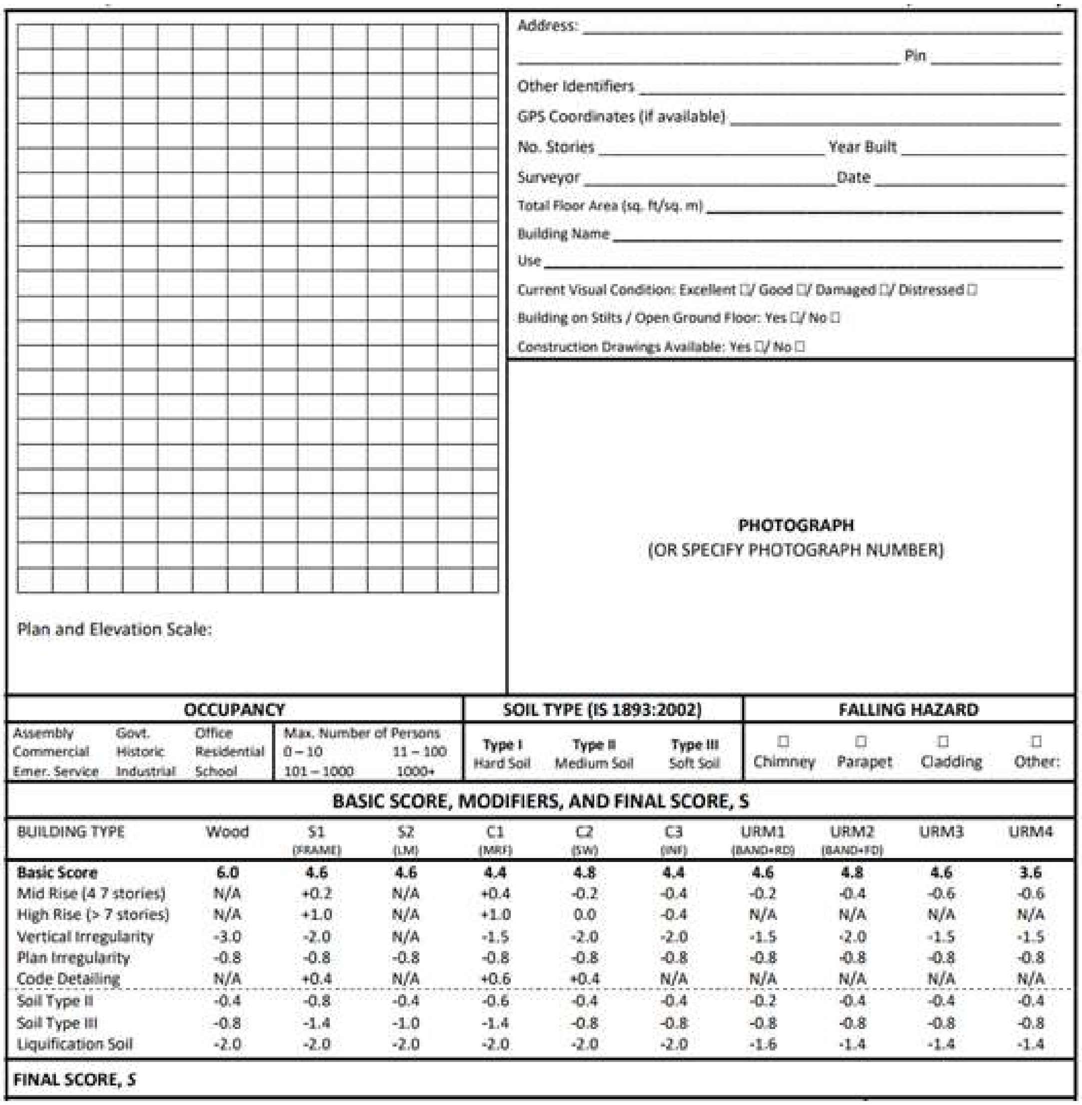
3.1 Overview

There is an urgent need to assess the seismic vulnerability of buildings in urban areas of India. Detailed seismic vulnerability evaluation is a technically complex and expensive procedure and can only be performed on a limited number of buildings. It is therefore very important to use simpler procedures that can help to rapidly evaluate the vulnerability profile of different types of buildings, so that the more complex evaluation procedures can be limited to the most critical buildings [18]. These are the following methods of seismic assessment of buildings.

1. Rapid visual screening (RVS) procedure requiring only visual evaluation and limited additional information (Level 1 procedure). This procedure is recommended for all buildings.
2. Preliminary/Simplified vulnerability assessment (SVA) procedure requiring limited engineering analysis based on information from visual observations and structural drawings or on-site measurements (Level 2 procedure). This procedure is recommended for all buildings with high concentration of people.
3. Detailed vulnerability assessment (DVA) procedure requiring detailed computer analysis, similar to or more complex than that required for design of a new building (Level 3 procedure). This procedure is recommended for all important and lifeline buildings.

3.2 Rapid Assessment

The motive behind the rapid visual screening method is to save and minimize the resources required for the safety assessment of buildings in great numbers. The RVS procedure is a simple procedure for quick evaluation of large building stock, usually based on the walk down surveys on-site for each building to indicate the buildings need more advanced analysis. This method utilizes the scores given to building type (known as a structural score or base score) and performance modifiers to decide the level of risk of building. The performance modifiers reflect the effect of building deficiencies (i.e., vulnerable parameters) on its response during ground shaking. Therefore, from the RVS result (i.e., final score), one can prioritize the buildings [12]. It also depicts that the score values assigned to each vulnerable parameter play a crucial role in deciding the risk (i.e., performance) of building. The format of all the RVS forms is similar to the one shown in Figure 3.1. The most important section in the RVS form is the checklist of vulnerable parameters and scores assigned to each parameter. The score value is the numerical depiction of the effect of parameters on a building's behavior. Thus, for a sample RVS form shown here, a smaller value indicates a higher effect of parameters on building behavior, which may sometimes cause severe damage or collapse [15]. The damage in a building may occur due to the presence of one or more vulnerable parameters. The final score of the building depicts the damaged state of the building. This method can be used for the safety assessment of buildings before an earthquake and after an earthquake. If used before an earthquake, the final score of the building depicts the most likely possible damage that the building might experience during a future earthquake. In this way, it helps extrapolate the damage and loss estimation of buildings in any region.



Address: ______
______ Pin ______
Other Identifiers ______
GPS Coordinates (if available) ______
No. Stories ______ Year Built ______
Surveyor ______ Date ______
Total Floor Area (sq. ft/sq. m) ______
Building Name ______
Use ______
Current Visual Condition: Excellent ☐/ Good ☐/ Damaged ☐/ Distressed ☐
Building on Stilts / Open Ground Floor: Yes ☐/ No ☐
Construction Drawings Available: Yes ☐/ No ☐

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBER)

Plan and Elevation Scale:

OCCUPANCY

Assembly Govt. Office
Commercial Historic Residential
Emer. Service Industrial School

Max. Number of Persons
0 – 10 11 – 100
101 – 1000 1000+

SOIL TYPE (IS 1893:2002)

Type I Hard Soil
Type II Medium Soil
Type III Soft Soil

FALLING HAZARD

☐ Chimney
☐ Parapet
☐ Cladding
☐ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**6.0**	**4.6**	**4.6**	**4.4**	**4.8**	**4.4**	**4.6**	**4.8**	**4.6**	**3.6**
Mid Rise (4 7 stories)	N/A	+0.2	N/A	+0.4	-0.2	-0.4	-0.2	-0.4	-0.6	-0.6
High Rise (> 7 stories)	N/A	+1.0	N/A	+1.0	0.0	-0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-1.5	-2.0	-2.0	-1.5	-2.0	-1.5	-1.5
Plan Irregularity	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8
Code Detailing	N/A	+0.4	N/A	+0.6	+0.4	N/A	N/A	N/A	N/A	N/A
Soil Type II	-0.4	-0.8	-0.4	-0.6	-0.4	-0.4	-0.2	-0.4	-0.4	-0.4
Soil Type III	-0.8	-1.4	-1.0	-1.4	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8
Liquification Soil	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-1.6	-1.4	-1.4	-1.4

FINAL SCORE, S

Fig. 3.1: Sample RVS form

3.3 Preliminary/Simplified Assessment

In Preliminary assessment of reinforced concrete buildings utilizes engineering information such as size and lateral stiffness of the building. This data is used to carry out simplified analysis of the structure to estimate the building drift. The analysis results between building drift and damage can be used to estimate the potential seismic hazard. However, this involves lot of computational work.A preliminary/simplified vulnerability assessment of reinforced concrete buildings provides valuable insights into potential weaknesses and lays the foundation for further in-depth evaluations. A simplified assessment can provide valuable insights for initial risk evaluation.

The assessment includes visual inspection, records analysis, historical data examination, and non-destructive testing. The identified vulnerabilities are then addressed through appropriate mitigation strategies to enhance the building's resilience. The preliminary vulnerability assessment includes the following steps:

Visual Inspection: A team of engineers conduct a comprehensive visual inspection of the building's interior and exterior. They observed several concerning findings, including:

a) Cracks on the exterior concrete panels, particularly around corners and joints.

b) Minor spalling and concrete delamination on some floors and ceilings.

c) Signs of rust stains and corrosion on exposed steel reinforcement at certain locations.

Records and Documentation Analysis: The team reviews the original construction documents, building plans, and maintenance records. The building's construction adhered to the seismic design code in effect is checked.

Historical Data Examination: The seismic history of the region needs to be studied whether the area had experienced several moderate seismic events over the past few decades. While the building had not suffered any major damage, it became evident that its vulnerability to seismic forces needed to be addressed.

Non-Destructive Testing: Non-destructive testing methods, if needed like ultrasound and infrared thermograph, can be employed to assess the condition of the concrete and reinforcement elements.

This procedure is more complex (and therefore more accurate) than the rapid assessment procedure. As mentioned, this method utilizes engineering information such as size and strength of lateral load resisting members and more explicit information on the design ground motion. This data is used to carry out a highly simplified analysis of the structure to estimate the building drift. Since good correlation exists between building drift and damage, the analysis results can be used to estimate the potential seismic hazard of the building. Unlike the rapid assessment procedure, the simplified vulnerability assessment requires the use of a computer; however, the required inputs can be collected in paper form for later entry into the software system.

3.4 Detailed Assessment

In detailed vulnerability assessment (DVA) of a building detailed engineering analysis is carried out while considering the nature of potential ground motions and the non-linear behavior of the structural members. The procedure requires in depth information regarding a building, which may not be readily available. The detailed vulnerability assessment procedure is most suitable for important structural buildings. It is crucial to understanding the performance of reinforced concrete buildings during seismic events. By identifying vulnerabilities and weak points, engineers can develop effective retrofitting strategies to enhance the building's seismic resilience and ensure the safety of occupants and assets. This assessment goes beyond a general inspection and focuses on intricate aspects of a structure's design, construction, and maintenance that could make it susceptible to damage or failure during various hazards, such as earthquakes, hurricanes, or other extreme events. Key aspects of detail vulnerability assessment:

i. Component-Level Evaluation: Detail vulnerability assessment involves scrutinizing individual building components such as columns, beams, walls, connections, and foundations. This microscopic examination helps identify inadequate materials, substandard construction techniques, or compromised structural integrity.

ii. Material and Workmanship: The assessment pays close attention to the quality of materials used and the craftsmanship during construction. Flaws such as inadequate reinforcement, poor concrete mix, or faulty welds can significantly impact a building's overall performance under stress.

iii. Non-Structural Elements: Beyond structural components, detail vulnerability assessment considers non-structural elements like partitions, facades, windows, and utilities. These elements can influence the building's functionality, occupant safety, and overall resilience.

iv. Load Paths and Redistribution: The assessment analyzes load paths, load-bearing capacities, and the potential for load redistribution in case of localized failures. This helps determine if the structure can effectively distribute loads and maintain stability even if certain components fail.

v. Connections and Joints: Connections between structural elements and joints play a crucial role in transferring forces within a building. Detail vulnerability assessment examines the integrity of these connections, ensuring that they are designed and executed to withstand the anticipated loads and movements.

vi. Deficiencies and Deterioration: Over time, buildings can experience deterioration due to environmental factors, corrosion, or wear. The assessment evaluates these potential deficiencies, identifying areas that require maintenance or repair to prevent further degradation.

vii. Functional and Aesthetic Considerations: While the primary focus is on structural integrity, detail vulnerability assessment also considers the functionality and aesthetic aspects of a building. Ensuring that a building remains functional and retains its architectural and functional features even after an extreme event is crucial.

3.5 Summary

Each type of vulnerability assessment procedure caters to specific hazards and challenges that a building may face. Depending on the building's location, purpose, and potential risks, stakeholders can choose the appropriate assessment method to ensure the building's safety and resilience in the face of various hazards. These various types of seismic vulnerability assessment procedures offer nuanced approaches to understanding a building's behavior during earthquakes. Though the latter preliminary assessment and detailed vulnerability assessment procedures are perfectly capable of identifying the deficit buildings but are costly, time-consuming and involves much more workforce. Compared to these procedures, the RVS procedure, i.e., rapid visual screening procedure, is the best alternative that requires significantly less time and serves the purpose.

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Chapter 4

Seismic Assessment of Buildings in Vijayawada City

4.1 History of Vijayawada City

Vijayawada is a historical city situated in Andhra Pradesh on the banks of Krishna River with latitude 16 03’11” N and longitude 80 03’91” E. The climate is tropical, with hot summers and moderate winters. The peak temperature reaches 47 °C in May - June, while the winter temperature is 20-27 °C. The average humidity is 78% and the average annual rainfall is 103 cm. Vijayawada gets its rainfall from both the south - west monsoon and north - east monsoon.

Vijayawada is located at the head of the Krishna delta, 70 km from the sea, bounded by the Indrakiladri Hills on the west and the Budameru River on the north. The Northern, North - Western, and South - Western parts of the city are covered by a low range of hills, while the Central, South - Western and North - Western parts are covered by rich and fertile agriculture lands with three major irrigation canals.

Fig. 4.1: Vijayawada City Map

The topography of Vijayawada is flat, with a few small to medium sized hills. The Krishna River runs through the city. The hills are part of the Eastern Ghats cut through by the Krishna River. It has very low elevation compared to the average elevation of the Ghats. This historical town has originated on the northern bank of the river Krishna and, by 1855 AD the town was in the form of small settlement on the eastern side of the Indrakiladri hills. It is also the commercial capital of the state of Andhra Pradesh, the third largest city in the state and largest city in Krishna District. The population growth has been rapidly registering almost three-fold increase in 3 decades ending 2011 with a population account of 10.48 lakhs.

Vijayawada has a lot of scope for development and urban growth. With ever increasing population and unprecedented growth the city’s landscape is undergoing unwanted changes. The impervious nature imparted to the land surface because of construction of concrete roads has resulted in increased runoff and inundation of the low lying areas in the city even from the normal spell of rainfall. Urban Heat Island is one of the upcoming climatological problems developing in the city. With inhabiting population of more than one million Vijayawada is the largest commercial center in the State of Andhra Pradesh and is well interconnected to many other cities in the region. It is also an important railway junction connecting north & south India. The airport which is located at a distance of 25 km is also contributing to the city’s growth. Vijayawada urban agglomeration consists of Vijayawada Municipal Corporation (VMC), Mangalagiri municipality and four panchayats.

4.2 Buildings Selected for Assessment

4.2.1 Tickle Road, Valluru Purnachandra Rao Road

This is a residential building with Stilt + 3 Floors, located on plain ground facing Tickle Road nearby Benz Circle with Geographic Coordinates 16°29’53” NL and 80º38’54” EL. Krishna River is 1.00 KM away and Bandar Canal is 0.50 KM from this building. The soils met with for foundations are Black Cotton soils. The height of each floor is 3.00 Mts.

The building shown in Fig. 4.2 is a G+3 storied residential reinforced concrete building. The building is roughly 35 years old and a moment resisting frame type building. It has symmetry or regularity in its plan but has vertical irregularity. The building has an open ground story which is used for the purpose of parking. This open ground story leads to vertical irregularity. Moreover, as can be seen in Fig 4.2 also, the space between the adjacent buildings is very small and not as per the Codal provisions. This might lead to a pounding problem in the future.

Fig. 4.2: Building no.1 Tickle road

4.2.2 Sitarampuram (Durga Agraharam)

This is a residential Building bearing H.No.30-17-30 in Sitarampuram area with Stilt + 5 floors located on plain ground near Eluru Road (Kothavanthena Centre). The Geographic Coordinates of this building are 16°31’07" NL and 80°38’22” EL. Ryves canal is 0.30 KM from this building. The soils are Black Cotton expansive soils. The height of each floor is 3.00 Mts.

The building shown in Fig. 4.3 is a G+5 storey residential reinforced concrete building. The building is roughly 26 years old and a moment resisting frame type building. It has symmetry or regularity in its plan but has vertical irregularity. The building has an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, the space between the adjacent buildings is very small and not as per the Codal provisions. This might lead to a pounding problem in the future.

(a) (b)

Fig. 4.3: Building no.2 Sitarampuram

4.2.3 Governerpet (Venkateswara Rao Street)

This is a residential building with H. No. 29-3-8 located in Ward No. 24 in Governorpet area with Geographic Coordinates 16°30’48” NL and 80°37’51” EL. The Ryves canal is about 0.50 KM from this building. The foundations are met with Black Cotton soil. The height of each floor is 3.00 Mts.

The building shown in Fig. 4.4 is a G+3 storey residential reinforced concrete building. The building is roughly 23 years old and a moment resisting frame type building. It has symmetry or regularity in its plan but has vertical irregularity. The building has stiffness variation between ground floor and Fist floor (hold RVS) an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, the space between the adjacent buildings is very small and not as per the Codal provisions. This might lead to a pounding problem in the future.

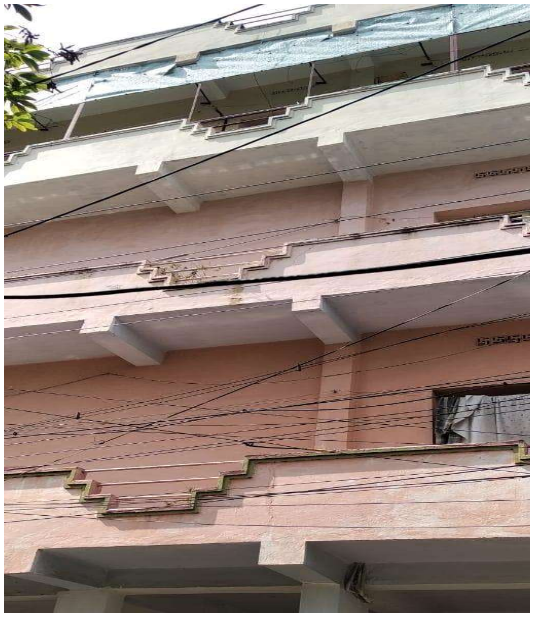


Fig. 4.4: Building no.3 Governerpet

4.2.4 Choultry (Madapati Guest House) Tarapet

This is a commercial building being used as a Guest House with Stilt + 3 floors, located in Commercial area of Vijayawada Old town near Railway Station. The Geographic Coordinates of this building are 16°31'06" NL and 80°36'41" EL. The soils met with are Black cotton soils. The height of each floor is 3.66 Mts. The building shown in Fig. 4.5 is a G+3 storey residential reinforced concrete building. The building is roughly 20 years old and a moment resisting frame type building. It has Symmetry and regularity in its plan and has vertical irregularity safe to assume for RVS. The building has an open ground storey which is used for the purpose of parking and Stair case head room. This open ground storey and staircase head room leads to vertical irregularity.

Fig. 4.5: Building no.4 Choultry

4.2.5 Jammidoddi (Endowments Dept. office)

This is an office building of Endowments Department with Stilt + 4 floors, located in old town of Vijayawada in hill slope of Indra Keeladdri Hill.

Fig. 4.6: Building no.5 Jammidoddi

The Geographic Coordinates of this building are 16°30'58" NL and 80°40'33" EL. The soils met with in foundations are hard gravel / murram. The height of each floor is 3.66 Mts. sliding of hill slopes is common during rainy season in this area. The building shown in Fig. 4.6 is a G+4 storey Govt. office reinforced concrete building. The building is roughly 11 years old and a moment resisting frame type building. The Plan is 'L' Shaped Plan Irregularity and has vertical irregularity. The building has an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, as can be seen in Fig 4.6 also, the space between the adjacent buildings is very small and not as per the Codal provisions. This might lead to a pounding problem in the future.

4.2.6 Mahanadu Road, Gunadala

This is a residential building H.No.48-19-17, with Stilt + 5 floors, located in Gunadala area of Vijayawada city close to Mahanadu Road. The Geological Coordinates of this building are 16°30'52" NL and 80°40'33" EL. The soils met with in foundations are pure Black cotton soils. These were all agricultural lands until 20 years back. The roof height of each floor is 3.00 Mts.

The building shown in Fig. 4.7 is a Stilt+5 storey residential reinforced concrete building. The building is roughly 10 years old and a moment resisting frame type building. It has symmetry or regularity in its plan but has vertical irregularity. The building has an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, as can be seen in Fig 4.7 the space between the adjacent buildings as per the Codal provisions.

Fig. 4.7: Building no.6 Mahanadu

4.2.7 Brindavan (Labbipet)

This is a residential building in Brindavan Nagar of Labbipet area H. No.40-15/2-19/8A near Benz Circle with Stilt + 4 floors. The Geological Coordinates of this building are 16°29’57” NL and 80°38’48” EL. Krishna River is 1.00 KM away and Bandar Canal is 0.50 KM from this building. The soils met with foundations are Black Cotton. The height of each floor is 3.00 Mts. The building shown in Fig. 4.8 is a Stilt +4 storey residential reinforced concrete building. The building is roughly 5 years old and a moment resisting frame type building. It has symmetry or regularity in its plan but has vertical irregularity. The building has an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, as can be seen in Fig. 4.8 the space between the adjacent buildings as per the Codal provisions.

Fig. 4.8: Building no.7 Brindavan

4.2.8 GPV – ECE Block (Benz circle fly over)

This is the Govt. Polytechnic Building for Electronics & Communications Engineering Lab in Ground + 2 Floors facing Ring Road Benz Circle Flyover on NH-16. The Geographic Coordinates of this building are 16°30’16” NL and 80°39’30” EL. The soil is Black Cotton. The roof height of each floor is 3.60 Mts.

The building shown in Fig. 4.9 is a G+2 storey reinforced concrete building with educational classrooms. The building is roughly 21 years old and a moment resisting frame type building. It has symmetry or regularity in its plan and vertical regularity. Moreover, the space between the adjacent buildings is as per the Codal provisions.

Fig. 4.9: Building no.8 GPV

Fig. 4.10: Building no.9 GPV Hostel

4.2.9 GPV Hostel Block, Benz Circle Fly over

This is Govt. building with G + 2 floors, located facing Benz Circle Flyover on NH-16 opp. to Ramesh Hospitals, used for Polytechnic Students Hostel. The Geographic Coordinates of this building are 16°30’20” NL and 80°39’34” EL. The soils are Black Cotton.Roof height of each floor is 3.00 Mts. The building shown in Fig. 4.10 is a G+2 storey residential hostel reinforced concrete building. The building is roughly 10 years old and a moment resisting frame type building. It has symmetry or regularity in its plan and vertical regularity. Moreover, the space between the adjacent buildings is as per the Codal provisions.

4.2.10 MARK Residency, A. S. Ramarao Road Gunadala

This is a residential building with Stilt + 5 floors located in Moghalrajpuram East Hill slope area abutting A. S. Ramarao Road. The soils are Black cotton. Landslides during rainy season in this area are common. Geographic Coordinates of this building are 16°30’15” NL and 80°39’30” EL. The roof height of each floor is 3.00 Mts. The building shown in Fig. 10.0 is a Stilt +5 storey residential reinforced concrete building. The building is roughly 8 years old and a moment resisting frame type building. It has symmetry or regularity in its plan but has vertical irregularity. The building has an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, as can be seen in Fig. 4.11 also, the space between the adjacent buildings is as per the Codal provisions.

Fig. 4.11: Building no.10 Mark

Fig. 4.12: Building no.11 AB Plaza

4.2.11 AB Plaza, Krishna Lanka, NH-16 & 65

This is a residential building with Stilt + 5 floors, located in Krishna Lanka flood affected area in between Krishna River and Bandar Canal abutting NH-16 & 65. The soil is black cotton / soft. The Geographic Coordinates of this building are 16°29’45” NL and 80°38’49” EL. The roof height of each floor is 3.00 Mts. The building shown in Fig. 4.12 is a Stilt +5 storey residential reinforced concrete building. The building is roughly 16 years old and a moment resisting frame type building. It has symmetry or regularity in its plan but has vertical irregularity. The building has an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, as can be seen in Fig. 4.12 also, the space between the adjacent buildings is as per the Codal provisions.

4.2.12 Chakradhar, No.5 Route, ITI Road

This is an office building with Stilt + 5 floors, located in Ramachandra Nagar, facing ITI Road. The soil is black cotton / soft. The Geographic Coordinates of this building are 16°30’17” NL and 80°39’19” EL. The roof height of each floor is 3.00 Mts.

The building shown in Fig. 4.13 is a STILT +5 Floors reinforced concrete building with office spaces and residential. The building is roughly 7 years old and a moment resisting frame type building. It has irregularities in its plan and vertical irregularity. The building has an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, the space between the adjacent buildings is as per the Codal provisions.

Fig. 4.13: Building no.12 Chakradhar

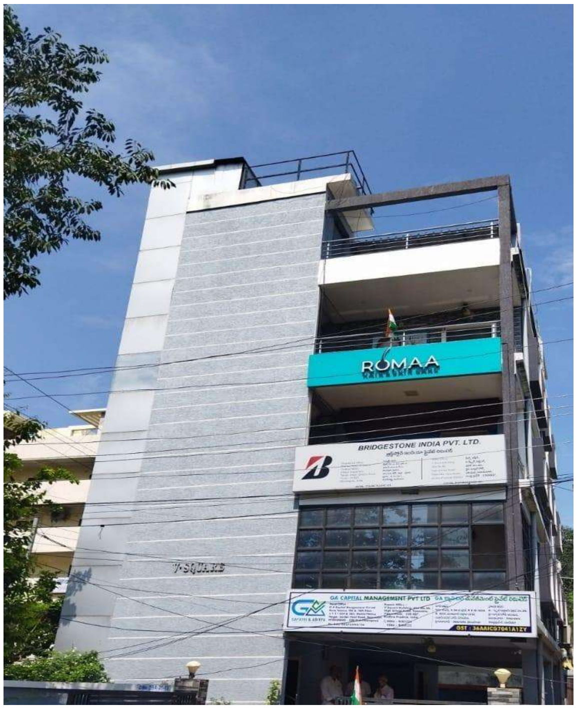


Fig. 4.14: Building no.13 High School

4.2.13 High School Road, Patamata

This is an office-cum-residential building with stilt +4 Floors located on plain ground facing High School Road in Auto Nagar area of Patamata with Geographic coordinates 16°30’03” NL and 80°40’12” EL. The roof height of each floor is 3.00 Mts. The building shown in Fig. 2.14 is a Stilt +4 storey reinforced concrete building with office spaces & residential. The building is roughly 7 years old and a moment resisting frame type building. It has irregularity in its plan but has vertical irregularity. The building has an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, the space between the adjacent buildings is as per the Codal provisions.

4.2.14 Ranganath Residency, Bandar Road, Mogalrajpuram

This is a residential building with Stilt + 5 floors, located on plain ground in Mogalrajpuram near Bandar Road. The Geographic Coordinates of this building are 16°30’08” NL and 80°39’01” EL. The roof height of each floor is 3.00 Mts. The building shown in Fig. 2.15 is a Stilt +5 Floors storey residential reinforced concrete building. The building is roughly 15 years old and a moment resisting frame type building. It has symmetry or regularity in its plan but has vertical irregularity. The building has an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, the space between the adjacent buildings is as per the Codal provisions.

Fig. 4.15: Building no.14 Ranganath

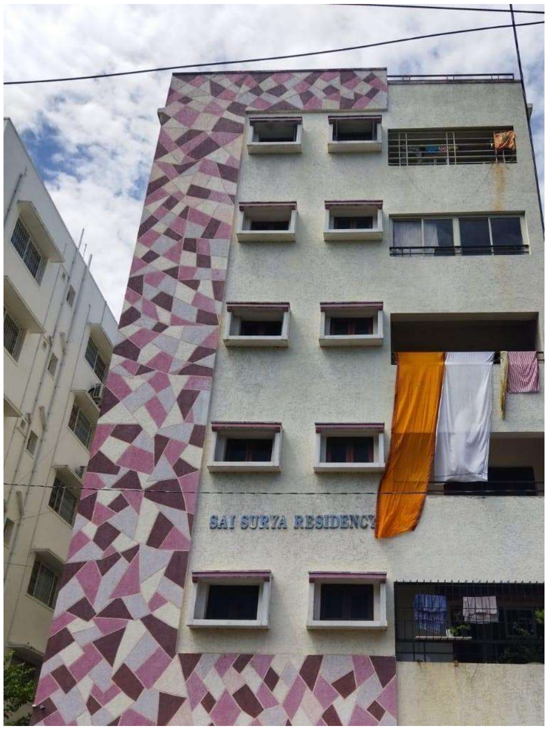


Fig. 4.16: Building no.15 Machavaram

4.2.15 Machavaram, Narla Vari Street

This is a residential building with Stilt + 5 floors on plain ground at a distance of about 100 m. away from Ryves Canal between Vijayawada Bypass Road and Eluru Road in Machavaram down locality. The Geographic Coordinates of this location are 16°31’24” NL and 80°39’13” EL. The soils met with for foundations are Black Cotton soil. The height of each floor is 3.00 m. The building shown in Fig. 2.16 is a Stilt +5 floors residential reinforced concrete building. The building is roughly 9 years old and a moment resisting frame type building. It has symmetry or regularity in its plan but has vertical irregularity. The building has an open ground storey which is used for the purpose of parking. This open ground storey leads to vertical irregularity. Moreover, the space between the adjacent buildings is very small and not as per the Codal provisions. This might lead to a pounding problem in the future.

4.2.16 Summary

The location of the selected buildings is shown in the following figure along with their coordinates.

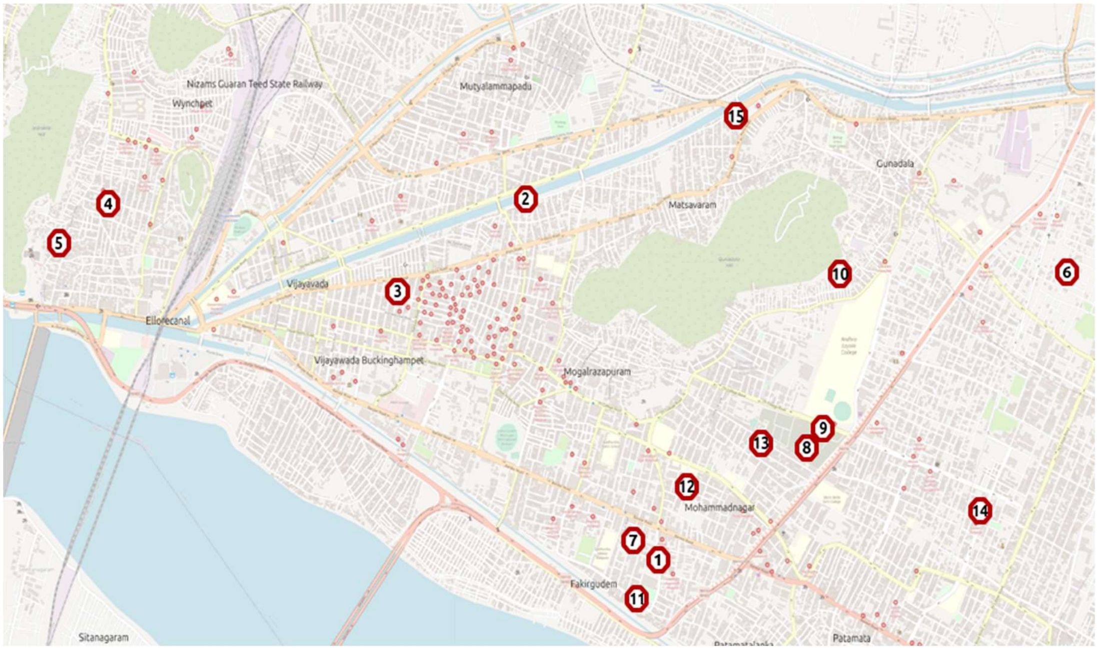


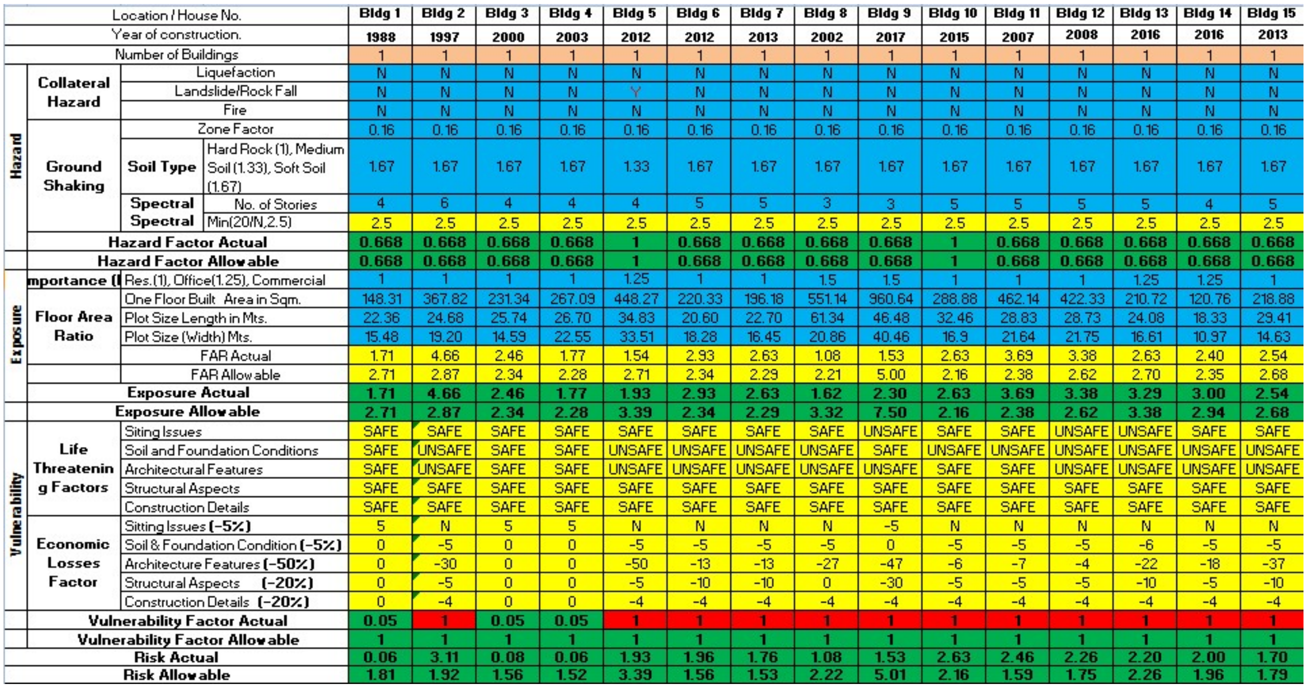
Fig. 4.17 Location of the surveyed building

Table 1: Latitude and longitude of surveyed buildings

S. No	Longitude	Latitude	Name
1	80.648333	16.498056	TSNo:147 Tickle Road
2	80.639444	16.518611	Hno:30-17-30 Durga Agraharam
3	80.630833	16.513333	Hno:29-3-8W-24Governorpet
4	80.611389	16.518333	Madapati Guest House Tarapet
5	80.608056	16.516111	O/o. A P Endowment Dept. Jammidoddi
6	80.675833	16.514444	Hno:48-19-17MahanaduRdGunadala
7	80.646667	16.499167	Hno:40-15/2-19/8ALabbipet
8	80.658333	16.504444	GPV-ECE Block
9	80.659444	16.505555	GPV- Hostel Block
10	80.660588	16.5143518	MARK Residency
11	80.646944	16.495833	AB Plaza
12	80.6502778	16.5022222	Ranganath Res. Bandar Road.
13	80.6552778	16.5047222	Chakradhar No.5 Route, ITI Road
14	80.67	16.5008333	V-Square, High School Road, Patamata
15	80.6536111	16.5233333	Machavaram, Narne Vari Street

4.3 Rapid assessment of buildings

The rapid assessment of all 15 buildings was done using the FEMA154 RVS form. The assessment forms are shown in Annexure 1. In 1988, FEMA (Federal Emergency Management Agency) published the first edition of the FEMA-154 report that included a rapid visual screening procedure for identifying the buildings that might pose a severe risk of losing a life when a damaging earthquake occurs. The primary objective of this method is to identify if a particular building requires further evaluation to assess its seismic vulnerability. The method consists of two main factors: the basic score and score modifiers. The basic score is a generic score assigned to a building typology with no vulnerability present in it. A score modifier is a score given to those building vulnerable parameters which affects building performance during an earthquake. The advantage of using this method for assessment is that the method clearly defines the expected damage state of the building qualitatively, for example, slight damage, moderate damage, etc.



Location / House No.				Bldg 1	Bldg 2	Bldg 3	Bldg 4	Bldg 5	Bldg 6	Bldg 7	Bldg 8	Bldg 9	Bldg 10	Bldg 11	Bldg 12	Bldg 13	Bldg 14	Bldg 15
Year of construction.				1988	1997	2000	2003	2012	2012	2013	2002	2017	2015	2007	2008	2016	2016	2013
Number of Buildings				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hazard	**Collateral Hazard**	Liquefaction		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
		Landslide/Rock Fall		N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N
		Fire		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Ground Shaking	Zone Factor		0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
		Soil Type	Hard Rock (1), Medium Soil (1.33), Soft Soil (1.67)	1.67	1.67	1.67	1.67	1.33	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
		Spectral	No. of Stories	4	6	4	4	4	5	5	3	3	5	5	5	5	4	5
		Spectral	Min(20/N,2.5)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Hazard Factor Actual			**0.668**	**0.668**	**0.668**	**0.668**	**1**	**0.668**	**0.668**	**0.668**	**0.668**	**1**	**0.668**	**0.668**	**0.668**	**0.668**	**0.668**
	Hazard Factor Allowable			**0.668**	**0.668**	**0.668**	**0.668**	**1**	**0.668**	**0.668**	**0.668**	**0.668**	**1**	**0.668**	**0.668**	**0.668**	**0.668**	**0.668**
Exposure	**mportance (I**	Res.(1), Office(1.25), Commercial		1	1	1	1	1.25	1	1	1.5	1.5	1	1	1	1.25	1.25	1
	Floor Area Ratio	One Floor Built Area in Sqm.		148.31	367.82	231.34	267.09	448.27	220.33	196.18	551.14	960.64	288.88	462.14	422.33	210.72	120.76	218.88
		Plot Size Length in Mts.		22.36	24.68	25.74	26.70	34.83	20.60	22.70	61.34	46.48	32.46	28.83	28.73	24.08	18.33	29.41
		Plot Size (Width) Mts.		15.48	19.20	14.59	22.55	33.51	18.28	16.45	20.86	40.46	16.9	21.64	21.75	16.61	10.97	14.63
		FAR Actual		1.71	4.66	2.46	1.77	1.54	2.93	2.63	1.08	1.53	2.63	3.69	3.38	2.63	2.40	2.54
		FAR Allowable		2.71	2.87	2.34	2.28	2.71	2.34	2.29	2.21	5.00	2.16	2.38	2.62	2.70	2.35	2.68
	Exposure Actual			**1.71**	**4.66**	**2.46**	**1.77**	**1.93**	**2.93**	**2.63**	**1.62**	**2.30**	**2.63**	**3.69**	**3.38**	**3.29**	**3.00**	**2.54**
	Exposure Allowable			**2.71**	**2.87**	**2.34**	**2.28**	**3.39**	**2.34**	**2.29**	**3.32**	**7.50**	**2.16**	**2.38**	**2.62**	**3.38**	**2.94**	**2.68**
Vulnerability	**Life Threatening Factors**	Siting Issues		SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	UNSAFE	SAFE	SAFE	UNSAFE	UNSAFE	SAFE	SAFE
		Soil and Foundation Conditions		SAFE	UNSAFE	SAFE	SAFE	UNSAFE	UNSAFE	UNSAFE	UNSAFE	SAFE	UNSAFE	UNSAFE	UNSAFE	UNSAFE	UNSAFE	UNSAFE
		Architectural Features		SAFE	UNSAFE	SAFE	SAFE	UNSAFE	UNSAFE	UNSAFE	UNSAFE	UNSAFE	SAFE	SAFE	UNSAFE	UNSAFE	UNSAFE	UNSAFE
		Structural Aspects		SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE
		Construction Details		SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE	SAFE
	Economic Losses Factor	Sitting Issues **(-5%)**		5	N	5	5	N	N	N	N	-5	N	N	N	N	N	N
		Soil & Foundation Condition **(-5%)**		0	-5	0	0	-5	-5	-5	-5	0	-5	-5	-5	-6	-5	-5
		Architecture Features **(-50%)**		0	-30	0	0	-50	-13	-13	-27	-47	-6	-7	-4	-22	-18	-37
		Structural Aspects **(-20%)**		0	-5	0	0	-5	-10	-10	0	-30	-5	-5	-5	-10	-5	-10
		Construction Details **(-20%)**		0	-4	0	0	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4
	Vulnerability Factor Actual			**0.05**	**1**	**0.05**	**0.05**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Vulnerability Factor Allowable			**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Risk Actual				**0.06**	**3.11**	**0.08**	**0.06**	**1.93**	**1.96**	**1.76**	**1.08**	**1.53**	**2.63**	**2.46**	**2.26**	**2.20**	**2.00**	**1.70**
Risk Allowable				**1.81**	**1.92**	**1.56**	**1.52**	**3.39**	**1.56**	**1.53**	**2.22**	**5.01**	**2.16**	**1.59**	**1.75**	**2.26**	**1.96**	**1.79**

Fig. 4.18: Summary of assessment as per BMTPC Method

Moreover, the building information collected during the survey further used to calculate the risk of the building using the BMTPC method. BMTPC (Building Materials and Technology Promotion Council) in 2012 documented a methodology for the seismic safety assessment of typical housing typologies in India. The method is a result of an intensive field survey and a detailed study of historical documents. It provides a seismic safety index and performance rating to a building with respect to an ideal building of the same typology. Moreover, it divides all vulnerable parameters into two categories viz., life-threatening parameters and economic loss inducing parameters. Each economic loss inducing parameter has been assigned a score value or index values derived based on Delphi-Method. Delphi method is based on previous studies and the experience of the experts who assign scores to each parameter. As BMTPC (2012) method separates each factor into two sets, it becomes easy to determine the factors affecting life safety. But it has a few disadvantages over its use.

In BMTPC methods all the vulnerable parameters are categorized into 5 major factors: (i) Siting issue; (ii) Soil and foundation issue; (iii) Architectural issue; (iv) Structural issue and (v) Construction issue. Fig. 4.18 clearly shows that out of 5 buildings, 12 buildings have their risk level more than the allowable risk. This means that those 12 building will undergo major damage during any future major earthquake event. Moreover, this also implies that these 12 buildings need further detail evaluation to take necessary mitigation action.

4.4 Result analysis of rapid assessment

4.4.1 Result Analysis of BMTPC method

As mentioned in the previous section, the BMTPC method categories all the vulnerable parameters into five broad factors. Thus, after rapid survey, the data collected used to determine the risk of the building using BMTPC method. The Fig. 4.19 shows the contribution of each factor in overall risk of the building. It shows that the *Architectural issues* have highest contribution in overall risk of building followed by *Structural issues* and *Construction issues*.

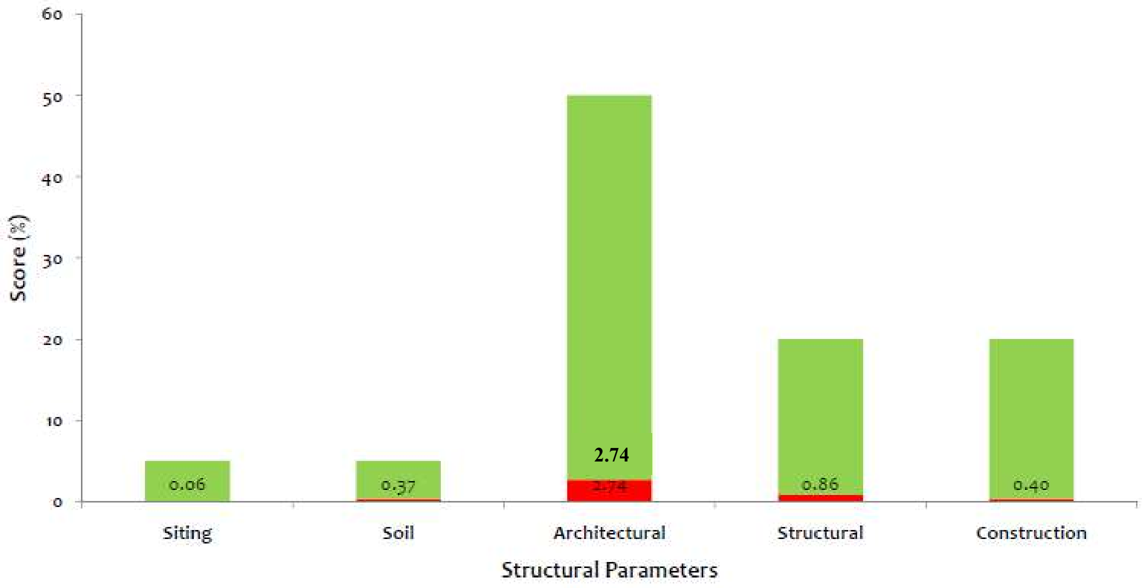


Fig. 4.19: Contribution of each factor in overall risk

After knowing the contribution of each factor in overall risk of building, the contribution of each vulnerable of each of the factor was determined. Fig. 4.20 shows the contribution of commonly present vulnerable parameters related architectural issues. It clearly shows that the majority of buildings have *elevation profile* issues with the highest contribution followed by *openings in walls*, *plan shape* and *parapet projections*.

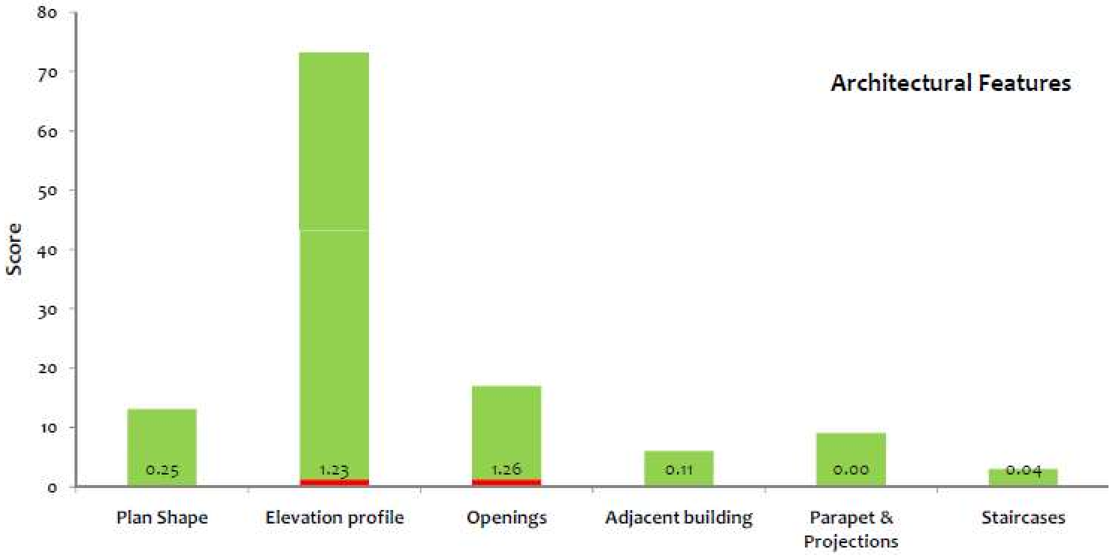


Fig. 4.20: Contribution of vulnerable parameters related architectural issues in overall risk of building

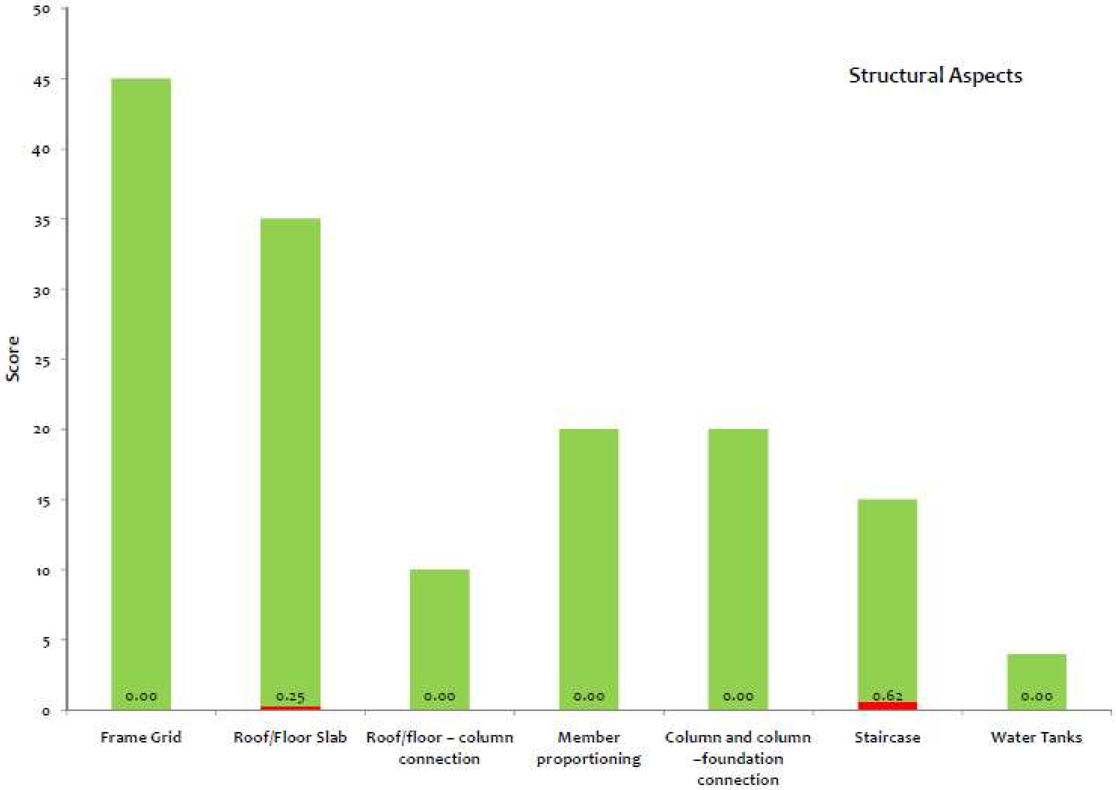


Fig. 4.21: Contribution of vulnerable parameters related structural issues in overall risk of building.

Fig. 4.21 shows the contribution of commonly present vulnerable parameters related structural issues. It shows that *frame grid*, *floor slab*, *member proportioning*, and *column-to-column* connection are most common parameters present in the buildings. Out of these frame grid and floor slab parameter has highest contribution in the risk of building.

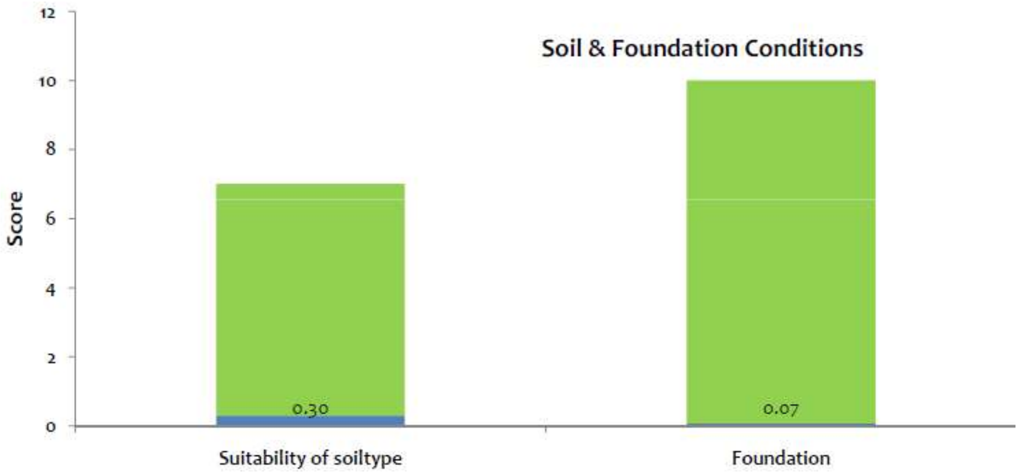


Fig. 4.22: Contribution of vulnerable parameters related soil issues in overall risk of building

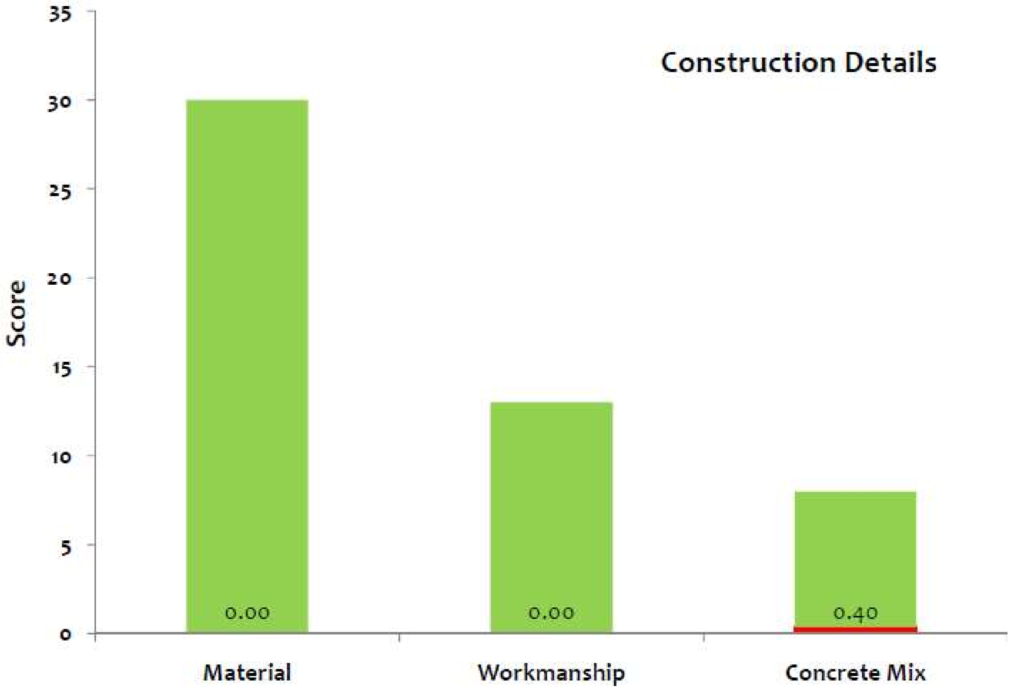


Fig. 4.23: Contribution of vulnerable parameters related construction issues in overall risk of building

Similarly, Fig. 4.22 and Fig. 4.23 show the contribution of vulnerable parameters related to soil and construction issues respectively in overall risk of the buildings. Parameters such as *foundation*, *suitability of soil* and *materials* have more contributions in overall risk of surveyed buildings in Vijayawada.

4.5 Result analysis of detailed assessment

4.5.1 Data collection

For the purpose of detailed assessment, additional data such as structural drawings of building, compressive strength of structural members are collected. The objective of the detailed assessment is to understand the behavior of the buildings with irregularity. The data of drawings collected for buildings is shown in Annexure 2. Because detailed assessment involves numerical modeling and of buildings in sophisticated software, the data of compressive strength of structural members. These compressive strengths are determined using the NDT (Non-Destructive Testing or Rebound Hammer Test). The details of the ND Test collected for all buildings are shown in Annexure 3. For the non-destructive testing the readings were taken on each face of column at three levels of height (E, M, E) i.e., near 1st end, then at centre and then near opposite end as shown in Fig. 4.23.

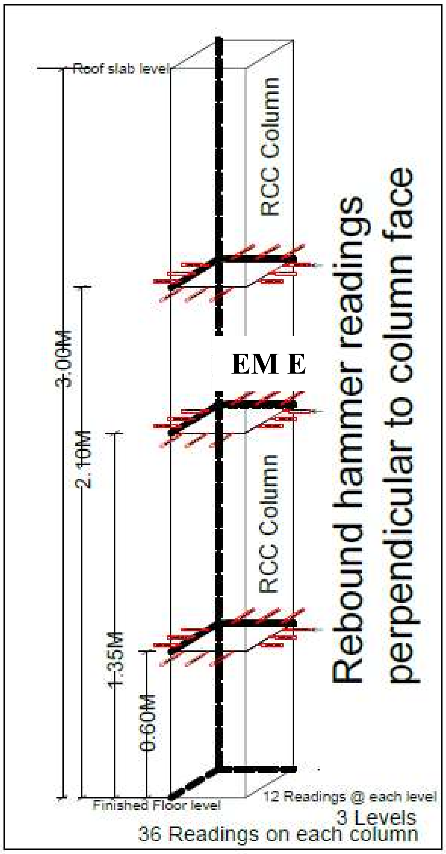
Earthquake resistant design requires calculation of earthquake forces on buildings and structures. The guide to earthquake resistant design of building and structures are given by IS 1893:2016 in India. The base shear calculation of all surveyed buildings is calculated using the collected information of each building.

First step to calculate earthquake loads on structure is to identify the earthquake zone for which structure needs to be designed. This earthquake zones are displayed in a map on page – 11 of IS-1893:2016 Part I. After earthquake zone has been identified, the following steps are followed:

Step 1: Calculate design horizontal seismic coefficient, A_h which is given by

$$A_h = \frac{ZIS_a}{2Rg}$$

Here, *Z* is the zone factor, given in Table 3 of IS-1893:2016 Part I. *I* is the important factor of the structure depending on the function or use. This factor can be obtained from Table 8 of IS-1893:2016 Part I. *R* is response reduction factor. This value is obtained from Table 9 of IS-1893:2016 Part I. The value of 1/R shall not be more than 1.0. S_a/g is an average response acceleration coefficient. This value depends on time period of structure and on soil type and can be determined using Figure 2A of IS-1893:2016 Part I.



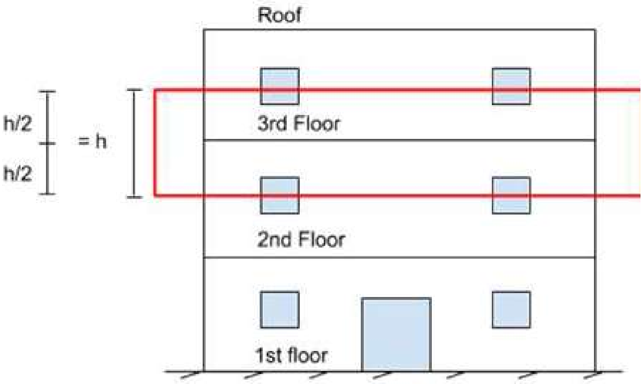
E = End point of Column face ↗
M = Mid point of Column face ↗
E = End point of Column face ↗

FFL=Finished Floor Level.

Fig. 4.24: Locations on structural members for doing NDT

Step 2: Calculate design seismic base shear for the structure (V_B).

This is the total design lateral force along any principal direction. This is calculated as: $V_B = A_h \times W$. Where, A_h represents horizontal seismic coefficient, as discussed previously. W is total seismic weight of the structure. As per the Clause number 3.26 of IS-1893:2016 Part I seismic weight of the structure is defined as sum of: (i) dead load of the floor, (ii) appropriate contributions of weights of columns, (iii) walls and any other permanent elements from the storeys above and below, finishes and services, and (iv) appropriate amounts of specified imposed load on the floor. The pictorial representation of seismic weight calculation is shown in Fig below:



$$(W_3) = W_{SLAB3} + W_{BEAM3} + 0.5W_{COLUMN3} + 0.5W_{COLUMN2} + 0.5W_{WALLS3} + 0.5W_{WALLS2}$$

Step 3: Calculate distribution of design forces on the structure.

The seismic design base shear calculation as discussed previously is distributed on the structure as design seismic forces. This is calculated as below:

$$Q_i = V_B \frac{W_i h_i^2}{\sum_{i=1}^{n} W_i h_i^2}$$

Here, Q_i is design lateral force at floor i; W_i = seismic weight of the floor i; h_i = height of the floor i from the base; and n = number of storeys of the building at which masses are located.

4.5.2 Result analysis

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used, and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level (FFL). At every level maximum 12 readings around the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis.

In building 1 (Tickle road) There are 28 columns in each floor. Rebound Hammer readings are taken at 3 levels for each column wherever possible and average of 12 readings at each level are considered as one reading for analysis purpose. There are 84 readings in Stilt Floor and 74 readings for each upper floor, totaling to 309 readings in 4 floors. The boxplots are shown below.

The means in floors GF, F1, F2, and F3 are 38.16, 33.62, 33.97, and 34.08 respectively. The overall mean is 34.96. The means are shown in the bar graph below.

The significance test of the equality of floor means is also carried out by the analysis of variance and its result is shown in Table 4.2.

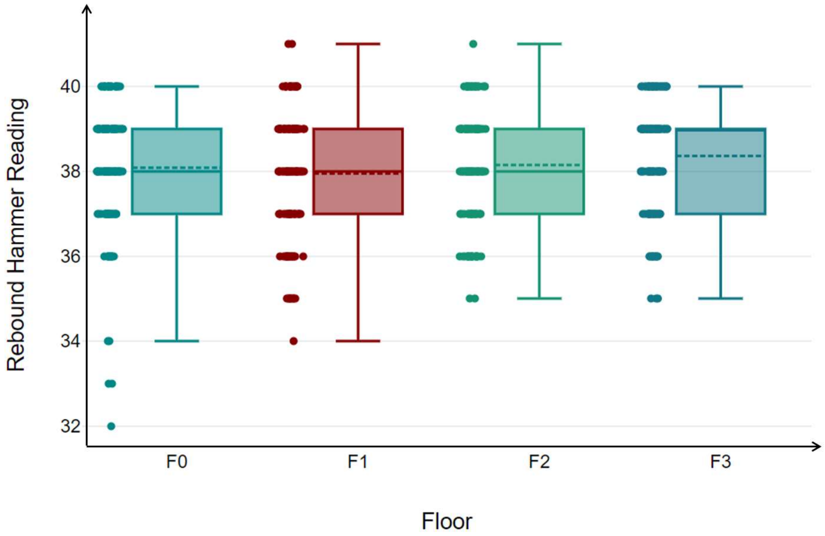


Fig. 4.25: Boxplot of NDT readings for building 1 (Tickle road)

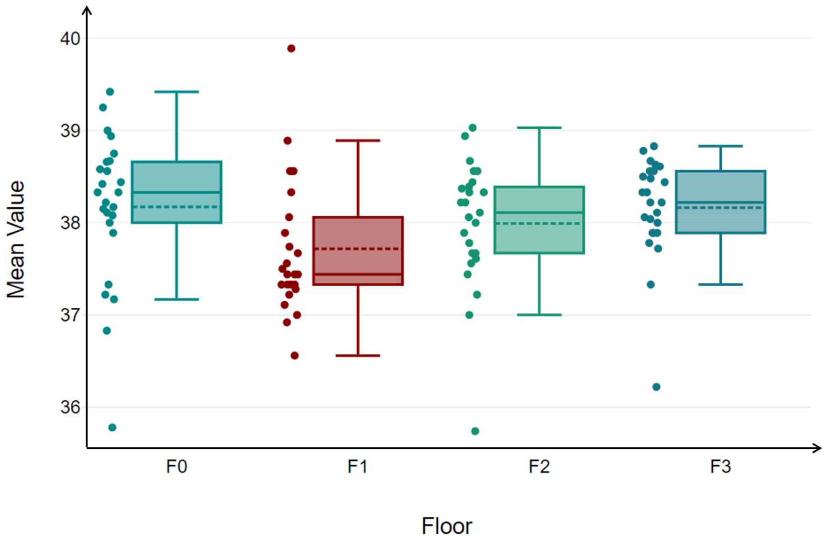


Fig. 4.26: Bar plot of NDT readings for building 1 (Tickle road)

Table 4.2: Analysis of variance for building 1 (Tickle road)

	Estimate	Std. Error	t-value	p-value
GF	38.158	1.120	34.060	0
F1	-4.539	1.584	-2.865	0.00444
F2	-4.184	1.584	-2.641	0.00867
F3	-4.082	1.84	-2.576	0.01041

Similarly, the analyses of other 14 buildings were also performed in the same fashion and its detailed results can be found in Annexure 4. Further, to understand the nonlinear behavior of the buildings, few buildings were selected, and a nonlinear static analysis was performed on a single frame of the building in both X and Y direction.

This nonlinear static analysis is also called *pushover* analysis. During this analysis, the control note is usually considered at the centre of mass of the roof of the building. Upon incorporating the material as well as geometric nonlinearity in a mathematical model of the structure, the structure is loaded monotonically with increasing loads. The model is loaded until either target displacement is reached or the structure reaches to collapse stage. Target displacement is maximum displacement that a structure is likely to experience during an earthquake. As the effects of inelastic material response are incorporated into the model, the procedure gives a fairly accurate estimate of the seismic response of the structure.

The nonlinear analysis was performed only on few selected buildings. The result of the analysis for the selected buildings is shown in Fig. 4.27, Fig. 4.28 and Fig. 4.29 respectively. The result of nonlinear static analysis is nothing but a plot of displacement of building vs. base shear. This is also called as *capacity curve (pushover curve)*. From the plot of capacity curve anyone can determine four important engineering parameters of the buildings like: initial stiffness, ultimate strength, ductility, and energy dissipation. The initial slope of any capacity curve shows the initial slope of the building. The highest point on any capacity curve represents the ultimate strength of the building. The ratio of displacement at failure point and displacement at yield point represents the ductility of the building and lastly, the area under the curve shows the energy dissipation of the building.

Fig. 4.26 indicates that the initial stiffness of the 1st building along X direction is much higher that its initial stiffness in Y direction. Due to vulnerable parameters present in the building, its ultimate strength value varies for X as well as Y direction. Another major concern for 1st building is the ductility ratio along both directions. Due to presence of vulnerable parameter, the ductility of building along Y direction is more than ductility in X direction. This also implies that the building is comparatively more flexible along Y direction than X direction. The curve for X direction shows abrupt failure at displacement of 0.03 m which also shows a kind of brittle behavior of building post yielding.

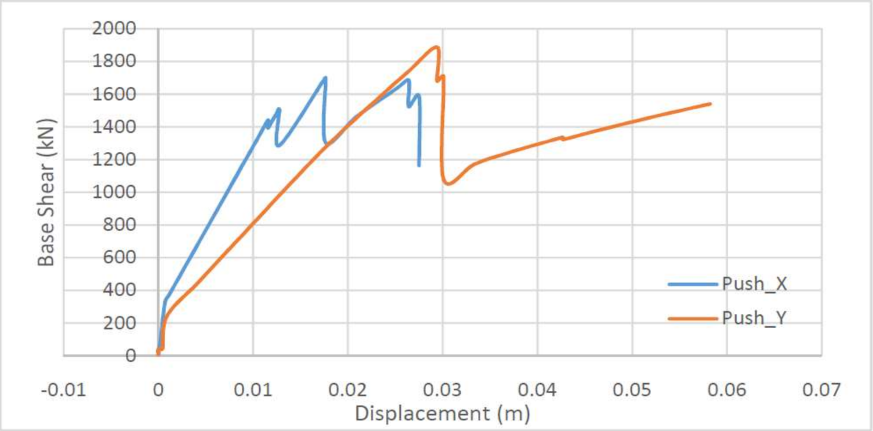


Fig. 4.27: Capacity curve of building 1 (Tickle road)

Fig. 4.28 shows that the initial stiffness of the 9th building along X direction is much higher that its initial stiffness in Y direction. Due to vulnerable parameters present in the building, its ultimate strength value varies for X as well as Y direction. The major concern for this building is also a ductility ratio along both directions. Due to presence of vulnerable parameter, the ductility of building along Y direction is more than ductility in X direction. This also implies that the building is comparatively more flexible along Y direction than X direction. Similar to the behavior of 1st building, the curve for X direction for this 9th building shows abrupt failure at displacement of 0.015 m which also shows a kind of brittle behavior of building post yielding.

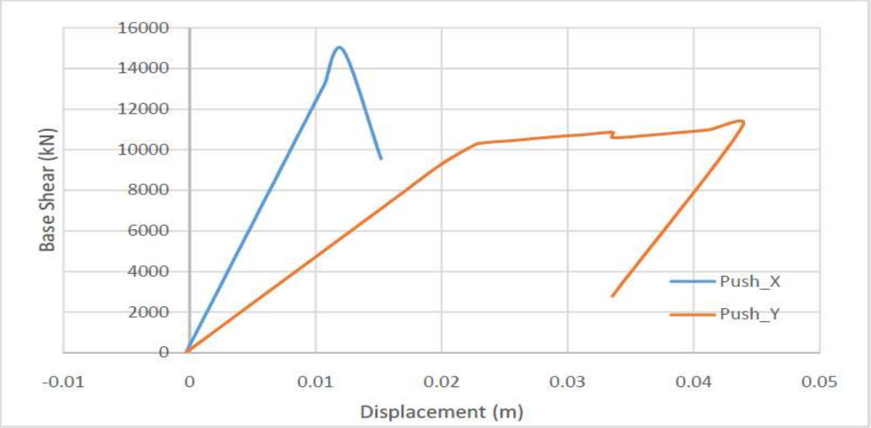


Fig. 4.28: Capacity curve of building 9 (GPV Hostel)

Similarly, Fig. 4.29 shows that the initial stiffness of the 10th building along X direction is much higher that its initial stiffness in Y direction. Due to vulnerable parameters present in the building, its ultimate strength value has a huge difference in its values for X as well as Y direction. The major concern for this building is also a ductility ratio along both directions. Due to presence of vulnerable parameter, the ductility of building along Y direction is more than ductility in X direction. This also implies that the building is comparatively more flexible along Y direction than X direction.

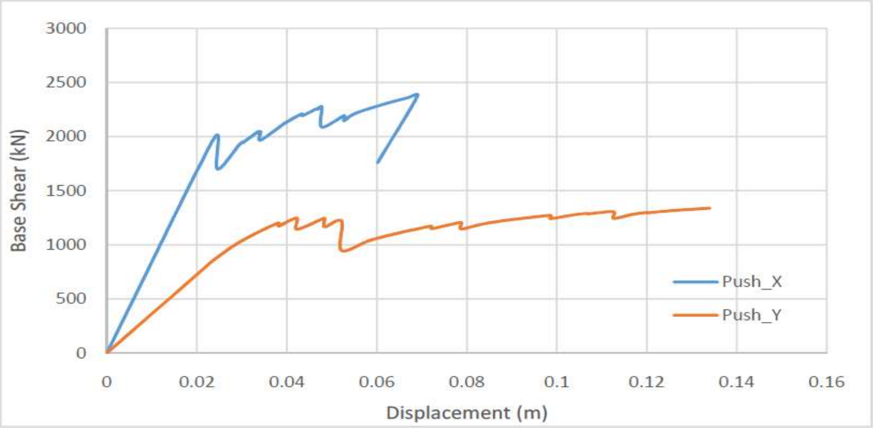


Fig. 4.29: Capacity curve of building 10 (Mark residency)

4.6 Summary

The assessment of selected buildings was divided in to two phases. In the first phase the rapid visual survey of building was performed using the RVS method developed by FEMA 154 as well as BMTPC. Later the results of BMTC method were used to perform the result analysis and to identify the parameters contributing most in the overall risk. In the second phase the detail information of buildings was collected, the numerical model was created, and a nonlinear static analysis was performed. The result of nonlinear analysis was helpful in understanding the nonlinear behavior of buildings.

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Chapter 5

Conclusion and Future Scope

5.1 Conclusion

Total 15 reinforced concrete buildings were selected randomly from nearly 6 different locations in Vijayawada city. The rapid assessments of buildings have shown that the out of 15, 12 buildings have seismic risk more than the allowable risk limit. This implies many aspects about the current built scenarios not only in Vijayawada city but also in many other cities in India. It clearly implies that: (i) current construction industry is having a nun controlled growth; (ii) the construction practices must be regularly checked and evaluated; (iii) awareness about the seismic code provisions among the engineers and builders; (iv) awareness about the importance of engineer's input during design and construction of building; (v) awareness about the adverse effects of the vertical irregularities on building performance during earthquake; (vi) similarly, awareness about the adverse effects of the vertical irregularities on building performance during earthquake; (vii) awareness about the municipal guidelines for the construction; and many more.

5.2 Future Scope

The present study can further be extended to perform rapid assessment of buildings in much larger scale. Moreover, the same can also be done in different cities in India, specifically in cities lying in higher seismic zones. This will help understand the overall risk different cities in India.

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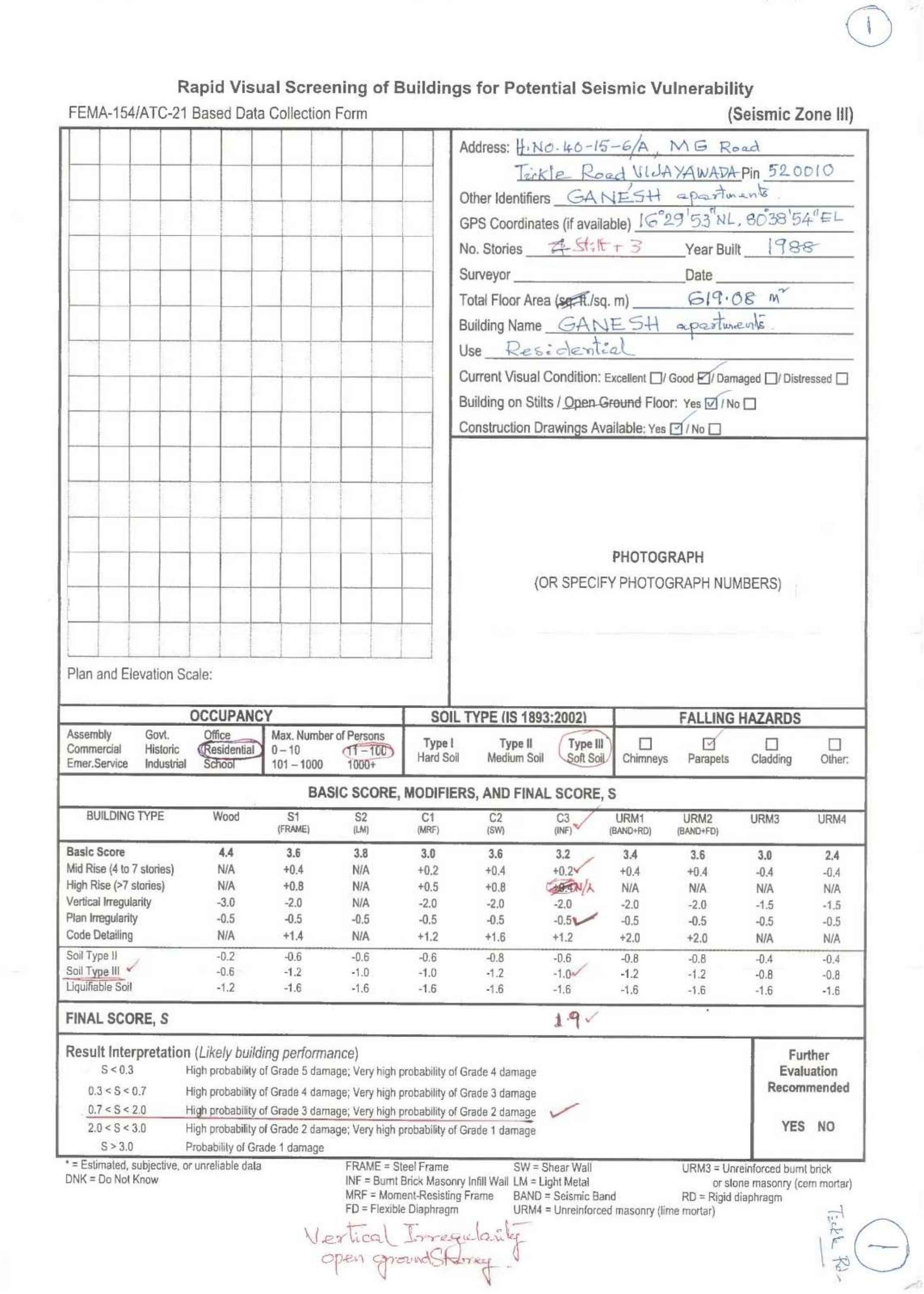
Annexures

Annexure I: Rapid Visual Screening of Buildings



①

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form

(Seismic Zone III)

Address: H.NO. 40-15-6/A, MG Road
Tickle Road VIJAYAWADA Pin 520010
Other Identifiers GANESH apartments.
GPS Coordinates (if available) 16°29'53"NL, 80°38'54"EL
No. Stories ~~4~~ Stilt + 3 Year Built 1988
Surveyor Date
Total Floor Area (~~sq. ft.~~/sq. m) 619.08 m²
Building Name GANESH apartments.
Use Residential
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
Building on Stilts / ~~Open Ground~~ Floor: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

Plan and Elevation Scale:

OCCUPANCY

Assembly Govt. Office
Commercial Historic [✓ Residential]
Emer.Service Industrial School

Max. Number of Persons
0 – 10 [✓ 11 – 100]
101 – 1000 1000+

SOIL TYPE (IS 1893:2002)

Type I Hard Soil Type II Medium Soil [✓ Type III Soft Soil]

FALLING HAZARDS

☐ Chimneys ☑ Parapets ☐ Cladding ☐ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF) ✓	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**4.4**	**3.6**	**3.8**	**3.0**	**3.6**	**3.2**	**3.4**	**3.6**	**3.0**	**2.4**
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	N/A	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5 ✓	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, *S*						1.9 ✓				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage ✓
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 3.0	Probability of Grade 1 damage

Further Evaluation Recommended

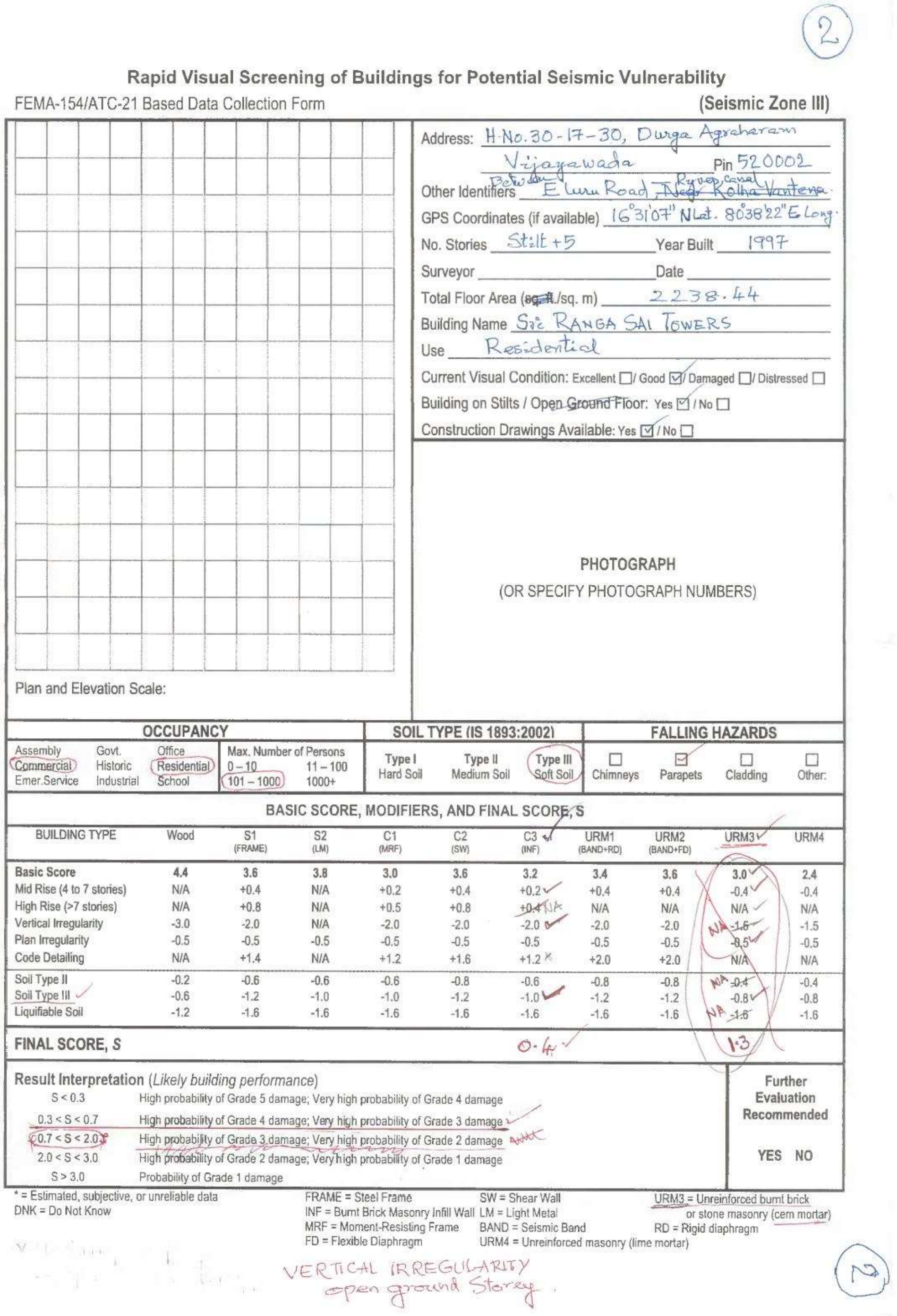
YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Vertical Irregularity
open groundStorey.

Tickle Rd.



②

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form **(Seismic Zone III)**

Address: H-No.30-17-30, Durga Agraharam
Vijayawada Pin 520002
Other Identifiers Between Eluru Road, ~~Near~~ Ryves canal Kotha Vantena.
GPS Coordinates (if available) 16°31'07" N Lat. 80°38'22" E Long.
No. Stories Stilt +5 Year Built 1997
Surveyor ____ Date ____
Total Floor Area (~~sq. ft.~~/sq. m) 2238.44
Building Name Sri RANGA SAI TOWERS
Use Residential
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
Building on Stilts / Open Ground Floor: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

Plan and Elevation Scale:

OCCUPANCY					SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly	Govt.	Office	Max. Number of Persons		Type I Hard Soil	Type II Medium Soil	[✓ Type III Soft Soil]	☐ Chimneys	☑ Parapets	☐ Cladding	☐ Other:
[✓ Commercial]	Historic	[✓ Residential]	0 – 10	11 – 100							
Emer.Service	Industrial	School	[✓ 101 – 1000]	1000+							

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 ✓ (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3 ✓	URM4
Basic Score	4.4	3.6	3.8	3.0	3.6	3.2	3.4	3.6	3.0 ✓	2.4
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4 ✓	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	~~+0.4~~ NA	N/A	N/A	N/A ✓	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	NA ~~-1.5~~	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	~~-0.5~~ ✓	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2 ✗	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	NA ~~-0.4~~	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8 ✓	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	NA ~~-1.6~~	-1.6
FINAL SCORE, S						0.4 ✓			1.3	

Result Interpretation (*Likely building performance*)

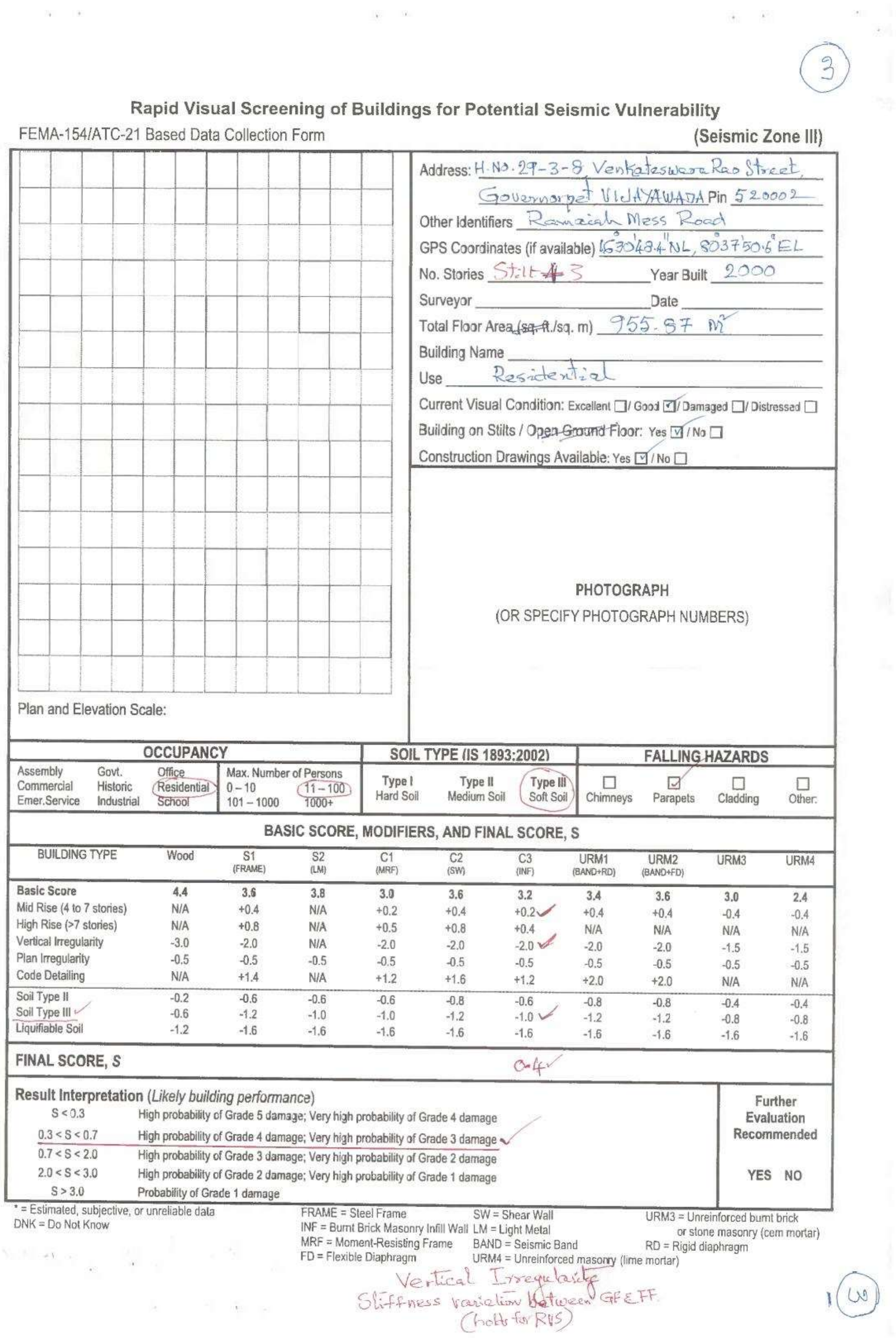
S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage	**Further Evaluation Recommended**
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage ✓	
[✓ 0.7 < S < 2.0]	High probability of Grade 3 damage; Very high probability of Grade 2 damage	
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage	**YES NO**
S > 3.0	Probability of Grade 1 damage	

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

VERTICAL IRREGULARITY
open ground Storey.

②



③

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form

(Seismic Zone III)

Address: H.No. 29-3-8 Venkateswara Rao Street,
Governorpet VIJAYAWADA Pin 520002
Other Identifiers Ramaiah Mess Road
GPS Coordinates (if available) 16°30'48.4"NL, 80°37'50.6"EL
No. Stories Stilt ~~4~~ 3 Year Built 2000
Surveyor ______ Date ______
Total Floor Area ~~(sq. ft.~~/sq. m) 955.87 M²
Building Name ______
Use Residential
Current Visual Condition: Excellent ☐ / Good ☑ / Damaged ☐ / Distressed ☐
Building on Stilts / ~~Open Ground~~ Floor: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

Plan and Elevation Scale:

OCCUPANCY
Assembly Govt. Office
Commercial Historic [✓ Residential]
Emer.Service Industrial School

Max. Number of Persons
0 – 10 [✓ 11 – 100]
101 – 1000 1000+

SOIL TYPE (IS 1893:2002)
Type I Hard Soil
Type II Medium Soil
[✓ Type III Soft Soil]

FALLING HAZARDS
☐ Chimneys ☑ Parapets ☐ Cladding ☐ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**4.4**	**3.6**	**3.8**	**3.0**	**3.6**	**3.2**	**3.4**	**3.6**	**3.0**	**2.4**
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, *S*						0.4 ✓				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage ✓
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 3.0	Probability of Grade 1 damage

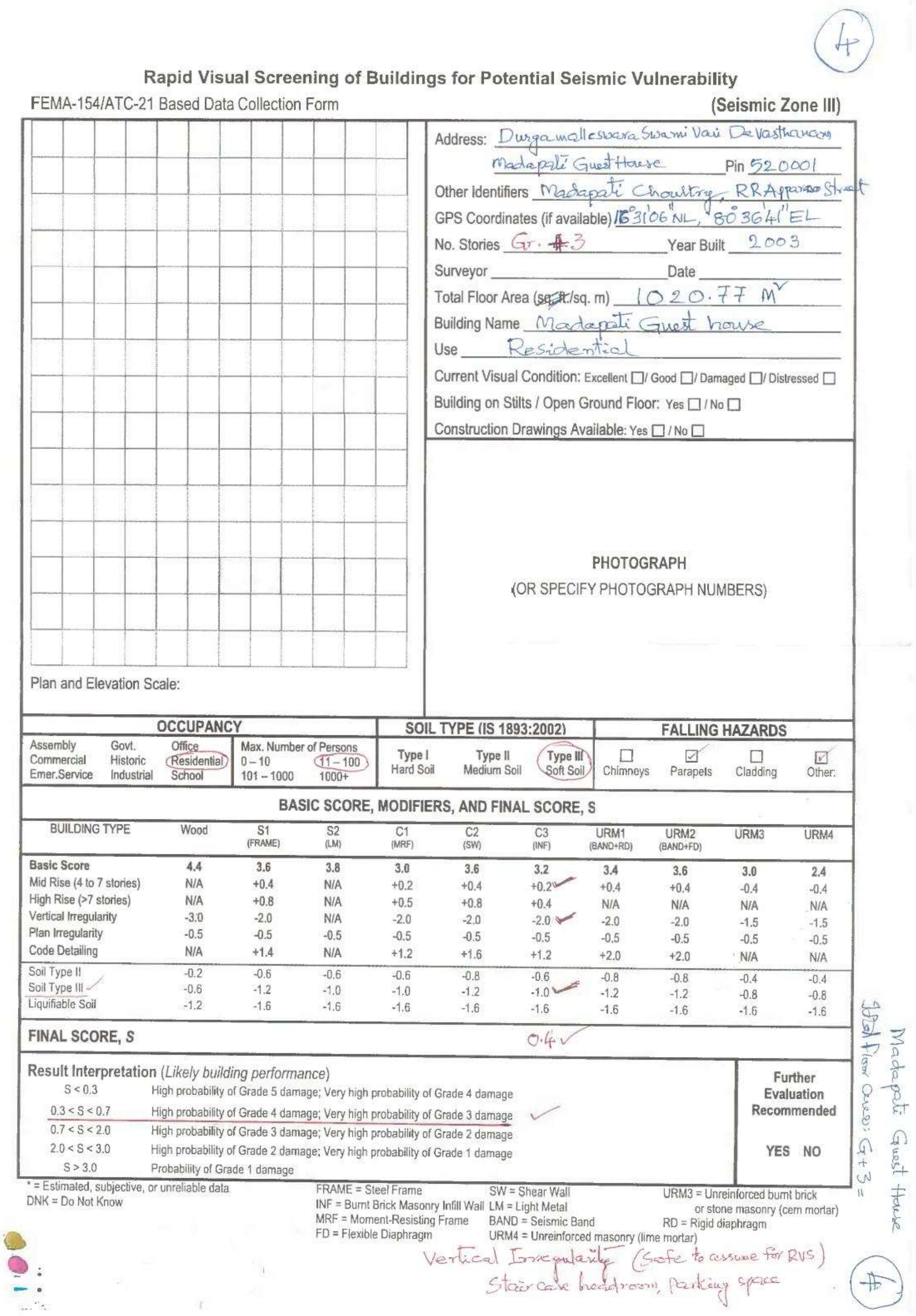
Further Evaluation Recommended
YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Vertical Irregularity
Stiffness variation between GF & FF
(holds for RVS)

1 (ω)



(4)

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form

(Seismic Zone III)

Address: Durgamalleswara Swami Vari Devasthanam
Madapati Guest House Pin 520001
Other Identifiers Madapati Choultry, RR Apparao Street
GPS Coordinates (if available) 16°31'06"NL, 80°36'41"EL
No. Stories Gr. ~~4~~ 3 Year Built 2003
Surveyor ______ Date ______
Total Floor Area (~~sq.ft~~/sq. m) 1020.77 M²
Building Name Madapati Guest house
Use Residential
Current Visual Condition: Excellent ☐/ Good ☐/ Damaged ☐/ Distressed ☐
Building on Stilts / Open Ground Floor: Yes ☐ / No ☐
Construction Drawings Available: Yes ☐ / No ☐

PHOTOGRAPH

(OR SPECIFY PHOTOGRAPH NUMBERS)

Plan and Elevation Scale:

OCCUPANCY					SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly	Govt.	Office	Max. Number of Persons		Type I Hard Soil	Type II Medium Soil	[✓ Type III Soft Soil]	☐ Chimneys	☑ Parapets	☐ Cladding	☑ Other:
Commercial	Historic	[✓ Residential]	0 – 10	[✓ 11 – 100]							
Emer.Service	Industrial	School	101 – 1000	1000+							

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	4.4	3.6	3.8	3.0	3.6	3.2	3.4	3.6	3.0	2.4
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, S						0.4 ✓				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage	
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage	✓
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage	
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage	
S > 3.0	Probability of Grade 1 damage	

Further Evaluation Recommended

YES NO

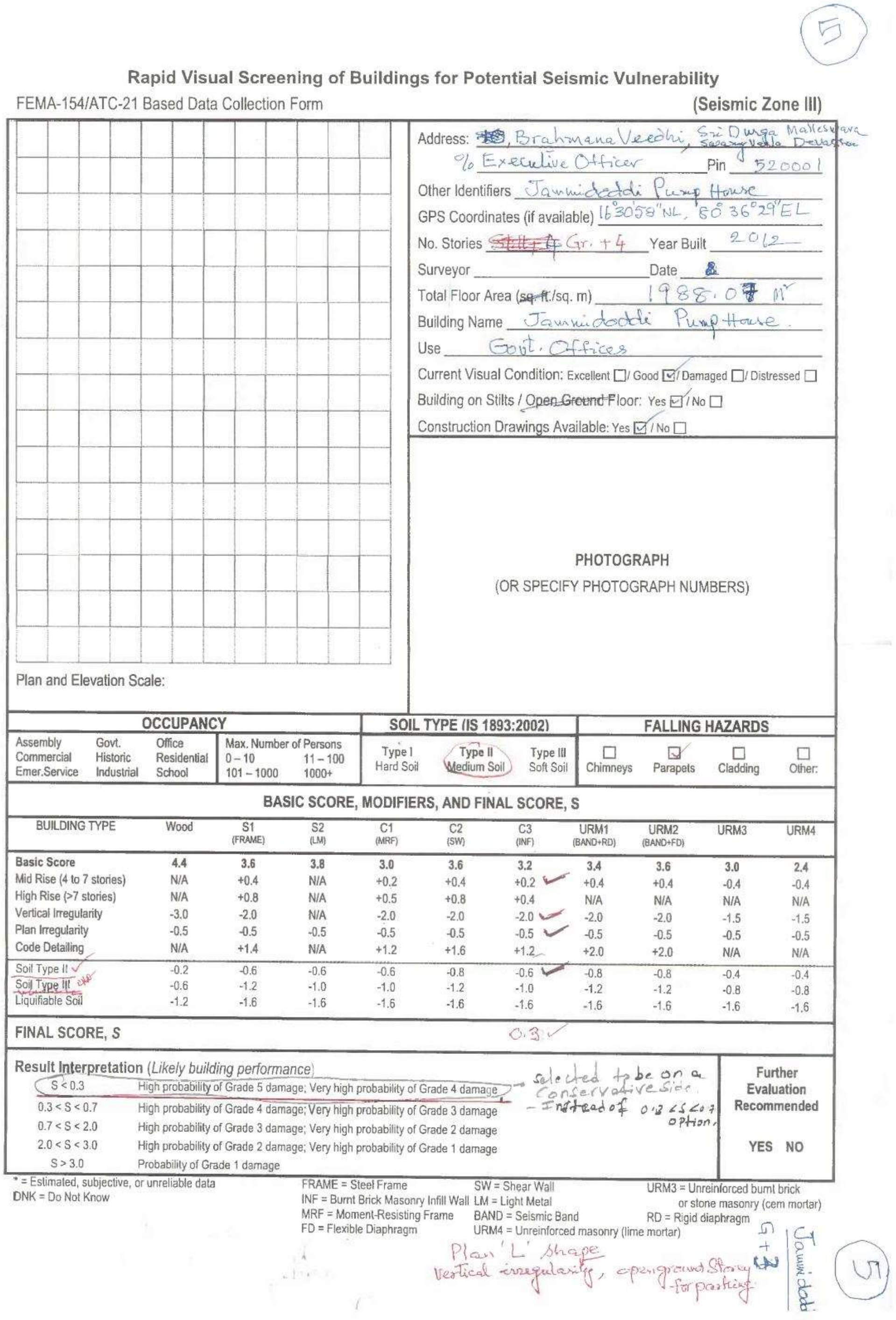
* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Madapati Guest House
Total Floor area: G+3 =

Vertical Irregularity (Safe to assume for RVS)
Stair case headroom, parking space

(4)



⑤

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form

(Seismic Zone III)

Address: [illegible], Brahmana Veedhi, Sri Durga Malleswara Swamy Varla Devasthan
% Executive Officer Pin 520001
Other Identifiers Jammidoddi Pump House
GPS Coordinates (if available) 16°30'58"NL, 80°36'29"EL
No. Stories ~~Stilt + 4~~ Gr. + 4 Year Built 2012
Surveyor Date [illegible]
Total Floor Area (~~sq ft.~~/sq. m) 1988.07 m²
Building Name Jammidoddi Pump House.
Use Govt. Offices
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
Building on Stilts / ~~Open Ground~~ Floor: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

Plan and Elevation Scale:

PHOTOGRAPH

(OR SPECIFY PHOTOGRAPH NUMBERS)

OCCUPANCY					SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly Commercial Emer.Service	Govt. Historic Industrial	Office Residential School	Max. Number of Persons 0 – 10 101 – 1000	11 – 100 1000+	Type I Hard Soil	[✓ Type II Medium Soil]	Type III Soft Soil	☐ Chimneys	☑ Parapets	☐ Cladding	☐ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**4.4**	**3.6**	**3.8**	**3.0**	**3.6**	**3.2**	**3.4**	**3.6**	**3.0**	**2.4**
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5 ✓	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II ✓	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6 ✓	-0.8	-0.8	-0.4	-0.4
Soil Type III	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, S						0.3 ✓				

Result Interpretation (*Likely building performance*)

[✓ S < 0.3]	[✓ High probability of Grade 5 damage; Very high probability of Grade 4 damage]	→ selected to be on a conservative side - Instead of 0.3 < S < 0.7 option.
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage	
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage	
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage	
S > 3.0	Probability of Grade 1 damage	

Further Evaluation Recommended

YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

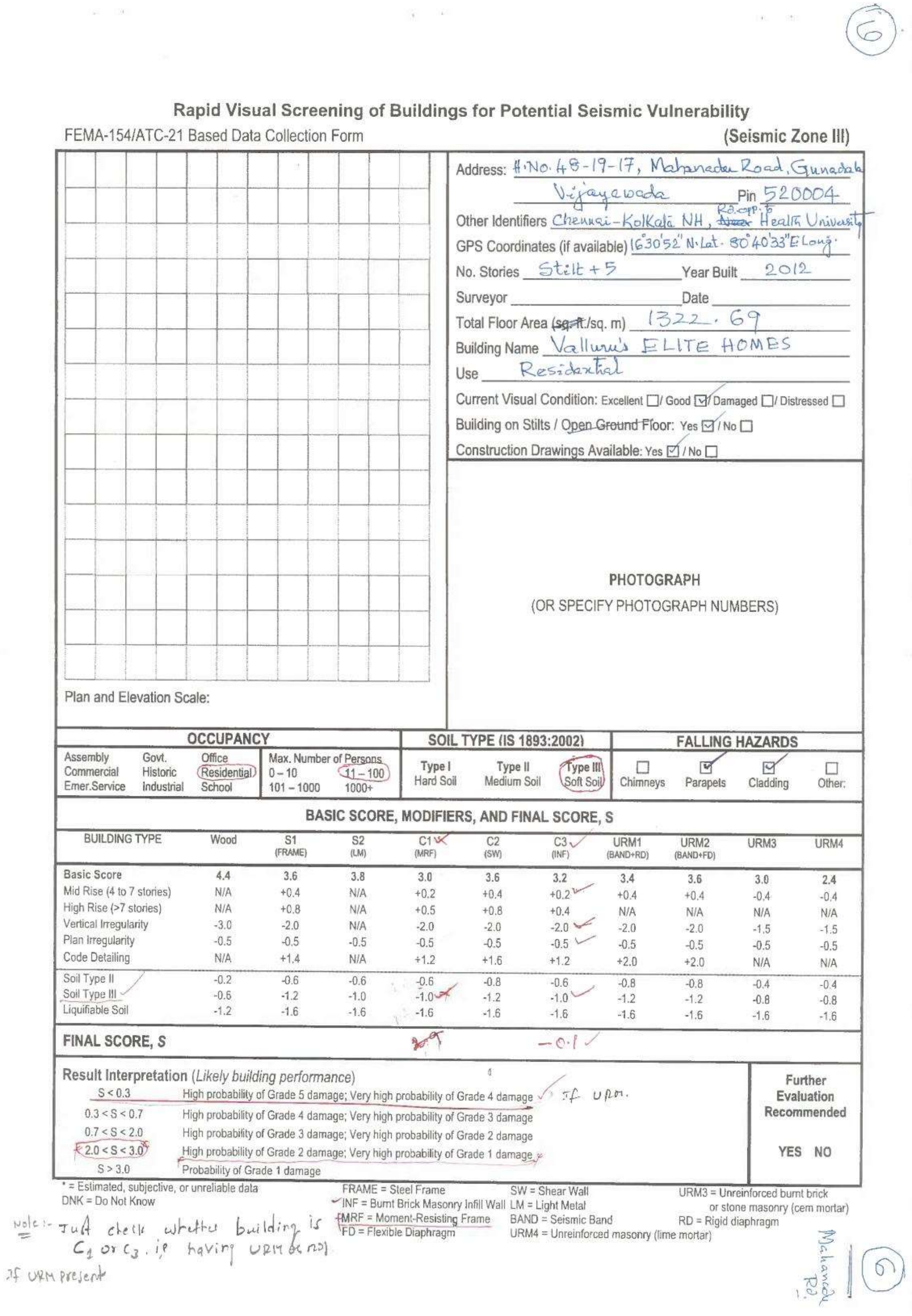
FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Plan 'L' shape
Vertical irregularity, open ground Story - for parking

G + 4

Jammidoddi

⑤



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Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form

(Seismic Zone III)

Address: H.No. 48-19-17, Mahanadu Road, Gunadala
Vijayawada Pin 520004
Other Identifiers Chennai-Kolkata NH, Rd. opp. to ~~Near~~ Health University
GPS Coordinates (if available) 16°30'52" N. Lat. 80°40'33" E Long.
No. Stories Stilt + 5 Year Built 2012
Surveyor ____ Date ____
Total Floor Area (~~sq. ft.~~/sq. m) 1322.69
Building Name Valluru's ELITE HOMES
Use Residential
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
Building on Stilts / ~~Open Ground Floor~~: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

Plan and Elevation Scale:

OCCUPANCY					SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly Commercial Emer.Service	Govt. Historic Industrial	Office [✓ Residential] School	Max. Number of Persons 0 – 10 101 – 1000	[✓ 11 – 100] 1000+	Type I Hard Soil	Type II Medium Soil	[✓ Type III Soft Soil]	☐ Chimneys	☑ Parapets	☑ Cladding	☐ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 ✗ (MRF)	C2 (SW)	C3 ✓ (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	4.4	3.6	3.8	3.0	3.6	3.2	3.4	3.6	3.0	2.4
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5 ✓	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0 ✓	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, S				2.9		-0.1 ✓				

Result Interpretation (*Likely building performance*)

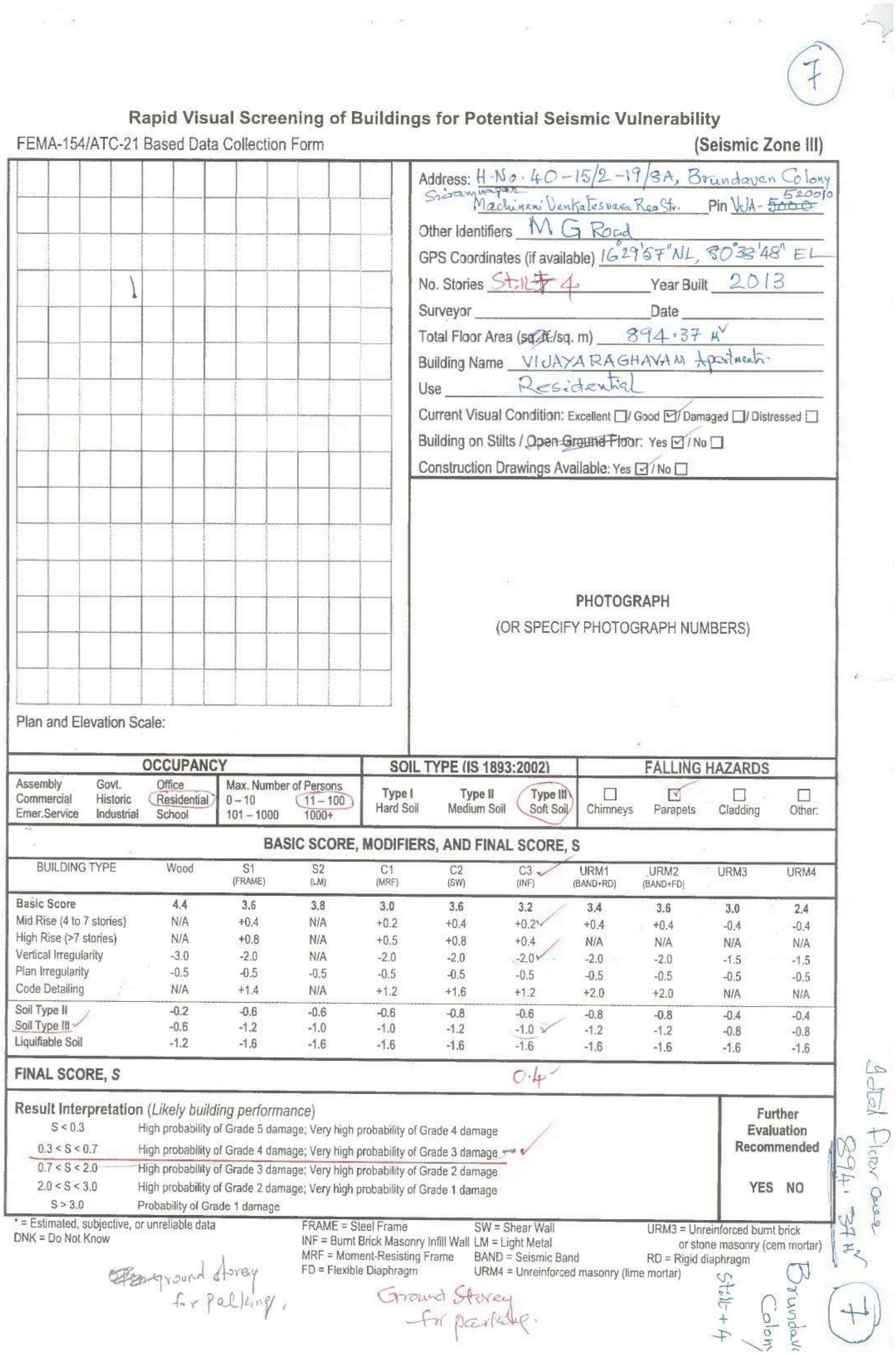
S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage ✓ If URM.	**Further Evaluation Recommended**
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage	
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage	
[✓ 2.0 < S < 3.0]	High probability of Grade 2 damage; Very high probability of Grade 1 damage	**YES NO**
S > 3.0	Probability of Grade 1 damage	

* = Estimated, subjective, or unreliable data
DNK = Do Not Know
FRAME = Steel Frame
✓ INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Note:- Just check whether building is C1 or C3, i.e having URM or not
If URM present

Mahanadu Rd.

⑥



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Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form

(Seismic Zone III)

Address: H-No. 40-15/2-19/8A, Brundaven Colony
~~Sriramnagar~~ Machineni Venkatesvara Rao Str. Pin VJA-~~5000~~ 520010
Other Identifiers M G Road
GPS Coordinates (if available) 16°29'57"NL, 80°38'48" EL
No. Stories Stilt + 4 Year Built 2013
Surveyor ______ Date ______
Total Floor Area (~~sq. ft.~~/sq. m) 894·37 M^2
Building Name VIJAYARAGHAVAM Apartments.
Use Residential
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
Building on Stilts / ~~Open Ground Floor~~: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

Plan and Elevation Scale:

PHOTOGRAPH

(OR SPECIFY PHOTOGRAPH NUMBERS)

OCCUPANCY					SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly Commercial Emer.Service	Govt. Historic Industrial	Office [✓ Residential] School	Max. Number of Persons 0 – 10 101 – 1000	 [✓ 11 – 100] 1000+	**Type I** Hard Soil	**Type II** Medium Soil	[✓ **Type III** Soft Soil]	☐ Chimneys	☑ Parapets	☐ Cladding	☐ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF) ✓	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**4.4**	**3.6**	**3.8**	**3.0**	**3.6**	**3.2** ✓	**3.4**	**3.6**	**3.0**	**2.4**
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, *S*						0.4				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage → ✓
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 3.0	Probability of Grade 1 damage

Further Evaluation Recommended

YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm

SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)

URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Ground storey for parking,

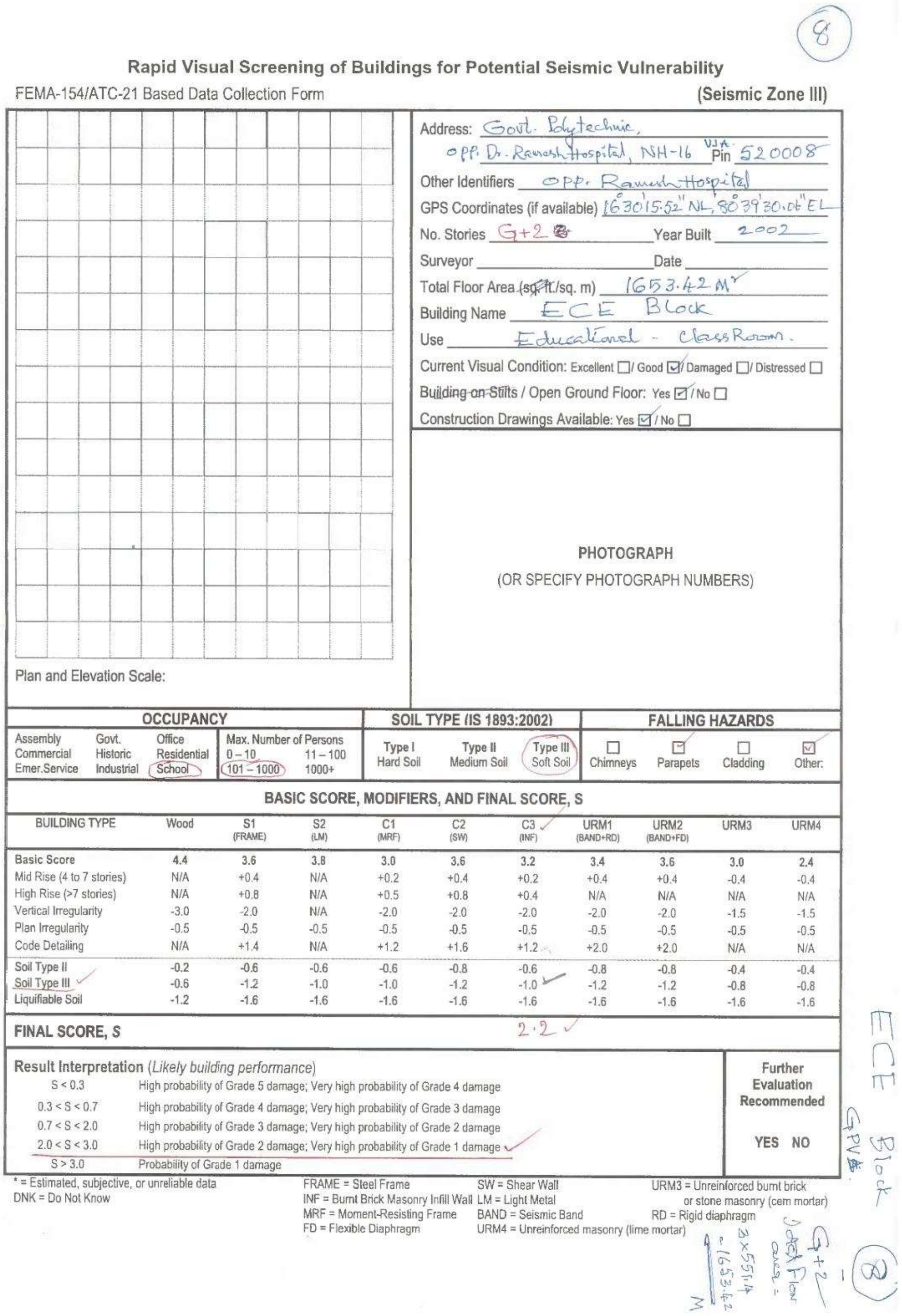
Ground Storey for parking.

Total Floor area 894·37 M^2

Stilt + 4

Brundavan Colony

⑦



⑧

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form (Seismic Zone III)

Address: Govt. Polytechnic,
opp. Dr. Ramesh Hospital, NH-16 VJA. Pin 520008
Other Identifiers opp. Ramesh Hospital
GPS Coordinates (if available) 16°30'15.52" NL, 80°39'30.06" EL
No. Stories G+2 Year Built 2002
Surveyor ______ Date ______
Total Floor Area (~~sq. ft.~~/sq. m) 1653.42 M²
Building Name ECE Block
Use Educational - ClassRoom.
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
~~Building on Stilts~~ / Open Ground Floor: Yes ☑/ No ☐
Construction Drawings Available: Yes ☑/ No ☐

Plan and Elevation Scale:

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

OCCUPANCY

Assembly Govt. Office
Commercial Historic Residential
Emer.Service Industrial [✓ School]

Max. Number of Persons
0 – 10 11 – 100
[✓ 101 – 1000] 1000+

SOIL TYPE (IS 1893:2002)

Type I Hard Soil
Type II Medium Soil
[✓ Type III Soft Soil]

FALLING HAZARDS

☐ Chimneys ☑ Parapets ☐ Cladding ☑ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 ✓ (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	4.4	3.6	3.8	3.0	3.6	3.2	3.4	3.6	3.0	2.4
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, S						2.2 ✓				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage ✓
S > 3.0	Probability of Grade 1 damage

Further Evaluation Recommended

YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm

SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)

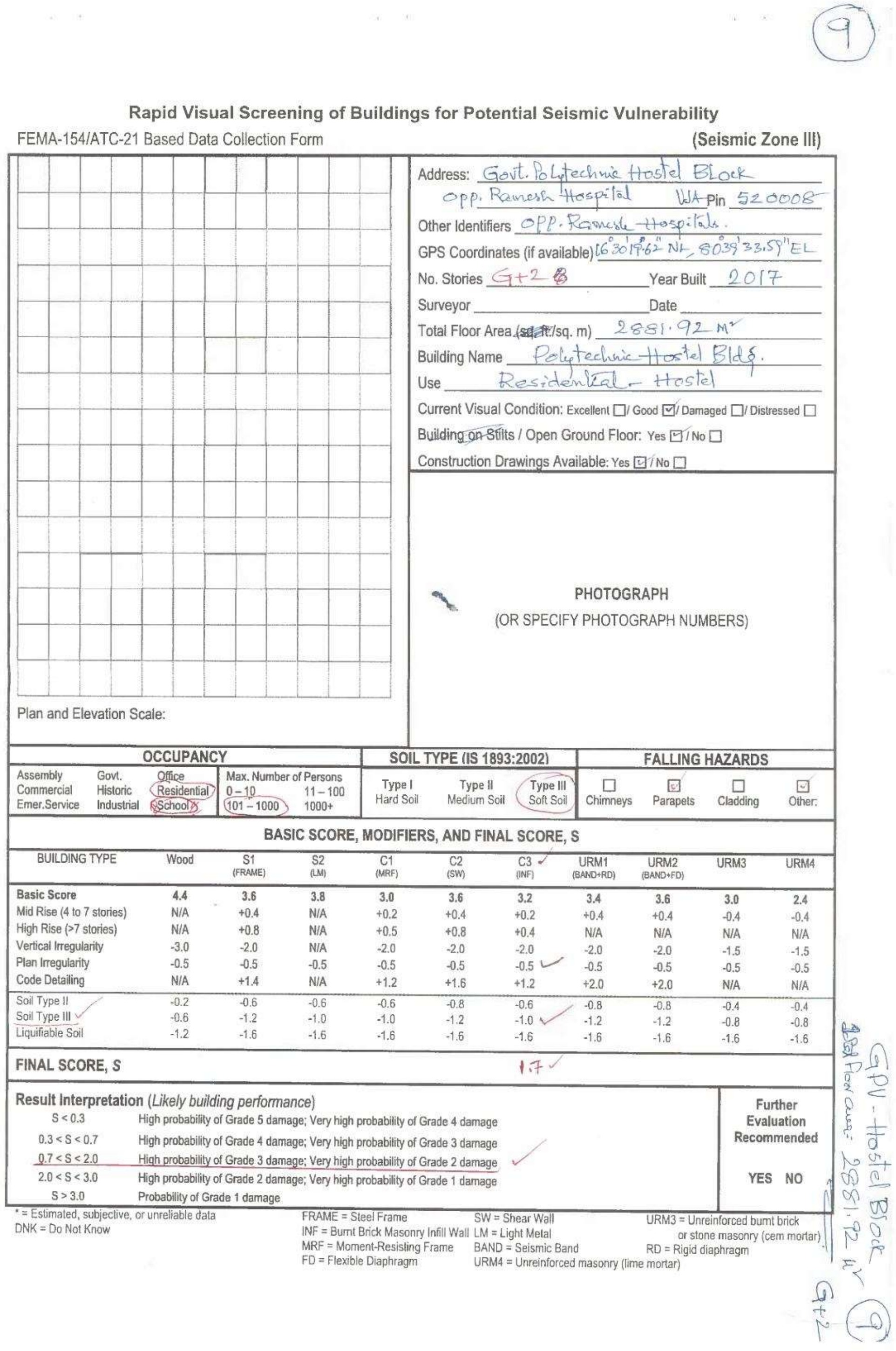
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

ECE Block

GPV

G+2
Total Floor area = 3×551.14 = 1653.42 M

⑧



(9)

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form

(Seismic Zone III)

Address: Govt. Polytechnic Hostel Block
opp. Ramesh Hospital ~~WA~~ Pin 520008
Other Identifiers OPP. Ramesh Hospitals.
GPS Coordinates (if available) 16°30'19.62" NL, 80°39'33.59" EL
No. Stories G+2
Year Built 2017
Surveyor
Date
Total Floor Area (~~sq. ft.~~/sq. m) 2881.92 m²
Building Name Polytechnic Hostel Bldg.
Use Residential - Hostel
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
~~Building on Stilts~~ / Open Ground Floor: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

Plan and Elevation Scale:

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

OCCUPANCY					SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly Commercial Emer.Service	Govt. Historic Industrial	Office [✓ Residential] [✓ School]	Max. Number of Persons 0 – 10 [✓ 101 – 1000]	 11 – 100 1000+	Type I Hard Soil	Type II Medium Soil	[✓ Type III Soft Soil]	☐ Chimneys	☑ Parapets	☐ Cladding	☑ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF) ✓	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**4.4**	**3.6**	**3.8**	**3.0**	**3.6**	**3.2**	**3.4**	**3.6**	**3.0**	**2.4**
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5 ✓	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, *S*						1.7 ✓				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage	
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage	
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage	✓
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage	
S > 3.0	Probability of Grade 1 damage	

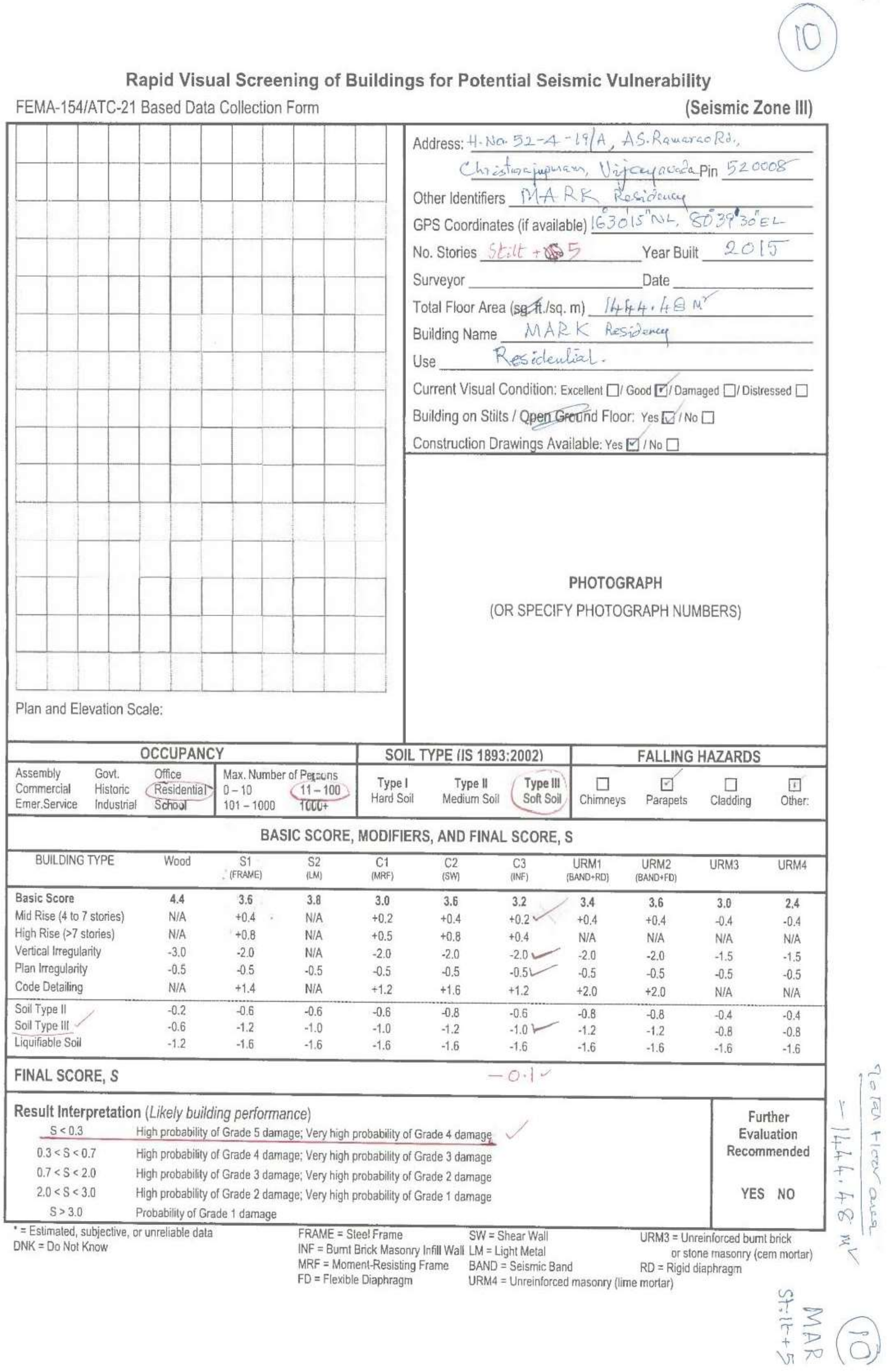
Further Evaluation Recommended

YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

GPV - Hostel Block
~~1st~~ Floor area: 2881.92 m²
G+2
(9)



10

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form **(Seismic Zone III)**

Address: H. No. 52-4-19/A, A.S. Ramarao Rd.,
Christurajupuram, Vijayawada Pin 520008
Other Identifiers MARK Residency
GPS Coordinates (if available) 16°30'15"NL, 80°39'30"EL
No. Stories Stilt + 5 Year Built 2015
Surveyor ______ Date ______
Total Floor Area (~~sq. ft.~~/sq. m) 1444.48 m²
Building Name MARK Residency
Use Residential.
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
Building on Stilts / Open Ground Floor: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

Plan and Elevation Scale:

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

OCCUPANCY				SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly Commercial Emer.Service	Govt. Historic Industrial	Office [✓ Residential] School	Max. Number of Persons 0 – 10 [✓ 11 – 100] 101 – 1000 1000+	Type I Hard Soil	Type II Medium Soil	[✓ Type III Soft Soil]	☐ Chimneys	☑ Parapets	☐ Cladding	☐ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**4.4**	**3.6**	**3.8**	**3.0**	**3.6**	**3.2** ✓	**3.4**	**3.6**	**3.0**	**2.4**
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5 ✓	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, S						−0.1 ✓				

Result Interpretation (*Likely building performance*)

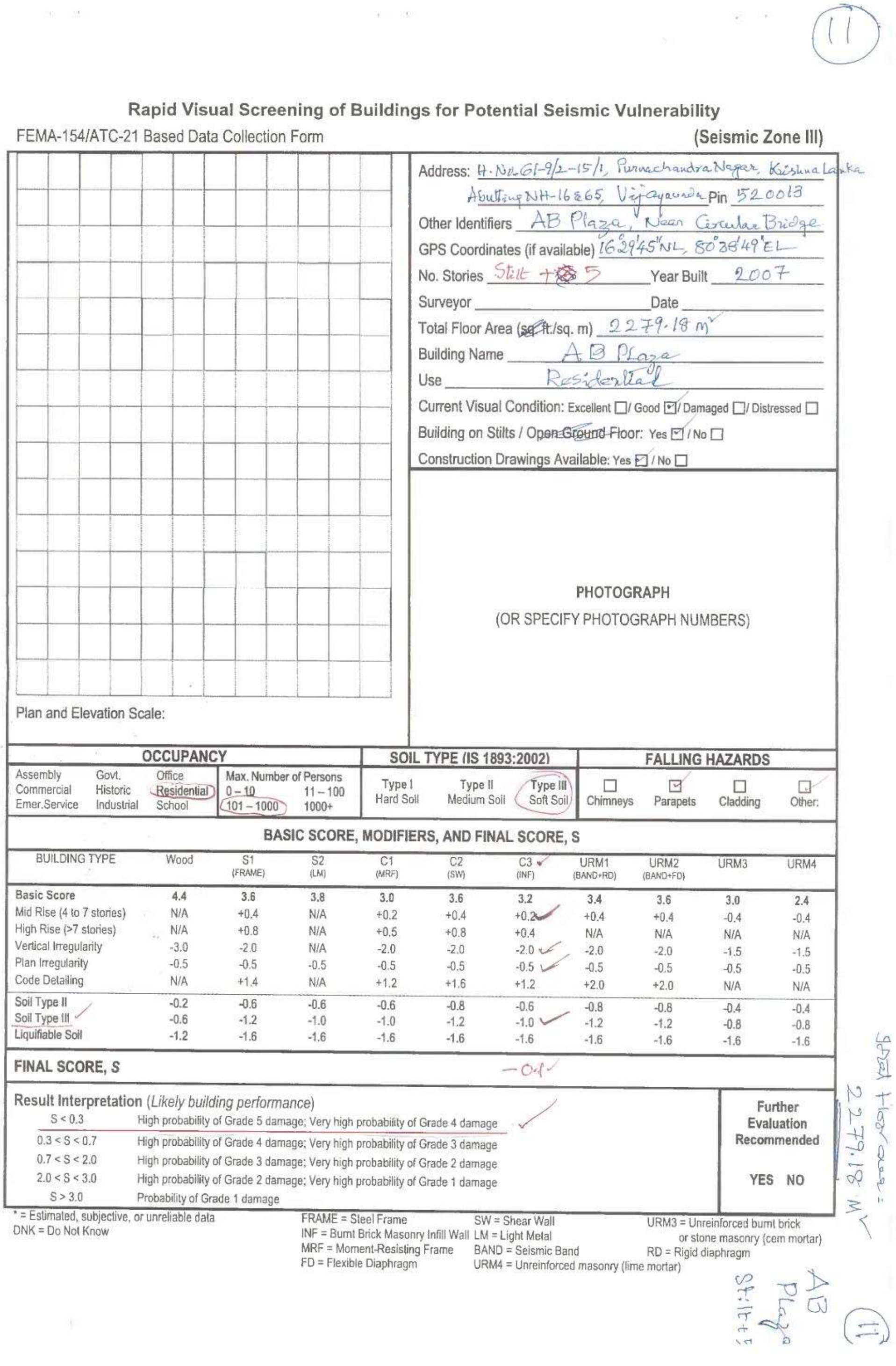
S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage ✓	**Further Evaluation Recommended**
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage	
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage	
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage	**YES NO**
S > 3.0	Probability of Grade 1 damage	

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Total floor area = 1444.48 m² ✓

MAR
Stilt+5
10



⑪

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form (Seismic Zone III)

Address: H. No. 61-9/2-15/1, Purnachandra Nagar, Krishna Lanka
Abutting NH-16 & 65, Vijayawada Pin 520013
Other Identifiers AB Plaza, Near Circular Bridge
GPS Coordinates (if available) 16°29'45"NL, 80°38'49"EL
No. Stories Stilt + 5 Year Built 2007
Surveyor ______ Date ______
Total Floor Area (~~sq. ft.~~/sq. m) 2279.18 m²✓
Building Name AB Plaza
Use Residential
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
Building on Stilts / ~~Open Ground Floor~~: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

Plan and Elevation Scale:

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

OCCUPANCY					SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly Commercial Emer.Service	Govt. Historic Industrial	Office [✓ Residential] School	Max. Number of Persons 0 – 10 [✓ 101 – 1000]	 11 – 100 1000+	Type I Hard Soil	Type II Medium Soil	[✓ Type III Soft Soil]	☐ Chimneys	☑ Parapets	☐ Cladding	☐ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF) ✓	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	4.4	3.6	3.8	3.0	3.6	3.2	3.4	3.6	3.0	2.4
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5 ✓	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, S						-0.1 ✓				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage ✓	**Further Evaluation Recommended** **YES NO**
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage	
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage	
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage	
S > 3.0	Probability of Grade 1 damage	

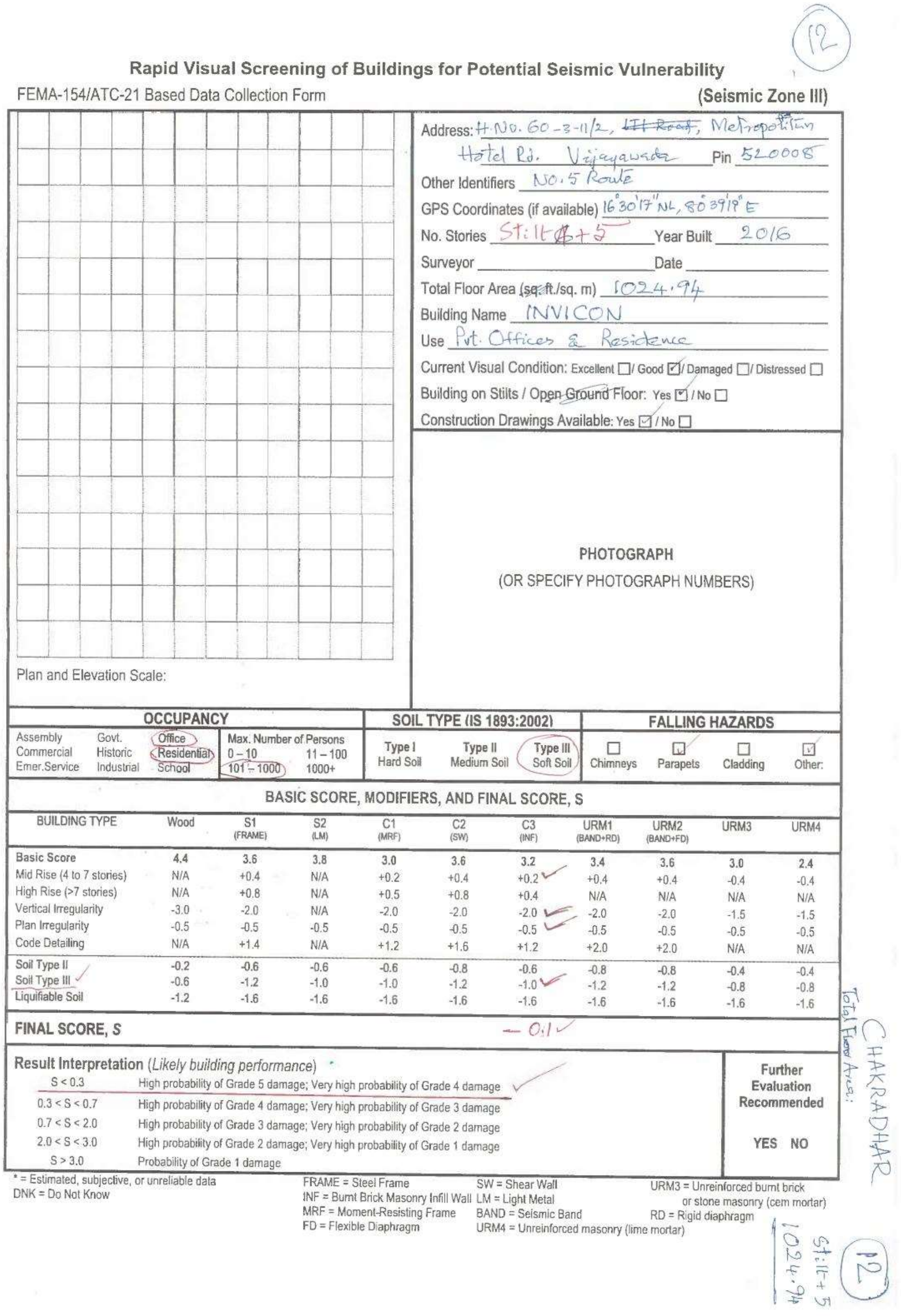
* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Total Floor area = 2279.18 m✓

AB Plaza
Stilt+5

⑪



(12)

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form

(Seismic Zone III)

Address: H.No. 60-3-11/2, ~~LH Road~~, Metropolitan Hotel Rd. Vijayawada Pin 520008

Other Identifiers No. 5 Route

GPS Coordinates (if available) 16°30'17"NL, 80°39'19"E

No. Stories Stilt ~~4~~+5 Year Built 2016

Surveyor Date

Total Floor Area (~~sq.~~ ft./sq. m) 1024.94

Building Name INVICON

Use Pvt. Offices & Residence

Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐

Building on Stilts / Open Ground Floor: Yes ☑ / No ☐

Construction Drawings Available: Yes ☑ / No ☐

Plan and Elevation Scale:

PHOTOGRAPH

(OR SPECIFY PHOTOGRAPH NUMBERS)

OCCUPANCY

Assembly Govt. [✓ Office]
Commercial Historic [✓ Residential]
Emer.Service Industrial School

Max. Number of Persons
0 – 10 11 – 100
[✓ 101 – 1000] 1000+

SOIL TYPE (IS 1893:2002)

Type I Hard Soil / Type II Medium Soil / [✓ Type III Soft Soil]

FALLING HAZARDS

☐ Chimneys ☑ Parapets ☐ Cladding ☑ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	4.4	3.6	3.8	3.0	3.6	3.2	3.4	3.6	3.0	2.4
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5 ✓	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, *S*						– 0.1 ✓				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage ✓
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 3.0	Probability of Grade 1 damage

Further Evaluation Recommended

YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

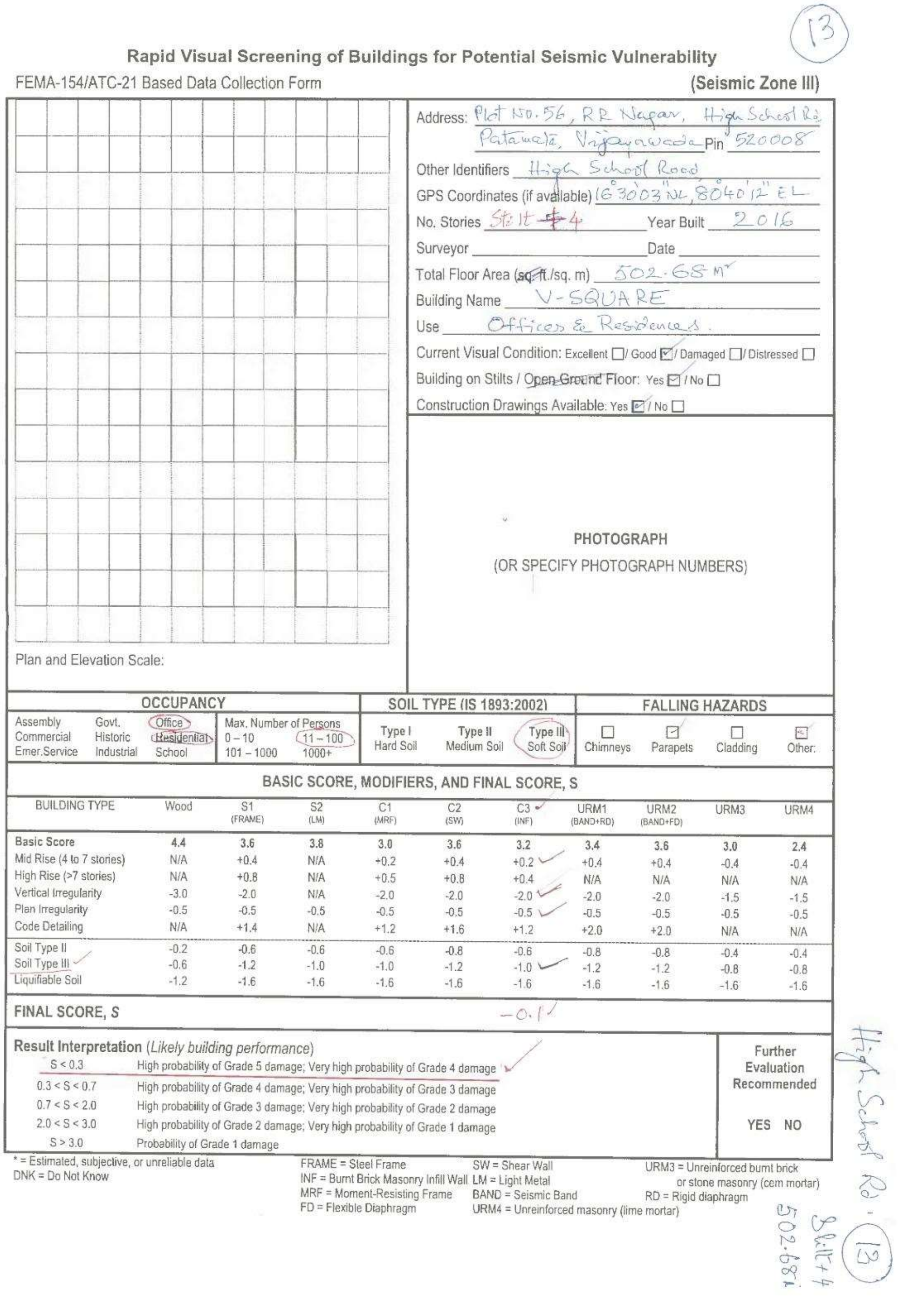
Total Floor Area:

CHAKRADHAR

Stilt+5

1024.94

(12)



(13)

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form **(Seismic Zone III)**

Address: Plot No. 56, RR Nagar, High School Rd
Patamata, Vijayawada Pin 520008
Other Identifiers High School Road
GPS Coordinates (if available) 16°30'03" NL, 80°40'12" EL
No. Stories Stilt +4 Year Built 2016
Surveyor ____ Date ____
Total Floor Area (~~sq.~~ ft./sq. m) 502.68 m²
Building Name V-SQUARE
Use Offices & Residences.
Current Visual Condition: Excellent ☐ / Good ☑ / Damaged ☐ / Distressed ☐
Building on Stilts / ~~Open Ground~~ Floor: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

Plan and Elevation Scale:

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

OCCUPANCY					SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly Commercial Emer.Service	Govt. Historic Industrial	[✓ Office] [✓ Residential] School	Max. Number of Persons 0 – 10 101 – 1000	[✓ 11 – 100] 1000+	Type I Hard Soil	Type II Medium Soil	[✓ Type III Soft Soil]	☐ Chimneys	☑ Parapets	☐ Cladding	☑ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF) ✓	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**4.4**	**3.6**	**3.8**	**3.0**	**3.6**	**3.2**	**3.4**	**3.6**	**3.0**	**2.4**
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5 ✓	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, *S*						-0.1 ✓				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage ✓
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 3.0	Probability of Grade 1 damage

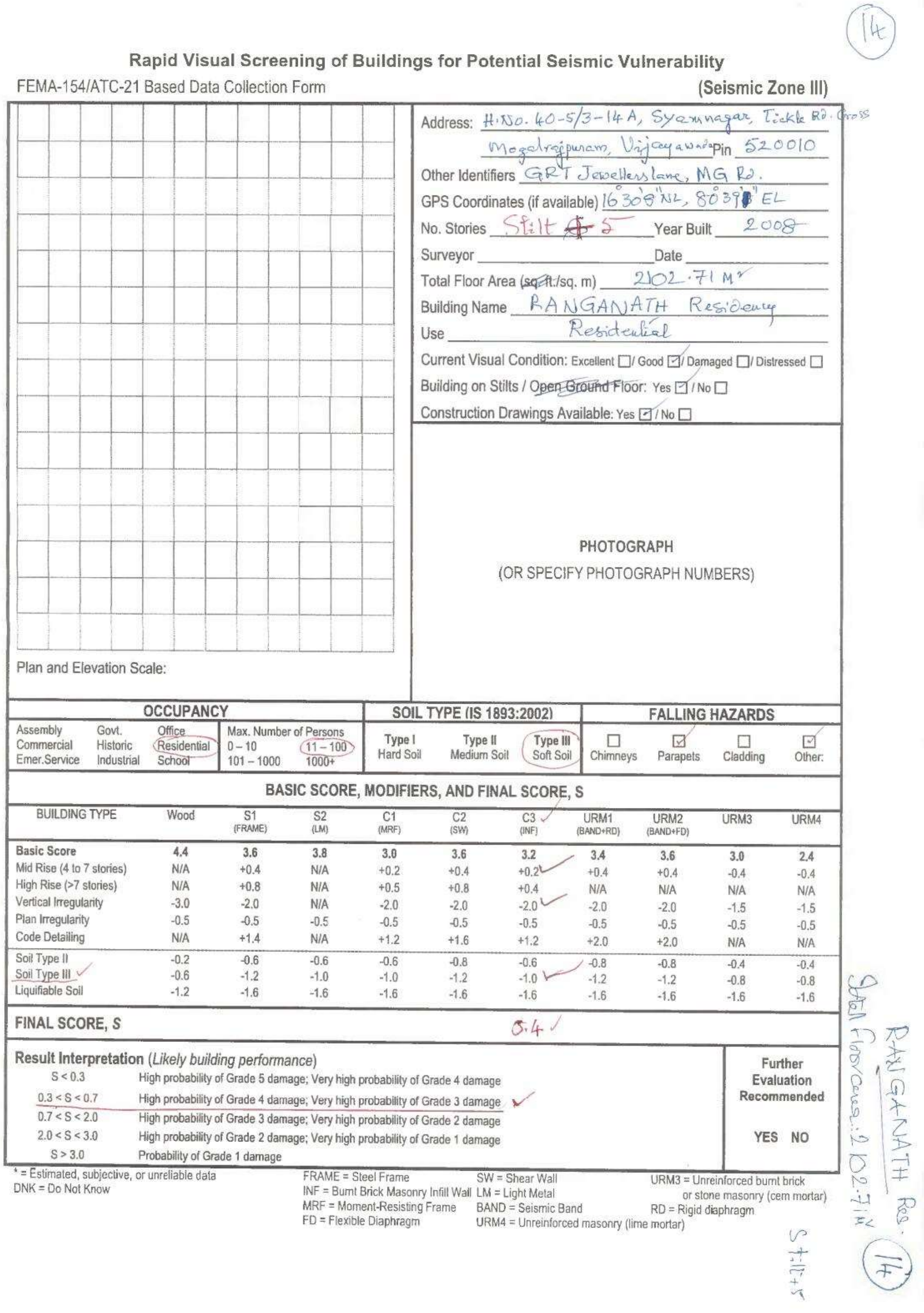
Further Evaluation Recommended

YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

High School Rd - (13)
Stilt+4
502.68m²



⑭

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form **(Seismic Zone III)**

Address: H.No. 40-5/3-14A, Syamnagar, Tickle Rd. Cross
Mogalrajpuram, Vijayawada Pin 520010
Other Identifiers GRT Jewellers lane, MG Rd.
GPS Coordinates (if available) 16°30'8"NL, 80°39'8"EL
No. Stories Stilt ~~4~~ 5 Year Built 2008
Surveyor ______ Date ______
Total Floor Area (~~sq. ft.~~/sq. m) 2102.71 M²
Building Name RANGANATH Residency
Use Residential
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
Building on Stilts / ~~Open Ground~~ Floor: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

Plan and Elevation Scale:

OCCUPANCY				SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly Commercial Emer.Service	Govt. Historic Industrial	Office [✓ Residential] School	Max. Number of Persons 0 – 10 [✓ 11 – 100] 101 – 1000 1000+	Type I Hard Soil	Type II Medium Soil	[✓ Type III Soft Soil]	☐ Chimneys	☑ Parapets	☐ Cladding	☑ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF) ✓	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	4.4	3.6	3.8	3.0	3.6	3.2	3.4	3.6	3.0	2.4
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0 ✓	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, *S*						0.4 ✓				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage ✓
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 3.0	Probability of Grade 1 damage

Further Evaluation Recommended
YES NO

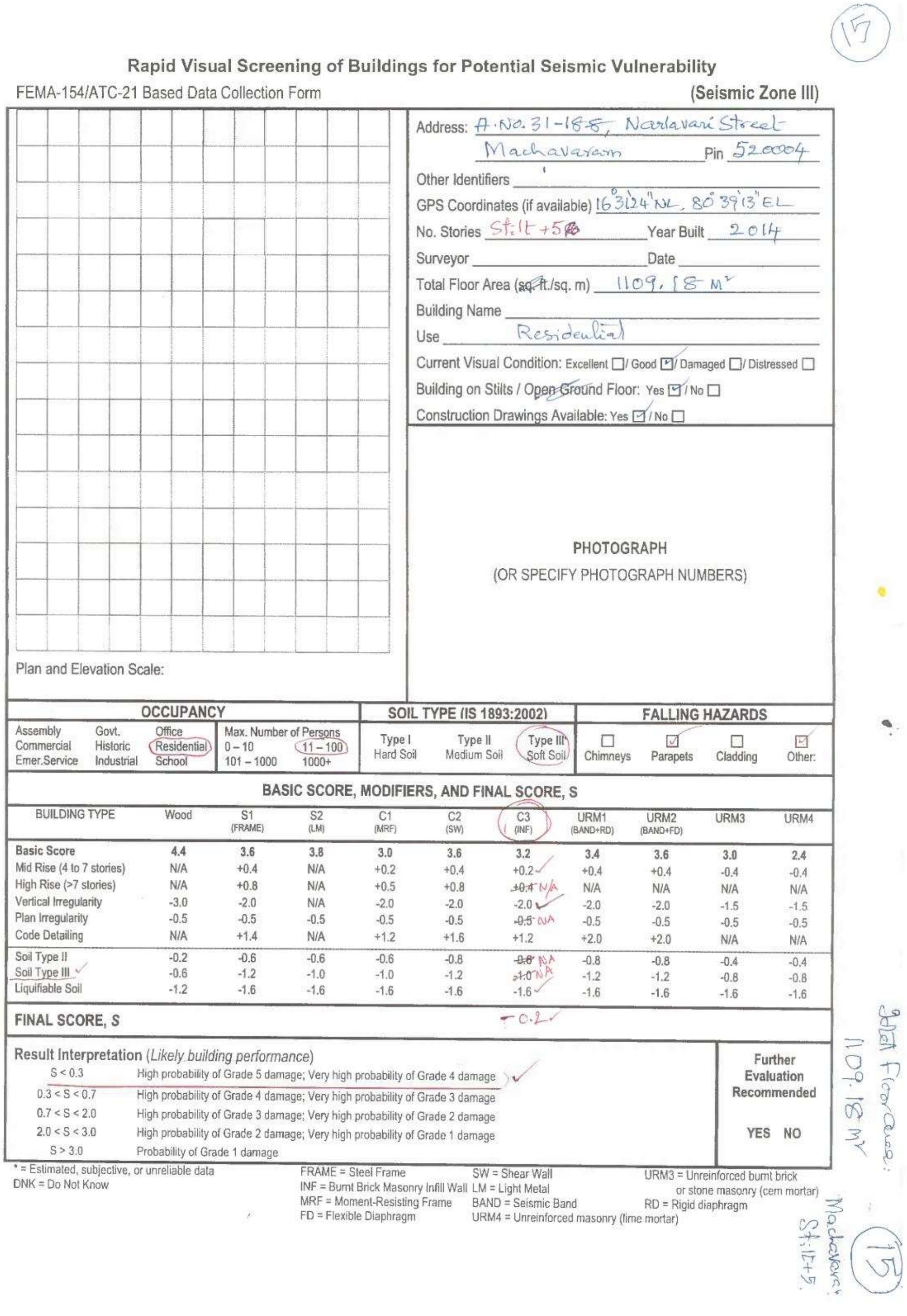
* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm

SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)

URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Total Floor area: 2102.71 m²
RANGANATH Res.
⑭
S+5



⑮

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form

(Seismic Zone III)

Address: A.No. 31-18~~8~~, Narlavari Street
Machavaram Pin 520004
Other Identifiers
GPS Coordinates (if available) 16°31'24"NL, 80°39'13"EL
No. Stories Stilt +5
Year Built 2014
Surveyor
Date
Total Floor Area (~~sq. ft.~~/sq. m) 1109.18 M^2
Building Name
Use Residential
Current Visual Condition: Excellent ☐/ Good ☑/ Damaged ☐/ Distressed ☐
Building on Stilts / ~~Open Ground~~ Floor: Yes ☑ / No ☐
Construction Drawings Available: Yes ☑ / No ☐

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

Plan and Elevation Scale:

OCCUPANCY				SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly Commercial Emer.Service	Govt. Historic Industrial	Office [✓ Residential] School	Max. Number of Persons 0 – 10 [✓ 11 – 100] 101 – 1000 1000+	Type I Hard Soil	Type II Medium Soil	[✓ Type III Soft Soil]	☐ Chimneys	☑ Parapets	☐ Cladding	☑ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	[✓ C3 (INF)]	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**4.4**	**3.6**	**3.8**	**3.0**	**3.6**	**3.2**	**3.4**	**3.6**	**3.0**	**2.4**
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2 ✓	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	~~+0.4~~ N/A	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0 ✓	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	~~-0.5~~ NA	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	~~-0.6~~ NA	-0.8	-0.8	-0.4	-0.4
Soil Type III ✓	-0.6	-1.2	-1.0	-1.0	-1.2	~~-1.0~~ NA	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6 ✓	-1.6	-1.6	-1.6	-1.6
FINAL SCORE, *S*						-0.2 ✓				

Result Interpretation (*Likely building performance*)

S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage ✓	
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage	
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage	
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage	
S > 3.0	Probability of Grade 1 damage	

Further Evaluation Recommended

YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm

SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)

URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Total Floor area :
1109.18 m^2

Machavaram
Stilt+5.

⑮

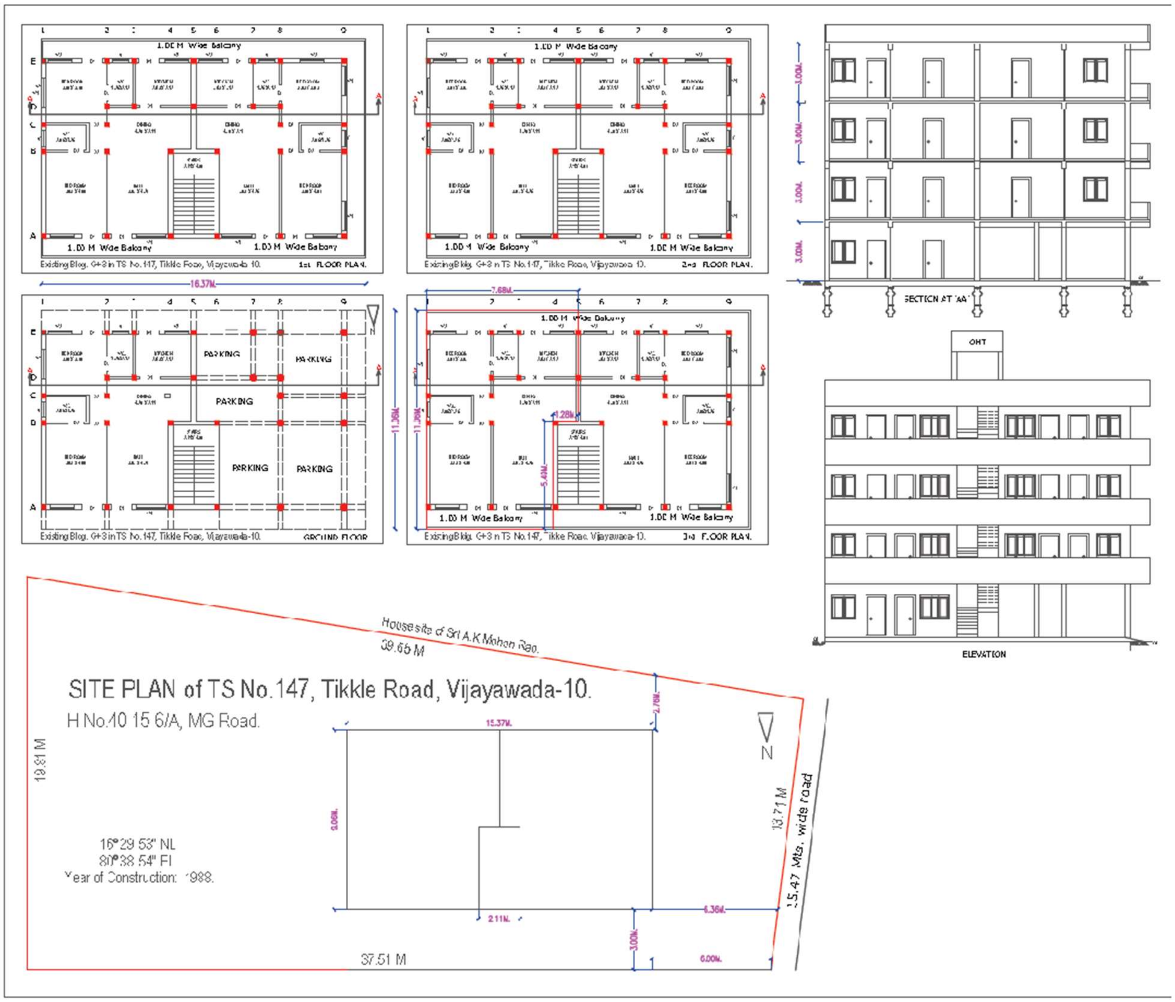
Summary of Annexure 1:

Sl. No.	Building Name	Final Score (S)	Damage Grade	Recommendation for Further Evaluation
1	TSNo:147 Tickle Road	1.9	Grade 3	No
2	Hno:30-17-30 Durga Agraharam	0.4	Grade 4	No
3	Hno:29-3-8W-24Governorpet	0.4	Grade 4	No
4	Madapati Guest House Tarapet	0.4	Grade 4	No
5	O/o. A P Endowment Dept. Jammidoddi	0.3	Grade 5	Yes
6	Hno:48-19-17MahanaduRdGunadala	-0.1	Grade 5	Yes
7	Hno:40-15/2-19/8ALabbipet	0.4	Grade 4	No
8	GPV-ECE Block	2.2	Grade 2	No
9	GPV- Hostel Block	1.7	Grade 3	No
10	MARK Residency	-0.1	Grade 5	Yes
11	AB Plaza	-0.1	Grade 5	Yes
12	Ranganath Res. Bandar Road.	-0.1	Grade 5	Yes
13	Chakradhar No.5 Route, ITI Road	-0.1	Grade 5	Yes
14	V-Square, High School Road, Patamata	0.4	Grade 4	No
15	Machavaram, Narne Vari Street	-0.2	Grade 5	Yes

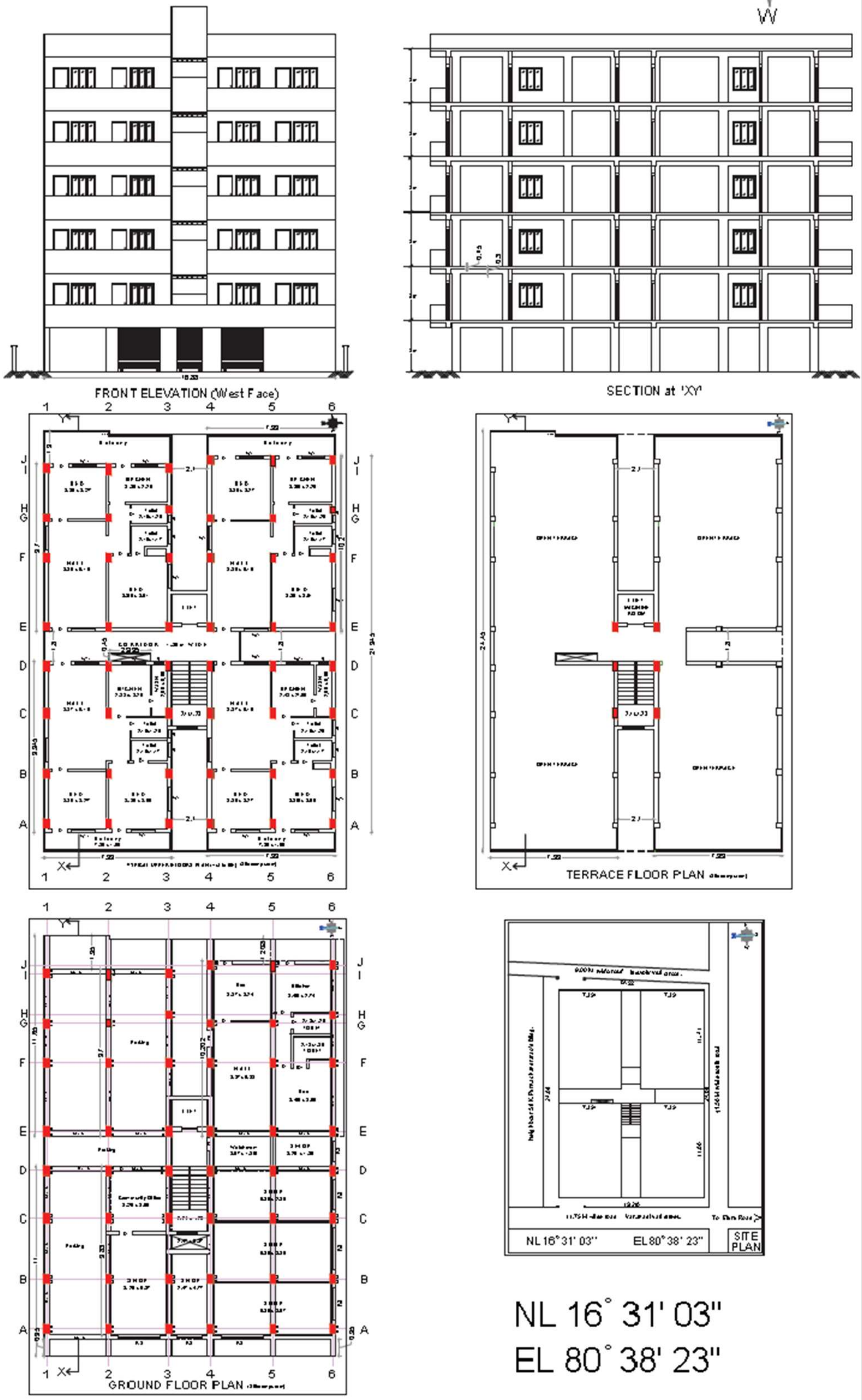
The *S* represents the final score of the building which is a quantitative assessment. Moreover, for better and easier understanding, the method has also defined the range of score values to interpret the result based on qualitative assessment. This qualitative assessment ranges from *Damage Grade 1* up to *Damage Grade 5*. Here *Damage Grade 1* represents the lowest damage state or negligible damage state whereas *Damage Grade 5* represents the very severe damage state of the building. Therefore, when the surveyed building has a damage grade of 5, the surveyor recommends the further evaluation as Yes. This means that further detailed assessment of the building is necessary.

--o0o—

Annexure II: Detailed Building Plans with Sections & Elevations

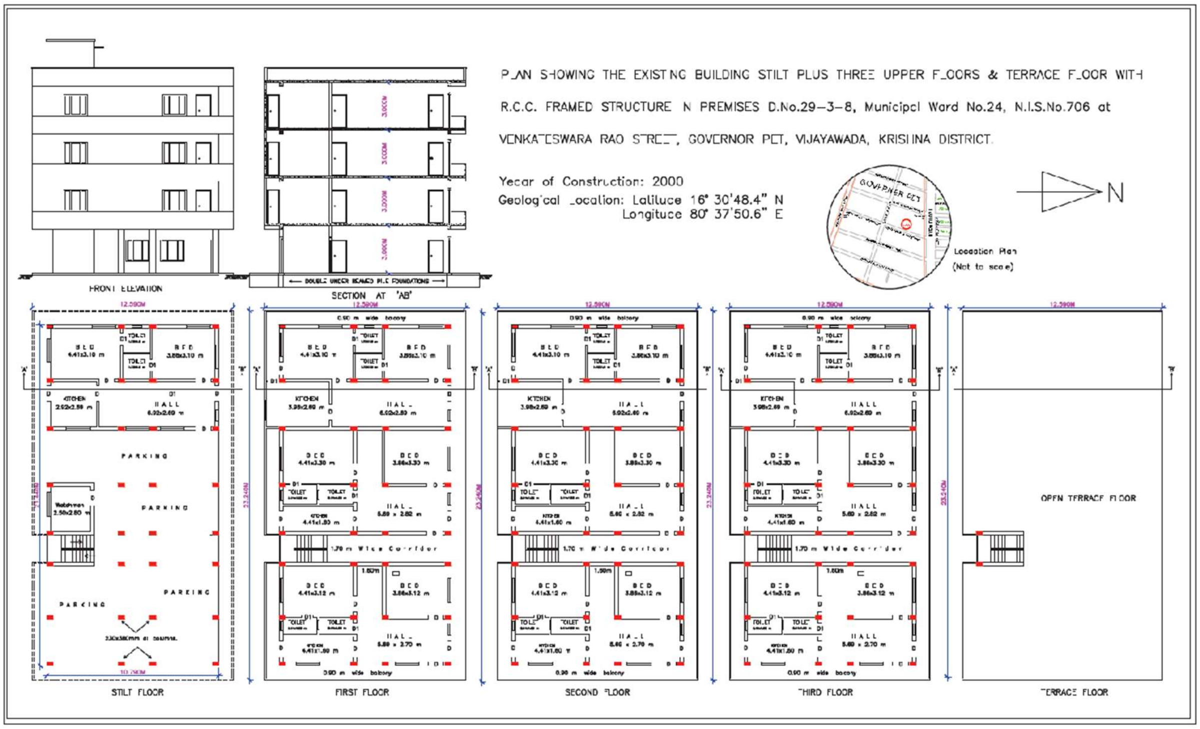


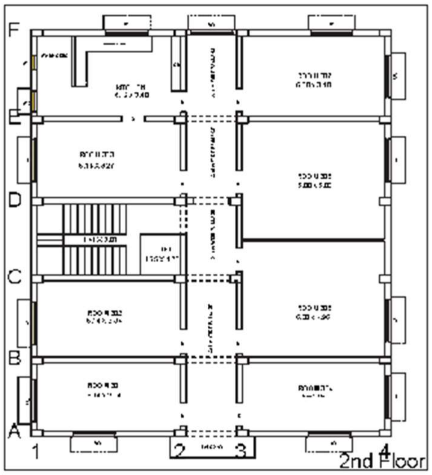
Plan showing the existing building "SRI RANGA SAI TOWERS" in G+5 Upper Floors situated at Sitaramapuram, Vijayawada, Door No. 30-17-30, RS No.159/2 at Durga Agraharam.
Approved B.A.No.561/1997 dt. 2-7-1997.



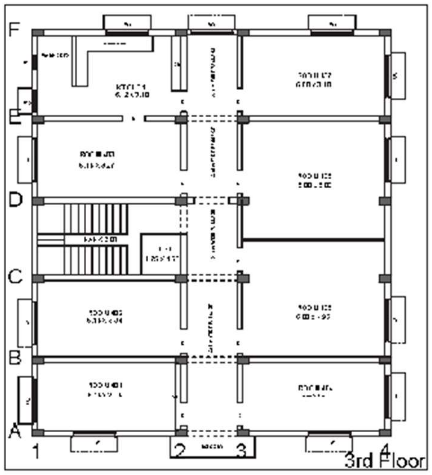
NL 16° 31' 03''
EL 80° 38' 23''

31.1.2022

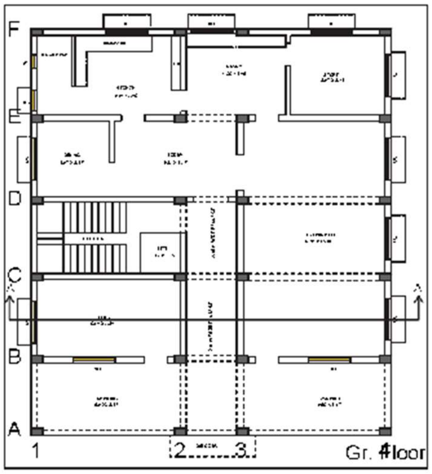

PLAN SHOWING THE EXISTING BUILDING STILT PLUS THREE UPPER FLOORS & TERRACE FLOOR WITH
R.C.C. FRAMED STRUCTURE IN PREMISES D.No.29–3–8, Municipal Ward No.24, N.I.S.No.706 at
VENKATESWARA RAO STREET, GOVERNOR PET, VIJAYAWADA, KRISHNA DISTRICT.
Year of Construction: 2000
Geological Location: Latitude 16° 30'48.4" N
Longitude 80° 37'50.6" E
GOVERNER PET
Location Plan
(Not to scale)
N
FRONT ELEVATION
3.000M
DOUBLE UNDER REAMED PILE FOUNDATIONS
SECTION AT 'AB'
12.590M
23.340M
0.90 m wide balcony
BED
4.41x3.10 m
BED
3.86x3.10 m
TOILET
D1
D
'A'
'B'
KITCHEN
2.92x2.59 m
3.98x2.59 m
HALL
6.92x2.69 m
PARKING
Watchman
2.50x2.60 m
BED
4.41x3.30 m
BED
3.86x3.30 m
HALL
5.60 x 2.62 m
KITCHEN
4.41x1.60 m
1.70 m Wide Corridor
1.60m
BED
4.41x3.12 m
BED
3.86x3.12 m
HALL
5.60 x 2.70 m
10.290M
STILT FLOOR
FIRST FLOOR
SECOND FLOOR
THIRD FLOOR
OPEN TERRACE FLOOR
TERRACE FLOOR



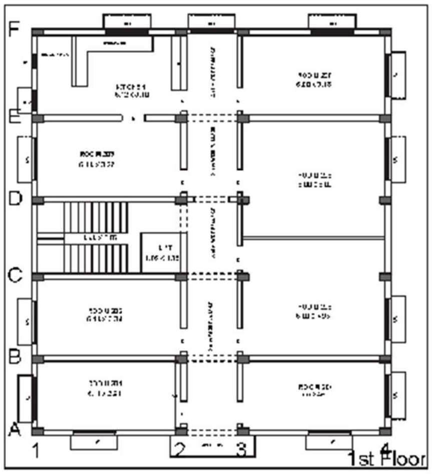
2nd Floor



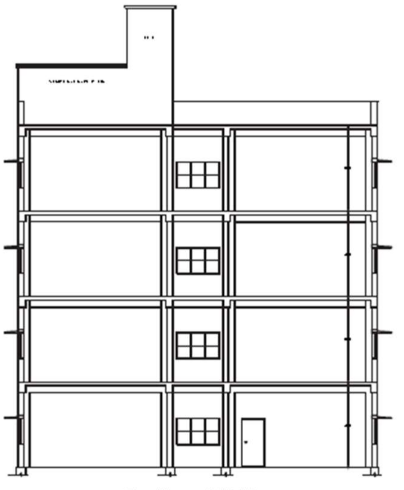
3rd Floor



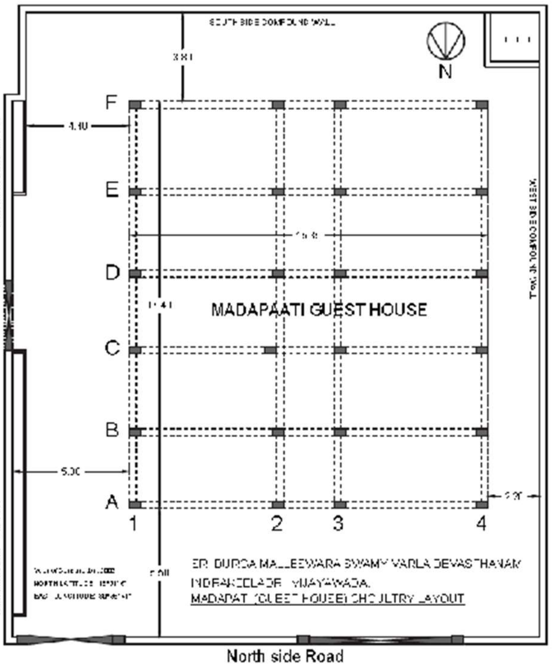
Gr. Floor

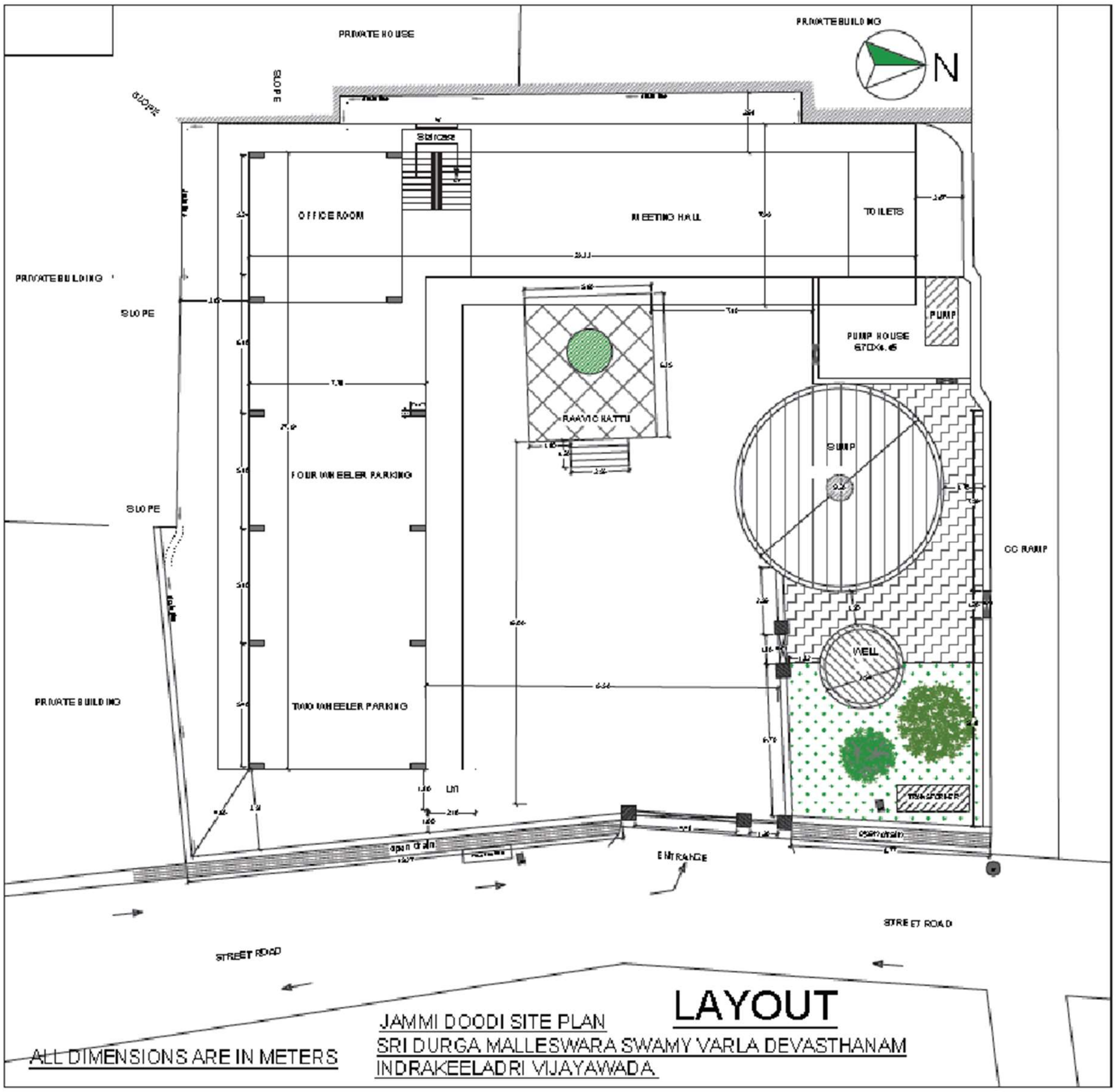


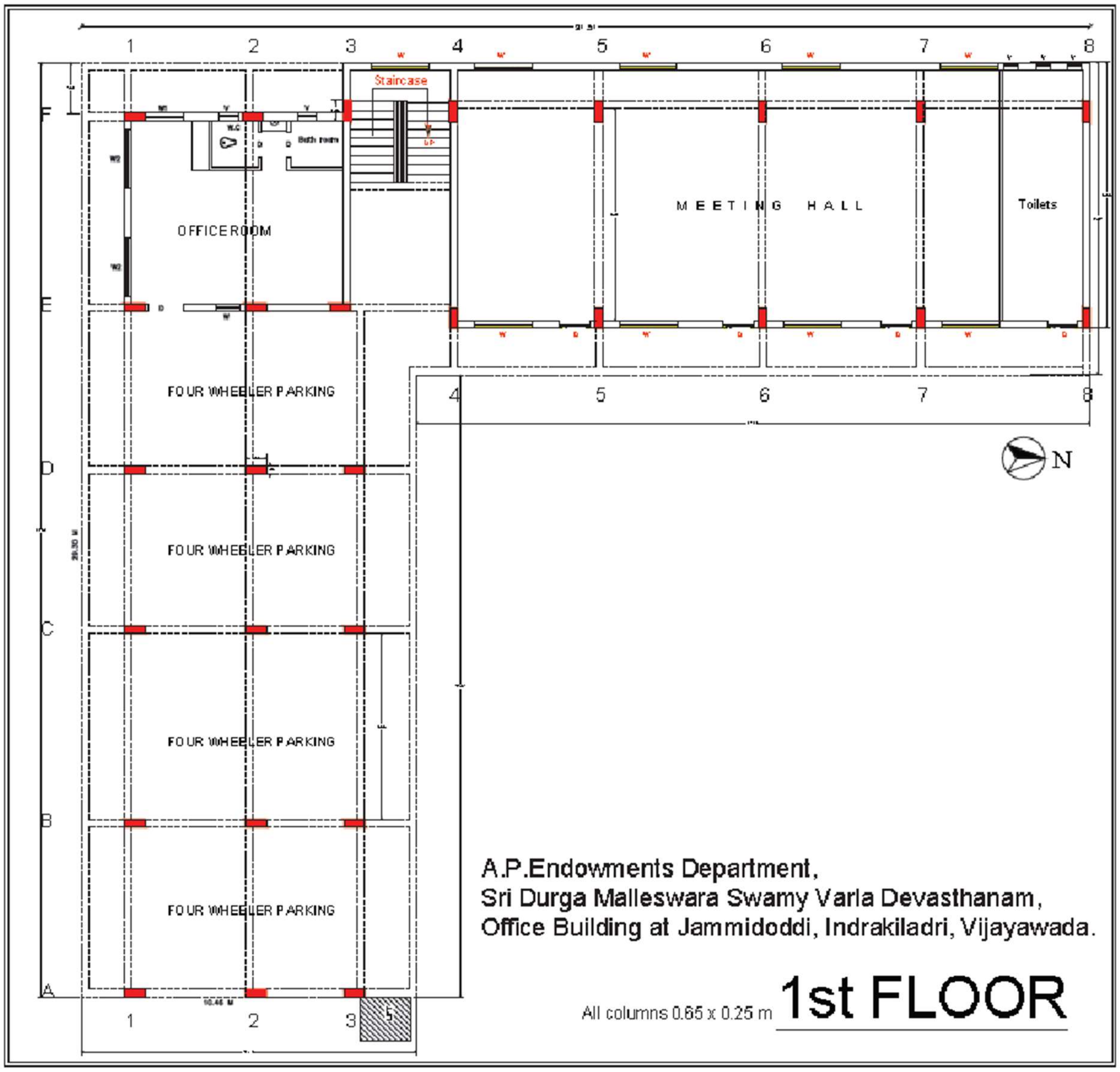
1st Floor

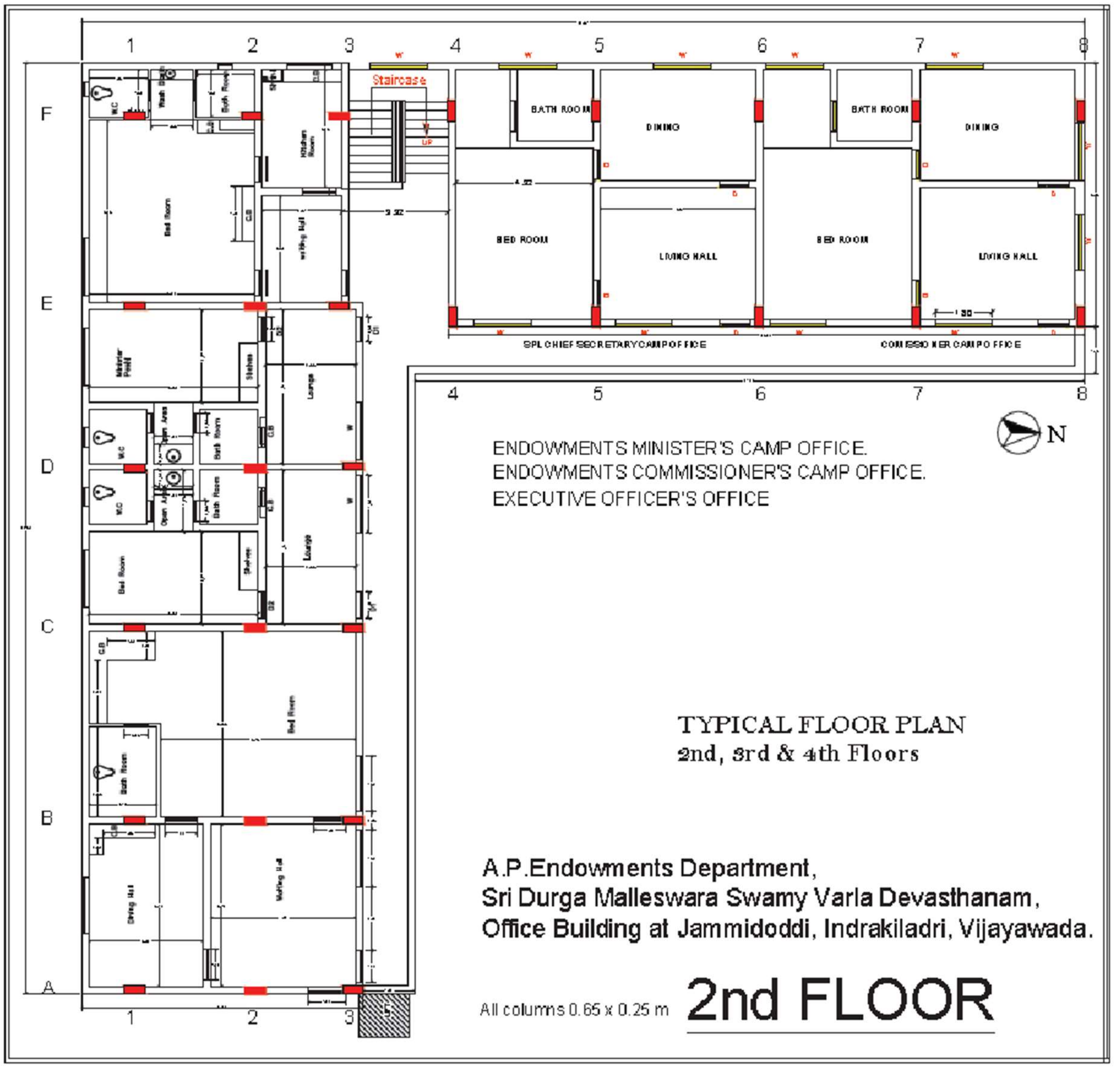


Section at 'AA'

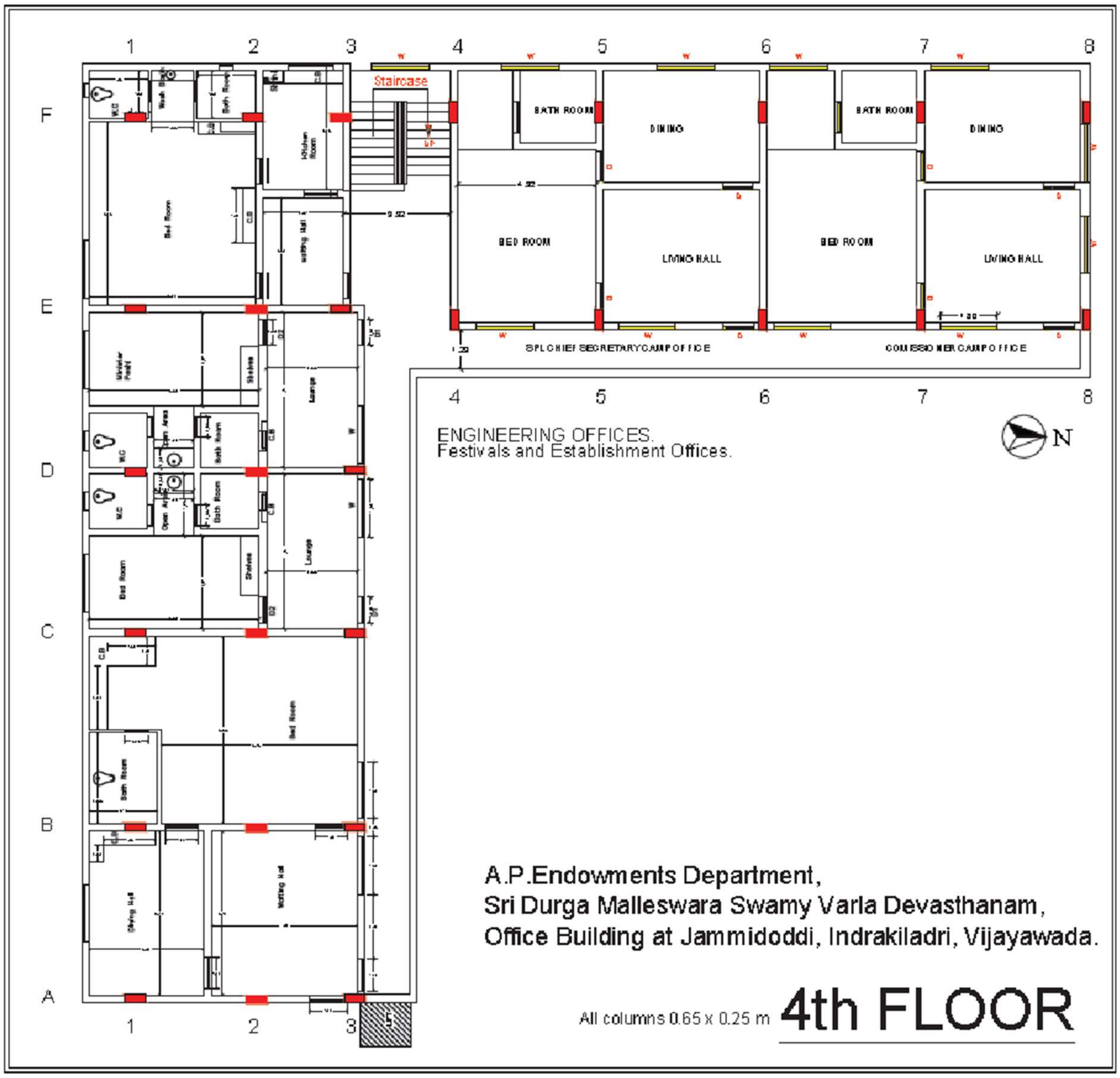


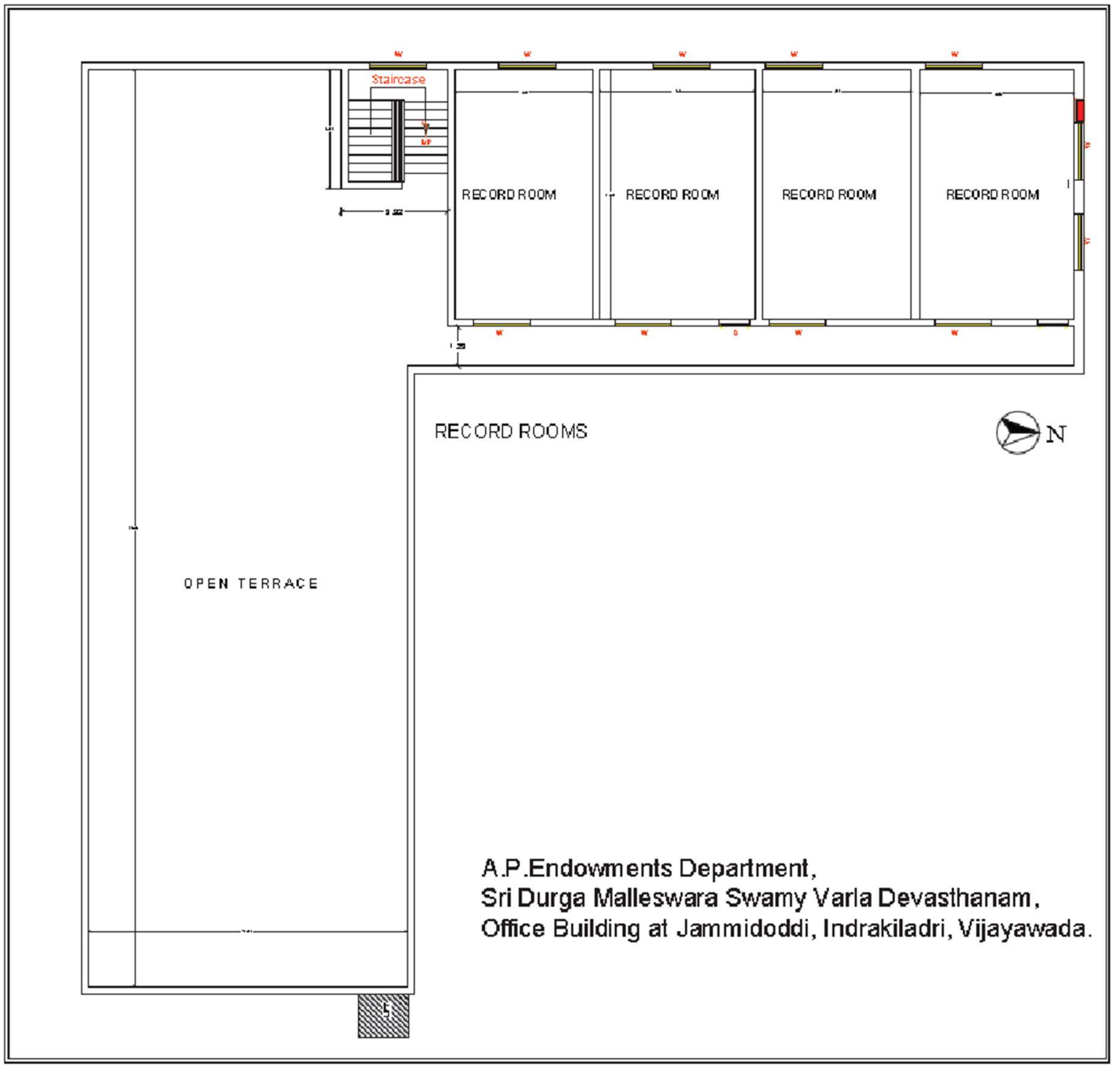

PRIVATE HOUSE
PRIVATE BUILDING
N
SLOPE
SLOPE
Staircase
OFFICE ROOM
MEETING HALL
TOILETS
PRIVATE BUILDING
SLOPE
PUMP
PUMP HOUSE
6.70X4.65
RAAVICHATTU
SUMP
FOUR WHEELER PARKING
SLOPE
CC RAMP
WELL
PRIVATE BUILDING
TWO WHEELER PARKING
LIFT
TRANSFORMER
open drain
ENTRANCE
STREET ROAD
STREET ROAD
LAYOUT
JAMMI DOODI SITE PLAN
ALL DIMENSIONS ARE IN METERS
SRI DURGA MALLESWARA SWAMY VARLA DEVASTHANAM
INDRAKEELADRI VIJAYAWADA


1
2
3
4
5
6
7
8
F
E
D
C
B
A
Staircase
Bath room
W.C
OFFICE ROOM
W2
MEETING HALL
Toilets
FOUR WHEELER PARKING
FOUR WHEELER PARKING
FOUR WHEELER PARKING
FOUR WHEELER PARKING
N
A.P.Endowments Department,
Sri Durga Malleswara Swamy Varla Devasthanam,
Office Building at Jammidoddi, Indrakiladri, Vijayawada.
All columns 0.65 x 0.25 m
1st FLOOR

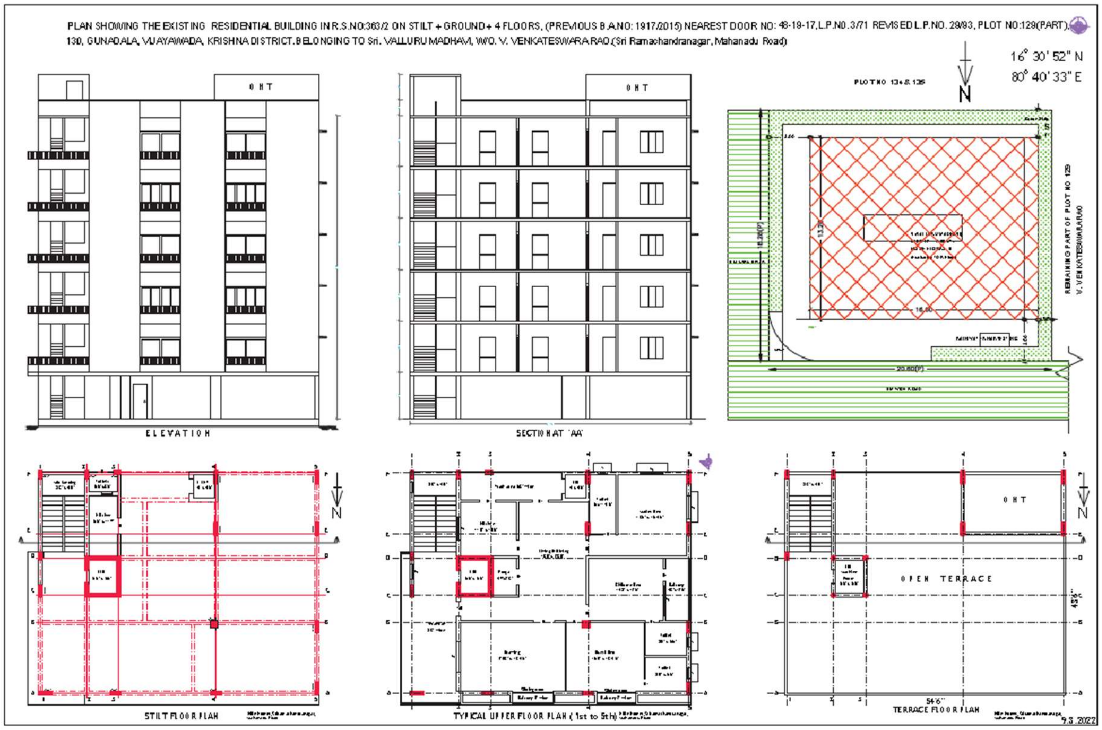

1
2
3
4
5
6
7
8
F
E
D
C
B
A
Staircase
UP
BATH ROOM
DINING
BATH ROOM
DINING
BED ROOM
LIVING HALL
BED ROOM
LIVING HALL
SPL CHIEF SECRETARY CAMP OFFICE
COMISSIONER CAMP OFFICE
W.C
Wash Basin
Bath Room
Kitchen Room
Bed Room
Waiting Hall
Minister Pooja
Shelves
Lounge
Open Area
Bath Room
W.C
Lounge
Bed Room
Shelves
Bed Room
Bath Room
Dining Hall
Waiting Hall
N
ENDOWMENTS MINISTER'S CAMP OFFICE.
ENDOWMENTS COMMISSIONER'S CAMP OFFICE.
EXECUTIVE OFFICER'S OFFICE
TYPICAL FLOOR PLAN
2nd, 3rd & 4th Floors
A.P.Endowments Department,
Sri Durga Malleswara Swamy Varla Devasthanam,
Office Building at Jammidoddi, Indrakiladri, Vijayawada.
All columns 0.65 x 0.25 m
2nd FLOOR


1
2
3
4
5
6
7
8
F
E
D
C
B
A
Staircase
BATH ROOM
DINING
BATH ROOM
DINING
Kitchen Room
Bed Room
Waiting Hall
BED ROOM
LIVING HALL
BED ROOM
LIVING HALL
SPL CHIEF SECRETARY CAMP OFFICE
COMMISSIONER CAMP OFFICE
Lounge
Lounge
Bed Room
Bath Room
Bed Room
Bath Room
Dining Hall
Waiting Hall
Shelves
ENGINEERING OFFICES,
Admn., Accounts and Audit Offices.
N
A.P.Endowments Department,
Sri Durga Malleswara Swamy Varla Devasthanam,
Office Building at Jammidoddi, Indrakiladri, Vijayawada.
All columns 0.65 x 0.25 m
3rd FLOOR

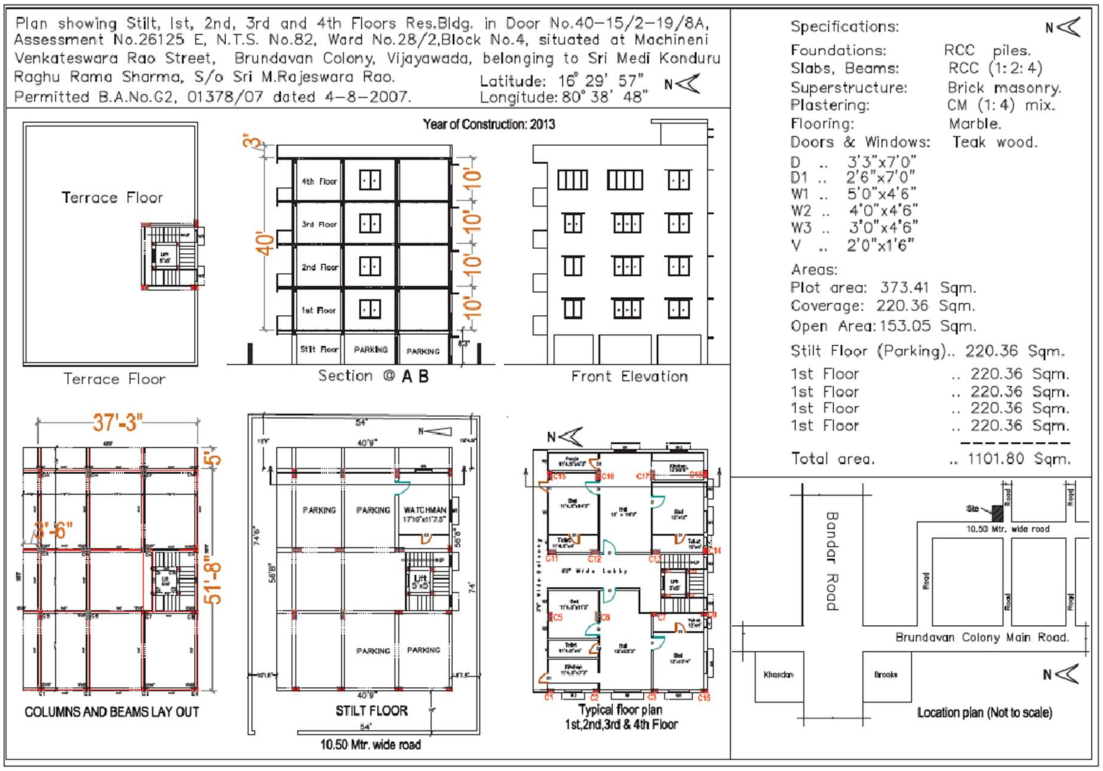

Staircase
BATH ROOM
DINING
BED ROOM
LIVING HALL
SPL CHIEF SECRETARY CAMP OFFICE
COMISSIONER CAMP OFFICE
Kitchen Room
Bed Room
waiting Hall
Wash Basin
Bath Room
W.C
Lounge
Shelves
Open Area
Dining Hall
Waiting Hall
ENGINEERING OFFICES.
Festivals and Establishment Offices.
N
1
2
3
4
5
6
7
8
A
B
C
D
E
F
A.P.Endowments Department,
Sri Durga Malleswara Swamy Varla Devasthanam,
Office Building at Jammidoddi, Indrakiladri, Vijayawada.
All columns 0.65 x 0.25 m
4th FLOOR



A.P.Endowments Department,
Sri Durga Malleswara Swamy Varla Devasthanam,
Office Building at Jammidoddi, Indrakiladri, Vijayawada.



PLAN SHOWING THE EXISTING RESIDENTIAL BUILDING IN R.S.NO:363/2 ON STILT + GROUND + 4 FLOORS, (PREVIOUS B.A.NO: 1917/2015) NEAREST DOOR NO: 48-18-17, L.P.NO.3/71 REVISED L.P.NO. 28/93, PLOT NO:129(PART), 130, GUNADALA, VIJAYAWADA, KRISHNA DISTRICT. BELONGING TO Sri. VALLURU MADHAVI, W/O. V. VENKATESWARA RAO (Sri Ramachandranagar, Mahanadu Road)



Plan showing Stilt, Ist, 2nd, 3rd and 4th Floors Res.Bldg. in Door No.40–15/2–19/8A, Assessment No.26125 E, N.T.S. No.82, Ward No.28/2,Block No.4, situated at Machineni Venkateswara Rao Street, Brundavan Colony, Vijayawada, belonging to Sri Medi Konduru Raghu Rama Sharma, S/o Sri M.Rajeswara Rao.
Permitted B.A.No.G2, 01378/07 dated 4–8–2007.
Latitude: 16° 29' 57"
Longitude: 80° 38' 48"

Year of Construction: 2013

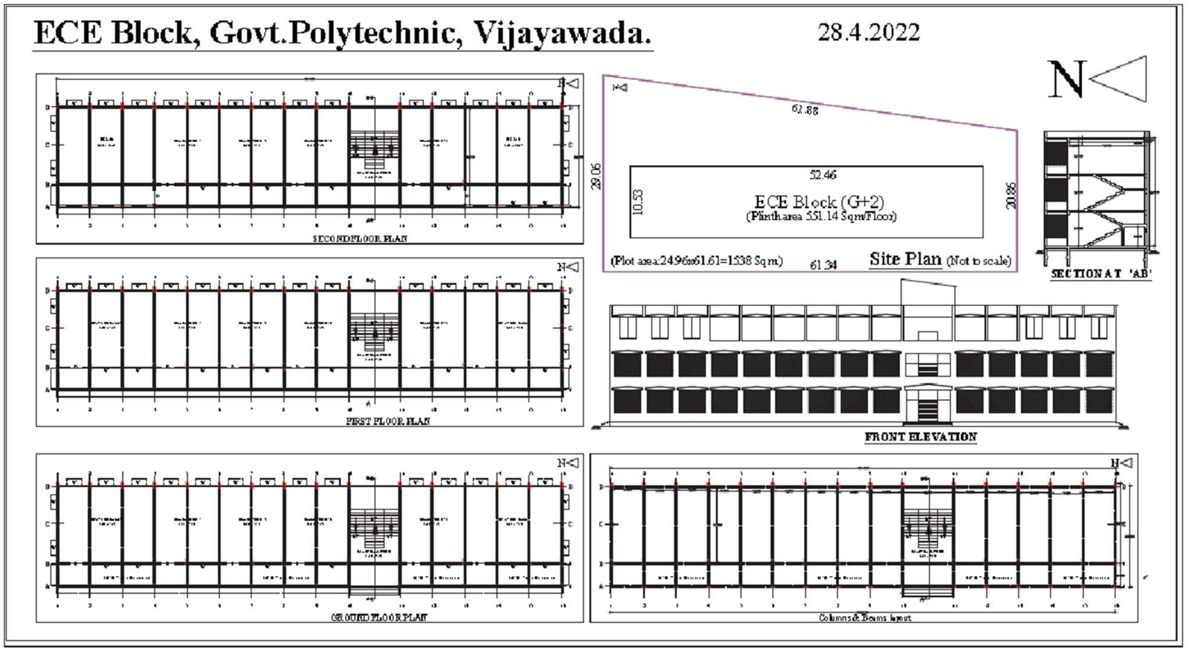
Specifications:

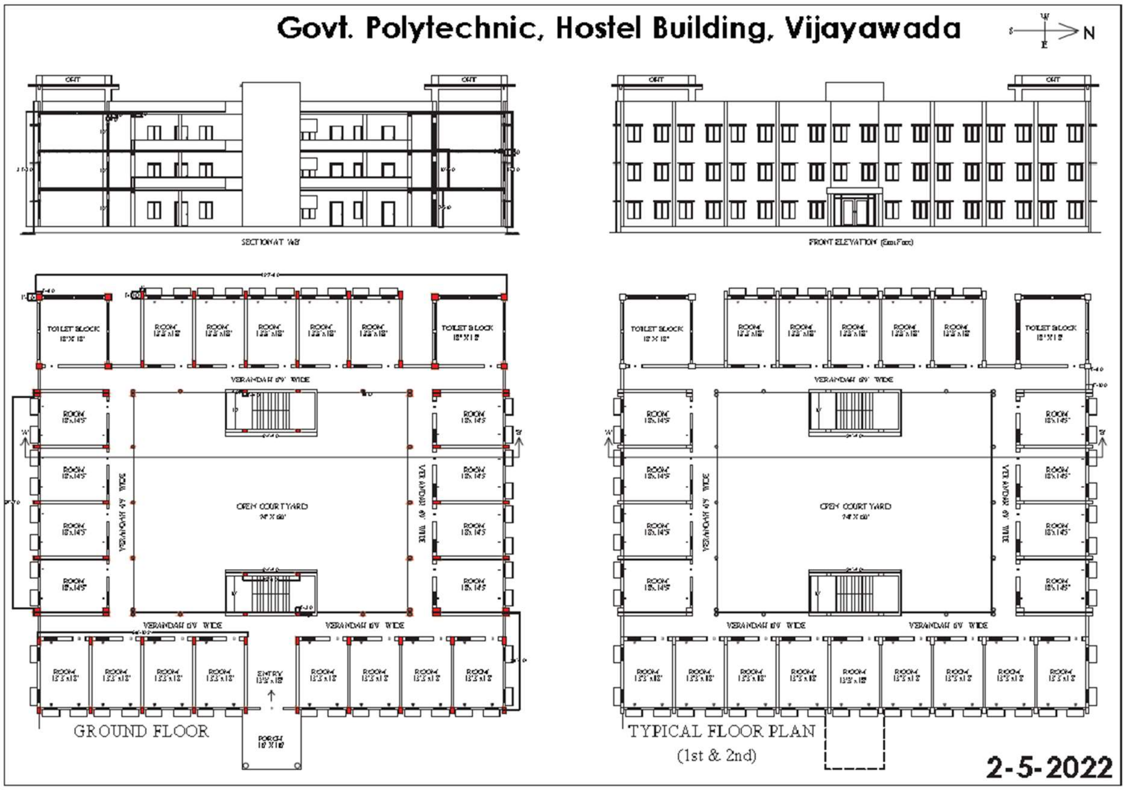
Foundations:	RCC piles.
Slabs, Beams:	RCC (1:2:4)
Superstructure:	Brick masonry.
Plastering:	CM (1:4) mix.
Flooring:	Marble.
Doors & Windows:	Teak wood.

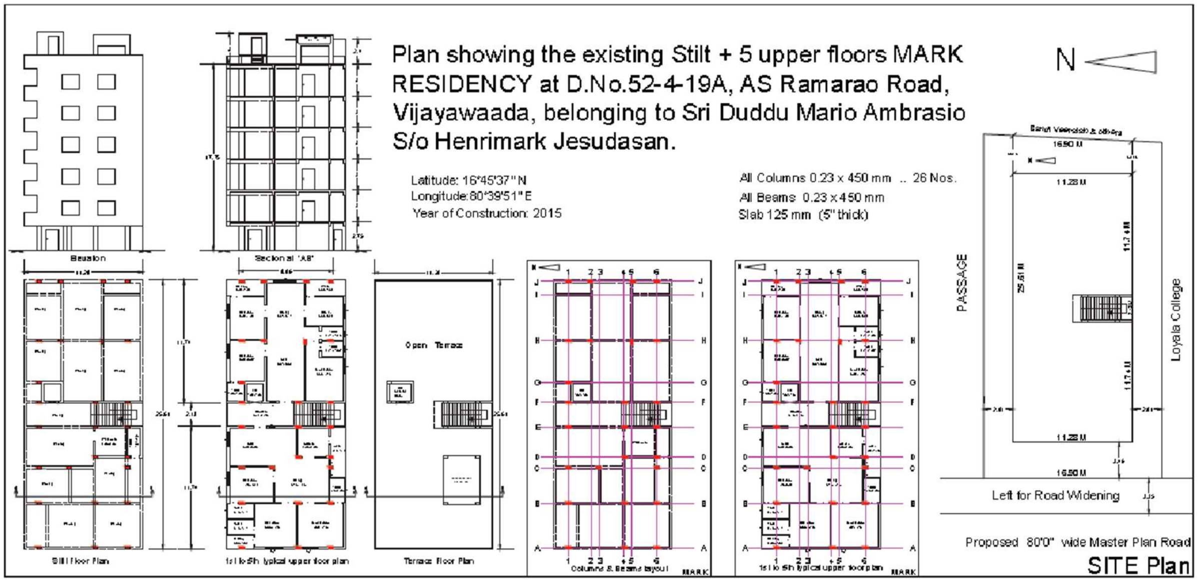
D ..	3'3"x7'0"
D1 ..	2'6"x7'0"
W1 ..	5'0"x4'6"
W2 ..	4'0"x4'6"
W3 ..	3'0"x4'6"
V ..	2'0"x1'6"

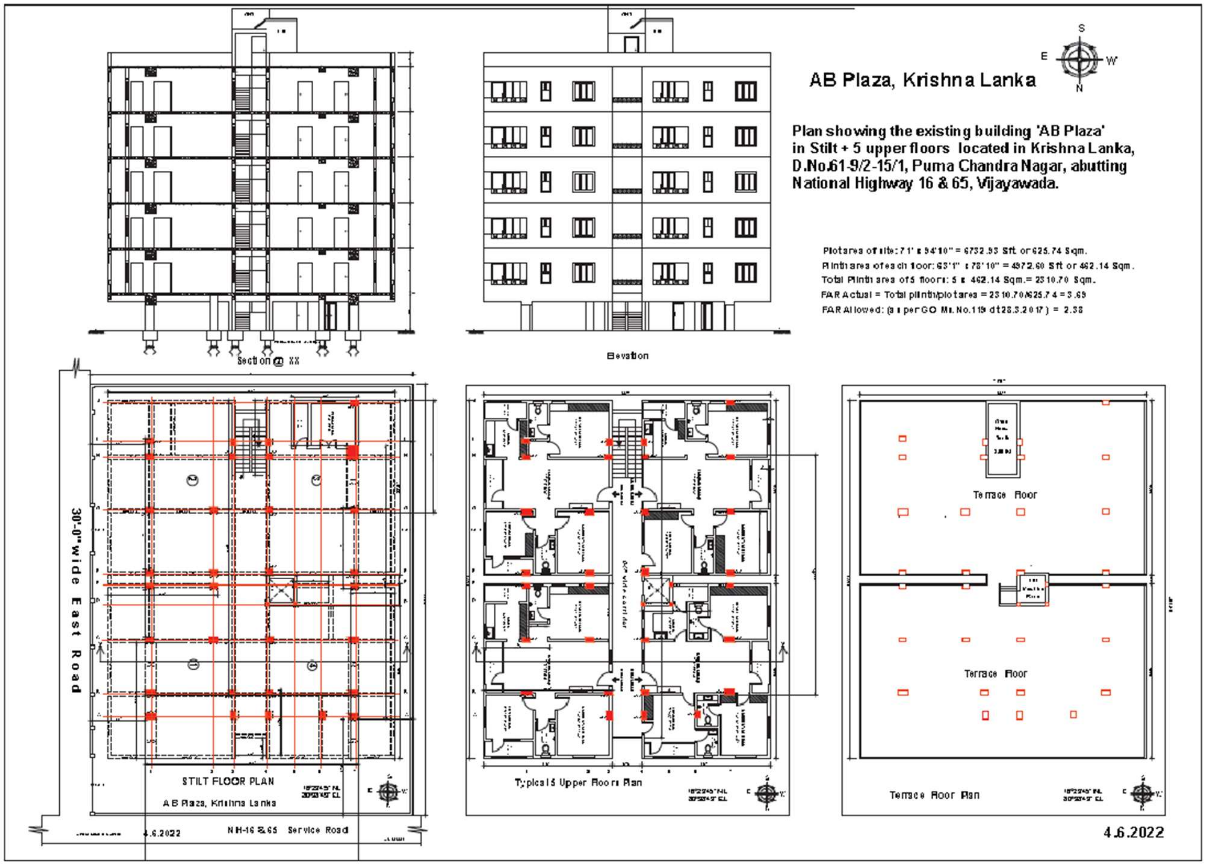
Areas:

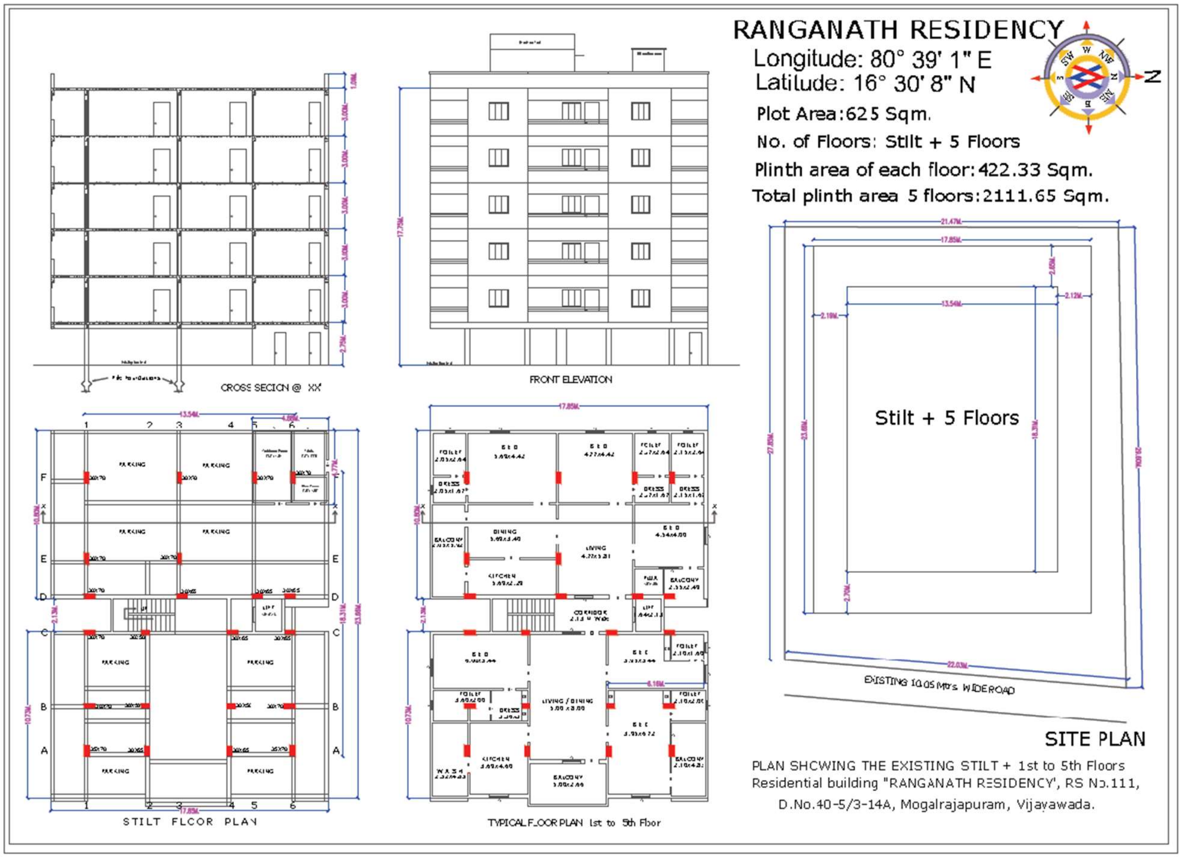
Plot area:	373.41 Sqm.
Coverage:	220.36 Sqm.
Open Area:	153.05 Sqm.
Stilt Floor (Parking)..	220.36 Sqm.
1st Floor	.. 220.36 Sqm.
1st Floor	.. 220.36 Sqm.
1st Floor	.. 220.36 Sqm.
1st Floor	.. 220.36 Sqm.
Total area.	.. 1101.80 Sqm.


ECE Block, Govt.Polytechnic, Vijayawada.
28.4.2022
N
SECOND FLOOR PLAN
FIRST FLOOR PLAN
GROUND FLOOR PLAN
61.88
52.46
29.06
10.53
ECE Block (G+2)
(Plinth area 551.14 Sqm/Floor)
20.86
(Plot area:24.96x61.61=1538 Sq.m)
61.34
Site Plan (Not to scale)
SECTION AT 'AB'
FRONT ELEVATION
Columns & Beams layout


Govt. Polytechnic, Hostel Building, Vijayawada
W
S
E
N
SECTION AT 'AB'
FRONT ELEVATION (East Face)
TOILET BLOCK
ROOM
VERANDAH 6'0" WIDE
OPEN COURT YARD
ENTRY
PORCH
GROUND FLOOR
TYPICAL FLOOR PLAN
(1st & 2nd)
2-5-2022


Plan showing the existing Stilt + 5 upper floors MARK RESIDENCY at D.No.52-4-19A, AS Ramarao Road, Vijayawaada, belonging to Sri Duddu Mario Ambrasio S/o Henrimark Jesudasan.
Latitude: 16°45'37" N
Longitude: 80°39'51" E
Year of Construction: 2015
All Columns 0.23 x 450 mm .. 26 Nos.
All Beams 0.23 x 450 mm
Slab 125 mm (5" thick)
N
Elevation
Section at 'AB'
Open Terrace
Stilt floor Plan
1st to 5th typical upper floor plan
Terrace floor Plan
Columns & Beams layout
1st to 5th typical upper floor plan
MARK
16.90 M
11.28 M
25.61 M
11.74 M
PASSAGE
Loyala College
Left for Road Widening
Proposed 80'0" wide Master Plan Road
SITE Plan

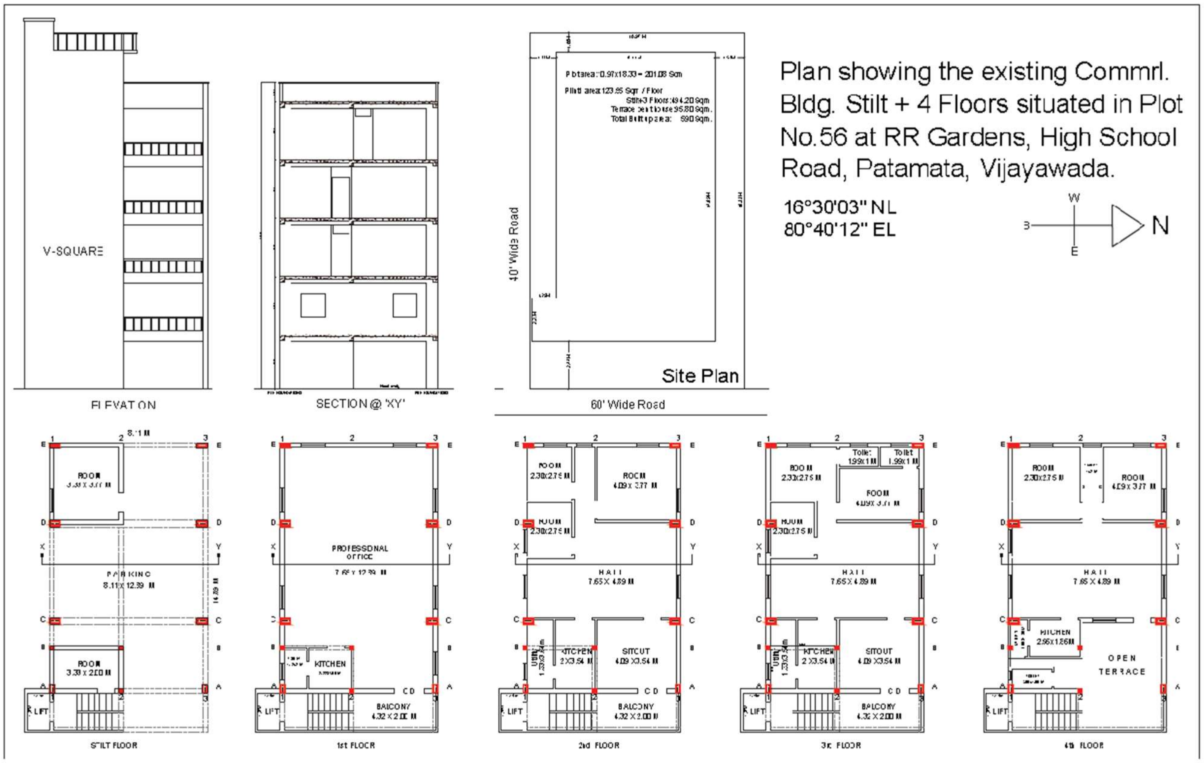

AB Plaza, Krishna Lanka
S
E
W
N
Plan showing the existing building 'AB Plaza' in Stilt + 5 upper floors located in Krishna Lanka, D.No.61-9/2-15/1, Puma Chandra Nagar, abutting National Highway 16 & 65, Vijayawada.
Plotarea of site: 71' x 94'10" = 6732.93 Sft or 625.74 Sqm.
Plinth area of each floor: 63'1" x 78'10" = 4972.60 Sft or 462.14 Sqm.
Total Plinth area of 5 floors: 5 x 462.14 Sqm.= 2310.70 Sqm.
FAR Actual = Total plinth/plotarea = 2310.70/625.74 = 3.69
FAR Allowed: (as per GO Ms.No.119 dt 28.3.2017) = 2.38
Section @ XX
Elevation
30'-0" wide East Road
STILT FLOOR PLAN
A B Plaza, Krishna Lanka
4.6.2022
NH-16 & 65 Service Road
Typical 5 Upper Floors Plan
Terrace Floor
Terrace Floor
Terrace Floor Plan
4.6.2022


RANGANATH RESIDENCY
Longitude: 80° 39' 1" E
Latilude: 16° 30' 8" N
Plot Area:625 Sqm.
No. of Floors: Stilt + 5 Floors
Plinth area of each floor:422.33 Sqm.
Total plinth area 5 floors:2111.65 Sqm.
N
CROSS SECION @ XX'
FRONT ELEVATION
STILT FLOOR PLAN
PARKING
LIFT
TYPICAL FLOOR PLAN 1st to 5th Floor
BED
TOILET
DRESS
DINING
LIVING
KITCHEN
BALCONY
CORRIDOR
LIVING / DINING
WASH
21.47M.
17.85M.
13.54M.
2.85M.
2.12M.
2.19M.
2.70M.
22.03M.
Stilt + 5 Floors
EXISTING 10.05 Mtrs. WIDEROAD
SITE PLAN
PLAN SHCWING THE EXISTING STILT + 1st to 5th Floors
Residential building "RANGANATH RESIDENCY", RS No.111,
D.No.40-5/3-14A, Mogalrajapuram, Vijayawada.

PLAN SHOWING THE EXISTING offices BUILDING Stilt+5 upper floors in RS No.8 (D.No.60-3-11/2) , ITI Road, No.5 Route, Vijayawada "CHAKRADHAR"

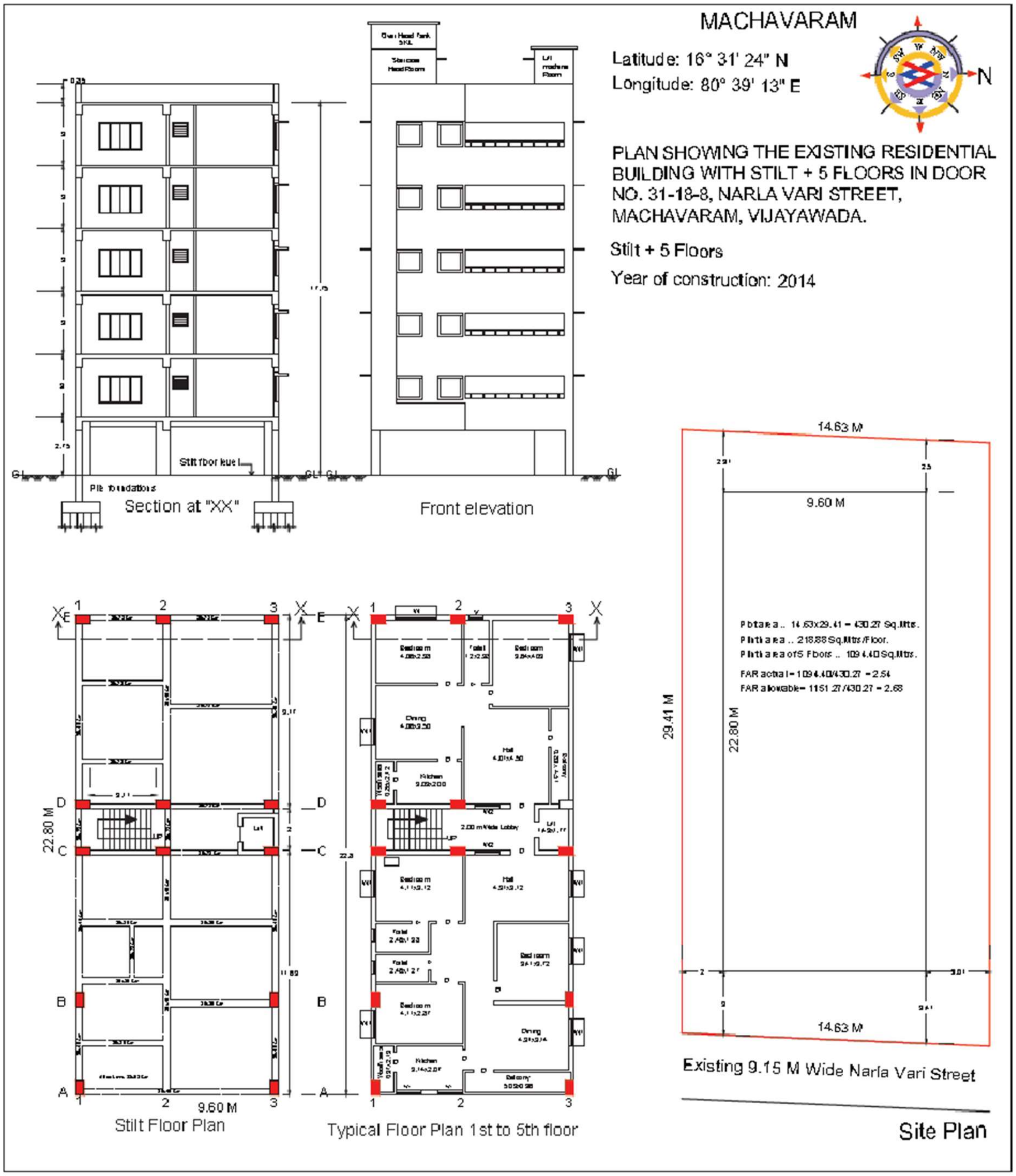
Latitude: 16° 30' 17" N

Longitude: 80° 39' 19" E



Plan showing the existing Commrl. Bldg. Stilt + 4 Floors situated in Plot No.56 at RR Gardens, High School Road, Patamata, Vijayawada.

16°30'03" NL
80°40'12" EL


MACHAVARAM
Latitude: 16° 31' 24" N
Longitude: 80° 39' 13" E
N
PLAN SHOWING THE EXISTING RESIDENTIAL BUILDING WITH STILT + 5 FLOORS IN DOOR NO. 31-18-8, NARLA VARI STREET, MACHAVARAM, VIJAYAWADA.
Stilt + 5 Floors
Year of construction: 2014
Over Head Tank
Staircase Head Room
Lift machine Room
Stilt floor level
Pile foundations
GL
Section at "XX"
Front elevation
X
E
D
C
B
A
1
2
3
22.80 M
9.60 M
Stilt Floor Plan
Bedroom
Toilet
Dining
Hall
Kitchen
Lift
2.00 m Wide Lobby
UP
Balcony
22.8
Typical Floor Plan 1st to 5th floor
14.63 M
9.60 M
29.41 M
22.80 M
Plot area .. 14.63x29.41 = 430.27 Sq.Mts.
Plinth area .. 218.88 Sq.Mts./Floor.
Plinth area of 5 Floors .. 1094.40 Sq.Mts.
FAR actual = 1094.40/430.27 = 2.54
FAR allowable = 1151.27/430.27 = 2.68
14.63 M
Existing 9.15 M Wide Narla Vari Street
Site Plan

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Annexure III: R-Values of Columns

House No. & Location: H.No.40-15-6/A, T.S.No.147, **Tickle Road**, Vijayawada-10

Latitude: 16° 29' 53" N Longitude: 80° 38' 54" E

Year of construction: 1988

Floor Height: **Ground Floor (3.00 Mts. Ht.)**

Col. No. & Size	*R Value location from FFL*	*R Value of Column face*												*Avg. Values*	*Avg. R Value of Col.*
		North			*East*			*South*			*West*				
		E	*M*	*E*	*E*	*M*	*E*	*E*	*M*	*E*	*E*	*M*	*E*		
A1 230x230	2.10 M	37	33	36	37	38	38	Covered by wall			Covered by wall			36.50	37.22
	1.35 M	36	40	34	36	39	37							37.00	
	0.60 M	37	38	38	38	40	38							38.17	
A2 230x230	2.10 M	38	33	36	Covered by wall			Covered by wall			Covered by wall			35.67	35.78
	1.35 M	32	36	34										34.00	
	0.60 M	39	38	36										37.67	
A4 230x230	2.10 M	38	40	39	Covered by wall			Covered by wall			37	37	38	38.17	38.56
	1.35 M	39	39	38							39	40	37	38.67	
	0.60 M	38	40	39							39	39	38	38.83	
A6 230x230	2.10 M	36	39	37	37	38	38	Covered by wall			37	37	36	37.22	38.22
	1.35 M	40	38	38	38	39	37				39	38	40	38.56	
	0.60 M	38	40	39	40	39	38				40	39	37	38.89	
A8 300 dia.	2.10 M	37			37			39			37			37.50	38.75
	1.35 M	40			39			40			40			39.75	
	0.60 M	40			38			39			39			39.00	
A9 300 dia.	2.10 M	37			40			39			40			39.00	39.42
	1.35 M	40			41			40			39			40.00	
	0.60 M	39			40			38			40			39.25	
B1 230x230	2.10 M	Covered by wall			37	41	38	Covered by wall			Covered by wall			38.67	38.44
	1.35 M				36	38	39							37.67	
	0.60 M				39	40	38							39.00	
B2 230x230	2.10 M	Covered by wall			Covered by wall			39	40	38	38	39	39	38.83	38.66
	1.35 M							37	39	37	39	40	38	38.33	
	0.60 M							39	39	38	40	39	38	38.83	
B4 230x230	2.10 M	Covered by wall			39	39	40	37	39	40	Covered by wall			39.00	38.94
	1.35 M				38	39	39	40	38	39				38.83	
	0.60 M				40	38	39	39	40	38				39.00	
B6 230x230	2.10 M	Covered by wall			Covered by wall			37	39	39	37	39	36	37.83	38.33
	1.35 M							38	40	39	38	37	39	38.50	
	0.60 M							39	40	38	37	40	38	38.67	
B8 300 dia.	2.10 M	37			38			38			40			38.25	39.00
	1.35 M	39			40			41			39			39.75	
	0.60 M	38			39			40			39			39.00	
B9 300 dia.	2.10 M	38			39			39			40			39.00	39.25
	1.35 M	40			39			40			39			39.50	

	0.60 M	39			40			40			38			39.25	
C1 230x230	2.10 M	Covered by wall			39	38	36	Covered by wall			Covered by wall			37.67	37.56
	1.35 M				36	38	38							37.33	
	0.60 M				37	39	37							37.67	
C2 230x230	2.10 M	38	38	39	36	38	37	Covered by wall			39	36	36	37.44	38.15
	1.35 M	39	41	38	40	39	38				40	38	39	39.11	
	0.60 M	37	39	36	37	39	39				38	39	37	37.89	
C8 300 dia.	2.10 M	38			37			38			36			37.25	38.58
	1.35 M	39			39			40			38			39.00	
	0.60 M	39			40			39			40			39.50	
C9 300 dia.	2.10 M	36			39			39			39			38.25	38.42
	1.35 M	38			37			38			37			37.50	
	0.60 M	40			39			40			39			39.50	
D2 230x230	2.10 M	Covered by wall			37	38	38	Covered by wall			Covered by wall			37.67	37.89
	1.35 M				36	39	38							37.67	
	0.60 M				40	39	36							38.33	
D3 230x230	2.10 M	38	38	39	Covered by wall			Covered by wall			Covered by wall			38.33	38.33
	1.35 M	38	39	37										38.00	
	0.60 M	40	40	36										38.67	
D5 230x230 .	2.10 M	Covered by wall			Covered by wall			Covered by wall			36	39	39	38.00	38.11
	1.35 M										38	40	37	38.33	
	0.60 M										40	38	36	38.00	
D7 300 dia.	2.10 M	38			38			38			38			38.00	38.17
	1.35 M	39			36			35			39			37.25	
	0.60 M	39			39			39			40			39.25	
D8 300 dia.	2.10 M	38			38			35			39			37.50	38.08
	1.35 M	39			39			39			38			38.75	
	0.60 M	37			40			38			37			38.00	
E1 230x230	2.10 M	Covered by wall			36	39	37	37	39	39	Covered by wall			37.83	38.11
	1.35 M				38	40	37	38	40	38				38.50	
	0.60 M				37	40	38	38	37	38				38.00	
E2 230x230	2.10 M	Covered by wall			Covered by wall			Covered by wall			39	37	38	38.00	38.00
	1.35 M										36	39	38	37.67	
	0.60 M										38	38	39	38.33	
E3 230x230	2.10 M	Covered by wall			Covered by wall			Covered by wall			37	39	38	38.00	38.67
	1.35 M										39	39	38	38.67	
	0.60 M										40	38	40	39.33	
E5 230x230	2.10 M	Covered by wall			Covered by wall			Covered by wall			37	37	39	37.67	38.44
	1.35 M										39	40	38	39.00	
	0.60 M										39	38	39	38.67	
E7 300 dia.	2.10 M	36			36			36			36			36.00	37.33
	1.35 M	39			39			38			37			38.25	
	0.60 M	37			40			37			37			37.75	
E8 300 dia.	2.10 M	36			38			34			36			36.00	37.17
	1.35 M	38			39			38			39			38.50	

	0.60 M	37	37	37	37	37.00	
E9 300 dia.	2.10 M	35	36	35	35	35.25	36.83
	1.35 M	38	38	39	38	38.25	
	0.60 M	36	36	40	36	37.00	
					Average		**38.16**
			84 Readings				

1st Floor (3.00 Mts. Ht.)															
Col. No. & Size	***R Value location from FFL***	***R Value of Column face***												***Avg. Values***	***Ave. R Value of Col.***
		North			***East***			***South***			***West***				
		E	***M***	***E***	***E***	***M***	***E***	***E***	***M***	***E***	***E***	***M***	***E***		
A1 230x230	2.10 M	39	37	38	No access			Covered by wall			Covered by wall			38.00	38.56
	1.35 M	39	40	36										38.33	
	0.60 M	40	40	38										39.33	
A2 230x230	2.10 M	38	37	38	Covered by wall			Covered by wall			Covered by wall			37.67	38.56
	1.35 M	39	40	37										38.67	
	0.60 M	39	41	38										39.33	
A4 230x230	2.10 M	38	39	38	Covered by wall			Covered by wall			38	37	36	37.67	38.06
	1.35 M	39	40	37							38	40	37	38.50	
	0.60 M	40	39	36							36	39	38	38.00	
A6 230x230	2.10 M	38	37	36	38	37	36	Covered by wall			Covered by wall			37.00	37.89
	1.35 M	36	40	38	39	38	40							38.50	
	0.60 M	38	39	36	37	39	40							38.17	
A8 230x230	2.10 M	38	35	36	Covered by wall			Covered by wall			Covered by wall			36.33	37.44
	1.35 M	39	38	39										38.67	
	0.60 M	36	39	37										37.33	
A9 230x230	2.10 M	39	35	37	Covered by wall			Covered by wall			38	39	36	37.33	38.11
	1.35 M	39	39	38							40	38	38	38.67	
	0.60 M	37	39	40							36	39	39	38.33	
B1 230x230	2.10 M	Covered by wall			No access			Covered by wall			Covered by wall				0.00
	1.35 M														
	0.60 M														
B2 230x230	2.10 M	Covered by wall			Covered by wall			36	35	34	37	35	36	35.50	37.00
	1.35 M							36	40	38	36	39	38	37.83	
	0.60 M							37	39	38	37	38	37	37.67	
B4 230x230	2.10 M	Covered by wall			36	34	36	37	36	38	Covered by wall			36.17	37.28
	1.35 M				36	37	36	36	37	36				36.33	
	0.60 M				39	38	40	40	39	40				39.33	
B6 230x230	2.10 M	Covered by wall			Covered by wall			37	39	35	38	38	36	37.17	37.56
	1.35 M							36	39	37	38	40	37	37.83	
	0.60 M							37	38	38	36	39	38	37.67	
B8 230x230	2.10 M	Covered by wall			39	38	38	37	38	39	Covered by wall			38.17	38.89
	1.35 M				39	40	39	40	41	39				39.67	
	0.60 M				38	39	39	39	40	40				39.17	
B9	2.10 M	37	38	36	37	39	38	38	39	37	Covered			37.67	38.56

230x230	1.35 M	36	40	39	39	39	39	37	40	38	by wall			38.56	
	0.60 M	38	39	38	41	40	40	39	40	39				39.33	
C1 230x230	2.10 M	Covered by wall			No access			Covered by wall			Covered by wall				0.00
	1.35 M														
	0.60 M														
C2 230x230	2.10 M	38	36	37	36	39	37	Covered by wall			37	39	37	37.33	37.74
	1.35 M	37	38	36	37	40	38				37	39	39	37.89	
	0.60 M	36	39	38	37	39	36				39	40	38	38.00	
C8 230x230	2.10 M	37	38	37	36	38	37	Covered by wall			37	36	38	37.11	37.67
	1.35 M	36	39	39	37	39	39				39	36	39	38.11	
	0.60 M	37	40	38	38	37	39				35	38	38	37.78	
C9 230x230	2.10 M	Covered by wall			Covered by wall			Covered by wall			37	38	36	37.00	37.44
	1.35 M										36	38	39	37.67	
	0.60 M										37	39	37	37.67	
D2 230x230	2.10 M	Covered by wall			37	38	36	Covered by wall			Covered by wall			37.00	37.44
	1.35 M				36	40	38							38.00	
	0.60 M				37	39	36							37.33	
D3 230x230	2.10 M	36	38	37	Covered by wall			Covered by wall			Covered by wall			37.00	37.33
	1.35 M	38	38	37										37.67	
	0.60 M	37	39	36										37.33	
D5 230x230.	2.10 M	Covered by wall			Covered by wall			Covered by wall			Covered by wall				0.00
	1.35 M														
	0.60 M														
D7 230x230	2.10 M	36	37	35	Covered by wall			Covered by wall			Covered by wall			36.00	37.11
	1.35 M	37	40	37										38.00	
	0.60 M	38	38	36										37.33	
D8 230x230	2.10 M	Covered by wall			Covered by wall			Covered by wall			37	39	38	38.00	37.33
	1.35 M										35	38	37	36.67	
	0.60 M										36	40	37	37.67	
E1 230x230	2.10 M	Covered by wall			No access			35	39	35	Covered by wall			36.33	37.22
	1.35 M							38	38	36				37.33	
	0.60 M							37	39	38				38.00	
E2 230x230	2.10 M	Covered by wall			Covered by wall			38	37	35	Covered by wall			36.67	37.33
	1.35 M							35	39	36				36.67	
	0.60 M							38	39	39				38.67	
E3 230x230	2.10 M	Covered by wall			Covered by wall			38	39	37	Covered by wall			38.00	38.33
	1.35 M							37	40	38				38.33	
	0.60 M							39	38	39				38.67	
E5 230x230	2.10 M	Covered by wall			Covered by wall			37	35	38	Covered by wall			36.67	37.33
	1.35 M							38	39	37				38.00	
	0.60 M							37	38	37				37.33	
E7 230x230	2.10 M	Covered by wall			Covered by wall			35	38	34	Covered by wall			35.67	36.56
	1.35 M							36	37	36				36.33	
	0.60 M							38	38	37				37.67	
E8	2.10 M	Covered			Covered			37	36	38	35	38	35	36.50	37.50

230x230	1.35 M	by wall			by wall			38	40	39	38	39	35	38.17	
	0.60 M							37	39	38	39	38	36	37.83	
E9 230x230	2.10 M	37	36	37	36	36	35	36	35	34	35	34	37	35.67	36.92
	1.35 M	38	38	36	39	38	36	36	40	38	34	39	35	37.25	
	0.60 M	39	36	38	38	36	39	38	39	38	37	36	40	37.83	
												Average			**33.61**
			75 Readings												

2nd Floor (3.00 Mts. Ht.)

Col. No. & Size	*R Value location from FFL*	*R Value of Column face*												*Avg. Values*	*Ave. R Value of Col.*
		North			*East*			*South*			*West*				
		E	*M*	*E*	*E*	*M*	*E*	*E*	*M*	*E*	*E*	*M*	*E*		
A1 230x230	2.10 M	36	38	38	No access			Covered by wall			Covered by wall			37.33	37.67
	1.35 M	37	39	36										37.33	
	0.60 M	38	40	37										38.33	
A2 230x230	2.10 M	38	37	37	Covered by wall			Covered by wall			Covered by wall			37.33	37.89
	1.35 M	37	38	37										37.33	
	0.60 M	39	40	38										39.00	
A4 230x230	2.10 M	38	38	39	Covered by wall			Covered by wall			39	37	36	37.83	35.74
	1.35 M	38	39	36							36	39	37	37.50	
	0.60 M	36	39	36							38	39	39	37.83	
A6 230x230	2.10 M	38	37	36	38	37	38	Covered by wall			Covered by wall			37.33	38.56
	1.35 M	36	40	38	40	38	40							38.67	
	0.60 M	38	39	36	37	39	40							38.17	
A8 230x230	2.10 M	38	36	36	Covered by wall			Covered by wall			Covered by wall			36.67	38.22
	1.35 M	39	40	39										39.33	
	0.60 M	40	39	37										38.67	
A9 230x230	2.10 M	39	35	38	Covered by wall			Covered by wall			36	37	36	36.83	38.06
	1.35 M	40	39	37							40	38	38	38.67	
	0.60 M	37	40	40							36	39	40	38.67	
B1 230x230	2.10 M	Covered by wall			No access			Covered by wall			Covered by wall				0.00
	1.35 M														
	0.60 M														
B2 230x230	2.10 M	Covered by wall			Covered by wall			36	35	36	37	37	36	36.17	37.61
	1.35 M							36	39	37	40	39	38	38.17	
	0.60 M							40	39	38	37	38	39	38.50	
B4 230x230	2.10 M	Covered by wall			37	34	36	37	36	36	Covered by wall			36.00	37.44
	1.35 M				35	39	36	36	40	39				37.50	
	0.60 M				39	38	40	39	39	38				38.83	
B6 230x230	2.10 M	Covered by wall			Covered by wall			37	39	38	38	39	36	37.83	38.33
	1.35 M							40	39	37	38	40	38	38.67	
	0.60 M							37	38	39	40	39	38	38.50	
B8 230x230	2.10 M	Covered by wall			36	38	38	37	38	39	Covered by wall			37.67	38.94
	1.35 M				38	40	39	40	41	39				39.50	

	0.60 M				40	39	40	40	40	39				39.67	
B9 230x230	2.10 M	37	38	38	37	39	40	38	39	39	Covered by wall			38.33	39.03
	1.35 M	39	40	39	40	39	39	40	40	38				39.33	
	0.60 M	40	39	38	41	40	40	38	40	39				39.44	
C1 230x230	2.10 M	Covered by wall			No access			Covered by wall			Covered by wall				0.00
	1.35 M														
	0.60 M														
C2 230x230	2.10 M	38	39	37	36	39	38	Covered by wall			37	39	38	37.89	38.37
	1.35 M	37	40	36	37	40	38				40	39	39	38.44	
	0.60 M	40	39	38	39	39	36				39	40	39	38.78	
C8 230x230	2.10 M	39	38	39	38	38	37	Covered by wall			37	39	38	38.11	38.56
	1.35 M	38	40	39	37	39	40				39	40	39	39.00	
	0.60 M	39	40	38	39	37	39				39	38	38	38.56	
C9 230x230	2.10 M	Covered by wall			Covered by wall			Covered by wall			39	38	36	37.67	38.11
	1.35 M										36	40	39	38.33	
	0.60 M										37	39	39	38.33	
D2 230x230	2.10 M	Covered by wall			39	38	39	Covered by wall			Covered by wall			38.67	38.44
	1.35 M				36	40	38							38.00	
	0.60 M				40	39	37							38.67	
D3 230x230	2.10 M	36	38	37	Covered by wall			Covered by wall			Covered by wall			37.00	37.78
	1.35 M	40	39	37										38.67	
	0.60 M	37	40	36										37.67	
D5 230x230.	2.10 M	Covered by wall			Covered by wall			Covered by wall			Covered by wall				0.00
	1.35 M														
	0.60 M														
D7 230x230	2.10 M	36	37	38	Covered by wall			Covered by wall			Covered by wall			37.00	37.67
	1.35 M	37	40	37										38.00	
	0.60 M	39	38	37										38.00	
D8 230x230	2.10 M	Covered by wall			Covered by wall			Covered by wall			38	39	38	38.33	38.00
	1.35 M										37	39	39	38.33	
	0.60 M										36	39	37	37.33	
E1 230x230	2.10 M	Covered by wall			No access			36	39	37	Covered by wall			37.33	38.33
	1.35 M							38	40	39				39.00	
	0.60 M							39	39	38				38.67	
E2 230x230	2.10 M	Covered by wall			Covered by wall			38	37	38	Covered by wall			37.67	38.22
	1.35 M							40	39	36				38.33	
	0.60 M							38	38	40				38.67	
E3 230x230	2.10 M	Covered by wall			Covered by wall			38	39	37	Covered by wall			38.00	38.67
	1.35 M							38	40	39				39.00	
	0.60 M							40	38	39				39.00	
E5 230x230	2.10 M	Covered by wall			Covered by wall			36	35	38	Covered by wall			36.33	37.00
	1.35 M							37	38	37				37.33	
	0.60 M							37	38	37				37.33	
E7 230x230	2.10 M	Covered by wall			Covered by wall			35	38	36	Covered by wall			36.33	37.22
	1.35 M							36	39	36				37.00	

	0.60 M							38	38	39				38.33	
E8 230x230	2.10 M	Covered by wall			Covered by wall			35	36	35	37	38	35	36.00	37.56
	1.35 M							37	40	36	38	40	37	38.00	
	0.60 M							40	39	38	37	38	40	38.67	
E9 230x230	2.10 M	37	38	40	38	38	37	37	39	38	37	39	37	37.92	38.39
	1.35 M	39	39	39	39	40	38	38	40	38	38	39	38	38.75	
	0.60 M	40	36	38	38	38	40	38	39	40	37	38	40	38.50	
											Average				**33.92**
			75 Readings												

3rd Floor (3.00 Mts. Ht.)															
Col. No. & Size	***R Value location from FFL***	***R Value of Column face***												***Avg. Values***	***Ave. R Value of Col.***
		North			***East***			***South***			***West***				
		E	***M***	***E***	***E***	***M***	***E***	***E***	***M***	***E***	***E***	***M***	***E***		
A1 230x230	2.10 M	36	38	37	No access			Covered by wall			Covered by wall			37.00	38.22
	1.35 M	39	40	39										39.33	
	0.60 M	38	40	37										38.33	
A2 230x230	2.10 M	36	37	39	Covered by wall			Covered by wall			Covered by wall			37.33	37.78
	1.35 M	39	38	37										38.00	
	0.60 M	37	39	38										38.00	
A4 230x230	2.10 M	39	38	39	Covered by wall			Covered by wall			39	37	38	38.33	38.83
	1.35 M	40	39	39							38	40	37	38.83	
	0.60 M	40	39	40							39	39	39	39.33	
A6 230x230	2.10 M	38	37	38	39	37	38	Covered by wall			Covered by wall			37.83	38.44
	1.35 M	39	40	38	40	38	39							39.00	
	0.60 M	38	39	37	38	39	40							38.50	
A8 230x230	2.10 M	38	37	39	Covered by wall			Covered by wall			Covered by wall			38.00	38.78
	1.35 M	39	40	39										39.33	
	0.60 M	40	39	38										39.00	
A9 230x230	2.10 M	39	39	38	Covered by wall			Covered by wall			39	37	36	38.00	38.50
	1.35 M	40	39	38							38	39	40	39.00	
	0.60 M	37	40	39							36	39	40	38.50	
B1 230x230	2.10 M	Covered by wall			No access			Covered by wall			Covered by wall				0.00
	1.35 M														
	0.60 M														
B2 230x230	2.10 M	Covered by wall			Covered by wall			36	35	37	36	37	35	36.00	37.89
	1.35 M							36	40	39	40	39	39	38.83	
	0.60 M							40	39	38	37	40	39	38.83	
B4 230x230	2.10 M	Covered by wall			37	38	36	37	38	36	Covered by wall			37.00	38.00
	1.35 M				35	39	37	37	40	39				37.83	
	0.60 M				40	38	40	40	39	38				39.17	
B6 230x230	2.10 M	Covered by wall			Covered by wall			35	39	36	38	39	36	37.17	38.33
	1.35 M							40	40	39	38	40	38	39.17	
	0.60 M							37	40	39	40	39	38	38.83	
B8	2.10 M	Covered			36	38	38	37	38	37	Covered			37.33	38.61

230x230	1.35 M	by wall			38	40	39	39	39	39	by wall			39.00	
	0.60 M				40	39	40	39	40	39				39.50	
B9 230x230	2.10 M	39	38	37	37	36	40	37	39	38	Covered by wall			37.89	38.63
	1.35 M	38	40	39	40	39	39	40	38	37				38.89	
	0.60 M	39	39	37	39	40	40	39	40	39				39.11	
C1 230x230	2.10 M	Covered by wall			No access			Covered by wall			Covered by wall				0.00
	1.35 M														
	0.60 M														
C2 230x230	2.10 M	36	39	38	38	39	38	Covered by wall			38	39	38	38.11	38.48
	1.35 M	37	40	39	37	40	39				40	39	40	39.00	
	0.60 M	37	39	38	39	40	36				39	38	39	38.33	
C8 230x230	2.10 M	36	38	39	37	38	39	Covered by wall			37	36	38	37.56	38.04
	1.35 M	38	39	36	38	40	40				38	38	37	38.22	
	0.60 M	37	40	38	40	37	39				39	37	38	38.33	
C9 230x230	2.10 M	Covered by wall			Covered by wall			Covered by wall			38	38	37	37.67	38.67
	1.35 M										39	40	39	39.33	
	0.60 M										38	40	39	39.00	
D2 230x230	2.10 M	Covered by wall			38	37	39	Covered by wall			Covered by wall			38.00	38.56
	1.35 M				39	40	38							39.00	
	0.60 M				39	39	38							38.67	
D3 230x230	2.10 M	36	36	37	Covered by wall			Covered by wall			Covered by wall			36.33	37.89
	1.35 M	39	39	40										39.33	
	0.60 M	38	40	36										38.00	
D5 230x230.	2.10 M	Covered by wall			Covered by wall			Covered by wall			Covered by wall				0.00
	1.35 M														
	0.60 M														
D7 230x230	2.10 M	38	37	39	Covered by wall			Covered by wall			Covered by wall			38.00	38.33
	1.35 M	40	38	37										38.33	
	0.60 M	39	40	37										38.67	
D8 230x230	2.10 M	Covered by wall			Covered by wall			Covered by wall			36	39	37	37.33	38.11
	1.35 M										35	39	40	38.00	
	0.60 M										40	39	38	39.00	
E1 230x230	2.10 M	Covered by wall			No access			35	39	36	Covered by wall			36.67	37.89
	1.35 M							38	40	39				39.00	
	0.60 M							37	40	37				38.00	
E2 230x230	2.10 M	Covered by wall			Covered by wall			36	37	39	Covered by wall			37.33	38.56
	1.35 M							40	39	38				39.00	
	0.60 M							40	38	40				39.33	
E3 230x230	2.10 M	Covered by wall			Covered by wall			36	36	37	Covered by wall			36.33	38.22
	1.35 M							40	38	39				39.00	
	0.60 M							40	38	40				39.33	
E5 230x230	2.10 M	Covered by wall			Covered by wall			36	36	38	Covered by wall			36.67	37.33
	1.35 M							37	38	35				36.67	
	0.60 M							39	40	37				38.67	
E7	2.10 M	Covered			Covered			35	37	34	Covered			35.33	36.22

230x230	1.35 M	by wall			by wall			36	38	36	by wall			36.67	
	0.60 M							36	38	36				36.67	
E8 230x230	2.10 M	Covered by wall			Covered by wall			35	37	35	37	38	36	36.33	37.72
	1.35 M							36	40	39	38	40	37	38.33	
	0.60 M							40	39	37	37	39	39	38.50	
E9 230x230	2.10 M	39	38	40	37	38	37	36	39	37	37	35	34	37.25	38.06
	1.35 M	37	40	39	37	40	38	39	40	38	38	40	38	38.67	
	0.60 M	40	36	39	38	37	39	38	39	39	36	38	40	38.25	
											Average				**34.07**
			75 Readings												

House No. & Location: H.No.40-15-6/A, T.S.No.147, Tickle Road, Vijayawada-10.

Latitude: 16 29' 53" N

Year of construction: 1988

Sl. No.	**Col. No. & size**	**Average R Value of columns in each Floor.**				
		Gr. Floor	**1st Floor**	**2nd Floor**	**3rd Floor**	**Average**
1	A1 230x230	37.22	38.56	37.67	38.22	37.92
2	A2 230x230	35.78	38.56	37.89	37.78	37.50
3	A4 230x230	38.56	38.06	35.74	38.83	37.80
4	A6 230x230	38.22	37.89	38.56	38.44	38.28
5	A8 230x230	38.75	37.44	38.22	38.78	38.30
6	A9 230x230	39.42	38.11	38.06	38.50	38.52
7	B1 230x230	38.44	0.00	0.00	0.00	9.61
8	B2 230x230	38.66	37.00	37.61	37.89	37.79
9	B4 230x230	38.94	37.28	37.44	38.00	37.92
10	B6 230x230	38.33	37.56	38.33	38.33	38.14
11	B8 230x230	39.00	38.89	38.94	38.61	38.86
12	B9 230x230	39.25	38.56	39.03	38.63	38.87
13	C1 230x230	37.56	0.00	0.00	0.00	9.39
14	C2 230x230	38.15	37.74	38.37	38.48	38.19

15	C8 230x230	38.58	37.67	38.56	38.04	38.21
16	C9 230x230	38.42	37.44	38.11	38.67	38.16
17	D2 230x230	37.89	37.44	38.44	38.56	38.08
18	D3 230x230	38.33	37.33	37.78	37.89	37.83
19	D5 230x230.	38.11	0.00	0.00	0.00	9.53
20	D7 230x230	38.17	37.11	37.67	38.33	37.82
21	D8 230x230	38.08	37.33	38.00	38.11	37.88
22	E1 230x230	38.11	37.22	38.33	37.89	37.89
23	E2 230x230	38.00	37.33	38.22	38.56	38.03
24	E3 230x230	38.67	38.33	38.67	38.22	38.47
25	E5 230x230	38.44	37.33	37.00	37.33	37.53
26	E7 230x230	37.33	36.56	37.22	36.22	36.83
27	E8 230x230	37.17	37.50	37.56	37.72	37.49
28	E9 230x230	36.83	36.92	38.39	38.06	37.55
		38.16	**33.61**	**33.92**	**34.07**	**34.94**

House No. & Location: H.No.30-17-30, R.S.No.159/2, **Sitarampuram**,
Durga Agraharam, Vijayawada.

Residential Building. (**Sri Ranga Sai Towers**) Ground + 5 Upper Floors.

Latitude: 16° 31' 03" N

Longitude: 80° 38' 23" E

Year of construction: 1997

Floor Height: **Ground Floor (3.00 Mts.Ht.)**

Col. No. & size	R Value location from FFL	R Value of Column face												Avg values	Ave. R Value of Col.
		North			East			South			West				
		E	M	E	E	M	E	E	M	E	E	M	E		
A1 500x300	2.10 M	32	31	30	31	32	32	32	34	33	33	31	34	32.08	32.53
	1.35 M	31	33	33	30	35	31	33	31	32	39	31	38	33.08	
	0.60 M	32	32	31	32	33	32	32	32	34	33	34	32	32.42	
A2 500x300	2.10 M	31	32	32	Covered by wall			32	33	31	Covered by wall			31.83	32.06
	1.35 M	30	33	31				34	31	32				31.83	
	0.60 M	32	34	32				31	32	34				32.50	
A3 500x300	2.10 M	33	31	32	Covered by wall			30	32	29	Covered by wall			31.17	32.00
	1.35 M	34	31	35				30	33	31				32.33	
	0.60 M	33	33	32				32	34	31				32.50	
A4 500x300	2.10 M	31	32	31	Covered by wall			30	32	32	Covered by wall			31.33	32.11
	1.35 M	30	35	34				31	34	33				32.83	
	0.60 M	31	33	30				32	33	34				32.17	
A5 500x300	2.10 M	31	33	30	Covered by wall			32	31	30	Covered by wall			31.17	31.72
	1.35 M	29	34	30				32	33	32				31.67	
	0.60 M	30	34	32				31	34	33				32.33	
A6 500x300	2.10 M	30	31	29	Covered by wall			31	33	30	Covered by wall			30.67	31.56
	1.35 M	29	33	32				32	34	31				31.83	
	0.60 M	31	34	32				32	33	31				32.17	
B1 500x300	2.10 M	31	32	31	37	31	31	30	31	31	31	33	31	31.67	32.03
	1.35 M	33	34	32	32	33	29	33	32	30	30	34	32	32.00	
	0.60 M	31	33	30	33	34	31	32	34	32	33	34	32	32.42	
B2 500x300	2.10 M	31	33	30	Covered by wall			30	31	30	Covered by wall			30.83	31.67
	1.35 M	32	33	31				33	32	32				32.17	
	0.60 M	31	33	31				32	34	31				32.00	
B3 500x300	2.10 M	29	31	32	Covered by wall			29	30	29	Covered by wall			30.00	31.28
	1.35 M	32	33	32				31	32	31				31.83	
	0.60 M	32	34	31				30	33	32				32.00	
B4 500x300	2.10 M	30	32	30	Covered by wall			Covered by wall			Covered by wall			30.67	31.89
	1.35 M	30	33	31										31.33	
	0.60 M	34	34	33										33.67	
B5 500x300	2.10 M	Covered by wall			30	33	31	Covered by wall			31	32	31	31.33	32.00
	1.35 M				31	34	30				30	33	32	31.67	
	0.60 M				33	34	33				32	34	32	33.00	

B6 500x300	2.10 M	Covered by wall			Covered by wall			31	31	30	Covered by wall			30.67	31.33
	1.35 M							30	33	30				31.00	
	0.60 M							32	34	31				32.33	
C1 500x300	2.10 M	29	31	30	29	30	29	30	32	30	29	31	31	30.08	31.58
	1.35 M	30	32	29	31	32	31	31	34	31	34	34	33	31.83	
	0.60 M	33	33	32	30	33	32	33	34	33	34	35	32	32.83	
C2 500x300	2.10 M	31	31	30	Covered by wall			31	32	31	Covered by wall			31.00	32.06
	1.35 M	33	33	31				33	33	32				32.50	
	0.60 M	31	34	32				32	34	33				32.67	
C3 500x300	2.10 M	30	30	31	Covered by wall			31	32	31	Covered by wall			30.83	31.17
	1.35 M	30	31	31				No access						30.67	
	0.60 M	32	33	32										32.33	
C4 500x300	2.10 M	32	33	32	Covered by wall			Covered by wall			Covered by wall			32.33	32.33
	1.35 M	No access													
	0.60 M														
C5 500x300	2.10 M	Covered by wall			30	31	30	Covered by wall			31	32	30	30.67	31.78
	1.35 M				30	33	29				32	33	32	31.50	
	0.60 M				32	34	31				32	35	35	33.17	
C6 500x300	2.10 M	Covered by wall			Covered by wall			30	32	29	Covered by wall			30.33	31.56
	1.35 M							32	33	31				32.00	
	0.60 M							32	32	33				32.33	
D1 500x300	2.10 M	29	31	29	31	32	31	32	33	32	31	31	30	31.00	32.03
	1.35 M	34	33	33	30	33	30	30	33	31	30	32	32	31.75	
	0.60 M	34	35	32	34	33	34	33	34	31	33	33	34	33.33	
D2 500x300	2.10 M	30	29	31	31	33	31	Covered by wall			Covered by wall			30.83	32.33
	1.35 M	32	33	31	33	33	32							32.33	
	0.60 M	33	34	33	34	35	34							33.83	
D3 500x300	2.10 M	Covered by wall			31	33	31	30	33	32	Covered by wall			31.67	32.61
	1.35 M				32	34	34	30	34	33				32.83	
	0.60 M				32	34	33	33	34	34				33.33	
D4 500x300	2.10 M	30	32	30	Covered by wall			Covered by wall			Covered by wall			30.67	31.67
	1.35 M	32	33	30										31.67	
	0.60 M	32	34	32										32.67	
D5 500x300	2.10 M	Covered by wall			Covered by wall			Covered by wall			31	32	32	31.67	33.00
	1.35 M										34	34	33	33.67	
	0.60 M										33	35	33	33.67	
D6 500x300	2.10 M	Covered by wall			Covered by wall			30	30	31	Covered by wall			30.33	31.22
	1.35 M							30	31	30				30.33	
	0.60 M							33	34	32				33.00	
E1 500x300	2.10 M	29	30	29	29	31	30	32	33	33	31	32	32	30.92	32.06
	1.35 M	33	32	32	30	32	29	33	34	32	34	33	32	32.17	
	0.60 M	33	34	33	30	33	32	33	34	31	34	35	35	33.08	
E2 500x300	2.10 M	30	31	30	31	32	32	31	32	31	32	33	32	31.42	32.17
	1.35 M	30	32	31	34	34	33	32	33	32	31	33	32	32.25	
	0.60 M	31	33	32	35	35	35	33	34	32	32	30	32	32.83	

E3 500x300	2.10 M	29	31	30	Covered by wall			31	32	32	32	32	31	31.11	31.85
	1.35 M	30	32	30				32	32	32	32	33	32	31.67	
	0.60 M	30	32	32				33	34	33	33	34	34	32.78	
E4 500x300	2.10 M	32	30	30	Covered by wall			30	32	31	31	34	31	31.25	32.38
	1.35 M	30	31	30				32	33	31	34	35	32	32.00	
	0.60 M	33	34	33				33	34	34	34	35	35	33.89	
E5 500x300	2.10 M	32	33	34	30	33	32	31	35	31	32	33	34	32.50	32.97
	1.35 M	35	33	35	32	34	34	32	34	33	31	32	32	33.08	
	0.60 M	31	35	32	31	34	33	33	35	32	35	34	35	33.33	
E6 500x300	2.10 M	31	32	31	34	35	34	34	32	34	34	31	32	32.83	33.06
	1.35 M	33	35	33	32	34	35	32	33	31	32	35	33	33.17	
	0.60 M	32	34	32	33	33	34	31	32	32	34	36	35	33.17	
F1 500x300	2.10 M	29	30	32	31	34	32	31	32	31	31	34	32	31.58	32.47
	1.35 M	31	34	30	33	34	31	31	34	33	33	34	31	32.42	
	0.60 M	33	32	33	32	32	33	34	33	34	34	36	35	33.42	
F2 500x300	2.10 M	33	34	34	34	35	34	32	33	34	31	34	32	33.33	33.25
	1.35 M	32	35	33	33	34	35	33	34	32	33	34	32	33.33	
	0.60 M	32	34	33	31	35	34	32	32	33	32	35	34	33.08	
F3 500x300	2.10 M	32	32	32	32	34	32	32	32	33	32	34	32	32.42	32.92
	1.35 M	32	34	33	34	35	34	33	34	31	32	35	33	33.33	
	0.60 M	33	33	32	32	34	33	32	32	34	34	33	34	33.00	
F4 500x300	2.10 M	29	33	30	Covered by wall			31	31	33	Covered by wall			31.17	32.39
	1.35 M	33	34	32				32	34	32				32.83	
	0.60 M	34	33	34				33	32	33				33.17	
F5 500x300	2.10 M	32	31	32	33	31	30	31	30	30	32	33	32	31.42	32.17
	1.35 M	30	32	30	33	34	33	32	34	33	33	34	31	32.42	
	0.60 M	32	33	31	34	32	34	33	32	32	32	34	33	32.67	
F6 500x300	2.10 M	30	34	30	Covered by wall			30	34	33	Covered by wall			31.83	32.47
	1.35 M	33	35	33				32	34	31				33.00	
	0.60 M	Cladding						33	32	33				32.67	
G1 500x300	2.10 M	32	33	31	31	33	32	32	32	31	31	29	30	31.42	32.08
	1.35 M	33	34	32	32	34	32	32	33	32	31	33	32	32.50	
	0.60 M	32	34	31	31	33	31	31	34	32	32	34	33	32.33	
G2 500x300	2.10 M	31	30	31	30	33	30	33	32	32	31	32	31	31.33	32.06
	1.35 M	32	34	32	32	33	32	31	33	32	30	34	31	32.17	
	0.60 M	32	32	34	30	32	31	33	34	33	34	33	34	32.67	
G4 500x300	2.10 M	30	30	31	Covered by wall			33	30	32	Covered by wall			31.00	32.11
	1.35 M	31	32	32				32	34	30				31.83	
	0.60 M	32	34	33				33	35	34				33.50	
G5 500x300	2.10 M	31	31	32	32	33	32	32	31	32	30	32	31	31.58	32.22
	1.35 M	32	33	34	33	34	31	30	34	33	31	33	32	32.50	
	0.60 M	32	34	33	32	34	32	31	33	32	32	34	32	32.58	
H3 500x300	2.10 M	31	32	31	31	32	32	32	33	31	32	32	31	31.67	32.19
	1.35 M	32	32	33	32	33	31	32	33	32	33	34	32	32.42	
	0.60 M	34	33	32	33	34	32	31	32	32	32	32	33	32.50	

H6 500x300	2.10 M	31	33	31	Covered by wall			31	33	32	Covered by wall			31.83	32.40
	1.35 M	32	32	33				33	34	32				32.67	
	0.60 M	Cladding						32	34	33				33.00	
I1 500x300	2.10 M	32	32	31	31	34	30	31	32	31	32	32	33	31.75	32.50
	1.35 M	32	33	32	32	35	32	32	34	32	33	34	32	32.75	
	0.60 M	34	33	34	31	34	32	33	31	33	34	33	34	33.00	
I2 500x300	2.10 M	32	31	32	31	32	32	30	31	31	30	32	33	31.42	32.11
	1.35 M	32	33	31	32	34	33	33	34	33	31	33	32	32.58	
	0.60 M	31	33	32	33	33	32	32	34	32	32	31	33	32.33	
I3 500x300	2.10 M	34	31	32	31	32	31	31	32	32	31	32	31	31.67	32.25
	1.35 M	33	35	34	31	35	32	32	35	32	30	35	33	33.08	
	0.60 M	33	33	32	32	33	32	31	33	31	31	31	32	32.00	
J4 500x300	2.10 M	32	31	32	30	32	30	Covered by wall			Covered by wall			31.17	32.33
	1.35 M	32	35	34	31	35	31							33.00	
	0.60 M	31	34	32	33	34	33							32.83	
J5 500x300	2.10 M	Covered by wall			31	32	31	Covered by wall			31	32	32	31.50	32.39
	1.35 M				33	35	33				32	34	33	33.33	
	0.60 M				32	34	32				32	32	32	32.33	
J6 500x300	2.10 M	Covered by wall			32	32	31	31	31	32	Covered by wall			31.50	32.56
	1.35 M				33	34	33	32	33	34				33.17	
	0.60 M				32	34	32	33	34	33				33.00	
															32.14
					142 Readings										

1st Floor (3.00 Mts.Ht.)

Col. No. & size	**R Value location from FFL**	**R Value of Column face**												**Avg values**	**Ave. R Value of Col.**
		North			**East**			**South**			**West**				
		E	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**		
A1 500x300	2.10 M	No access			Covered by wall			29	31	29	Covered by wall			29.67	31.11
	1.35 M							31	32	30				31.00	
	0.60 M							32	33	33				32.67	
A2 500x300	2.10 M	30	31	31	31	30	31	31	30	31	Covered by wall			30.67	32.00
	1.35 M	32	33	29	33	32	32	33	32	33				32.11	
	0.60 M	33	34	32	34	34	34	32	34	32				33.22	
A3 500x300	2.10 M	29	31	29	Covered by wall			No access			Covered by wall			29.67	31.67
	1.35 M	33	33	31										32.33	
	0.60 M	32	34	33										33.00	
A4 500x300	2.10 M	No access			Covered by wall			30	31	29	Covered by wall			30.00	31.89
	1.35 M							33	33	32				32.67	
	0.60 M							34	34	31				33.00	
A5 500x300	2.10 M	29	32	31	30	30	31	29	31	29	Covered by wall			30.22	31.52
	1.35 M	32	33	32	32	33	34	29	31	30				31.78	
	0.60 M	32	34	31	33	35	34	31	32	31				32.56	

A6 500x300	2.10 M	Covered by wall			Covered by wall			30	32	30	No access			30.67	32.11
	1.35 M							33	32	31				32.00	
	0.60 M							33	34	34				33.67	
B1 500x300	2.10 M	No access			Covered by wall			30	32	31	Covered by wall			31.00	31.44
	1.35 M							31	32	30				31.00	
	0.60 M							31	34	32				32.33	
B2 500x300	2.10 M	30	31	30	29	31	30	30	32	30	31	32	33	30.75	32.17
	1.35 M	32	32	34	31	33	31	33	34	31	32	34	32	32.42	
	0.60 M	33	34	33	34	33	32	33	34	33	33	35	33	33.33	
B3 500x300	2.10 M	29	31	29	Covered by wall			No access			Covered by wall			29.67	31.22
	1.35 M	30	33	32										31.67	
	0.60 M	31	34	32										32.33	
B4 500x300	2.10 M	No access			Covered by wall			30	31	31	Covered by wall			30.67	31.89
	1.35 M							32	31	32				31.67	
	0.60 M							32	33	35				33.33	
B5 500x300	2.10 M	32	31	32	30	31	31	31	32	30	30	31	29	30.83	31.94
	1.35 M	31	33	32	32	33	33	32	33	30	29	32	31	31.75	
	0.60 M	34	34	35	35	33	34	33	35	33	30	31	32	33.25	
B6 500x300	2.10 M	30	31	29	Covered by wall			No access			Covered by wall			30.00	31.78
	1.35 M	32	33	29										31.33	
	0.60 M	34	33	35										34.00	
C1 500x300	2.10 M	No access			Covered by wall			30	31	29	Covered by wall			30.00	31.22
	1.35 M							31	32	30				31.00	
	0.60 M							32	33	33				32.67	
C2 500x300	2.10 M	29	30	29	30	31	29	29	31	30	30	32	30	30.00	31.61
	1.35 M	32	33	31	33	34	33	30	33	32	30	33	29	31.92	
	0.60 M	33	35	32	34	33	33	32	34	32	31	34	32	32.92	
C3 500x300	2.10 M	30	29	31	Covered by wall			30	31	29	Covered by wall			30.00	31.39
	1.35 M	31	33	31				31	33	32				31.83	
	0.60 M	32	34	32				33	31	32				32.33	
C4 500x300	2.10 M	30	31	30	Covered by wall			29	32	30	Covered by wall			30.33	32.11
	1.35 M	32	34	33				32	33	32				32.67	
	0.60 M	33	35	33				32	34	33				33.33	
C5 500x300	2.10 M	30	31	31	30	32	31	29	32	32	30	31	33	31.00	32.39
	1.35 M	29	34	32	32	35	33	33	34	33	33	32	32	32.67	
	0.60 M	32	34	33	31	35	33	34	35	34	33	34	34	33.50	
C6 500x300	2.10 M	31	32	32	Covered by wall			No access			Covered by wall			31.67	31.67
	1.35 M	Cladding													
	0.60 M														
D1 500x300	2.10 M	No access			29	31	29	30	33	29	Covered by wall			30.17	31.78
	1.35 M				31	32	32	32	34	32				32.17	
	0.60 M				32	33	34	32	33	34				33.00	
D2 500x300	2.10 M	Covered by wall			28	30	31	Covered by wall			31	31	29	30.00	31.17
	1.35 M				31	33	32				30	32	30	31.33	
	0.60 M				32	34	32				31	33	31	32.17	

D3 500x300	2.10 M	Covered by wall			30	32	30	29	31	29	Covered by wall			30.17	31.61
	1.35 M				31	34	32	30	33	31				31.83	
	0.60 M				32	35	33	32	33	32				32.83	
D4 500x300	2.10 M	29	32	30	30	31	29	30	33	30	Covered by wall			30.44	31.41
	1.35 M	31	33	31	31	32	30	32	34	29				31.44	
	0.60 M	33	35	30	32	33	33	33	32	30				32.33	
D5 500x300	2.10 M	30	30	31	No access			31	32	29	30	31	31	30.56	32.15
	1.35 M	31	33	31				33	34	33	34	33	32	32.67	
	0.60 M	32	34	32				32	35	33	34	35	32	33.22	
D6 500x300	2.10 M	31	34	30	No access			No access			Covered by wall			31.67	31.67
	1.35 M	Cladding													
	0.60 M														
E1 500x300	2.10 M	No access			Covered by wall			30	31	31	30	32	29	30.50	31.28
	1.35 M							32	33	30	31	32	31	31.50	
	0.60 M							31	34	31	30	34	31	31.83	
E2 500x300	2.10 M	30	30	29	29	31	30	31	32	31	31	32	30	30.50	31.69
	1.35 M	31	33	29	32	34	32	33	33	32	32	33	32	32.17	
	0.60 M	31	32	30	33	33	34	34	32	34	31	34	31	32.42	
E3 500x300	2.10 M	29	30	28	Covered by wall			30	32	30	29	30	29	29.67	31.41
	1.35 M	31	32	30				33	34	32	32	33	32	32.11	
	0.60 M	32	33	32				31	33	32	32	34	33	32.44	
E4 500x300	2.10 M	30	32	29	Covered by wall			29	31	30	28	29	28	29.56	31.85
	1.35 M	32	33	33				32	34	31	32	35	32	32.67	
	0.60 M	31	35	32				33	35	34	33	34	33	33.33	
E5 500x300	2.10 M	29	31	29	30	31	29	30	31	31	No access			30.11	31.04
	1.35 M	30	31	30	31	33	29	30	33	30				30.78	
	0.60 M	32	33	32	32	34	30	31	34	32				32.22	
E6 500x300	2.10 M	30	31	29	Covered by wall			No access			No access			30.00	31.11
	1.35 M	29	33	31										31.00	
	0.60 M	31	34	32										32.33	
F1 500x300	2.10 M	No access			Covered by wall			28	30	28	Covered by wall			28.67	30.89
	1.35 M							30	33	31				31.33	
	0.60 M							32	34	32				32.67	
F2 500x300	2.10 M	29	30	30	29	31	30	30	31	31	31	32	30	30.33	31.78
	1.35 M	32	33	32	29	34	32	33	34	32	32	35	32	32.50	
	0.60 M	33	32	33	30	32	31	31	35	32	33	35	33	32.50	
F3 500x300	2.10 M	31	30	30	Covered by wall			No access			Covered by wall			30.33	31.56
	1.35 M	32	32	31										31.67	
	0.60 M	33	34	31										32.67	
F4 500x300	2.10 M	No access			Covered by wall			30	30	31	Covered by wall			30.33	31.33
	1.35 M							31	33	30				31.33	
	0.60 M							32	34	31				32.33	
F5 500x300	2.10 M	30	29	30	30	32	31	30	32	29	29	32	30	30.33	31.39
	1.35 M	28	30	29	32	32	31	31	32	33	31	34	32	31.25	
	0.60 M	31	30	30	33	34	33	34	33	34	32	34	33	32.58	

F6 500x300	2.10 M	28	30	29	Covered by wall			No access			Covered by wall			29.00	31.22
	1.35 M	31	33	31										31.67	
	0.60 M	33	34	32										33.00	
G1 500x300	2.10 M	No access			Covered by wall			30	32	30	Covered by wall			30.67	31.89
	1.35 M							32	33	30				31.67	
	0.60 M							33	34	33				33.33	
G2 500x300	2.10 M	29	31	29	28	30	30	30	31	29	32	32	30	30.08	31.44
	1.35 M	32	33	30	30	32	31	32	33	30	32	34	31	31.67	
	0.60 M	33	34	32	32	33	32	33	33	34	31	33	31	32.58	
G4 500x300	2.10 M	No access			Covered by wall			29	32	29	Covered by wall			30.00	31.89
	1.35 M							33	34	32				33.00	
	0.60 M							32	34	32				32.67	
G5 500x300	2.10 M	29	30	29	30	32	32	30	31	29	30	30	29	30.08	31.42
	1.35 M	32	32	32	31	33	31	30	33	30	31	33	29	31.42	
	0.60 M	31	35	33	33	34	32	31	34	31	33	34	32	32.75	
H3 500x300	2.10 M	31	33	29	Covered by wall			No access			Covered by wall			31.00	31.00
	1.35 M	Cladding													
	0.60 M														
H6 500x300	2.10 M	31	34	30	Covered by wall			No access			Covered by wall			31.67	31.67
	1.35 M	Cladding													
	0.60 M														
I1 500x300	2.10 M	No access			30	32	29	29	31	30	Covered by wall			30.17	31.27
	1.35 M				31	33	32	31	32	32				31.83	
	0.60 M				32	33	31	32	33	30				31.83	
I2 500x300	2.10 M	30	32	31	29	31	30	30	31	29	30	32	30	30.42	31.03
	1.35 M	31	32	30	29	32	29	30	32	31	30	33	31	30.83	
	0.60 M	33	33	30	32	34	30	31	32	31	32	34	30	31.83	
I3 500x300	2.10 M	31	31	30	29	31	30	No access			Covered by wall			30.33	31.17
	1.35 M	31	32	31	31	33	31							31.50	
	0.60 M	32	34	30	32	32	30							31.67	
J4 500x300	2.10 M	No access			30	31	31	29	31	31	Covered by wall			30.50	31.06
	1.35 M				31	33	31	30	32	31				31.33	
	0.60 M				30	32	31	31	32	32				31.33	
J5 500x300	2.10 M	31	32	31	30	31	29	29	31	29	30	32	31	30.50	31.36
	1.35 M	30	34	30	31	32	31	30	34	30	30	32	31	31.25	
	0.60 M	32	33	32	31	34	31	32	33	32	32	34	32	32.33	
J6 500x300	2.10 M	31	33	32	29	31	30	No access			Covered by wall			31.00	31.08
	1.35 M	Cladding			30	32	31							31.00	
	0.60 M				31	33	30							31.33	
															31.54
					136 Readings										

2nd Floor (3.00 Mts.Ht.)

Col. No. & size	R Value location from FFL	R Value of Column face												Avg values	Ave. R Value of Col.
		North			East			South			West				
		E	M	E	E	M	E	E	M	E	E	M	E		
A1 500x300	2.10 M	No access			Covered by wall			29	30	29	Covered by wall			29.33	31.00
	1.35 M							31	32	31				31.33	
	0.60 M							32	33	32				32.33	
A2 500x300	2.10 M	30	30	31	30	30	29	29	30	30	Covered by wall			29.89	31.41
	1.35 M	29	32	29	32	33	32	32	33	32				31.56	
	0.60 M	32	34	31	33	34	33	33	34	31				32.78	
A3 500x300	2.10 M	30	31	29	Covered by wall			No access			Covered by wall			30.00	31.56
	1.35 M	32	32	31										31.67	
	0.60 M	32	34	33										33.00	
A4 500x300	2.10 M	No access			Covered by wall			29	31	29	Covered by wall			29.67	31.44
	1.35 M							32	33	31				32.00	
	0.60 M							32	35	31				32.67	
A5 500x300	2.10 M	29	32	29	30	30	31	30	31	29	Covered by wall			30.11	31.41
	1.35 M	31	33	32	32	33	33	29	33	30				31.78	
	0.60 M	32	35	31	32	34	32	30	34	31				32.33	
A6 500x300	2.10 M	Covered by wall			Covered by wall			29	31	30	No access			30.00	31.78
	1.35 M							31	35	31				32.33	
	0.60 M							33	34	32				33.00	
B1 500x300	2.10 M	No access			Covered by wall			30	32	30	Covered by wall			30.67	31.33
	1.35 M							31	32	29				30.67	
	0.60 M							32	34	32				32.67	
B2 500x300	2.10 M	30	31	29	29	31	30	30	32	29	29	32	30	30.17	31.19
	1.35 M	31	31	32	31	32	31	33	33	31	32	34	32	31.92	
	0.60 M	30	34	31	30	32	32	31	34	30	31	32	31	31.50	
B3 500x300	2.10 M	29	31	30	Covered by wall			No access			Covered by wall			30.00	31.56
	1.35 M	31	33	32										32.00	
	0.60 M	31	35	32										32.67	
B4 500x300	2.10 M	No access			Covered by wall			30	30	29	Covered by wall			29.67	31.89
	1.35 M							32	33	32				32.33	
	0.60 M							34	33	34				33.67	
B5 500x300	2.10 M	31	31	30	30	31	30	29	32	30	29	31	29	30.25	31.72
	1.35 M	31	33	32	32	33	32	31	33	31	29	33	31	31.75	
	0.60 M	34	35	33	35	34	34	33	34	33	30	34	29	33.17	
B6 500x300	2.10 M	30	31	30	Covered by wall			No access			Covered by wall			30.33	31.44
	1.35 M	32	33	30										31.67	
	0.60 M	31	33	33										32.33	
C1 500x300	2.10 M	No access			Covered by wall			29	31	29	Covered by wall			29.67	31.33
	1.35 M							32	32	30				31.33	
	0.60 M							32	34	33				33.00	
C2	2.10 M	29	31	30	30	31	29	29	31	30	29	30	29	29.83	31.44

500x300	1.35 M	32	33	31	33	35	33	30	33	32	30	32	30	32.00	
	0.60 M	34	34	32	34	32	33	31	32	32	31	33	32	32.50	
C3 500x300	2.10 M	30	29	29	Covered by wall			29	31	29	Covered by wall			29.50	31.11
	1.35 M	31	33	30				31	33	32				31.67	
	0.60 M	31	32	32				33	34	31				32.17	
C4 500x300	2.10 M	30	31	31	Covered by wall			31	32	30	Covered by wall			30.83	32.06
	1.35 M	32	35	33				31	33	31				32.50	
	0.60 M	32	34	32				32	34	33				32.83	
C5 500x300	2.10 M	30	32	29	29	32	30	29	32	31	29	31	30	30.33	32.03
	1.35 M	31	34	31	32	34	33	32	33	32	33	33	32	32.50	
	0.60 M	32	34	32	31	33	33	34	36	34	32	34	34	33.25	
C6 500x300	2.10 M	30	32	31	Covered by wall			No access			Covered by wall			31.00	31.00
	1.35 M	Cladding													
	0.60 M														
D1 500x300	2.10 M	No access			29	30	29	30	33	30	Covered by wall			30.17	31.61
	1.35 M				31	32	31	32	33	32				31.83	
	0.60 M				32	34	33	32	32	34				32.83	
D2 500x300	2.10 M	Covered by wall			28	30	29	Covered by wall			30	31	29	29.50	30.89
	1.35 M				30	31	32				30	33	31	31.17	
	0.60 M				31	34	31				31	33	32	32.00	
D3 500x300	2.10 M	Covered by wall			29	31	30	30	31	29	Covered by wall			30.00	31.28
	1.35 M				31	33	32	30	32	31				31.50	
	0.60 M				31	35	31	31	34	32				32.33	
D4 500x300	2.10 M	29	32	31	30	30	29	30	32	30	Covered by wall			30.33	31.11
	1.35 M	31	32	30	31	32	30	32	33	31				31.33	
	0.60 M	32	35	30	31	33	31	31	32	30				31.67	
D5 500x300	2.10 M	30	30	29	No access			30	31	29	30	30	31	30.00	31.59
	1.35 M	30	33	31				33	34	33	32	33	31	32.22	
	0.60 M	32	34	31				31	33	32	34	34	32	32.56	
D6 500x300	2.10 M	31	32	30	No access			No access			Covered by wall			31.00	31.00
	1.35 M	Cladding													
	0.60 M														
E1 500x300	2.10 M	No access			Covered by wall			29	31	30	30	31	29	30.00	31.00
	1.35 M							32	32	30	30	32	31	31.17	
	0.60 M							32	34	31	30	33	31	31.83	
E2 500x300	2.10 M	29	30	29	30	31	30	30	32	30	29	31	29	30.00	31.17
	1.35 M	31	32	29	32	33	32	31	32	32	32	32	30	31.50	
	0.60 M	30	31	30	33	33	32	33	34	33	31	33	31	32.00	
E3 500x300	2.10 M	29	30	29	Covered by wall			30	31	29	29	30	30	29.67	31.11
	1.35 M	32	31	30				33	32	32	32	34	32	32.00	
	0.60 M	32	32	31				30	33	32	31	33	31	31.67	
E4 500x300	2.10 M	30	32	30	Covered by wall			29	31	29	29	30	28	29.78	31.48
	1.35 M	32	33	32				31	33	31	32	34	32	32.22	
	0.60 M	31	34	32				33	34	32	32	33	31	32.44	
E5	2.10 M	30	31	29	30	30	28	29	31	30	No access			29.78	31.00

500x300	1.35 M	30	33	31	31	34	29	30	33	30				31.22	
	0.60 M	32	32	32	32	32	30	31	35	32				32.00	
E6 500x300	2.10 M	30	30	29	Covered by wall			No access			No access			29.67	30.89
	1.35 M	29	33	30										30.67	
	0.60 M	31	35	31										32.33	
F1 500x300	2.10 M	No access			Covered by wall			29	31	28	Covered by wall			29.33	31.67
	1.35 M							30	35	31				32.00	
	0.60 M							32	35	34				33.67	
F2 500x300	2.10 M	29	31	30	30	31	30	30	31	30	31	31	30	30.33	31.61
	1.35 M	30	33	32	29	34	31	32	33	32	31	35	32	32.00	
	0.60 M	32	34	32	30	33	31	31	35	32	33	34	33	32.50	
F3 500x300	2.10 M	29	30	30	Covered by wall			No access			Covered by wall			29.67	31.11
	1.35 M	32	33	31										32.00	
	0.60 M	31	34	30										31.67	
F4 500x300	2.10 M	No access			Covered by wall			30	30	29	Covered by wall			29.67	30.44
	1.35 M							29	33	30				30.67	
	0.60 M							31	32	30				31.00	
F5 500x300	2.10 M	29	30	30	30	31	30	29	30	28	29	31	30	29.75	31.28
	1.35 M	29	32	29	32	33	31	31	34	33	31	35	32	31.83	
	0.60 M	31	31	30	31	34	31	34	33	34	32	34	32	32.25	
F6 500x300	2.10 M	28	29	29	Covered by wall			No access			Covered by wall			28.67	30.89
	1.35 M	30	33	31										31.33	
	0.60 M	31	35	32										32.67	
G1 500x300	2.10 M	No access			Covered by wall			29	32	30	Covered by wall			30.33	31.33
	1.35 M							32	33	29				31.33	
	0.60 M							32	33	32				32.33	
G2 500x300	2.10 M	30	30	29	29	30	30	29	31	29	30	31	29	29.75	31.39
	1.35 M	32	32	31	30	33	30	32	31	32	32	34	32	31.75	
	0.60 M	32	35	32	31	34	32	32	34	32	33	32	33	32.67	
G4 500x300	2.10 M	No access			Covered by wall			29	31	29	Covered by wall			29.67	31.67
	1.35 M							31	34	32				32.33	
	0.60 M							32	35	32				33.00	
G5 500x300	2.10 M	30	30	29	30	32	29	30	31	30	30	31	29	30.08	31.11
	1.35 M	31	33	32	31	32	30	30	33	32	30	32	31	31.42	
	0.60 M	32	34	31	30	33	30	31	32	32	33	33	31	31.83	
H3 500x300	2.10 M	31	33	31	Covered by wall			No access			Covered by wall			31.67	31.67
	1.35 M	Cladding													
	0.60 M														
H6 500x300	2.10 M	30	34	31	Covered by wall			No access			Covered by wall			31.67	31.67
	1.35 M	Cladding													
	0.60 M														
I1 500x300	2.10 M	No access			30	32	29	30	31	29	Covered by wall			30.17	31.11
	1.35 M				31	34	32	30	32	31				31.67	
	0.60 M				31	33	31	31	33	30				31.50	
I2	2.10 M	30	31	30	30	31	29	30	31	30	30	31	29	30.17	31.31

500x300	1.35 M	30	32	30	29	33	30	31	34	30	33	32	32	31.33	
	0.60 M	31	34	32	31	34	31	32	35	32	31	35	31	32.42	
I3 500x300	2.10 M	31	30	29	30	31	29	No access			Covered by wall			30.00	31.11
	1.35 M	31	33	31	31	33	30							31.50	
	0.60 M	32	33	31	31	34	30							31.83	
J4 500x300	2.10 M	No access			30	30	30	29	31	30	Covered by wall			30.00	31.39
	1.35 M				32	32	33	30	33	31				31.83	
	0.60 M				30	35	31	31	35	32				32.33	
J5 500x300	2.10 M	29	32	30	30	30	29	30	30	29	29	32	30	30.00	31.33
	1.35 M	31	33	30	31	33	32	29	33	29	30	34	32	31.42	
	0.60 M	33	34	31	32	34	32	32	35	32	31	34	31	32.58	
J6 500x300	2.10 M	31	33	31	31	32	30	No access			Covered by wall			31.33	31.42
	1.35 M	Cladding			30	33	31							31.33	
	0.60 M				31	34	30							31.67	
															31.34
						136 Readings									

3rd Floor (3.00 Mts.Ht.)															
Col. No. & size	**R Value location from FFL**	**R Value of Column face**													**Ave. R Value of Col.**
		North			**East**			**South**			**West**				
		E	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**		
A1 500x300	2.10 M	No access			Covered by wall			30	30	29	Covered by wall				31.44
	1.35 M							33	33	32					
	0.60 M							32	32	32					
A2 500x300	2.10 M	29	30	30	30	31	29	30	30	29	Covered by wall				31.70
	1.35 M	29	33	29	32	32	33	32	34	33					
	0.60 M	33	34	32	34	34	33	33	34	34					
A3 500x300	2.10 M	29	31	30	Covered by wall			No access			Covered by wall				31.78
	1.35 M	32	33	32											
	0.60 M	32	34	33											
A4 500x300	2.10 M	No access			Covered by wall			29	30	29	Covered by wall				31.22
	1.35 M							31	34	30					
	0.60 M							33	34	31					
A5 500x300	2.10 M	30	30	29	30	31	30	30	31	31	Covered by wall				31.30
	1.35 M	31	33	31	31	34	33	29	32	31					
	0.60 M	32	34	31	32	30	32	32	33	32					
A6 500x300	2.10 M	Covered by wall			Covered by wall			29	32	31	No access				31.56
	1.35 M							31	33	30					
	0.60 M							32	34	32					
B1 500x300	2.10 M	No access			Covered by wall			29	32	29	Covered by wall				31.22
	1.35 M							31	33	30					
	0.60 M							31	34	32					
B2	2.10 M	30	31	30	30	31	31	29	31	29	30	32	30		31.56

500x300	1.35 M	32	33	32	31	33	32	32	35	31	32	33	31	
	0.60 M	35	34	34	31	32	31	31	33	30	30	33	31	
B3 500x300	2.10 M	29	31	29	Covered by wall			No access			Covered by wall			31.89
	1.35 M	32	34	32										
	0.60 M	33	35	32										
B4 500x300	2.10 M	No access			Covered by wall			29	31	29	Covered by wall			31.78
	1.35 M							32	35	32				
	0.60 M							32	33	33				
B5 500x300	2.10 M	29	31	30	30	31	29	29	30	30	29	30	29	31.50
	1.35 M	31	33	31	32	33	32	31	32	32	29	33	31	
	0.60 M	32	35	33	33	35	34	33	34	33	31	35	29	
B6 500x300	2.10 M	31	32	30	Covered by wall			No access			Covered by wall			31.78
	1.35 M	31	33	31										
	0.60 M	32	34	32										
C1 500x300	2.10 M	No access			Covered by wall			30	29	29	Covered by wall			30.78
	1.35 M							31	33	30				
	0.60 M							31	32	32				
C2 500x300	2.10 M	29	31	30	29	31	29	31	31	30	29	31	29	31.33
	1.35 M	33	31	32	33	34	30	30	34	31	30	35	30	
	0.60 M	32	34	32	30	33	29	31	35	32	31	34	32	
C3 500x300	2.10 M	29	29	30	Covered by wall			30	30	29	Covered by wall			31.06
	1.35 M	30	33	31				31	32	32				
	0.60 M	31	34	32				32	33	31				
C4 500x300	2.10 M	29	31	30	Covered by wall			30	32	29	Covered by wall			31.50
	1.35 M	31	35	32				30	34	31				
	0.60 M	30	35	31				31	34	32				
C5 500x300	2.10 M	30	32	31	29	29	30	29	30	31	29	30	30	31.42
	1.35 M	32	34	31	32	33	33	31	32	32	32	31	32	
	0.60 M	29	32	30	30	32	32	33	34	33	32	35	34	
C6 500x300	2.10 M	31	33	31	Covered by wall			No access			Covered by wall			31.67
	1.35 M	Cladding												
	0.60 M													
D1 500x300	2.10 M	No access			30	31	29	29	32	29	Covered by wall			31.11
	1.35 M				30	31	31	32	32	32				
	0.60 M				31	33	32	32	33	31				
D2 500x300	2.10 M	Covered by wall			29	30	29	Covered by wall			30	29	29	31.22
	1.35 M				30	33	32				30	34	32	
	0.60 M				32	35	31				31	33	33	
D3 500x300	2.10 M	Covered by wall			29	30	30	30	31	30	Covered by wall			31.39
	1.35 M				31	33	32	30	34	31				
	0.60 M				32	34	31	31	34	32				
D4 500x300	2.10 M	30	31	30	29	31	30	30	29	30	Covered by wall			31.48
	1.35 M	32	33	32	31	33	32	31	34	32				
	0.60 M	33	33	32	31	35	31	31	32	32				
D5	2.10 M	29	30	29	No access			29	31	30	29	30	29	31.48

500x300	1.35 M	32	34	32				33	33	32	31	32	31	
	0.60 M	30	35	31				31	33	34	34	34	32	
D6 500x300	2.10 M	30	33	31	No access			No access			Covered by wall			31.33
	1.35 M	Cladding												
	0.60 M													
E1 500x300	2.10 M	No access			Covered by wall			29	31	29	30	30	29	30.94
	1.35 M							31	32	30	32	32	31	
	0.60 M							32	33	31	30	34	31	
E2 500x300	2.10 M	31	30	29	29	31	30	30	32	30	30	29	29	31.33
	1.35 M	31	34	29	32	33	31	31	34	32	32	34	30	
	0.60 M	32	33	30	33	34	32	32	34	31	31	33	30	
E3 500x300	2.10 M	29	30	29	Covered by wall			30	30	29	29	31	30	30.96
	1.35 M	32	30	29				33	31	32	32	33	32	
	0.60 M	31	32	31				31	33	31	32	33	31	
E4 500x300	2.10 M	29	31	30	Covered by wall			29	32	30	29	30	29	31.15
	1.35 M	30	33	31				31	34	31	32	33	32	
	0.60 M	32	34	32				30	32	32	30	32	31	
E5 500x300	2.10 M	29	31	29	29	30	28	30	31	29	No access			30.96
	1.35 M	30	34	31	31	33	30	30	32	30				
	0.60 M	32	32	33	33	32	30	31	35	31				
E6 500x300	2.10 M	30	30	29	Covered by wall			No access			No access			31.33
	1.35 M	33	33	31										
	0.60 M	31	35	30										
F1 500x300	2.10 M	No access			Covered by wall			29	30	29	Covered by wall			30.78
	1.35 M							30	32	31				
	0.60 M							32	33	31				
F2 500x300	2.10 M	31	31	30	29	32	29	29	31	31	31	30	30	31.25
	1.35 M	29	33	31	29	34	31	32	32	32	30	32	32	
	0.60 M	31	34	31	31	32	31	31	34	33	31	34	31	
F3 500x300	2.10 M	30	29	30	Covered by wall			No access			Covered by wall			31.33
	1.35 M	32	35	31										
	0.60 M	31	32	32										
F4 500x300	2.10 M	No access			Covered by wall			29	31	30	Covered by wall			31.56
	1.35 M							31	33	32				
	0.60 M							32	34	32				
F5 500x300	2.10 M	29	30	30	29	31	29	29	30	28	30	31	30	30.97
	1.35 M	29	32	29	32	32	30	31	34	32	31	35	31	
	0.60 M	31	32	31	31	33	31	30	32	30	33	34	33	
F6 500x300	2.10 M	28	30	29	Covered by wall			No access			Covered by wall			30.67
	1.35 M	30	34	32										
	0.60 M	29	33	31										
G1 500x300	2.10 M	No access			Covered by wall			29	30	29	Covered by wall			30.11
	1.35 M							30	31	29				
	0.60 M							31	32	30				
G2	2.10 M	28	29	29	29	30	29	29	31	30	30	30	29	31.03

500x300	1.35 M	30	32	30	31	33	30	32	33	31	32	35	31	
	0.60 M	31	34	32	30	33	30	31	35	32	31	32	33	
G4 500x300	2.10 M	No access			Covered by wall			29	30	29	Covered by wall			30.78
	1.35 M							31	33	30				
	0.60 M							32	32	31				
G5 500x300	2.10 M	28	30	30	29	31	29	30	29	30	29	31	29	31.17
	1.35 M	31	35	32	32	34	31	30	34	32	30	33	30	
	0.60 M	31	34	31	31	33	30	33	32	33	32	32	31	
H3 500x300	2.10 M	33	32	31	Covered by wall			No access			Covered by wall			32.00
	1.35 M	Cladding												
	0.60 M													
H6 500x300	2.10 M	31	32	31	Covered by wall			No access			Covered by wall			31.33
	1.35 M	Cladding												
	0.60 M													
I1 500x300	2.10 M	No access			29	30	29	30	31	29	Covered by wall			30.67
	1.35 M				31	32	30	30	32	31				
	0.60 M				31	32	31	30	34	30				
I2 500x300	2.10 M	29	31	29	30	30	29	29	31	28	30	30	29	30.75
	1.35 M	29	33	30	29	32	30	30	32	30	29	32	32	
	0.60 M	32	34	31	30	34	31	31	33	32	31	34	31	
I3 500x300	2.10 M	29	30	30	29	31	29	No access			Covered by wall			30.94
	1.35 M	31	32	29	31	33	30							
	0.60 M	32	33	31	31	34	32							
J4 500x300	2.10 M	No access			28	30	30	28	31	29	Covered by wall			31.06
	1.35 M				31	34	31	30	32	31				
	0.60 M				30	35	31	31	35	32				
J5 500x300	2.10 M	29	31	28	30	31	29	30	31	29	29	31	29	30.97
	1.35 M	30	32	30	29	33	29	31	34	32	32	32	31	
	0.60 M	30	34	31	30	32	31	33	34	32	30	35	31	
J6 500x300	2.10 M	29	30	30	30	29	30	No access			Covered by wall			30.67
	1.35 M	Cladding			30	32	31							
	0.60 M				32	34	31							
														31.23
					136 Readings									

4th Floor (3.00 Mts.Ht.)

Col. No. & size	R Value location from FFL	R Value of Column face												Ave. R Value of Col.
		North			East			South			West			
		E	M	E	E	M	E	E	M	E	E	M	E	
A1 500x300	2.10 M	No access			Covered by wall			28	30	31	Covered by wall			31.00
	1.35 M							31	32	32				
	0.60 M							32	32	31				
A2 500x300	2.10 M	29	31	30	30	29	30	30	30	29	Covered by wall			31.59
	1.35 M	30	32	31	31	32	33	32	33	32				

	0.60 M	33	34	32	34	34	33	33	34	32				
A3 500x300	2.10 M	29	30	30	Covered by wall			No access			Covered by wall			31.11
	1.35 M	31	33	30										
	0.60 M	31	34	32										
A4 500x300	2.10 M	No access			Covered by wall			28	30	29	Covered by wall			31.00
	1.35 M							31	32	30				
	0.60 M							33	34	32				
A5 500x300	2.10 M	29	30	30	30	29	30	30	31	29	Covered by wall			30.96
	1.35 M	30	29	31	31	33	32	30	32	31				
	0.60 M	31	33	31	33	31	32	32	34	32				
A6 500x300	2.10 M	Covered by wall			Covered by wall			29	32	31	No access			31.00
	1.35 M							31	32	30				
	0.60 M							32	31	31				
B1 500x300	2.10 M	No access			Covered by wall			30	31	30	Covered by wall			31.33
	1.35 M							31	33	31				
	0.60 M							30	33	33				
B2 500x300	2.10 M	30	31	30	29	31	30	29	31	30	28	30	29	30.92
	1.35 M	30	31	31	31	33	30	31	34	31	32	32	31	
	0.60 M	32	34	32	30	33	31	31	33	30	30	33	29	
B3 500x300	2.10 M	29	31	30	Covered by wall			No access			Covered by wall			31.44
	1.35 M	29	34	32										
	0.60 M	32	35	31										
B4 500x300	2.10 M	No access			Covered by wall			28	30	29	Covered by wall			31.56
	1.35 M							32	34	32				
	0.60 M							32	34	33				
B5 500x300	2.10 M	29	31	30	29	30	28	29	30	30	29	29	28	30.58
	1.35 M	28	30	29	33	32	31	31	32	32	29	31	29	
	0.60 M	29	32	31	33	34	34	31	33	31	30	34	30	
B6 500x300	2.10 M	31	32	29	Covered by wall			No access			Covered by wall			31.33
	1.35 M	30	32	31										
	0.60 M	32	33	32										
C1 500x300	2.10 M	No access			Covered by wall			28	30	29	Covered by wall			30.44
	1.35 M							29	32	30				
	0.60 M							31	33	32				
C2 500x300	2.10 M	29	30	28	29	30	29	29	31	29	29	31	28	31.00
	1.35 M	31	30	32	33	31	30	30	34	33	31	34	30	
	0.60 M	30	34	31	30	32	31	32	36	32	31	34	32	
C3 500x300	2.10 M	29	29	28	Covered by wall			30	30	29	Covered by wall			30.33
	1.35 M	29	34	29				31	30	29				
	0.60 M	30	33	31				32	32	31				
C4 500x300	2.10 M	29	29	28	Covered by wall			30	30	29	Covered by wall			30.72
	1.35 M	30	30	29				31	34	32				
	0.60 M	30	34	31				32	33	32				
C5 500x300	2.10 M	30	31	31	29	29	28	29	30	31	29	30	29	31.14
	1.35 M	32	31	29	32	32	33	31	33	29	32	31	32	

	0.60 M	30	32	30	31	33	32	32	34	33	32	36	33	
C6 500x300	2.10 M	32	31	29	Covered by wall			No access			Covered by wall			30.67
	1.35 M	Cladding												
	0.60 M													
D1 500x300	2.10 M	No access			29	31	29	29	31	30	Covered by wall			31.17
	1.35 M				30	32	30	32	33	32				
	0.60 M				31	34	31	32	34	31				
D2 500x300	2.10 M	Covered by wall			28	30	29	Covered by wall			30	29	30	31.06
	1.35 M				30	34	31				30	33	32	
	0.60 M				33	35	31				31	33	30	
D3 500x300	2.10 M	Covered by wall			29	30	28	29	31	30	Covered by wall			30.72
	1.35 M				29	31	30	30	34	31				
	0.60 M				32	33	31	31	33	31				
D4 500x300	2.10 M	30	29	30	29	30	30	30	29	29	Covered by wall			31.26
	1.35 M	33	32	33	31	34	32	30	34	32				
	0.60 M	31	34	32	30	34	31	31	33	31				
D5 500x300	2.10 M	30	30	31	No access			29	31	29	29	30	30	31.44
	1.35 M	33	32	32				33	33	30	31	32	33	
	0.60 M	30	33	30				31	34	33	33	35	32	
D6 500x300	2.10 M	29	31	32	No access			No access			Covered by wall			30.67
	1.35 M	Cladding												
	0.60 M													
E1 500x300	2.10 M	No access			Covered by wall			29	31	29	30	30	29	31.00
	1.35 M							31	33	30	32	33	31	
	0.60 M							31	33	32	30	34	30	
E2 500x300	2.10 M	29	30	29	30	31	29	29	31	30	30	29	30	31.19
	1.35 M	30	31	30	29	33	31	32	34	32	32	34	31	
	0.60 M	31	33	31	32	34	33	32	35	31	31	34	30	
E3 500x300	2.10 M	29	30	29	Covered by wall			30	30	29	29	29	30	30.89
	1.35 M	30	32	29				31	32	32	32	31	32	
	0.60 M	30	33	31				31	33	31	32	34	33	
E4 500x300	2.10 M	29	29	28	Covered by wall			30	32	30	29	30	29	30.85
	1.35 M	30	33	30				31	32	31	32	34	32	
	0.60 M	31	33	32				30	32	32	30	32	30	
E5 500x300	2.10 M	30	31	29	29	31	28	30	31	29	No access			31.00
	1.35 M	30	32	29	31	33	31	30	33	32				
	0.60 M	32	33	32	32	32	30	31	35	31				
E6 500x300	2.10 M	29	30	29	Covered by wall			No access			No access			31.22
	1.35 M	32	33	32										
	0.60 M	32	34	30										
F1 500x300	2.10 M	No access			Covered by wall			30	30	29	Covered by wall			30.89
	1.35 M							31	32	30				
	0.60 M							31	33	32				
F2	2.10 M	30	31	30	30	32	30	29	30	31	29	30	30	31.36

500x300	1.35 M	29	34	30	29	34	32	32	33	31	30	32	31	
	0.60 M	32	35	31	32	33	31	32	34	33	31	35	31	
F3 500x300	2.10 M	29	28	31	Covered by wall			No access			Covered by wall			31.22
	1.35 M	32	33	30										
	0.60 M	32	34	32										
F4 500x300	2.10 M	No access			Covered by wall			29	30	28	Covered by wall			30.67
	1.35 M							31	33	30				
	0.60 M							31	32	32				
F5 500x300	2.10 M	29	29	28	29	30	29	30	29	31	29	31	30	30.83
	1.35 M	30	33	30	30	32	30	31	33	32	31	33	30	
	0.60 M	31	32	31	31	33	31	30	33	30	32	34	33	
F6 500x300	2.10 M	29	30	29	Covered by wall			No access			Covered by wall			31.33
	1.35 M	33	34	33										
	0.60 M	29	34	31										
G1 500x300	2.10 M	No access			Covered by wall			29	30	30	Covered by wall			30.56
	1.35 M							30	32	29				
	0.60 M							31	33	31				
G2 500x300	2.10 M	28	30	29	30	30	29	29	30	30	30	30	28	31.06
	1.35 M	29	32	30	31	34	30	32	34	32	33	35	31	
	0.60 M	31	33	29	30	33	30	31	35	32	31	34	33	
G4 500x300	2.10 M	No access			Covered by wall			28	29	28	Covered by wall			30.11
	1.35 M							30	32	30				
	0.60 M							31	32	31				
G5 500x300	2.10 M	28	30	29	29	31	30	30	31	30	29	31	30	31.36
	1.35 M	31	33	32	32	34	31	31	34	32	31	33	30	
	0.60 M	30	34	31	30	35	30	33	33	33	32	34	32	
H3 500x300	2.10 M	30	34	30	Covered by wall			No access			Covered by wall			31.33
	1.35 M	Cladding												
	0.60 M													
H6 500x300	2.10 M	31	33	31	Covered by wall			No access			Covered by wall			31.67
	1.35 M	Cladding												
	0.60 M													
I1 500x300	2.10 M	No access			28	30	29	30	30	29	Covered by wall			30.22
	1.35 M				30	31	30	29	32	30				
	0.60 M				31	32	30	30	33	30				
I2 500x300	2.10 M	29	30	29	31	30	30	30	31	28	30	30	28	30.67
	1.35 M	30	32	31	29	32	32	30	33	30	29	33	31	
	0.60 M	30	32	31	31	33	31	31	33	30	31	32	31	
I3 500x300	2.10 M	31	30	30	29	31	30	No access			Covered by wall			31.22
	1.35 M	31	32	30	31	32	31							
	0.60 M	32	34	31	31	34	32							
J4 500x300	2.10 M	No access			28	31	30	28	31	30	Covered by wall			31.44
	1.35 M				32	34	33	30	33	30				

	0.60 M				32	34	31	32	35	32				
J5 500x300	2.10 M	30	31	29	30	30	29	30	31	31	29	31	30	31.19
	1.35 M	30	32	31	29	33	30	31	33	32	33	32	32	
	0.60 M	32	33	31	31	33	31	32	34	32	30	34	31	
J6 500x300	2.10 M	30	30	31	30	29	31	No access			Covered by wall			31.33
	1.35 M	Cladding			33	32	31							
	0.60 M				32	34	33							
														31.01
					136 Readings									

5th Floor (3.00 Mts.Ht.)														
Col. No. & size	**R Value location from FFL**	**R Value of Column face**												**Ave. R Value of Col.**
		North			**East**			**South**			**West**			
		E	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**	
A1 500x300	2.10 M	No access			Covered by wall			28	30	29	Covered by wall			30.44
	1.35 M							31	31	32				
	0.60 M							30	32	31				
A2 500x300	2.10 M	30	31	29	29	29	30	30	31	29	Covered by wall			31.22
	1.35 M	30	32	30	32	32	31	30	33	31				
	0.60 M	33	33	32	34	33	33	31	33	32				
A3 500x300	2.10 M	29	30	28	Covered by wall			No access			Covered by wall			30.56
	1.35 M	29	33	30										
	0.60 M	31	33	32										
A4 500x300	2.10 M	No access			Covered by wall			28	31	29	Covered by wall			30.67
	1.35 M							29	32	30				
	0.60 M							32	33	32				
A5 500x300	2.10 M	29	31	30	30	31	30	30	31	30	Covered by wall			31.07
	1.35 M	30	30	31	32	33	31	30	33	31				
	0.60 M	29	32	30	33	33	32	32	34	31				
A6 500x300	2.10 M	Covered by wall			Covered by wall			30	32	31	No access			30.67
	1.35 M							29	30	30				
	0.60 M							30	33	31				
B1 500x300	2.10 M	No access			Covered by wall			30	29	30	Covered by wall			30.89
	1.35 M							31	33	29				
	0.60 M							30	34	32				
B2 500x300	2.10 M	30	31	30	29	30	30	29	30	30	29	31	29	30.69
	1.35 M	29	32	30	30	33	30	31	32	31	30	30	31	
	0.60 M	32	33	32	30	34	31	32	33	30	29	32	30	
B3 500x300	2.10 M	29	32	30	Covered by wall			No access			Covered by wall			31.78
	1.35 M	30	34	33										
	0.60 M	33	34	31										
B4 500x300	2.10 M	No access			Covered by wall			29	30	29	Covered by wall			31.44
	1.35 M							32	34	32				

	0.60 M							31	34	32				
B5 500x300	2.10 M	29	30	30	28	30	29	29	31	30	30	29	28	30.61
	1.35 M	30	30	29	33	32	31	31	34	32	29	32	30	
	0.60 M	29	31	30	31	33	32	32	33	31	30	34	30	
B6 500x300	2.10 M	29	32	29	Covered by wall			No access			Covered by wall			30.78
	1.35 M	30	32	30										
	0.60 M	31	32	32										
C1 500x300	2.10 M	No access			Covered by wall			28	30	30	Covered by wall			30.89
	1.35 M							31	32	30				
	0.60 M							31	34	32				
C2 500x300	2.10 M	29	30	29	29	30	30	29	30	29	29	30	28	31.11
	1.35 M	30	30	32	33	33	30	32	34	33	32	34	30	
	0.60 M	29	32	31	32	32	31	32	34	33	33	34	32	
C3 500x300	2.10 M	29	30	28	Covered by wall			28	30	29	Covered by wall			29.61
	1.35 M	28	30	29				29	31	29				
	0.60 M	30	31	29				30	32	31				
C4 500x300	2.10 M	30	29	29	Covered by wall			28	30	29	Covered by wall			30.44
	1.35 M	29	30	28				31	32	31				
	0.60 M	30	33	31				33	33	32				
C5 500x300	2.10 M	29	31	30	29	29	30	29	30	30	29	30	30	30.94
	1.35 M	31	30	29	32	32	33	31	32	29	33	31	32	
	0.60 M	30	31	30	30	32	32	31	34	33	32	35	33	
C6 500x300	2.10 M	30	31	28	Covered by wall			No access			Covered by wall			29.67
	1.35 M	Cladding												
	0.60 M													
D1 500x300	2.10 M	No access			29	30	28	28	31	29	Covered by wall			30.89
	1.35 M				30	32	31	32	34	32				
	0.60 M				31	33	32	31	33	30				
D2 500x300	2.10 M	Covered by wall			28	30	30	Covered by wall			31	29	30	30.83
	1.35 M				30	32	31				30	32	31	
	0.60 M				33	32	31				31	34	30	
D3 500x300	2.10 M	Covered by wall			29	29	28	29	31	29	Covered by wall			30.17
	1.35 M				29	31	30	31	32	30				
	0.60 M				31	33	30	29	33	29				
D4 500x300	2.10 M	30	29	29	30	30	29	30	29	31	Covered by wall			31.07
	1.35 M	31	32	34	30	33	31	30	34	31				
	0.60 M	32	33	33	30	34	31	30	32	31				
D5 500x300	2.10 M	30	30	31	No access			29	30	29	30	29	30	31.56
	1.35 M	33	32	32				33	34	32	33	32	34	
	0.60 M	30	33	30				31	33	33	32	34	33	
D6 500x300	2.10 M	29	31	31	No access			No access			Covered by wall			30.33
	1.35 M	Cladding												
	0.60 M													
E1 500x300	2.10 M	No access			Covered by wall			29	30	29	30	30	28	30.67
	1.35 M							30	33	30	30	32	31	

	0.60 M							31	32	30	31	34	32	
E2 500x300	2.10 M	29	30	30	29	30	28	28	30	30	30	31	29	30.33
	1.35 M	29	30	31	30	33	31	32	34	31	32	32	31	
	0.60 M	30	32	29	31	33	32	31	33	30	20	31	30	
E3 500x300	2.10 M	28	30	28	Covered by wall			29	30	29	28	29	28	30.59
	1.35 M	30	32	30				31	32	30	32	31	32	
	0.60 M	31	34	31				30	34	31	31	33	32	
E4 500x300	2.10 M	29	28	28	Covered by wall			29	32	29	28	30	29	30.30
	1.35 M	29	32	30				32	31	31	32	33	29	
	0.60 M	31	31	30				30	32	32	29	32	30	
E5 500x300	2.10 M	29	30	29	29	31	28	29	30	29	No access			30.37
	1.35 M	28	31	29	29	32	32	30	33	30				
	0.60 M	31	30	32	30	32	31	31	34	31				
E6 500x300	2.10 M	29	30	29	Covered by wall			No access			No access			31.00
	1.35 M	30	33	30										
	0.60 M	32	35	31										
F1 500x300	2.10 M	No access			Covered by wall			29	30	29	Covered by wall			31.11
	1.35 M							31	33	30				
	0.60 M							32	34	32				
F2 500x300	2.10 M	29	31	30	31	29	30	29	30	29	29	29	30	30.75
	1.35 M	30	31	30	29	32	32	31	33	29	30	32	29	
	0.60 M	32	33	32	31	33	31	32	33	30	31	34	31	
F3 500x300	2.10 M	29	28	29	Covered by wall			No access			Covered by wall			30.77
	1.35 M	31	32	30										
	0.60 M	32	33	33										
F4 500x300	2.10 M	No access			Covered by wall			29	29	28	Covered by wall			30.89
	1.35 M							31	33	31				
	0.60 M							33	32	32				
F5 500x300	2.10 M	29	30	28	28	30	29	28	29	31	29	31	29	30.81
	1.35 M	29	31	30	31	32	30	31	34	32	31	34	31	
	0.60 M	31	33	31	31	34	31	30	33	31	32	34	31	
F6 500x300	2.10 M	29	30	28	Covered by wall			No access			Covered by wall			31.11
	1.35 M	32	34	33										
	0.60 M	29	35	30										
G1 500x300	2.10 M	No access			Covered by wall			29	31	30	Covered by wall			30.77
	1.35 M							30	32	29				
	0.60 M							31	34	31				
G2 500x300	2.10 M	29	30	29	29	29	29	29	28	31	30	30	29	30.97
	1.35 M	29	32	31	31	34	30	32	33	32	32	33	31	
	0.60 M	30	32	29	31	34	32	31	34	32	31	35	32	
G4 500x300	2.10 M	No access			Covered by wall			29	29	28	Covered by wall			30.22
	1.35 M							30	32	29				
	0.60 M							32	31	32				
G5 500x300	2.10 M	28	29	29	29	30	30	29	31	30	29	31	29	30.81
	1.35 M	29	30	31	30	34	31	31	34	30	31	33	30	

	0.60 M	30	32	30	29	33	29	33	34	33	31	35	32	
H3 500x300	2.10 M	29	33	31	Covered by wall			No access			Covered by wall			31.00
	1.35 M	Cladding												
	0.60 M													
H6 500x300	2.10 M	30	33	31	Covered by wall			No access			Covered by wall			31.33
	1.35 M	Cladding												
	0.60 M													
I1 500x300	2.10 M	No access			30	30	29	28	31	29	Covered by wall			30.39
	1.35 M				28	31	31	29	32	31				
	0.60 M				32	31	30	32	33	30				
I2 500x300	2.10 M	28	30	29	29	30	30	29	31	28	30	30	29	30.03
	1.35 M	29	30	28	29	32	30	30	33	29	20	34	30	
	0.60 M	28	32	30	31	33	31	31	34	30	31	32	31	
I3 500x300	2.10 M	31	29	29	29	30	28	No access			Covered by wall			31.00
	1.35 M	32	32	30	30	35	31							
	0.60 M	31	33	31	31	34	32							
J4 500x300	2.10 M	No access			28	31	30	28	31	30	Covered by wall			31.17
	1.35 M				32	33	33	30	33	30				
	0.60 M				31	32	30	32	35	32				
J5 500x300	2.10 M	28	30	29	29	30	29	30	31	29	29	32	29	30.83
	1.35 M	31	32	30	31	33	31	31	34	33	33	32	32	
	0.60 M	29	31	30	30	29	30	32	33	32	30	35	31	
J6 500x300	2.10 M	28	29	28	28	29	30	No access			Covered by wall			30.33
	1.35 M	Cladding			32	34	32							
	0.60 M				30	33	31							
														30.75
					136 Readings									

House No. & Location: H.No.30-17-30, R.S.No.159/2, **Sitarampuram,**
Durga Agraharam, Vijayawada.

Residential Building. (**Sri Ranga Sai Towers**) Ground + 5 Upper Floors.

Latitude: 16 31' 03" N

Longitude: 80 38' 23" E

Year of construction: 1997

Height of the Building: 18.00 Mtrs.

S.No.	**Col. No. & size**	**Average R Value of columns in each Floor.**						
		Gr. Floor	**1st Floor**	**2nd Floor**	**3rd Floor**	**4th Floor**	**5th Floor**	**Average**
1	A1 500x300	32.53	31.11	31.00	31.44	31.00	30.44	31.25
2	A2 500x300	32.06	32.00	31.41	31.70	31.59	31.22	31.66
3	A3 500x300	32.00	31.67	31.56	31.78	31.11	30.56	31.45
4	A4 500x300	32.11	31.89	31.44	31.22	31.00	30.67	31.39
5	A5 500x300	31.72	31.52	31.41	31.30	30.96	31.07	31.33
6	A6 500x300	31.56	32.11	31.78	31.56	31.00	30.67	31.45
7	B1 500x300	32.03	31.44	31.33	31.22	31.33	30.89	31.37
8	B2 500x300	31.67	32.17	31.19	31.56	30.92	30.69	31.37
9	B3 500x300	31.28	31.22	31.56	31.89	31.44	31.78	31.53
10	B4 500x300	31.89	31.89	31.89	31.78	31.56	31.44	31.74
11	B5 500x300	32.00	31.94	31.72	31.50	30.58	30.61	31.39

12	B6 500x300	31.33	31.78	31.44	31.78	31.33	30.78	31.41
13	C1 500x300	31.58	31.22	31.33	30.78	30.44	30.89	31.04
14	C2 500x300	32.06	31.61	31.44	31.33	31.00	31.11	31.43
15	C3 500x300	31.17	31.39	31.11	31.06	30.33	29.61	30.78
16	C4 500x300	32.33	32.11	32.06	31.50	30.72	30.44	31.53
17	C5 500x300	31.78	32.39	32.03	31.42	31.14	30.94	31.62
18	C6 500x300	31.56	31.67	31.00	31.67	30.67	29.67	31.04
19	D1 500x300	32.03	31.78	31.61	31.11	31.17	30.89	31.43
20	D2 500x300	32.33	31.17	30.89	31.22	31.06	30.83	31.25
21	D3 500x300	32.61	31.61	31.28	31.39	30.72	30.17	31.30
22	D4 500x300	31.67	31.41	31.11	31.48	31.26	31.07	31.33
23	D5 500x300	33.00	32.15	31.59	31.48	31.44	31.56	31.87
24	D6 500x300	31.22	31.67	31.00	31.33	30.67	30.33	31.04
25	E1 500x300	32.06	31.28	31.00	30.94	31.00	30.67	31.16
26	E2 500x300	32.17	31.69	31.17	31.33	31.19	30.33	31.31

27	E3 500x300	31.85	31.41	31.11	30.96	30.89	30.59	31.14
28	E4 500x300	32.38	31.85	31.48	31.15	30.85	30.30	31.34
29	E5 500x300	32.97	31.04	31.00	30.96	31.00	30.37	31.22
30	E6 500x300	33.06	31.11	30.89	31.33	31.22	31.00	31.44
31	F1 500x300	32.47	30.89	31.67	30.78	30.89	31.11	31.30
32	F2 500x300	33.25	31.78	31.61	31.25	31.36	30.75	31.67
33	F3 500x300	32.92	31.56	31.11	31.33	31.22	30.77	31.49
34	F4 500x300	32.39	31.33	30.44	31.56	30.67	30.89	31.21
35	F5 500x300	32.17	31.39	31.28	30.97	30.83	30.81	31.24
36	F6 500x300	32.47	31.22	30.89	30.67	31.33	31.11	31.28
37	G1 500x300	32.08	31.89	31.33	30.11	30.56	30.77	31.12
38	G2 500x300	32.06	31.44	31.39	31.03	31.06	30.97	31.33
39	G4 500x300	32.11	31.89	31.67	30.78	30.11	30.22	31.13
40	G5 500x300	32.22	31.42	31.11	31.17	31.36	30.81	31.35
41	H3 500x300	32.19	31.00	31.67	32.00	31.33	31.00	31.53

42	H6 500x300	32.40	31.67	31.67	31.33	31.67	31.33	31.68
43	I1 500x300	32.50	31.27	31.11	30.67	30.22	30.39	31.03
44	I2 500x300	32.11	31.03	31.31	30.75	30.67	30.03	30.98
45	I3 500x300	32.25	31.17	31.11	30.94	31.22	31.00	31.28
46	J4 500x300	32.33	31.06	31.39	31.06	31.44	31.17	31.41
47	J5 500x300	32.39	31.36	31.33	30.97	31.19	30.83	31.35
48	J6 500x300	32.56	31.08	31.42	30.67	31.33	30.33	31.23
Average		**32.14**	**31.54**	**31.34**	**31.23**	**31.02**	**30.75**	**31.34**

House No. & Location: D.No.29-3-8, **Venkateswara Rao Street,** Governor Pet, Vijayawada.
Stilt + 3 Floors

Latitude: 16° 30'48.4" N

Longitude: 80° 37'50.6" E

Year of construction: 2000

Floor: **Stilt Floor.**

Col. No. & size	**R Value location from FFL**	**R Value of Column face**												**Avg Values**	**Ave. R Value of Col.**
		North			**East**			**West**			**South**				
		E	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**		
A1 0.23x0.38	2.10 M	24	24	31	31	25	27	29	28	29	28	29	28	27.75	26.86
	1.35 M	25	28	25	26	27	26	27	26	27	26	27	26	26.33	
	0.60 M	26	26	24	26	27	28	26	28	26	26	28	27	26.50	
A2 0.23x0.38	2.10 M	25	26	25	25	26	28	28	29	28	28	27	28	26.92	26.55
	1.35 M	26	25	26	25	25	26	26	28	27	27	28	27	26.33	
	0.60 M	27	28	26	26	28	26	25	26	25	26	28	26	26.42	
A3 0.23x0.38	2.10 M	26	27	26	30	31	29	29	30	26	26	29	31	28.33	27.55
	1.35 M	26	28	27	27	28	27	27	27	27	28	30	28	27.50	
	0.60 M	25	26	25	25	27	26	26	27	31	30	28	26	26.83	
A4 0.23x0.38	2.10 M	25	26	27	26	26	26	25	26	25	26	26	25	25.75	26.36
	1.35 M	25	26	25	25	26	25	26	26	26	27	26	27	25.83	
	0.60 M	26	28	26	26	30	27	29	27	28	28	27	28	27.50	
B1 0.23x0.38	2.10 M	26	26	26	25	26	26	25	25	25	25	26	26	25.58	26.39
	1.35 M	27	28	26	26	27	26	26	26	26	27	26	26	26.42	
	0.60 M	28	30	28	26	27	28	27	27	25	26	27	27	27.17	
B2 0.23x0.38	2.10 M	26	26	26	26	27	26	26	25	26	26	26	26	26.00	26.30
	1.35 M	25	26	25	26	26	26	27	26	25	25	27	27	25.92	
	0.60 M	26	30	26	26	29	26	28	28	25	26	28	26	27.00	
B3 0.23x0.38	2.10 M	25	28	27	26	26	25	26	28	27	26	26	27	26.42	26.86
	1.35 M	26	28	27	26	27	26	27	28	25	26	27	27	26.67	
	0.60 M	27	28	28	27	27	26	29	30	26	27	28	27	27.50	
B4 0.23x0.38	2.10 M	26	28	25	26	28	27	26	28	27	26	28	29	27.00	27.42
	1.35 M	26	28	28	26	27	28	27	28	29	26	28	26	27.25	
	0.60 M	27	28	27	26	28	26	29	30	29	28	30	28	28.00	
C1 0.23x0.38	2.10 M	Covered by wall			26	26	26	26	26	26	26	26	27	26.11	26.96
	1.35 M				26	26	26	25	26	25	26	27	26	25.89	
	0.60 M				29	30	29	29	30	28	28	29	28	28.89	
C2 0.23x0.38	2.10 M	25	26	24	25	25	24	25	26	25	26	27	26	25.33	26.47
	1.35 M	26	27	26	26	27	25	26	27	26	27	28	26	26.42	
	0.60 M	27	28	27	28	28	28	27	28	28	27	28	28	27.67	
C3 0.23x0.38	2.10 M	26	26	25	25	26	24	26	27	26	25	26	24	25.50	26.38
	1.35 M	26	27	26	26	27	25	27	28	26	26	27	26	26.42	
	0.60 M	27	27	26	27	28	27	27	28	28	27	28	27	27.25	
C4 0.23x0.38	2.10 M	24	26	26	25	26	25	25	25	24	26	27	25	25.33	26.38
	1.35 M	25	27	27	26	27	26	26	27	27	27	27	27	26.58	

	0.60 M	26	28	26	27	28	26	27	28	27	28	28	28	27.25	
D1 0.23x0.38	2.10 M	Covered by wall			24	27	25	Covered by wall			24	27	26	25.50	27.11
	1.35 M				25	28	26				27	28	26	26.67	
	0.60 M				28	30	29				28	31	29	29.17	
D2 0.23x0.38	2.10 M	25	26	25	24	25	24	26	27	26	25	26	25	25.33	26.28
	1.35 M	26	27	26	25	26	25	26	28	27	26	27	26	26.25	
	0.60 M	27	28	28	26	27	26	27	29	28	27	28	26	27.25	
D3 0.23x0.38	2.10 M	24	27	26	25	26	24	25	27	27	26	27	25	25.75	26.86
	1.35 M	26	28	27	26	28	26	27	28	28	27	28	27	27.17	
	0.60 M	27	28	28	27	28	27	28	28	28	28	27	28	27.67	
D4 0.23x0.38	2.10 M	25	27	25	26	27	27	26	28	26	27	27	27	26.50	27.44
	1.35 M	27	28	26	27	28	27	27	29	27	28	28	28	27.50	
	0.60 M	28	28	28	27	29	28	28	29	28	29	29	29	28.33	
E1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			25	26	24	24	27	26	25.33	26.83
	1.35 M							26	28	26	27	28	26	26.83	
	0.60 M							27	28	27	28	31	29	28.33	
E2 0.23x0.38	2.10 M	24	25	24	26	27	25	24	27	25	26	27	25	25.42	26.56
	1.35 M	25	26	25	27	27	27	25	28	26	27	27	27	26.42	
	0.60 M	26	27	26	28	28	28	28	30	29	28	28	28	27.83	
E3 0.23x0.38	2.10 M	24	27	25	25	26	24	25	27	27	24	27	26	25.58	26.94
	1.35 M	25	28	26	26	27	26	27	28	28	27	28	26	26.83	
	0.60 M	28	30	29	27	28	27	28	28	28	28	31	29	28.42	
E4 0.23x0.38	2.10 M	27	28	28	28	28	27	28	29	27	29	30	29	28.17	28.44
	1.35 M	26	28	27	28	28	28	29	30	28	29	29	28	28.17	
	0.60 M	29	30	29	28	30	28	28	30	29	28	30	29	29.00	
F1 0.23x0.38	2.10 M	Covered by wall			26	27	27	Covered by wall			24	26	25	25.83	27.11
	1.35 M				27	28	27				25	28	26	26.83	
	0.60 M				28	29	28				28	30	29	28.67	
F2 0.23x0.38	2.10 M	Covered by wall			25	26	24	25	26	24	Covered by wall			25.00	26.00
	1.35 M				26	27	26	26	27	25				26.17	
	0.60 M				27	28	27	26	27	26				26.83	
F3 0.23x0.38	2.10 M	Covered by wall			26	28	26	27	27	27	Covered by wall			26.83	27.78
	1.35 M				27	28	27	28	27	28				27.50	
	0.60 M				28	30	28	29	30	29				29.00	
F4 0.23x0.38	2.10 M	2	27	26	26	26	26	Covered by wall			Covered by wall			22.17	25.72
	1.35 M	27	28	27	27	26	27							27.00	
	0.60 M	28	30	28	26	28	28							28.00	
G1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			27	28	28	27.67	28.00
	1.35 M										26	28	27	27.00	
	0.60 M										29	30	29	29.33	
G2 0.23x0.38	2.10 M	Covered by wall			25	26	24	Covered by wall			Covered by wall			25.00	26.22
	1.35 M				26	27	26							26.33	
	0.60 M				27	28	27							27.33	
G3 0.23x0.38	2.10 M	Covered by wall			26	27	25	Covered by wall			Covered by wall			26.00	27.00
	1.35 M				27	27	27							27.00	

	0.60 M				28	28	28							28.00	
G4 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			26	26	25	25.67	26.67
	1.35 M										27	28	26	27.00	
	0.60 M										27	28	27	27.33	
H1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			25	26	26	25	26	25	25.50	26.56
	1.35 M							27	28	26	26	27	27	26.83	
	0.60 M							28	28	28	26	28	26	27.33	
H2 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	27	26	Covered by wall			26.33	27.56
	1.35 M							27	28	28				27.67	
	0.60 M							28	30	28				28.67	
H3 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	27	26	Covered by wall			26.33	27.11
	1.35 M							27	28	27				27.33	
	0.60 M							27	28	28				27.67	
H4 0.23x0.38	2.10 M	27	28	28	Covered by wall			26	28	26	Covered by wall			27.17	27.50
	1.35 M	27	29	27				26	28	26				27.17	
	0.60 M	28	30	28				27	29	27				28.17	
															26.89
					96 Readings										

1st Floor															
Col. No. & size	**R Value location from FFL**	**R Value of Column face**												**Avg Values**	**Ave. R Value of Col.**
		North			**East**			**West**			**South**				
		E	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**		
A1 0.23x0.38	2.10 M	Covered by wall			26	28	27	Covered by wall			25	28	27	26.83	27.11
	1.35 M				27	28	27				28	30	28	28.00	
	0.60 M				26	27	26				26	28	26	26.50	
A2 0.23x0.38	2.10 M	Covered by wall			27	28	27	Covered by wall			Covered by wall			27.33	27.66
	1.35 M				27	29	27							27.67	
	0.60 M				27	30	27							28.00	
A3 0.23x0.38	2.10 M	Covered by wall			26	28	27	27	28	28	Covered by wall			27.33	28.16
	1.35 M				27	28	28	28	29	28				28.00	
	0.60 M				29	29	29	29	30	29				29.17	
A4 0.23x0.38	2.10 M	25	26	24	25	25	24	Covered by wall			Covered by wall			24.83	26.50
	1.35 M	26	28	28	26	28	26							27.00	
	0.60 M	27	28	27	28	28	28							27.67	
B1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			25	27	26	26.00	26.67
	1.35 M										26	28	25	26.33	
	0.60 M										27	29	27	27.67	
B2 0.23x0.38	2.10 M	26	27	26	Covered by wall			Covered by wall			Covered by wall			26.33	27.44
	1.35 M	27	29	27										27.67	
	0.60 M	28	29	28										28.33	
B3 0.23x0.38	2.10 M	Covered by wall			27	28	27	Covered by wall			27	29	27	27.50	27.72
	1.35 M				28	28	27				27	28	28	27.67	
	0.60 M				28	28	28				28	29	27	28.00	

B4 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			26	28	26	26.67	27.77
	1.35 M										28	28	27	27.67	
	0.60 M										29	29	29	29.00	
C1 0.23x0.38	2.10 M	25	26	25	Covered by wall			26	28	27	Covered by wall			26.17	26.89
	1.35 M	26	26	26				27	28	28				26.83	
	0.60 M	27	28	27				28	28	28				27.67	
C2 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	29	28	Covered by wall			27.67	27.89
	1.35 M							27	29	28				28.00	
	0.60 M							27	30	27				28.00	
C3 0.23x0.38	2.10 M	Covered by wall			Covered by wall			25	27	28	Covered by wall			26.67	27.67
	1.35 M							26	29	28				27.67	
	0.60 M							27	30	29				28.67	
C4 0.23x0.38	2.10 M	26	28	26	Covered by wall			25	27	28	Covered by wall			26.67	27.22
	1.35 M	27	28	27				26	27	27				27.00	
	0.60 M	28	28	27				27	30	28				28.00	
D1 0.23x0.38	2.10 M	Covered by wall			27	28	27	Covered by wall			28	28	27	27.50	27.89
	1.35 M				28	28	28				29	28	27	28.00	
	0.60 M				29	28	29				28	27	28	28.17	
D2 0.23x0.38	2.10 M	Covered by wall			26	27	28	Covered by wall			Covered by wall			27.00	28.00
	1.35 M				27	29	28							28.00	
	0.60 M				28	30	29							29.00	
D3 0.23x0.38	2.10 M	Covered by wall			28	29	28	27	28	27	Covered by wall			27.83	28.39
	1.35 M				29	28	29	27	29	28				28.33	
	0.60 M				29	30	29	28	29	29				29.00	
D4 0.23x0.38	2.10 M	28	27	28	28	29	29	Covered by wall			Covered by wall			28.17	28.05
	1.35 M	27	28	27	27	29	29							27.83	
	0.60 M	28	29	28	28	28	28							28.17	
E1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			26	28	26	26.67	27.88
	1.35 M										27	28	28	27.67	
	0.60 M										29	30	29	29.33	
E2 0.23x0.38	2.10 M	28	28	27	Covered by wall			Covered by wall			Covered by wall			27.67	27.77
	1.35 M	28	29	27										28.00	
	0.60 M	27	28	28										27.67	
E3 0.23x0.38	2.10 M	Covered by wall			26	28	27	Covered by wall			27	28	28	27.33	28.28
	1.35 M				27	29	28				28	29	27	28.00	
	0.60 M				29	30	30				29	30	29	29.50	
E4 0.23x0.38	2.10 M	27	28	27	Covered by wall			Covered by wall			Covered by wall			27.33	28.00
	1.35 M	28	29	27										28.00	
	0.60 M	27	30	29										28.67	
F1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			27	27	27	27	28	27	27.17	28.06
	1.35 M							27	29	28	28	29	28	28.17	
	0.60 M							28	29	28	29	30	29	28.83	
F2 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	28	27	Covered by wall			27.00	27.44
	1.35 M							28	28	28				28.00	
	0.60 M							27	28	27				27.33	

F3 0.23x0.38	2.10 M	Covered by wall			Covered by wall			28	29	28	Covered by wall			28.33	28.44
	1.35 M							27	29	28				28.00	
	0.60 M							28	30	29				29.00	
F4 0.23x0.38	2.10 M	28	29	27	Covered by wall			Covered by wall			Covered by wall			28.00	28.66
	1.35 M	28	30	28										28.67	
	0.60 M	29	30	29										29.33	
G1 0.23x0.38	2.10 M	Covered by wall			29	29	28	Covered by wall			28	29	29	28.67	29.22
	1.35 M				30	30	29				29	30	30	29.67	
	0.60 M				29	30	29				29	30	29	29.33	
G2 0.23x0.38	2.10 M	Covered by wall			27	29	28	Covered by wall			Covered by wall			28.00	27.88
	1.35 M				27	28	27							27.33	
	0.60 M				28	29	28							28.33	
G3 0.23x0.38	2.10 M	Covered by wall			27	29	27	Covered by wall			Covered by wall			27.67	28.11
	1.35 M				28	28	28							28.00	
	0.60 M				28	30	28							28.67	
G4 0.23x0.38	2.10 M	28	29	28	Covered by wall			Covered by wall			Covered by wall			28.33	28.89
	1.35 M	29	30	28										29.00	
	0.60 M	29	30	29										29.33	
H1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			28	28	28	28	29	27	28.00	28.66
	1.35 M							29	29	28	28	29	28	28.50	
	0.60 M							29	30	29	29	30	30	29.50	
H2 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	26	26	Covered by wall			26.00	27.44
	1.35 M							26	30	27				27.67	
	0.60 M							28	30	28				28.67	
H3 0.23x0.38	2.10 M	Covered by wall			Covered by wall			28	29	28	Covered by wall			28.33	28.88
	1.35 M							29	29	29				29.00	
	0.60 M							29	30	29				29.33	
H4 0.23x0.38	2.10 M	28	29	28	Covered by wall			29	29	28	Covered by wall			28.50	28.72
	1.35 M	29	28	27				28	29	29				28.33	
	0.60 M	29	29	29				30	30	29				29.33	
															27.92
				96 Readings											

Second Floor															
Col. No. & size	**R Value location from FFL**	**R Value of Column face**												**Avg Values**	**Ave. R Value of Col.**
		North			**East**			**West**			**South**				
		E	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**		
A1 0.23x0.38	2.10 M	Covered by wall			28	28	27	Covered by wall			27	28	27	27.50	28.05
	1.35 M				28	29	27				28	29	28	28.17	
	0.60 M				28	29	28				28	30	28	28.50	
A2 0.23x0.38	2.10 M	Covered by wall			28	29	28	Covered by wall			Covered by wall			28.33	28.77
	1.35 M				28	30	28							28.67	
	0.60 M				29	30	29							29.33	
A3 0.23x0.38	2.10 M	Covered by wall			25	26	24	25	25	24	Covered by wall			24.83	26.72
	1.35 M				26	28	28	26	28	26				27.00	

	0.60 M				27	30	27	28	30	28				28.33	
A4 0.23x0.38	2.10 M	26	28	27	27	28	28	Covered by wall			Covered by wall			27.33	28.16
	1.35 M	27	28	28	28	29	28							28.00	
	0.60 M	29	29	29	29	30	29							29.17	
B1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			27	27	28	27.33	27.89
	1.35 M										27	28	29	28.00	
	0.60 M										28	29	28	28.33	
B2 0.23x0.38	2.10 M	27	27	27	Covered by wall			Covered by wall			Covered by wall			27.00	27.55
	1.35 M	27	28	28										27.67	
	0.60 M	28	28	28										28.00	
B3 0.23x0.38	2.10 M	Covered by wall			27	28	27	Covered by wall			27	28	28	27.50	28.05
	1.35 M				27	28	28				29	28	29	28.17	
	0.60 M				28	29	28				28	29	29	28.50	
B4 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			27	28	27	27.33	27.66
	1.35 M										28	28	27	27.67	
	0.60 M										28	28	28	28.00	
C1 0.23x0.38	2.10 M	27	27	27	Covered by wall			28	29	27	Covered by wall			27.50	28.33
	1.35 M	29	30	28				28	29	27				28.50	
	0.60 M	28	30	29				29	30	28				29.00	
C2 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	27	26	Covered by wall			26.33	27.00
	1.35 M							26	28	26				26.67	
	0.60 M							27	30	27				28.00	
C3 0.23x0.38	2.10 M	Covered by wall			Covered by wall			27	28	27	Covered by wall			27.33	28.22
	1.35 M							28	28	28				28.00	
	0.60 M							29	30	29				29.33	
C4 0.23x0.38	2.10 M	28	28	27	Covered by wall			28	28	28	Covered by wall			27.83	28.72
	1.35 M	29	30	29				28	29	28				28.83	
	0.60 M	30	30	30				28	30	29				29.50	
D1 0.23x0.38	2.10 M	Covered by wall			27	29	27	Covered by wall			28	28	28	27.83	28.27
	1.35 M				28	28	28				28	29	28	28.17	
	0.60 M				28	29	28				29	30	29	28.83	
D2 0.23x0.38	2.10 M	Covered by wall			27	28	27	Covered by wall			Covered by wall			27.33	27.55
	1.35 M				27	27	27							27.00	
	0.60 M				28	29	28							28.33	
D3 0.23x0.38	2.10 M	Covered by wall			27	27	26	28	28	27	Covered by wall			27.17	27.61
	1.35 M				27	28	28	28	28	28				27.83	
	0.60 M				28	28	28	27	29	27				27.83	
D4 0.23x0.38	2.10 M	28	28	27	27	27	27	Covered by wall			Covered by wall			27.33	28.44
	1.35 M	28	30	29	28	28	28							28.50	
	0.60 M	29	30	30	29	30	29							29.50	
E1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			26	27	27	26.67	27.77
	1.35 M										27	28	28	27.67	
	0.60 M										28	30	29	29.00	
E2 0.23x0.38	2.10 M	26	27	27	Covered by wall			Covered by wall			Covered by wall			26.67	26.89
	1.35 M	27	28	26										27.00	

	0.60 M	27	27	27										27.00	
E3 0.23x0.38	2.10 M	Covered by wall			26	28	27	Covered by wall			26	27	26	26.67	27.72
	1.35 M				28	29	28				27	27	27	27.67	
	0.60 M				29	30	29				28	29	28	28.83	
E4 0.23x0.38	2.10 M	26	29	28	Covered by wall			Covered by wall			Covered by wall			27.67	27.77
	1.35 M	27	28	27										27.33	
	0.60 M	28	29	28										28.33	
F1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			27	29	27	27	27	27	27.33	27.88
	1.35 M							27	29	28	28	28	27	27.83	
	0.60 M							28	30	28	28	29	28	28.50	
F2 0.23x0.38	2.10 M	Covered by wall			Covered by wall			27	28	27	Covered by wall			27.33	28.33
	1.35 M							28	28	28				28.00	
	0.60 M							29	30	30				29.67	
F3 0.23x0.38	2.10 M	Covered by wall			Covered by wall			27	28	28	Covered by wall			27.67	28.11
	1.35 M							28	28	28				28.00	
	0.60 M							29	29	28				28.67	
F4 0.23x0.38	2.10 M	27	27	27	Covered by wall			Covered by wall			Covered by wall			27.00	27.77
	1.35 M	28	29	27										28.00	
	0.60 M	28	29	28										28.33	
G1 0.23x0.38	2.10 M	Covered by wall			27	28	27	Covered by wall			27	28	27	27.33	27.88
	1.35 M				28	29	27				27	29	27	27.83	
	0.60 M				28	30	28				28	29	28	28.50	
G2 0.23x0.38	2.10 M	Covered by wall			27	29	27	Covered by wall			Covered by wall			27.67	28.11
	1.35 M				28	28	28							28.00	
	0.60 M				28	30	28							28.67	
G3 0.23x0.38	2.10 M	Covered by wall			26	27	26	Covered by wall			Covered by wall			26.33	26.88
	1.35 M				27	27	27							27.00	
	0.60 M				27	28	27							27.33	
G4 0.23x0.38	2.10 M	26	26	26	Covered by wall			Covered by wall			Covered by wall			26.00	27.44
	1.35 M	26	30	27										27.67	
	0.60 M	28	30	28										28.67	
H1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			27	27	27	26	27	27	26.83	27.50
	1.35 M							27	28	28	27	28	27	27.50	
	0.60 M							28	28	29	28	28	28	28.17	
H2 0.23x0.38	2.10 M	Covered by wall			Covered by wall			27	28	27	Covered by wall			27.33	27.55
	1.35 M							27	27	27				27.00	
	0.60 M							28	29	28				28.33	
H3 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	27	27	Covered by wall			26.67	27.22
	1.35 M							27	28	27				27.33	
	0.60 M							27	28	28				27.67	
H4 0.23x0.38	2.10 M	27	28	27	Covered by wall			27	28	27	Covered by wall			27.33	28.16
	1.35 M	28	28	28				28	29	28				28.17	
	0.60 M	29	30	29				29	29	28				29.00	
															27.81
						96 Readings									

Third Floor															
Col. No. & size	**R Value location from FFL**	**R Value of Column face**												**Avg Values**	**Ave. R Value of Col.**
		North			**East**			**West**			**South**				
		E	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**	**E**	**M**	**E**		
A1 0.23x0.38	2.10 M	Covered by wall			25	28	25	Covered by wall			25	28	25	26.00	27.61
	1.35 M				27	28	28				27	28	28	27.67	
	0.60 M				29	30	29				29	29	29	29.17	
A2 0.23x0.38	2.10 M	Covered by wall			25	28	25	Covered by wall			Covered by wall			26.00	27.44
	1.35 M				26	29	26							27.00	
	0.60 M				29	30	29							29.33	
A3 0.23x0.38	2.10 M	Covered by wall			26	27	26	26	27	26	Covered by wall			26.33	27.50
	1.35 M				28	29	27	27	29	26				27.67	
	0.60 M				28	29	28	28	30	28				28.50	
A4 0.23x0.38	2.10 M	26	27	27	26	27	26	Covered by wall			Covered by wall			26.50	27.94
	1.35 M	28	29	27	28	29	27							28.00	
	0.60 M	29	30	28	29	31	29							29.33	
B1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			26	27	27	26.67	27.22
	1.35 M										26	28	28	27.33	
	0.60 M										28	28	27	27.67	
B2 0.23x0.38	2.10 M	27	28	27	Covered by wall			Covered by wall			Covered by wall			27.33	27.77
	1.35 M	27	28	28										27.67	
	0.60 M	28	29	28										28.33	
B3 0.23x0.38	2.10 M	Covered by wall			26	27	26	Covered by wall			26	27	26	26.33	26.94
	1.35 M				26	28	26				26	29	26	26.83	
	0.60 M				27	28	27				28	29	27	27.67	
B4 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			26	27	26	26.33	27.33
	1.35 M										26	29	26	27.00	
	0.60 M										28	30	28	28.67	
C1 0.23x0.38	2.10 M	26	28	26	Covered by wall			26	27	26	Covered by wall			26.50	27.56
	1.35 M	27	28	28				27	28	28				27.67	
	0.60 M	28	30	28				28	29	28				28.50	
C2 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	27	26	Covered by wall			26.33	27.78
	1.35 M							27	28	28				27.67	
	0.60 M							29	30	29				29.33	
C3 0.23x0.38	2.10 M	Covered by wall			Covered by wall			27	27	26	Covered by wall			26.67	27.67
	1.35 M							27	28	28				27.67	
	0.60 M							28	30	28				28.67	
C4 0.23x0.38	2.10 M	26	27	26	Covered by wall			27	27	26	Covered by wall			26.50	27.05
	1.35 M	26	27	26				26	29	26				26.67	
	0.60 M	27	28	27				28	30	28				28.00	
D1 0.23x0.38	2.10 M	Covered by wall			27	27	27	Covered by wall			27	27	27	27.00	27.89
	1.35 M				28	28	28				28	29	28	28.17	
	0.60 M				28	29	28				28	30	28	28.50	
D2 0.23x0.38	2.10 M	Covered by wall			26	27	26	Covered by wall			Covered by wall			26.33	27.00
	1.35 M				26	29	26							27.00	

	0.60 M				27	29	27							27.67	
D3 0.23x0.38	2.10 M	Covered by wall			26	27	26	26	27	26	Covered by wall			26.33	27.39
	1.35 M				26	29	26	27	29	27				27.33	
	0.60 M				28	30	28	28	29	28				28.50	
D4 0.23x0.38	2.10 M	26	28	26	26	27	26	Covered by wall			Covered by wall			26.50	27.72
	1.35 M	27	29	26	27	29	28							27.67	
	0.60 M	29	30	28	29	29	29							29.00	
E1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			Covered by wall			26	27	26	26.33	27.88
	1.35 M										27	29	28	28.00	
	0.60 M										29	30	29	29.33	
E2 0.23x0.38	2.10 M	26	27	26	Covered by wall			Covered by wall			Covered by wall			26.33	27.00
	1.35 M	26	28	27										27.00	
	0.60 M	27	28	28										27.67	
E3 0.23x0.38	2.10 M	Covered by wall			26	27	26	Covered by wall			26	27	26	26.33	27.78
	1.35 M				27	29	28				28	28	27	27.83	
	0.60 M				28	30	28				28	31	30	29.17	
E4 0.23x0.38	2.10 M	26	28	26	Covered by wall			Covered by wall			Covered by wall			26.67	27.77
	1.35 M	28	29	27										28.00	
	0.60 M	28	30	28										28.67	
F1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	28	26	26	28	26	26.67	28.05
	1.35 M							28	29	28	28	29	28	28.33	
	0.60 M							29	30	29	29	30	28	29.17	
F2 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	28	26	Covered by wall			26.67	28.22
	1.35 M							28	30	28				28.67	
	0.60 M							28	31	29				29.33	
F3 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	27	26	Covered by wall			26.33	27.77
	1.35 M							28	29	28				28.33	
	0.60 M							28	29	29				28.67	
F4 0.23x0.38	2.10 M	26	28	26	Covered by wall			Covered by wall			Covered by wall			26.67	27.66
	1.35 M	27	29	27										27.67	
	0.60 M	28	29	29										28.67	
G1 0.23x0.38	2.10 M	Covered by wall			26	27	26	Covered by wall			26	28	26	26.50	27.72
	1.35 M				27	28	27				27	29	29	27.83	
	0.60 M				28	30	28				28	30	29	28.83	
G2 0.23x0.38	2.10 M	Covered by wall			26	27	26	Covered by wall			Covered by wall			26.33	27.22
	1.35 M				27	28	27							27.33	
	0.60 M				27	30	27							28.00	
G3 0.23x0.38	2.10 M	Covered by wall			26	27	26	Covered by wall			Covered by wall			26.33	27.67
	1.35 M				27	28	27							27.33	
	0.60 M				29	30	29							29.33	
G4 0.23x0.38	2.10 M	26	27	26	Covered by wall			Covered by wall			Covered by wall			26.33	27.33
	1.35 M	27	28	27										27.33	
	0.60 M	27	30	28										28.33	
H1 0.23x0.38	2.10 M	Covered by wall			Covered by wall			26	27	26	26	27	26	26.33	27.56
	1.35 M							27	28	27	27	28	27	27.33	

	0.60 M							29	30	29	28	30	28	29.00	
H2 0.23x0.38	2.10 M	Covered by wall			Covered by wall			27	27	26	Covered by wall			26.67	27.55
	1.35 M							27	28	27				27.33	
	0.60 M							28	30	28				28.67	
H3 0.23x0.38	2.10 M	Covered by wall			Covered by wall			27	27	27	Covered by wall			27.00	28.22
	1.35 M							27	29	28				28.00	
	0.60 M							29	31	29				29.67	
H4 0.23x0.38	2.10 M	27	27	28	Covered by wall			27	27	27	Covered by wall			27.17	27.83
	1.35 M	27	29	27				27	29	27				27.67	
	0.60 M	27	29	28				29	30	29				28.67	
															27.60
			96 Readings												

R Value of each column						
S. No.	**Column No. and size**	**Ave.R value of columns in each floor**				**Average of each column**
		Stilt Floor	**1st Floor**	**2nd Floor**	**3rd Floor**	
1	A1 0.23x0.38	26.86	27.11	28.05	27.61	27.41
2	A2 0.23x0.38	26.55	27.66	28.77	27.44	27.61
3	A3 0.23x0.38	27.55	28.16	26.72	27.50	27.48
4	A4 0.23x0.38	26.36	26.50	28.16	27.94	27.24
5	B1 0.23x0.38	26.39	26.67	27.89	27.22	27.04
6	B2 0.23x0.38	26.30	27.44	27.55	27.77	27.27
7	B3 0.23x0.38	26.86	27.72	28.05	26.94	27.39
8	B4 0.23x0.38	27.42	27.77	27.66	27.33	27.55
9	C1 0.23x0.38	26.96	26.89	28.33	27.56	27.44

10	C2 0.23x0.38	26.47	27.89	27.00	27.78	27.29
11	C3 0.23x0.38	26.38	27.67	28.22	27.67	27.49
12	C4 0.23x0.38	26.38	27.22	28.72	27.05	27.34
13	D1 0.23x0.38	27.11	27.89	28.27	27.89	27.79
14	D2 0.23x0.38	26.28	28.00	27.55	27.00	27.21
15	D3 0.23x0.38	26.86	28.39	27.61	27.39	27.56
16	D4 0.23x0.38	27.44	28.05	28.44	27.72	27.91
17	E1 0.23x0.38	26.83	27.88	27.77	27.88	27.59
18	E2 0.23x0.38	26.56	27.77	26.89	27.00	27.06
19	E3 0.23x0.38	26.94	28.28	27.72	27.78	27.68
20	E4 0.23x0.38	28.44	28.00	27.77	27.77	28.00
21	F1 0.23x0.38	27.11	28.06	27.88	28.05	27.78
22	F2 0.23x0.38	26.00	27.44	28.33	28.22	27.50
23	F3 0.23x0.38	27.78	28.44	28.11	27.77	28.03
24	F4 0.23x0.38	25.72	28.66	27.77	27.66	27.45

25	G1 0.23x0.38	28.00	29.22	27.88	27.72	28.21
26	G2 0.23x0.38	26.22	27.88	28.11	27.22	27.36
27	G3 0.23x0.38	27.00	28.11	26.88	27.67	27.42
28	G4 0.23x0.38	26.67	28.89	27.44	27.33	27.58
29	H1 0.23x0.38	26.56	28.66	27.50	27.56	27.57
30	H2 0.23x0.38	27.56	27.44	27.55	27.55	27.53
31	H3 0.23x0.38	27.11	28.88	27.22	28.22	27.86
32	H4 0.23x0.38	27.50	28.72	28.16	27.83	28.05
	Ave.	**26.89**	**27.92**	**27.81**	**27.60**	**27.55**

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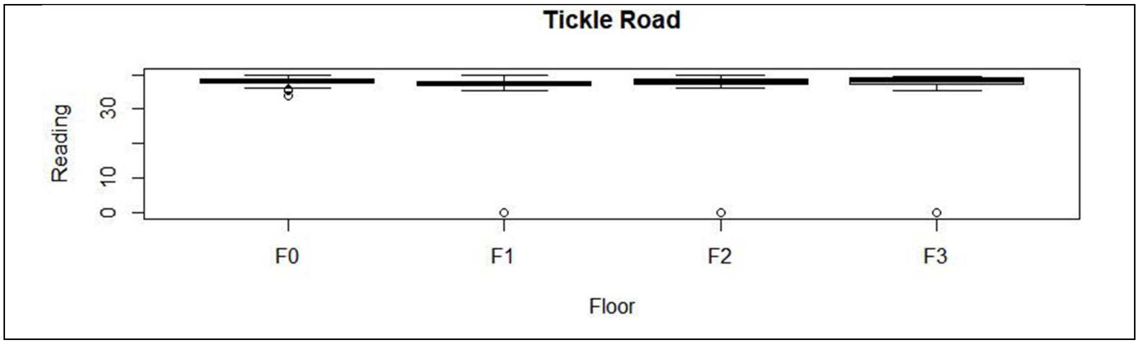
Annexure IV: Concrete Testing

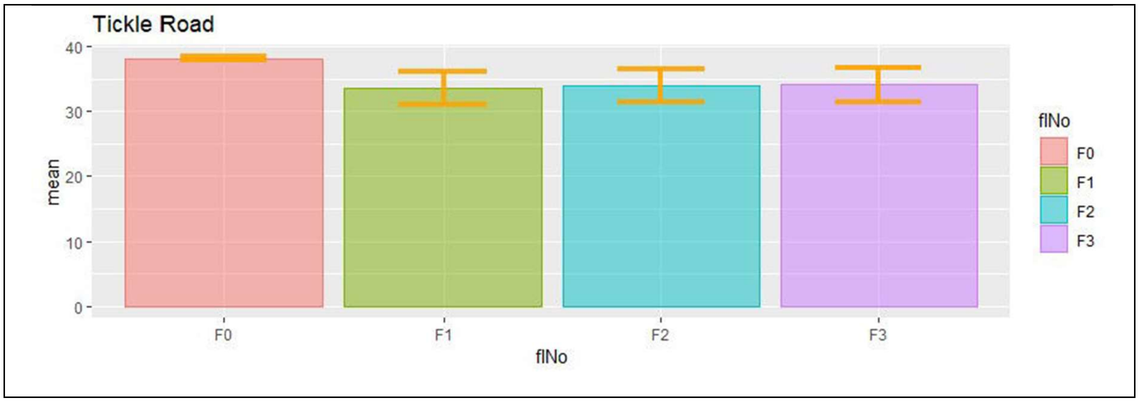
1. Tickle Road, Valluru Purnachandra Rao Road

This is a residential building with Stilt + 3 Floors, located on plain ground facing Tickle Road near by Benz Circle with Geographic Coordinates 16°29’53” N and 80°38′54" E. Krishna River is 1.00 km away and Bandar Canal is 0.50 km from this building. The soils met with for foundations are Black Cotton soils. The height of each floor is 3.00 m.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings all-round the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis. There are 28 columns in each floor. Rebound Hammer readings are taken at levels for each column wherever possible and average of 12 readings at each level are considered as one reading for analysispurpose. There are 84 readings in Stilt Floor and 75 readings for each upper floor, totaling to 309 readings in 4 floors. The box plots are shown below.



The means in floors GF, F1, F2, and F3, are 38.16, 33.62, 33.97, and 34.08 respectively. The overall mean is 34.96. The means are shown in the bar graph below.



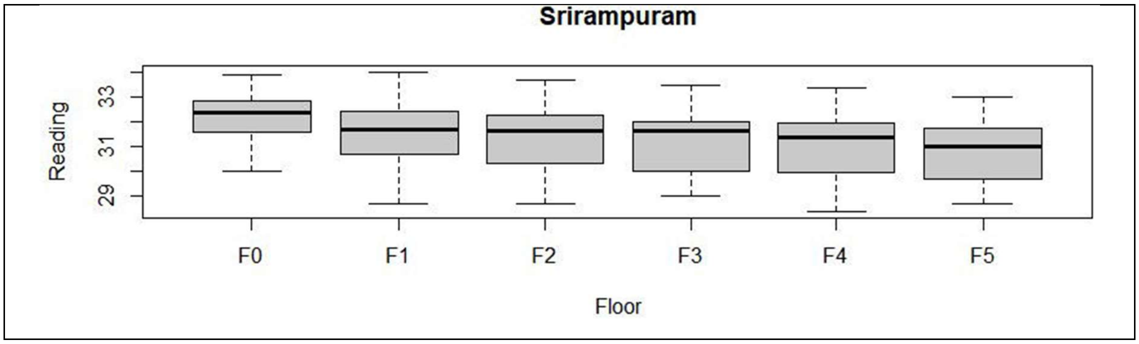
The significance test of the equality of floor means is carried out by analysis of variance.

	Estimate	Std. Error	t-value	p-value
GF	38.158	1.120	34.060	0
F1	-4.539	1.584	-2.865	0.00444
F2	-4.184	1.584	-2.641	0.00867
F3	-4.082	1.584	-2.576	0.01041

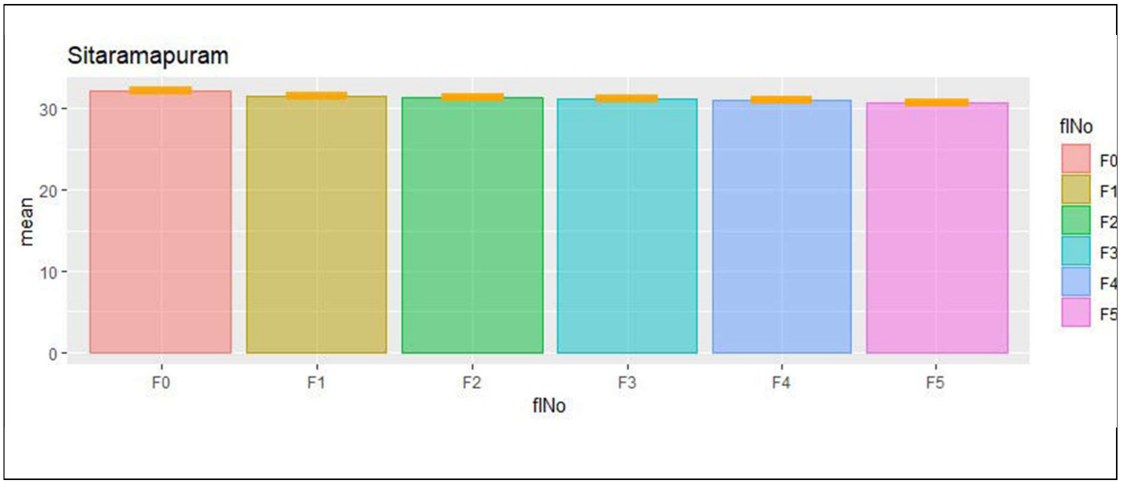
2. Sitarampuram (Durga Agraharam)

This is a residential Building bearing H. No. 30-17-30 in Sitarampuram area with Stilt + 5 floors located on plain ground near Eluru Road (Kothavanthena Centre). The Geographic Coordinates of this building are 16°31’07” N and 80°38’22” E. Ryves canal is 0.30 km from this building. The soils are Black Cotton expansive soils. The height of each floor is 3.00 m.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used, and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings all-round the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis. There are 48 columns in each floor. Rebound Hammer readings are taken at 3 levels on each column face wherever possible and an average of 12 readings at each level are considered as one reading for analysis purpose. There are 142 readings for the Stilt floor and 136 readings for each upper floor, totaling to 822 readings in 6 floors. The box plots are shown below.



The means in floors GF, F1, F2, F3, F4, and F5 are 32.15, 31.54, 31.34, 31.24, 31.03, and 30.76 respectively. The overall mean for the building is 31.34. The means are shown in the bar graph below.



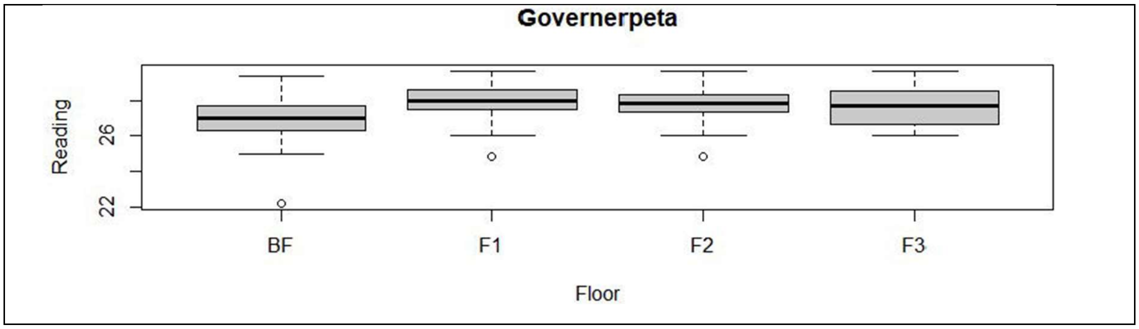
The significance test of the equality of floor means is carried out by analys is of variance.

	Estimate	Std. Error	t-value	p-value
GF	32.14764	0.08982	357.926	0
F1	-0.61083	0.12702	-4.809	0
F2	-0.80653	0.12702	-6.350	0
F3	-4.082	1.584	-2.576	0.01041
F4	-0.90708	0.12702	-7.141	0
F5	-1.11681	0.12702	-8.792	0
F6	-1.38799	0.12702	-10.927	0

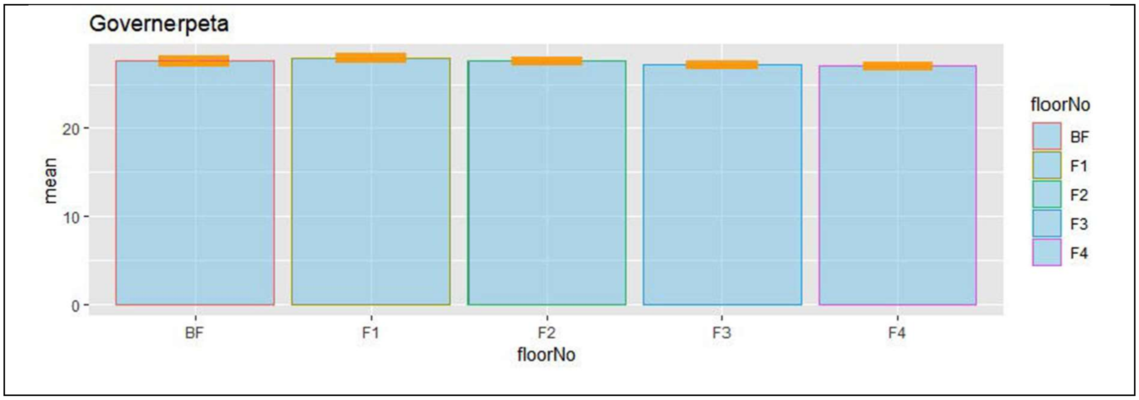
3. Governerpet (Venkateswara Rao Street)

This is a residential building H. No. 29-3-8 in Ward No. 24 in Governorpet area with Geographic Coordinates 16°30’48” N and 80°37’51” E. The Ryves canal is about 0.50 km from this building. The foundations are met with Black Cotton soils. The height of each floor is 3.00 m.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings all-round the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis. There are 31 columns in each floor. Rebound Hammer readings are taken at 3 levels on each column face wherever possible and average of 12 readings at each level are considered as one reading for analysis purpose. There are 96 readings for each floor, totaling to 384 readings for 4 floors. The box plots for the data are shown below.



The means in floors BF, F1, F2, and F3, are 26.92, 27.94, 27.83, and 27.62 respectively. The overall mean for the building is 27.58. The means are shown in the bar graph below.



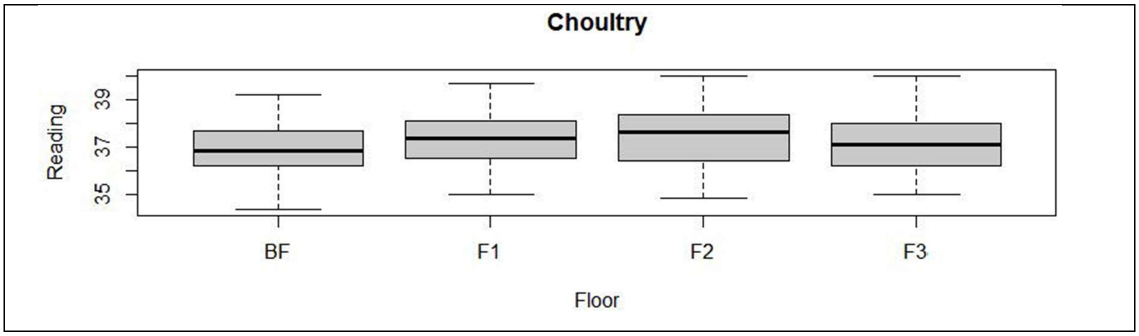
The significance test of the equality of floor means is carried out by analys is of variance.

	Estimate	Std. Error	t-value	p-value
GF	26.91990	0.09944	270.727	0
F1	1.01948	0.14062	7.250	0
F2	0.90792	0.14062	6.456	0
F3	0.70333	0.14062	5.002	0

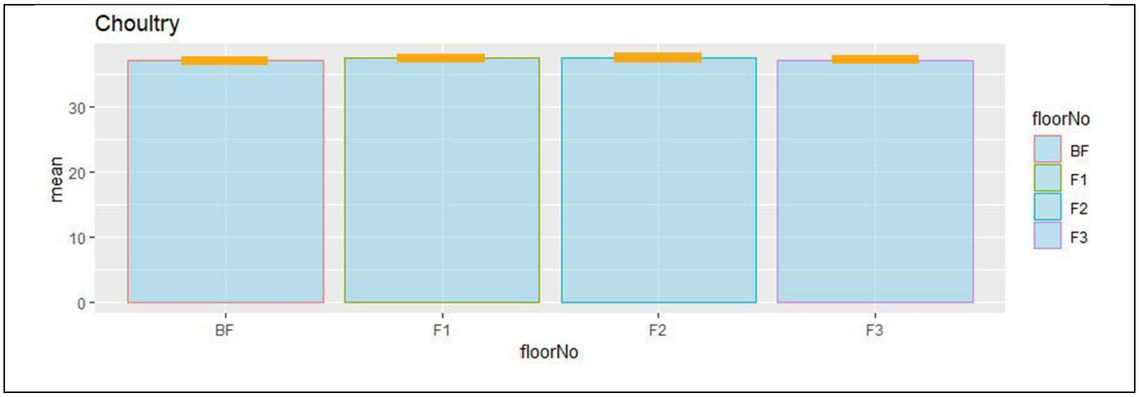
4. Choultry (Madapati Guest House) Tarapet.

This is a commercial building being used as a Guest House with Stilt + 3 floors, located in Commercial area of Vijayawada Old town near Railway Station. The Geographic Coordinates of this building are 16°31’06” N and 80°36’41” E. The soils met with are Black cotton soils. The height of each floor is 3.66 m. To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 1.00 m, 2.00 m and 3.00 m from finished floor level. At every level maximum 12 readings alround the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis.

There are 24 columns in each floor. Rebound Hammer readings are taken at 3 levels on each column face wherever possible and average of 12 readings at each level are considered as one reading for analys is purpose. There are 72 readings for each floor, totaling to 288 readings in 4 floors. The box plots are shown below.



The means in floors BF, F1, F2, and F3, are 36.96, 37.36, 37.43, and 37.13, respectively. The overall mean for the building is 37.22. The means are shown in the bar graph below.



The significance test of the equality of floor means is carried out by analysis of variance.

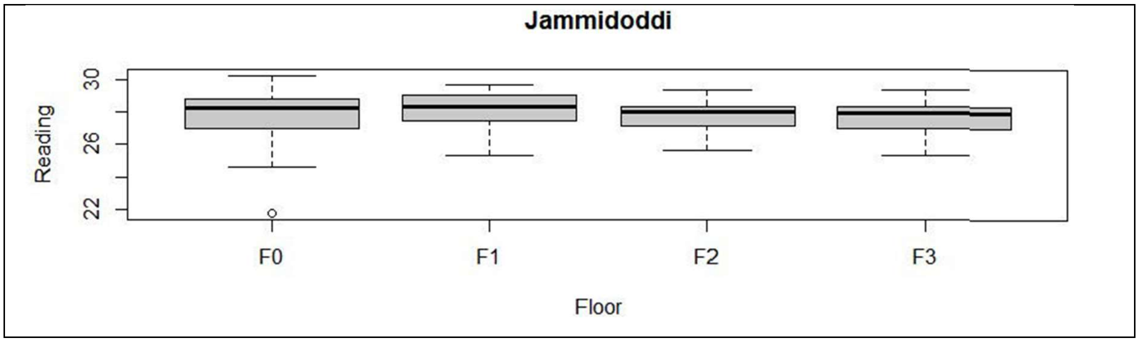
	Estimate	Std. Error	t-value	p-value
GF	36.9644	0.1390	265.94	0
F1	0.3921	0.1966	1.995	0.0470
F2	0.4633	0.1966	2.357	0.0191
F3	0.1696	0.1966	0.863	0.3890

5. Jammidoddi (Endowments Dept. Office)

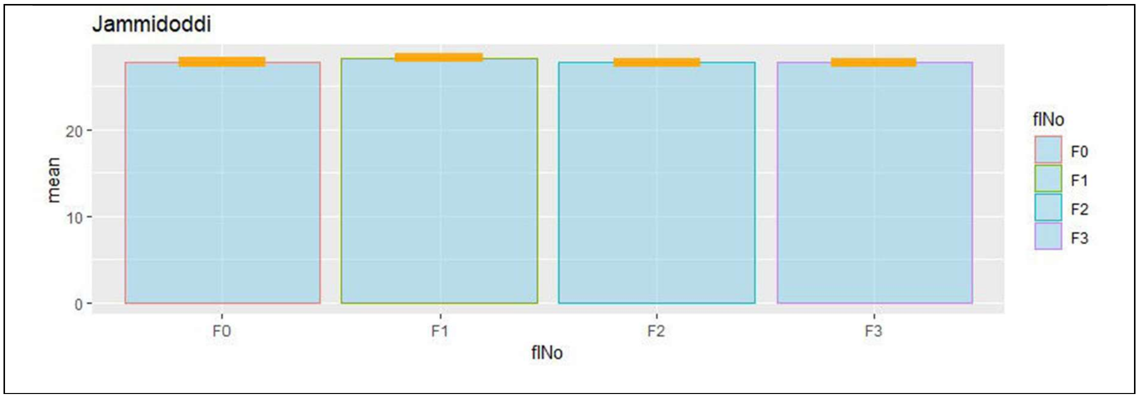
This is an office building of Endowments Department with Stilt + 3 floors, located in old town of Vijayawada in hill slope of Indra Keeladdri Hill. The Geographic Coordinates of this building are 16°30’58” N and 80°40’33” E. The soils met within foundations are hard gravel/murram. The height of each floor is 3.66 m sliding of hill slopes are common during rainy season in this area.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 1.00 m, 2.00 m and 3.00 m from finished floor level. At every level maximum 12 readings alround the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis.

There are 28 columns in each floor. Rebound Hammer readings are taken at 3 levels on each column face wherever possible and anaverage of 12 readings at each level are considered as one reading for analysis purpose. There are 84 readings in Stilt Floor and 80 readings for each upper floor, totaling to 324 readings for 4 floors. The box plots are shown below.



The means in floors GF, F1, F2, and F3 are 27.82, 28.24, 27.75, and 27.75 respectively. The overall mean is 27.89. The means are shown in the bar graph below.



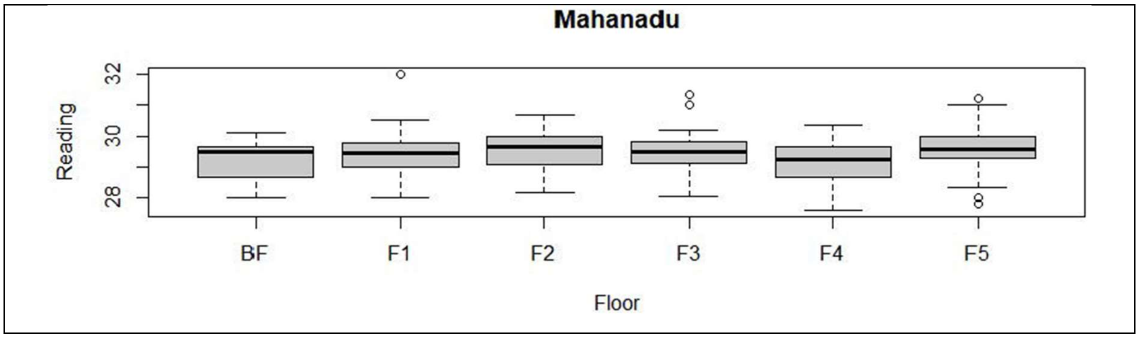
The significance test of the equality of floor means is carried out by analysis of variance.

	Estimate	Std. Error	t-value	p-value
GF	27.82083	0.11625	239.316	0
F1	0.41488	0.16440	2.524	0.0121
F2	-0.07143	0.16440	-0.434	0.6642
F3	-0.07321	0.16440	-0.445	0.6564

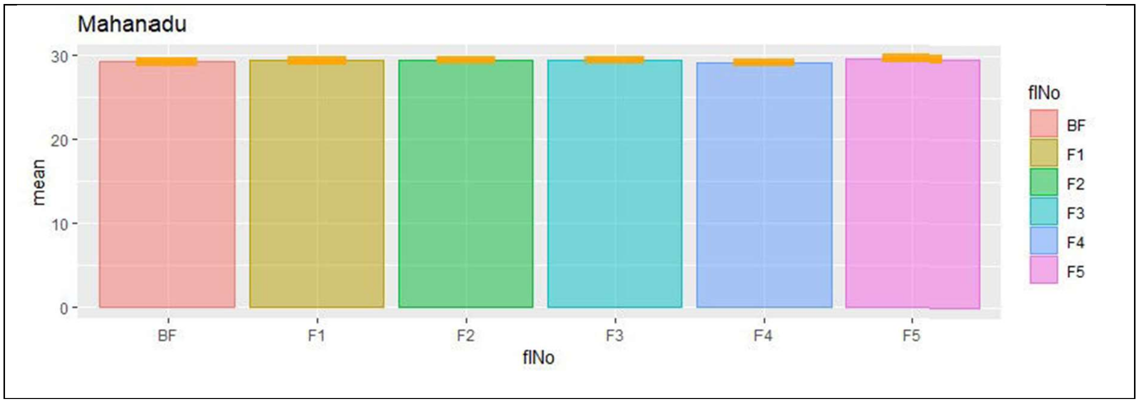
6. Mahanadu Road, Gunadala

This is a residential building H. No. 48-19-17, with Stilt + 5 floors, located in Gunadala area of Vijayawada city close to Mahanadu Road. The Geological Coordinates of this building are 16°30'52" N and 80°40'33" E. The soils met within foundations are pure Black cotton soils. These were all agricultural land still 20 years back.The roof height of each floor is 3.00 m.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings all-round the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis. There are 15 columns on each floor. Rebound Hammer readings are taken at 3 levels on each column face wherever possible and average of 12 readings at each level are considered as one reading for analysis purpose. There are 45 readings in Stilt floor and 43 readings for each upper floor, totaling to 260 readings for 6 floors. The box plots are shown below.



The means in floors BF, F1, F2, F3, F4, and F5 are 29.24, 29.41, 29.52, 29.44, 29.16 and 29.63 respectively. The overall mean for the building is 29.40. The means are shown in the bar graph below.



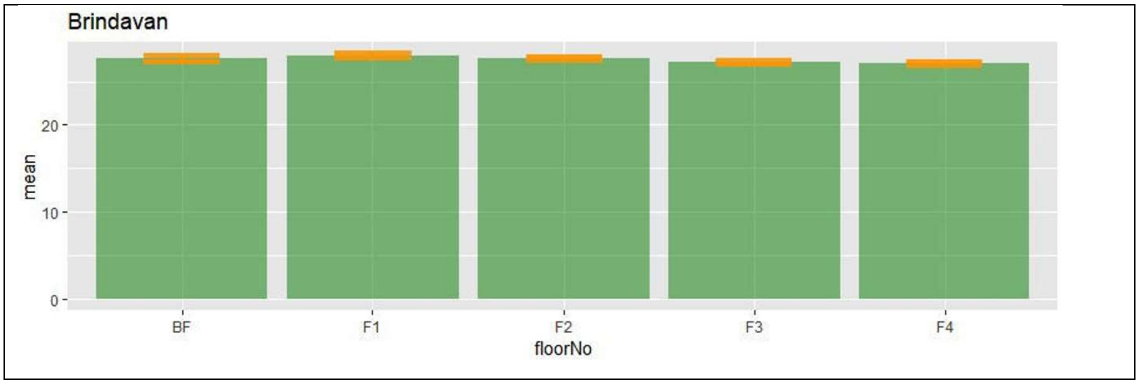
The significance test of the equality of floor means is carried out by analysis of variance.

	Estimate	Std. Error	t-value	p-value
GF	29.23911	0.09638	303.376	0
F1	0.17089	0.13630	1.254	0.21104
F2	0.28289	0.13630	2.075	0.03891
F3	0.20378	0.13630	1.495	0.13609
F4	-0.07844	0.13630	-0.576	0.56543
F5	0.39400	0.13630	2.891	0.00416

7. Brindavan (Labbipet)

This is a residential building in Brindavan Nagar of Labbipet area H. No. 40-15/2-19/8 Anear Benz Circle with Stilt + 4 floors. The Geological Coordinates of this building are 16°29’57” N and 80°38’48” E. Krishna River is 1.00 km away and Bandar Canal is 0.50 km from this building. The soils met with for foundations are Black Cotton. The height of each floor is 3.00 m. To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings alround the column i.e., 3 readings on each face of the column 4 faces are taken and average value adopted for analysis. There are 20 columns in each floor. Rebound Hammer readings are taken at levels for each column wherever possible and average of 12 readings at each level are considered as one reading for analysis purpose. There are 60 readings for each floor, totaling to 300 readings for the 5 floors.

The means in floors BF, F1, F2, F3, and F4 are 27.62, 27.91, 27.60, 27.19, and 27.08 respectively. The overall mean for the building is 27.48. A bar graph for the means is shown below.



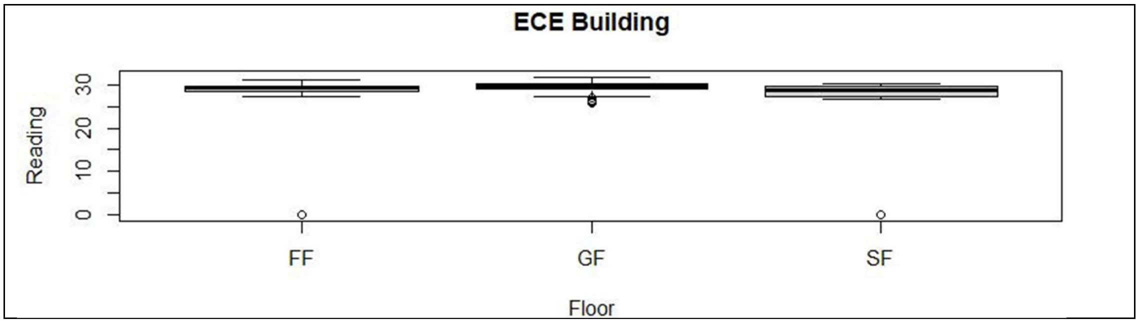
The significance test of the equality of floor means is carried out by analysis of variance.

	Estimate	Std. Error	t-value	p-value
GF	27.62050	0.12459	221.684	0
F1	0.29433	0.17620	1.670	0.09590
F2	-0.01917	0.17620	-0.109	0.91345
F3	-0.43017	0.17620	-2.441	0.01522
F4	-0.54283	0.17620	-3.081	0.00226

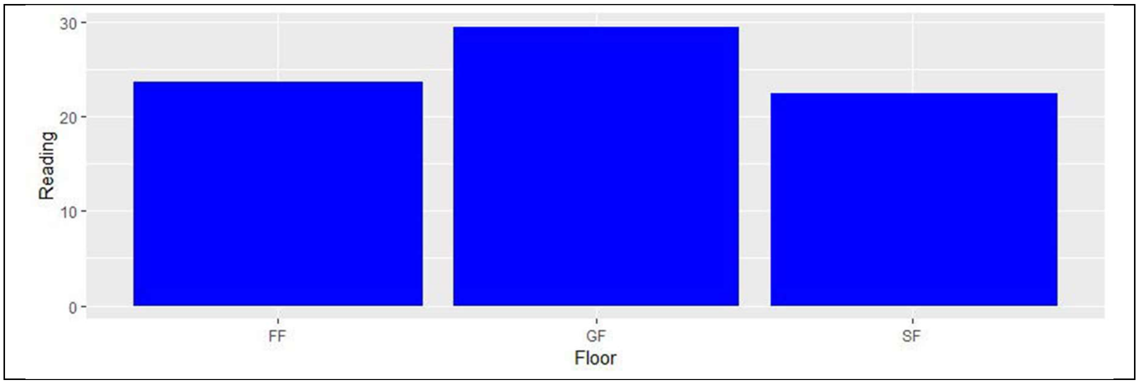
8. GPV–ECE Block (Benz Circle Flyover)

This is the Govt. Polytechnic Building for Electronics & Communications Engineering Lab in Ground + 2 Floors facing Ring Road Benz Circle Flyover on NH-16. The Geographic Coordinates of this building are 16°30’16” N and 80°39’30” E. The soil is Black Cotton. The roof height of each floor is 3.60 m. To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used, and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings all-round the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis. There are 50 columns in each floor. Rebound Hammer readings are taken at 3 levels on each column face wherever possible and an average of 12 readings at each level are considered as one reading for analysis purpose.

There are 150 readings In Ground Floor, 121 for F1 and 115 for F2 floor, totaling to 386 readings in 3 floors. The box plots are shown below. The means in floors FF, GF & SF are 23.68, 29.52 & 22.44, respectively. The overall mean for the building is 25.2.



The means are shown in the bar graph below.



The significance test of the equality of floor means is carried out by analysis of variance.

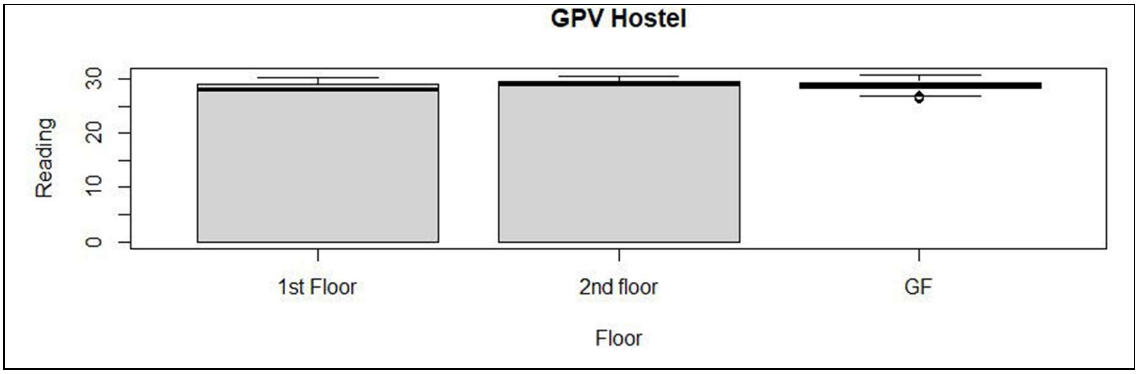
	Estimate	Std. Error	t-value	p-value
GF	23.6847	0.7974	29.701	0
GF	5.8341	1.1278	5.173	0
SF	-1.2472	1.1278	-1.106	0.269

9. GPV Hostel Block, Benz Circle Flyover.

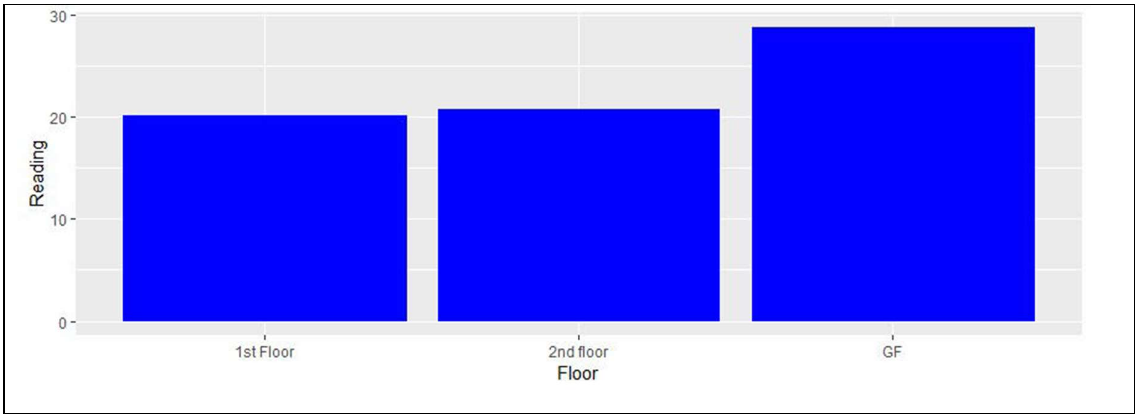
This is Govt. building with G+3 floors, located facing Benz Circle Flyover on NH-16 opp. to Ramesh Hospitals, used for Polytechnic Students Hostel. The Geographic Coordinates of this building are 16°30’20” N Land 80°39’34” E. The soils are Black Cotton. Roof height of each floor is 3.00 m.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used, and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings all-round the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis.

There are 94 columns in each floor. Rebound Hammer readings are taken at levels for each column wherever possible and average of 12 readings at each level are considered as one reading for analysis purpose. There are 282 readings in Ground floor, 192 in F1 and 189 in F2 floor, readings, totaling to 663 readings in 3 floors. The box plots are shown below.



The range of the readings in first floor is 0.00 to 30.33, in second floor is 0.00 to 30.50, and in ground floor is 26.44 to 30.67, while the median in these floors is 28.17, 29.00, and 28.89, respectively. The means in the floors first, second & ground are 20.16, 20.70, & 28.79, respectively. The overall mean for the building is 23.54. The means are shown in the bar graph below.



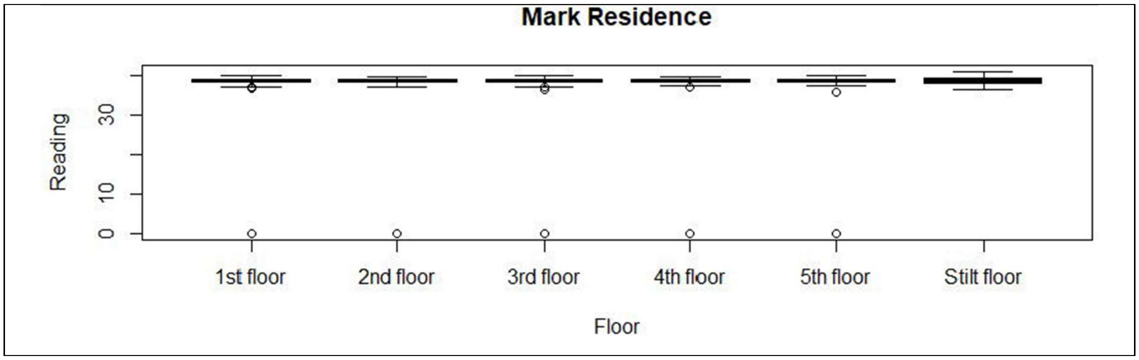
The significance test of the equality of floor means is carried out by analysis of variance.

	Estimate	Std. Error	t-value	p-value
GF	20.1622	0.6336	31.823	0
GF	0.5407	1.0063	0.537	0.591
SF	8.6290	0.8960	9.630	0

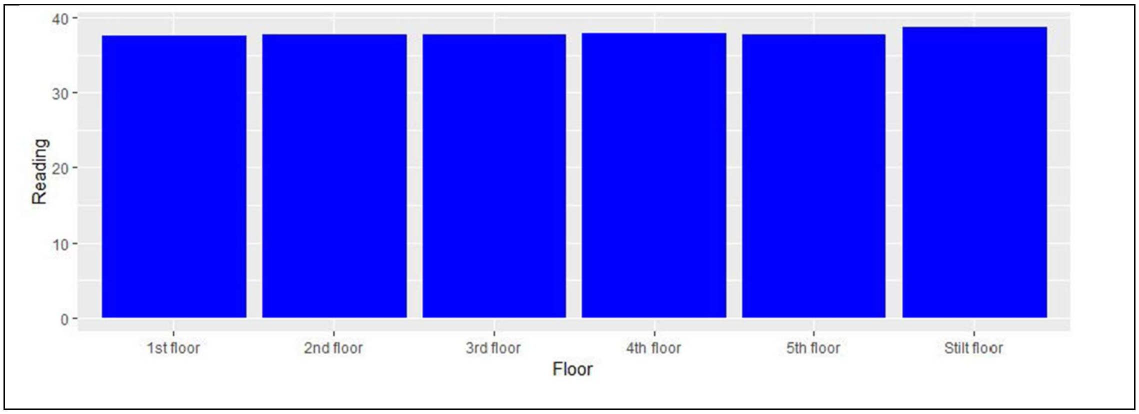
10. MARK Residency, A. S. Ramarao Road Gunadala.

This is a residential building with Stilt+5 floors located in Moghalrajpuram East Hillslope area abutting A.S.Ramarao Road. The soils are Black cotton. Landslides during rainy season in this area are common. Geographic Coordinates of this building are 16°30’15” N and 80°39’30” E. The roof height of each floor is 3.00 m.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used and readings taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings all around the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis. There are 26 columns in each floor. Rebound Hammer readings are taken at levels for each column wherever possible and average of 12 readings at each level are considered as one reading for analysis purpose. There are 78 readings for Stilt Floor and 76 readings each in upper floors, totaling to 458 readings in 6 floors. The box plots are shown below.



The means in first, second, third, fourth, fifth, and stilt floors are 37.66, 37.83, 37.72, 37.83, 37.79, and 38.79, respectively. The overall mean for the building is 37.94. The means are shown in the bar graph below.



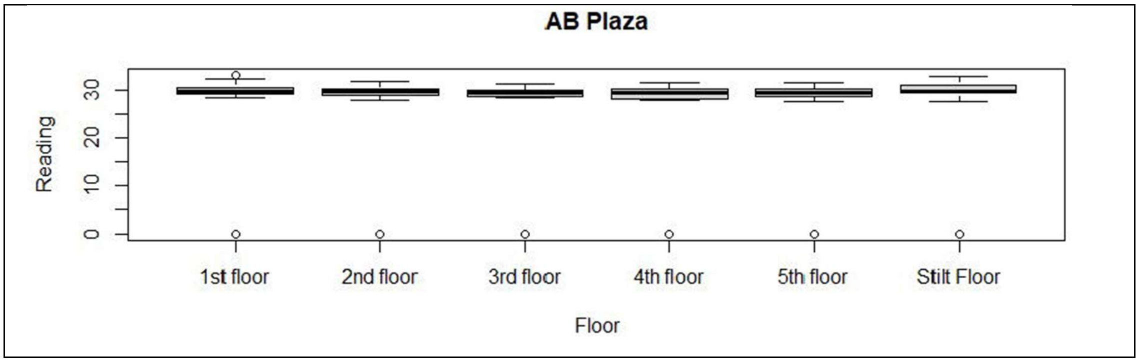
The significance test of the equality of floor means is carried out by analysis of variance.

	Estimate	Std. Error	t-value	p-value
GF	37.65772	0.63373	59.243	0
F1	0.16873	0.89623	0.188	0.851
F2	0.06354	0.89623	0.071	0.944
F3	0.17557	0.89623	0.196	0.845
F4	0.13228	0.89623	0.148	0.883
F5	1.13215	0.89623	1.263	0.207

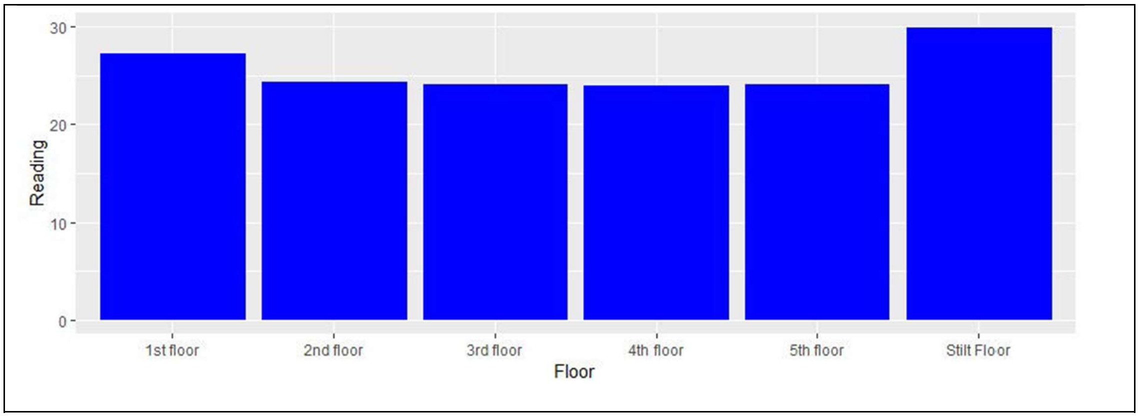
11. AB Plaza, Krishna Lanka, NH-16 & 65

This is a residential building with Stilt+5 floors, located in Krishna Lanka flood-affected area in between Krishna River and Bandar Canal abutting NH-16 & 65. The soil is black cotton/soft. The Geographic Coordinates of this building are 16°29’45” N and 80°38’49” E. The roof height of each floor is 3.00 m.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used and reading taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings all around the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis. There are 35 columns in Stilt floor and 33 columns each in F1 to F5 floors. Rebound Hammer readings are taken at 3 levels for each column wherever possible and an average of 12 readings at each level are considered as one reading for analysis purpose. There are 105 readings on the Stilt floor, 96 readings each in F1 and F5 upper floors, totaling to 545 readings in 6 floors. The box plots are shown below.



The means in first, second, third, fourth, fifth, and stilt floors are 27.28, 24.38, 24.07, 24.03, 24.12, and 29.96, respectively. The overall mean for the building is 25.64. The means are shown in the bar graph below.



The significance test of the equality of floor means is carried out by analysis of variance.

	Estimate	Std. Error	t-value	p-value
GF	27.277	1.013	26.940	0
F1	-2.896	1.432	-2.022	0.0436
F2	-3.212	1.432	-2.243	0.0252
F3	-3.251	1.432	-2.270	0.0235
F4	-3.159	1.432	-2.206	0.0277
F5	2.683	1.432	1.874	0.0614

12. Ranganath Residency, Bandar Road, Mogalrajpuram.

This is a residential building with Stilt+5 floors, located on plain ground in Mogalrajpuram near Bandar Road. The Geographic Coordinates of this building are 16°30’08” N and 80°39’01” E. The roof height of each floor is 3.00 m.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used and reading taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings all around the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis. There are 22 columns on the Stilt floor and 22 columns each in F1 to F5 floors. Rebound Hammer readings are taken at 3 levels for each column wherever possible and an average of 12 readings at each level are considered as one reading for analysis purposes. There are 648 readings on the Stilt floor, 376 in each upper floor totaling 2528 readings in 6 floors.

13. Chakradhar, No. 5 Route, ITI Road.

This is an office building with Stilt+5 floors, located in Ramachandra Nagar, facing ITI Road. The soil is black cotton/soft. The Geographic Coordinates of this building are 16°30’17”N and 80°39’19”E. The roof height of each floor is 3.00 m.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used, and reading taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m and 2.10 m from finished floor level. At every level maximum 12 readings all around the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis. There are 12 columns on the Stilt floor and 12 columns each in F1 to F5 floors. Rebound Hammer readings are taken at 3 levels for each column wherever possible and an average of 12 readings at each level are considered as one reading for analysis purposes. There are 387 readings on the Stilt floor, 153 in F1, 154 in F2, 153 in F3, and 147 each in F4 and F5 upper floors, totaling 1141 readings in 6 floors.

14. High School Road, Patamata.

This is an office-cum-residential building with stilt+4 floors located on plain ground facing High School Road in Auto Nagar area of Patamata with Geographic coordinates 16°30’03”N and 80°40’12”E. The roof height of each floor is 3.00 m.

To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used, and reading taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m, and 2.10 m from finished floor level. At every level maximum 12 readings all around the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis. There are 11 columns on the Stilt floor and 11 columns each in F1 to F4 floors. Rebound Hammer readings are taken at 3 levels for each column wherever possible and an average of 12 readings at each level are considered as one reading for analysis purpose. There are 297 readings on the Stilt floor, 177 in F1, 179 in F2, 208 in F3, and 182 in F4, totaling 1043 readings in 5 floors.

15. Machavaram, Narla Vari Street.

This is a residential building with Stilt+5 floors on plain ground at a distance of about 100m away from Ryves Canal between Vijayawada Bypass Road and Eluru Road in Machavaram down locality. The Geographic Coordinates of this location are 16°31’24” N and 80°39’13” E. The soils met with for foundations are Black Cotton soils. The height of each floor is 3.00 m. To ascertain the compressive strength of the existing RCC columns, Rebound Hammer is used, and reading taken perpendicular (90°) to face of each column at three levels of height i.e., 0.60 m, 1.35 m, and 2.10 m from finished floor level. At every level maximum 12 readings all around the column i.e., 3 readings on each face of the column 4 faces are taken and average adopted for analysis.

There are 13 columns in Stilt floor and 13 columns each in F1 to F5 floors. Rebound Hammer readings are taken at 3 levels for each column wherever possible and an average of 12 readings at each level are considered as one reading for analysis purpose. There are 411 readings on the Stilt floor and 216 readings each in F1 to F5 floors totaling to 1491 readings in 6 floors.

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Annexure V (Seismic Weight and Base Shear Calculations)

1. TICKLE ROAD, Ganesh Apartments, VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +

Weight of Beams (1) +

Weight of Slabs (1) +

½ Weight of Columns (1) +

½ Weight of Columns (2) +

½ Weight of Walls (1) +

½ Weight of Walls (2) +

Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm

Internal wall thickness: 230 mm

Specific weight of RCC: 25 KN / Cum

Specific weight of infill wall:20 KN / Cum

Type of soil: Medium

Size of columns:230 x 230 mm & 300 mm dia.

Size of Beams: 230 x 425 mm

Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN/ Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load 25%

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2

= ½ x (3.00-0.425) + ½ x (3.00-0.425) = **2.58 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2

= (½ x 3.00) + (½ x 3.00) = **3.00 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	16.37	11.06	0.125	25.00	565.79
Weight of columns 230x230 mm	17.00	0.23	0.23	3.00	25.00	67.45
300 mm dia.	11.00	3.14	0.023	3.00	25.00	58.34
Weight of Beams:						0.00
All beams in X-direction	3.00	0.23	16.37	0.425	25.00	120.01
	1.00	0.23	13.34	0.425	25.00	32.60
All beams in Y-direction	5.00	0.23	11.06	0.425	25.00	135.14

	1.00	0.23	2.72	0.425	25.00	6.65
	1.00	0.23	4.49	0.425	25.00	10.97
Weight of imposed Live Load (25%)	0.25	11.06	16.37	0.00	3.00	135.79
Weight of walls:						
All walls in X=direction:						
Internal walls:	1.00	0.23	5.14	2.58	20.00	61.00
	1.00	0.23	7.12	2.58	20.00	84.50
External walls:	1.00	0.23	6.06	2.58	20.00	71.92
	1.00	0.23	7.12	2.58	20.00	84.50
All walls in Y-direction:						
Internal walls:	1.00	0.23	9.06	2.58	20.00	107.52
	1.00	0.23	1.26	2.58	20.00	14.95
	1.00	0.23	4.26	2.58	20.00	50.56
External walls:	2.00	0.23	9.06	2.58	20.00	215.05
Total weight of 1st floor in KN :				**W1**		**1822.74**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd & 3rd FLOORS W2 & W3						
Weight of slab: (same as 1st floor)	1.00	16.37	11.06	0.125	25.00	565.79
Weight of columns: (same as 1st floor)	17.00	0.23	0.23	3.00	25.00	67.45
	11.00	3.14	0.023	3.00	25.00	58.34
Weight of Beams:						0.00
All beams in X-direction	3.00	0.23	16.37	0.425	25.00	120.01
	1.00	0.23	13.34	0.425	25.00	32.60
All beams in Y-direction	5.00	0.23	11.06	0.425	25.00	135.14
	1.00	0.23	2.72	0.425	25.00	6.65
	1.00	0.23	4.49	0.425	25.00	10.97
Weight of imposed Live Load: (same as 1st floor)	0.25	11.06	16.37	0.00	3.00	135.79
Weight of walls:						
All walls in X=direction:						
Internal walls:	1.00	0.23	15.37	2.58	20.00	182.41
	1.00	0.23	9.31	2.58	20.00	110.49
External walls:	2.00	0.23	15.37	2.58	20.00	364.82
All walls in Y-direction:						
Internal walls:	3.00	0.23	9.06	2.58	20.00	322.57
	2.00	0.23	1.26	2.58	20.00	29.91
	1.00	0.23	3.03	2.58	20.00	35.96
External walls:	2.00	0.23	9.06	2.58	20.00	215.05
Total weight of 2nd & 3rd floors each in KN :			**W2 = W3 =**			**2393.95**
Step 3: CALCULATION OF SEISMIC WEIGHT OF 4th Floor W4						
Weight of slab: (same as 1st floor)	1.00	16.37	11.06	0.125	25.00	565.79
Weight of Columns: = (½ x 3.00 Ht.) in floor 4	17.00	0.23	0.23	1.50	25.00	33.72
1/2 x 300mm dia.CS	11.00	3.14	0.023	1.50	25.00	29.17
Weight of beams: (same as 1st floor)						
All beams in X-direction	3.00	0.23	16.37	0.425	25.00	120.01
	1.00	0.23	13.34	0.425	25.00	32.60
All beams in Y-direction	5.00	0.23	11.06	0.425	25.00	135.14
	1.00	0.23	2.72	0.425	25.00	6.65
	1.00	0.23	4.49	0.425	25.00	10.97

Weight of imposed Live Load: (same as 1st floor)	0.25	11.06	16.37	0.00	3.00	135.79
Weight of walls:						
All walls in X=direction:						
Internal walls: (½ x 2.58 Ht.) in floor 4	1.00	0.23	15.37	1.29	20.00	91.21
	1.00	0.23	9.31	1.29	20.00	55.25
External walls: (½ x 2.58 Ht.) in floor 4	2.00	0.23	15.37	1.29	20.00	182.41
All walls in Y-direction:						
Internal walls: (½ x 2.58 Ht.)in floor 4	3.00	0.23	9.06	1.29	20.00	161.29
	2.00	0.23	1.26	1.29	20.00	14.95
	1.00	0.23	3.03	1.29	20.00	17.98
External walls: (½ x 2.58 Ht.)in floor 4	2.00	0.23	9.06	1.29	20.00	107.52
Total weight of 4th floor in KN :					**W4 =**	**1700.45**
Total seismic weight of the Building of all 4 floors in KN		**W1**	**W2**	**W3**	**W4**	**8311.09**
		1822.74	**2393.95**	**2393.95**	**1700.45**	

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1)
(Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x12/√ 15.37 = 0.275 Sec.

Ty = 0.09h/√dy = 0.09x12/√ 9.06 = 0.359 Sec.

(Sa/g)x = (Sa/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore Ah = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = 8311.09 x 0.04 = **332.44 KN**

(VB)y = **332.44 KN**

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2. SITARAMPURAM, (Durga Agraharam), VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +

Weight of Beams (1) +

Weight of Slabs (1) +

½ Weight of Columns (1) +

½ Weight of Columns (2) +

½ Weight of Walls (1) +

½ Weight of Walls (2) +

Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm

Internal wall thickness: 230 mm & 115 mm

Specific weight of RCC: 25 KN / Cum

Specific weight of infill wall: 20 KN / Cum

Type of soil: Medium

Size of columns: 300x400 mm, 300x500 mm and 300x650 mm.

Size of Beams: 300 x 450 mm

Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2

= ½ x (3.00-0.45) + ½ x (3.00-0.45) = **2.55 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2

=½ x 3.00 + ½ x 3.00 = **3.00 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	16.88	24.21	0.15	25.00	1525.64
(-)	1.00	2.10	0.87	0.15	25.00	
Weight of columns	6.00	0.30	0.40	3.00	25.00	54.00
	40.00	0.30	0.50	3.00	25.00	450.00
	2.00	0.30	0.65	3.00	25.00	29.25
Weight of Beams:						0.00
All beams in X-direction	4.00	0.30	16.88	0.45	25.00	227.88
	2.00	0.30	7.46	0.45	25.00	50.36

	1.00	0.30	2.70	0.45	25.00	9.11
All beams in Y-direction	4.00	0.30	24.21	0.45	25.00	326.84
	2.00	0.30	11.00	0.45	25.00	74.25
	2.00	0.30	11.65	0.45	25.00	78.64
Weight of imposed Live Load (25%)	0.25	0.00	0.00	0.00	1525.64	381.41
Weight of walls:						0.00
All walls in X=direction:						0.00
Internal walls:	2.00	0.23	6.86	2.55	20.00	160.94
	4.00	0.23	2.24	2.55	20.00	105.10
	3.00	0.12	6.86	2.55	20.00	120.70
	1.00	0.12	5.58	2.55	20.00	32.73
External walls:	1.00	0.23	13.53	2.55	20.00	158.71
	1.00	0.23	7.46	2.55	20.00	87.51
All walls in Y-direction:						0.00
Internal walls:	2.00	0.23	22.05	2.55	20.00	517.29
	2.00	0.23	9.83	2.55	20.00	230.61
External walls:	1.00	0.23	22.05	2.55	20.00	258.65
Total weight of 1st floor in KN :				**W1**		**4879.60**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd, 3rd, 4th & 5th FLOORS W2, W3, W4 & W5						
Weight of slab: (same as 1st floor)	1.00	16.88	24.21	0.15	25.00	1532.33
(-)	1.00	2.35	0.45	0.15	25.00	
Weight of columns: (same as 1st floor)	6.00	0.30	0.40	3.00	25.00	54.00
	40.00	0.30	0.50	3.00	25.00	450.00
	2.00	0.30	0.65	3.00	25.00	29.25
Weight of beams: (same as 1st floor)						0.00
All beams in X-direction	4.00	0.30	16.88	0.45	25.00	227.88
	2.00	0.30	7.46	0.45	25.00	50.36
	1.00	0.30	2.70	0.45	25.00	9.11
All beams in Y-direction	4.00	0.30	24.21	0.45	25.00	326.84
	2.00	0.30	11.00	0.45	25.00	74.25
	2.00	0.30	11.65	0.45	25.00	78.64
Weight of imposed Live Load: 25% (same as 1st floor)	0.25	0.00	0.00	0.00	1532.33	
Weight of walls:						0.00
All walls in **X=direction:**						0.00
Internal walls:	4.00	0.12	7.39	2.55	20.00	173.37
	4.00	0.12	5.56	2.55	20.00	130.44
	2.00	0.23	16.88	2.55	20.00	396.00
External walls:	2.00	0.23	16.88	2.55	20.00	396.00
All walls in **Y-direction:**						0.00
Internal walls:	4.00	0.12	9.49	2.55	20.00	222.52
	2.00	0.12	3.17	2.55	20.00	37.13
	2.00	0.12	2.90	2.55	20.00	34.02
	2.00	0.23	9.95	2.55	20.00	233.31
	1.00	0.23	9.70	2.55	20.00	113.78
	1.00	0.23	10.20	2.55	20.00	119.65
External walls:	2.00	0.23	9.95	2.55	20.00	233.31
	1.00	0.23	9.70	2.55	20.00	113.78
	1.00	0.23	10.20	2.55	20.00	119.65
Total weight of 2nd, 3rd, 4th & 5th floor each in KN :				**W2=W3=W4=W5=**		**5155.60**

Step 3: CALCULATION OF SEISMIC WEIGHT OF 6th Floor W6						
Weight of slab: (same as 1st floor)	1.00	16.88	24.21	0.15	25.00	1532.33
(-)	1.00	2.35	0.45	0.15	25.00	
Weight of columns: (same as 1st floor)	6.00	0.30	0.40	1.50	25.00	27.00
	40.00	0.30	0.50	1.50	25.00	225.00
	2.00	0.30	0.65	1.50	25.00	14.63
Weight of beams: (same as 1st floor)						0.00
All beams in X-direction	4.00	0.30	16.88	0.45	25.00	227.88
	2.00	0.30	7.46	0.45	25.00	50.36
	1.00	0.30	2.70	0.45	25.00	9.11
All beams in Y-direction	4.00	0.30	24.21	0.45	25.00	326.84
	2.00	0.30	11.00	0.45	25.00	74.25
	2.00	0.30	11.65	0.45	25.00	78.64
Weight of imposed Live Load: 25% (same as 1st floor)	0.25	0.00	0.00	0.00	1532.33	
Weight of walls:						0.00
All walls in **X=direction:**						0.00
Internal walls:	4.00	0.12	7.39	1.28	20.00	86.68
	4.00	0.12	5.56	1.28	20.00	65.22
	2.00	0.23	16.88	1.28	20.00	198.00
External walls:	2.00	0.23	16.88	1.28	20.00	198.00
All walls in **Y-direction:**						0.00
Internal walls:	4.00	0.12	9.49	1.28	20.00	111.26
	2.00	0.12	3.17	1.28	20.00	18.56
	2.00	0.12	2.90	1.28	20.00	17.01
	2.00	0.23	9.95	1.28	20.00	116.65
	1.00	0.23	9.70	1.28	20.00	56.89
	1.00	0.23	10.20	1.28	20.00	59.82
External walls:	2.00	0.23	9.95	1.28	20.00	116.65
	1.00	0.23	9.70	1.28	20.00	56.89
	1.00	0.23	10.20	1.28	20.00	59.82
Total weight of 6th floor:					**W6 =**	**3727.50**

Total seismic weight of the Building of all 4 floors in KN	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	
	4879.60	**5155.60**	**5155.60**	**5155.60**	**5155.60**	**3727.50**	**29229.50**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1) (Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x18/√16.88 = 0.394 Sec.

Ty = 0.09h/√dy = 0.09x18/√21.95 = 0.346 Sec.

(Sa/g)x = (Sa/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore Ah = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: CALCULATION OF BASE SHEAR (VB)

(VB)x = W x Ah(x) = 29229.50 x 0.04 = **1169.18 KN**

(VB)y = **1169.18 KN**

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3. GOVERNOR PET, Venkateswara Rao Street, VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +

Weight of Beams (1) +

Weight of Slabs (1) +

½ Weight of Columns (1) +

½ Weight of Columns (2) +

½ Weight of Walls (1) +

½ Weight of Walls (2) +

Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm

Internal wall thickness: 230 mm

Specific weight of RCC: 25 KN / Cum

Specific weight of infill wall: 20 KN / Cum

Type of soil: Medium

Size of columns: 230 x 380 mm

Size of Beams: 230 x 355 mm

Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2

= ½ x (3.00-0.355) + ½ x (3.00-0.355) = **2.645 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2

= (½ x 3.00) + (½ x 3.00) = **3.00 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	12.59	23.24	0.13	25.00	914.35
Weight of columns	32.00	0.23	0.38	3.00	25.00	209.76
Weight of Beams:						0.00
All beams in X-direction	8.00	0.23	12.59	0.38	25.00	220.07
All beams in Y-direction	4.00	0.23	23.24	0.38	25.00	203.12
Weight of imposed Live Load (25%)	0.25	12.59	23.24	0.00	3.00	219.44
Weight of walls:						
All walls in X=direction:						

Internal walls:	2.00	0.23	2.73	2.65	20.00	66.43
	2.00	0.23	10.79	2.65	20.00	262.56
	1.00	0.12	1.73	2.65	20.00	10.52
External walls:	1.00	0.23	2.73	2.65	20.00	33.22
	1.00	0.23	10.79	2.65	20.00	131.28
All walls in Y-direction:						
Internal walls:	1.00	0.23	6.64	2.65	20.00	80.79
	2.00	0.23	3.10	2.65	20.00	75.44
External walls:	1.00	0.23	8.59	2.65	20.00	104.51
	1.00	0.23	6.48	2.65	20.00	78.84
Total weight of 1st floor in KN :					**W1**	**2610.34**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd & 3rd FLOORS W2 & W3						
Weight of slab: (same as 1st floor)	1.00	12.59	23.24	0.13	25.00	914.35
Weight of columns: (same as 1st floor)	32.00	0.23	0.38	3.00	25.00	209.76
Weight of beams: (same as 1st floor)	8.00	0.23	12.59	0.38	25.00	220.07
	4.00	0.23	23.24	0.38	25.00	203.12
Weight of imposed Live Load: (same as 1st floor)	0.25	12.59	23.24	0.00	3.00	219.44
Weight of walls:						
All walls in X=direction:						
Internal walls:	6.00	0.23	10.79	2.65	20.00	787.69
	2.00	0.23	4.41	2.65	20.00	107.52
	1.00	0.12	1.73	2.65	20.00	10.54
External walls:	2.00	0.23	10.79	2.65	20.00	263.06
All walls in Y-direction:						
Internal walls:	1.00	0.23	17.05	2.65	20.00	207.45
	1.00	0.23	11.57	2.65	20.00	141.04
	1.00	0.23	5.00	2.65	20.00	60.95
External walls:	1.00	0.23	17.05	2.65	20.00	207.84
	1.00	0.23	19.74	2.65	20.00	240.63
Total weight of 2nd & 3rd floors each in KN : W2 = W3 =						**3793.46**
Step 3: CALCULATION OF SEISMIC WEIGHT OF 4th Floor W4						
Weight of slab: (same as 1st floor)	1.00	12.59	23.24	0.13	25.00	914.35
Weight of beams: (same as 1st floor)	8.00	0.23	12.59	0.38	25.00	220.07
	4.00	0.23	23.24	0.38	25.00	203.12
Weight of imposed Live Load: (same as 1st floor)	0.25	12.59	23.24	0.00	3.00	219.44
Weight of Columns: = (½ x 3.00 Ht.)in floor 4	32.00	0.23	0.38	1.50	25.00	104.88
All walls in X=direction:						
Internal walls: (½ x 2.65 Ht.)in floor 4	6.00	0.23	10.79	1.33	20.00	394.59
	2.00	0.23	4.41	1.33	20.00	53.76
	1.00	0.23	1.73	1.33	20.00	10.54
External walls: (½ x 2.65 Ht.)in floor 4	2.00	0.23	10.79	1.33	20.00	131.53
All walls in Y-direction:						
Internal walls: (½ x 2.65 Ht.)in floor 4	1.00	0.23	17.05	2.65	20.00	207.45
	1.00	0.23	11.57	2.65	20.00	141.04
	1.00	0.23	5.00	2.65	20.00	60.95
External walls: (½ x 2.65 Ht.)in floor 4	1.00	0.23	17.05	2.65	20.00	207.84

	1.00	0.23	19.74	2.65	20.00	240.63
Total weight of 4th floor in KN :					**W4 =**	**3110.19**
Total seismic weight of the Building all 4 floors		**W1**	**W2**	**W3**	**W4**	**13307.45 KN**
		2610.3	**3793.5**	**3793.5**	**3110.19**	

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1)
(Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x12.00/√10.79 = 0.329 Sec.

Ty = 0.09h/√dy = 0.09x12.00/√21.44 = 0.233 Sec.

(Sa/g)x = (Sa/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore **Ah** = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = 13307.45 x 0.04 = **532.30 KN**

(VB)y = **532.30 KN**

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4. MADAPATI CHOULTRY, VIJAYAWADA 30th Jun.2022

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +
Weight of Beams (1) +
Weight of Slabs (1) +
½ Weight of Columns (1) +
½ Weight of Columns (2) +
½ Weight of Walls (1) +
½ Weight of Walls (2) +
Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 300 mm
Internal wall thickness: 230 mm
Specific weight of RCC: 25 KN / Cum
Specific weight of infill wall: 20 KN / Cum
Type of soil: Medium
Size of columns: 300 x 500 mm
Size of Beams: 230 x 450 mm
Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2
= ½ x (3.66-0.45) + ½ x (3.66-0.45) = **3.21 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2
= (½ x 3.66) + (½ x 3.66) = **3.66 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	15.35	17.40	0.15	25.00	1001.59
Weight of columns	24.00	0.30	0.50	3.66	25.00	329.40
Weight of Beams:						
All beams in X-direction	6.00	0.23	0.45	15.35	25.00	
All beams in Y-direction	4.00	0.23	0.45	17.40	25.00	180.09
Weight of imposed Live Load (25%)	0.25	15.35	17.40	0.00	3.00	200.32
Weight of walls:						
All walls in X=direction:						
Internal walls:	6.00	0.23	5.60	3.21	20.00	496.14
External walls:	2.00	0.30	5.60	3.21	20.00	215.71

	1.00	0.30	2.15	3.21	20.00	41.41
All walls in Y-direction:						
Internal walls:	2.00	0.23	3.20	3.21	20.00	94.50
	2.00	0.23	3.00	3.21	20.00	88.60
	2.00	0.23	3.20	3.21	20.00	94.50
	3.00	0.23	3.40	3.21	20.00	150.61
External walls:	2.00	0.30	3.20	3.21	20.00	123.26
	2.00	0.30	3.00	3.21	20.00	115.56
	2.00	0.30	3.20	3.21	20.00	123.26
	2.00	0.30	3.40	3.21	20.00	130.97
Total weight of 1st floor in KN :				**W1**		**3385.92**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd & 3rd FLOORS W2 & W3						
Weight of slab: (same as 1st floor)	1.00	15.35	17.40	0.15	25.00	1001.59
Weight of columns: (same as 1st floor)	24.00	0.30	0.50	3.66	25.00	329.40
Weight of beams: (same as 1st floor)	6.00	0.23	0.45	15.35	25.00	238.31
	4.00	0.23	0.45	17.40	25.00	180.09
Weight of imposed Live Load: (same as 1st floor)	0.25	15.35	17.40	0.00	3.00	200.32
Weight of walls:						
All walls in X=direction:						
Internal walls:	7.00	0.23	5.60	3.21	20.00	578.83
External walls:	4.00	0.30	5.60	3.21	20.00	431.42
	1.00	0.30	2.15	3.21	20.00	41.41
All walls in Y-direction:						
Internal walls:	2.00	0.23	2.94	3.21	20.00	86.82
	2.00	0.23	3.00	3.21	20.00	88.60
	4.00	0.23	3.20	3.21	20.00	189.00
	3.00	0.23	3.40	3.21	20.00	150.61
External walls:	2.00	0.30	2.94	3.21	20.00	113.25
	2.00	0.30	3.00	3.21	20.00	115.56
	4.00	0.30	3.20	3.21	20.00	246.53
	2.00	0.30	3.40	3.21	20.00	130.97
Total weight of 2nd & 3rd floors each in KN :			**W2 = W3 =**			**4122.71**
Step 3: CALCULATION OF SEISMIC WEIGHT OF 4th Floor W4						
Weight of slab: (same as 1st floor)	1.00	15.35	17.40	0.15	25.00	1001.59
Weight of beams: (same as 1st floor)	6.00	0.23	0.45	15.35	25.00	238.31
	4.00	0.23	0.45	17.40	25.00	180.09
Weight of imposed Live Load: (same as 1st floor)	0.25	15.35	17.40	0.00	3.00	200.32
Weight of Columns: = (½ x 3.66 Ht.)in floor 4	24.00	0.30	0.50	1.83	25.00	164.70
All walls in X=direction:						
Internal walls: (½ x 3.21 Ht.)in floor 4	7.00	0.23	5.60	1.61	20.00	290.32
External walls: (½ x 3.21 Ht.)in floor 4	4.00	0.30	5.60	1.61	20.00	216.38
	1.00	0.30	2.15	1.61	20.00	20.77
All walls in Y-direction:						
Internal walls: (½ x 3.21 Ht.)in floor 4	2.00	0.23	2.94	1.61	20.00	43.55
	2.00	0.23	3.00	1.61	20.00	44.44
	4.00	0.23	3.20	1.61	20.00	94.80
	3.00	0.23	3.40	1.61	20.00	75.54

External walls: (½ x 3.21 Ht.)in floor 4	2.00	0.30	2.94	1.61	20.00	56.80
	2.00	0.30	3.00	1.61	20.00	57.96
	4.00	0.30	3.20	1.61	20.00	123.65
	2.00	0.30	3.40	1.61	20.00	65.69
Total weight of 4th floor in KN :					**W4 =**	**2874.89**
Total seismic weight of the Building of all 4 floors		**W1**	**W2**	**W3**	**W4**	**14506.23 KN**
		3385.9	**4123**	**4122.7**	**2874.89**	

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1)
(Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x14.64/√ 15.35 = 0.336 Sec.

Ty = 0.09h/√dy = 0.09x14.64/√ 17.40 = 0.316 Sec.

(**S**a/g)x = (**S**a/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore **Ah** = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = 14506.23 x 0.04 = **580.25 KN**

(VB)y = **580.25 KN**

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5. JAMMIDODDI, Endowments Dept. Office Bldg., Indrakiladri, VIJAYAWADA 30th Jun.2022

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +

Weight of Beams (1) +

Weight of Slabs (1) +

½ Weight of Columns (1) +

½ Weight of Columns (2) +

½ Weight of Walls (1) +

½ Weight of Walls (2) +

Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm

Internal wall thickness: 230 mm

Specific weight of RCC: 25 KN / Cum

Specific weight of infill wall: 20 KN / Cum

Type of soil: Medium

Size of columns: 250 x 650 mm

Size of Beams: 250 x 600 mm

Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2

= ½ x (3.75-0.60) + ½ x (3.75-0.60) = **3.15 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2

= (½ x 3.75) + (½ x 3.75) = **3.75 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	31.51	9.79	0.15	25.00	1156.81
	1.00	10.46	19.51	0.15	25.00	765.28
Weight of columns	28.00	0.25	0.65	3.75	25.00	426.56
Weight of Beams:						0.00
All beams in X-direction	4.00	0.25	10.46	0.60	25.00	156.90
	1.00	0.25	21.05	0.60	25.00	78.94
	3.00	0.25	31.51	0.60	25.00	354.49
All beams in Y-direction	5.00	0.25	0.45	0.60	25.00	8.44
	4.00	0.25	9.79	0.60	25.00	146.85
Weight of imposed Live Load (25%)	0.25	31.51	9.79	0.00	3.00	231.36
	0.25	10.46	19.51	0.00	3.00	150.06

Weight of walls:						0.00
All walls in X=direction:						0.00
Internal walls:	1.00	0.23	11.76	3.15	20.00	170.40
External walls:	1.00	0.23	21.05	3.15	20.00	305.01
	1.00	0.23	31.51	3.15	20.00	456.58
All walls in Y-direction:						0.00
Internal walls:	2.00	0.23	9.79	3.15	20.00	283.71
	2.00	0.12	9.79	3.15	20.00	141.86
External walls:	1.00	0.23	5.83	3.15	20.00	84.48
	1.00	0.23	8.33	3.15	20.00	120.70
Total weight of 1st floor in KN :					**W1**	**5038.43**
Step 2: CACULATION OF SEISMIC WEIGHT OF			**2nd & 3rd FLOORS**			**W2 & W3**
Weight of slab: (same as 1st floor)	1.00	31.51	9.79	0.15	25.00	1156.81
	1.00	10.46	19.51	0.15	25.00	765.28
Weight of columns: (same as 1st floor)	28.00	0.25	0.65	3.75	25.00	426.56
Weight of beams: (same as 1st floor)						0.00
All beams in X-direction	4.00	0.25	10.46	0.60	25.00	156.90
	1.00	0.25	21.05	0.60	25.00	78.94
	3.00	0.25	31.51	0.60	25.00	354.49
All beams in Y-direction	5.00	0.25	0.45	0.60	25.00	8.44
	4.00	0.25	9.79	0.60	25.00	146.85
Weight of imposed Live Load: 25% (same as 1st floor)	0.25	31.51	9.79	0.00	3.00	231.36
	0.25	10.46	19.51	0.00	3.00	150.06
Weight of walls:						0.00
All walls in **X=direction:**						0.00
Internal walls:	4.00	0.23	10.46	3.15	20.00	606.26
	4.00	0.23	2.29	3.15	20.00	132.73
	1.00	0.23	2.97	3.15	20.00	43.04
	1.00	0.12	5.68	3.15	20.00	68.76
External walls:	1.00	0.23	16.18	3.15	20.00	234.45
	1.00	0.23	31.51	3.15	20.00	456.58
	1.00	0.23	20.00	3.15	20.00	289.80
	1.00	0.23	10.46	3.15	20.00	151.57
All walls in **Y-direction:**						0.00
Internal walls:	1.00	0.23	17.89	3.15	20.00	259.23
	1.00	0.23	5.10	3.15	20.00	73.90
	2.00	0.23	4.05	3.15	20.00	117.37
	5.00	0.23	8.33	3.15	20.00	603.51
	2.00	0.23	2.24	3.15	20.00	64.92
	1.00	0.12	6.18	3.15	20.00	44.77
External walls:	1.00	0.23	29.30	3.15	20.00	424.56
	1.00	0.23	19.51	3.15	20.00	282.70
	1.00	0.23	9.79	3.15	20.00	141.86
Total weight of 2nd & 3rd floors each in KN :				**W2 = W3 =**		**7471.67**
Step 3: CALCULATION OF SEISMIC WEIGHT OF				**4th Floor**	**W4**	
Weight of slab: (same as 1st floor)	1.00	31.51	9.79	0.15	25.00	1156.81
	1.00	10.46	19.51	0.15	25.00	765.28
Weight of columns: (same as 1st floor)	28.00	0.25	0.65	3.75	25.00	426.56
Weight of beams: (same as 1st floor)						
All beams in X-direction	4.00	0.25	10.46	0.60	25.00	156.90

	1.00	0.25	21.05	0.60	25.00	78.94
	3.00	0.25	31.51	0.60	25.00	354.49
All beams in Y-direction	5.00	0.25	0.45	0.60	25.00	8.44
	4.00	0.25	9.79	0.60	25.00	146.85
Weight of imposed Live Load 25% (same as 1st floor)	0.25	31.51	9.79	0.00	3.00	231.36
	0.25	10.46	19.51	0.00	3.00	150.06
All walls in X=direction:						
Internal walls: (½ x 3.15 Ht.)in floor 4	7.00	0.23	5.60	1.58	20.00	284.00
External walls: (½ x 3.15 Ht.)in floor 4	4.00	0.30	5.60	1.58	20.00	211.68
	1.00	0.30	2.15	1.58	20.00	20.32
All walls in Y-direction:						
Internal walls: (½ x 3.15 Ht.)in floor 4	2.00	0.23	2.94	1.58	20.00	42.60
	2.00	0.23	3.00	1.58	20.00	43.47
	4.00	0.23	3.20	1.58	20.00	92.74
	3.00	0.23	3.40	1.58	20.00	73.90
External walls: (½ x 3.15 Ht.)in floor 4	2.00	0.30	2.94	1.58	20.00	55.57
	2.00	0.30	3.00	1.58	20.00	56.70
	4.00	0.30	3.20	1.58	20.00	120.96
	2.00	0.30	3.40	1.58	20.00	64.26
Total weight of 4th floor in KN :					**W4 =**	**4541.88**

	W1	W2	W3	W4	
Total seismic weight of the Building of all 4 floors	**5038.43**	**7471.67**	**7471.67**	**4541.88**	**24523.65 KN**

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1)
(Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x15/√30.16 = 0.246 Sec.

Ty = 0.09h/√dy = 0.09x15/√28.10 = 0.255 Sec.

(Sa/g)x = (Sa/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore Ah = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = 24523.65 x 0.04 = **980.946 KN**

(VB)y = 980.946 KN

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6. MAHANADU Rd., Sriramachandranagar, VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +

Weight of Beams (1) +

Weight of Slabs (1) +

½ Weight of Columns (1) +

½ Weight of Columns (2) +

½ Weight of Walls (1) +

½ Weight of Walls (2) +

Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm

Internal wall thickness: 115 mm

Specific weight of RCC: 25 KN / Cum

Specific weight of infill wall: 20 KN / Cum

Type of soil: Medium

Size of columns: 230x450mm, 230x600mm, 230x750mm and 450x450mm.

Size of Beams: 230 x 450 mm

Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2

= ½ x (2.75-0.45) + ½ x (3.00-0.45) = **2.425 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2

= (½ x 2.75) + (½ x 3.00) = **2.875 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	16.61	13.86	0.15	25.00	863.30
	1.00	9.08	0.60	0.15	25.00	20.44
Weight of columns	4.00	0.23	0.45	2.88	25.00	29.76
	2.00	0.23	0.60	2.88	25.00	19.84
	8.00	0.23	0.75	2.88	25.00	99.19
	1.00	0.45	0.45	2.88	25.00	14.55
Weight of Beams:						0.00

All beams in X-direction	3.00	0.23	16.61	0.45	25.00	128.94
	1.00	0.23	13.87	0.45	25.00	35.89
	1.00	0.23	5.52	0.45	25.00	14.28
All beams in Y-direction	4.00	0.23	13.26	0.45	25.00	137.24
	1.00	0.23	5.03	0.45	25.00	13.03
	1.00	0.23	7.01	0.45	25.00	18.14
Weight of imposed Live Load (25%)	0.25	16.61	13.26	0.00	3.00	165.19
Weight of walls:						0.00
All walls in X-direction:						0.00
Internal walls:	2.00	0.23	2.13	2.75	25.00	67.36
	2.00	0.23	1.68	2.43	20.00	15.42
External walls:	1.00	0.23	5.64	2.43	20.00	62.89
All walls in Y-direction:						
Internal walls:	2.00	0.23	2.44	2.75	25.00	77.17
	1.00	0.23	3.00	1.83	20.00	25.25
	2.00	0.23	5.03	2.43	20.00	112.31
External walls:	1.00	0.23	6.48	2.43	20.00	72.28
	1.00	0.23	1.07	2.43	20.00	11.94
Total weight of 1st floor in KN :					**W1**	**2004.40**
Step 2:CACULATION OF SEISMIC WEIGHT OF 2nd, 3rd, 4th & 5th Floors W2,W3,W4 & W5						
Weight of slab: (same as 1st floor)	1.00	16.61	13.86	0.15	25.00	863.30
	1.00	9.08	0.60	0.15	25.00	20.44
Weight of columns: (same as 1st floor)	4.00	0.23	0.45	3.00	25.00	31.05
	2.00	0.23	0.60	3.00	25.00	20.70
	8.00	0.23	0.75	3.00	25.00	103.50
	1.00	0.45	0.45	3.00	25.00	15.19
Weight of beams: (same as 1st floor)						
All beams in X-direction	3.00	0.23	16.61	0.45	25.00	128.94
	1.00	0.23	13.87	0.45	25.00	35.89
	1.00	0.23	5.52	0.45	25.00	14.28
All beams in Y-direction	4.00	0.23	13.26	0.45	25.00	137.24
	1.00	0.23	5.03	0.45	25.00	13.03
	1.00	0.23	7.01	0.45	25.00	18.14
Weight of imposed Live Load (25%)	0.25	16.61	13.26	0.00	3.00	165.19
Weight of walls:						
All walls in X-direction:						
Internal walls:	2.00	0.12	13.32	3.00	20.00	183.82
	1.00	0.12	2.44	3.00	20.00	16.84
	2.00	0.12	1.52	3.00	20.00	20.98
	2.00	0.23	2.44	3.00	25.00	84.18
External walls:	2.00	0.23	16.61	3.00	20.00	458.44
All walls in Y-direction:						
Internal walls:	1.00	0.23	10.82	3.00	20.00	149.32
	2.00	0.23	2.44	3.00	25.00	84.18
	1.00	0.12	5.75	3.00	20.00	39.68
	2.00	0.12	13.26	3.00	20.00	182.99
External walls:	2.00	0.23	13.26	3.00	20.00	365.98
Total weight of each 2nd, 3rd, 4th & 5th floors in KN :			**W2=W3=W4=W5=**			**3153.26**

Step 3: CALCULATION OF SEISMIC WEIGHT OF 6th Floor W6						
Weight of slab: (same as 1st floor)	1.00	16.61	13.86	0.15	25.00	863.30
	1.00	9.08	0.60	0.15	25.00	20.44
Wt.of Columns:=(½ x 3.00 Ht.) in floor 6	4.00	0.23	0.45	1.50	25.00	15.53
	2.00	0.23	0.60	1.50	25.00	10.35
	8.00	0.23	0.75	1.50	25.00	51.75
	1.00	0.45	0.45	1.50	25.00	7.59
Weight of beams: (same as 1st floor)						
All beams in X-direction	3.00	0.23	16.61	0.45	25.00	128.94
	1.00	0.23	13.87	0.45	25.00	35.89
	1.00	0.23	5.52	0.45	25.00	14.28
All beams in Y-direction	4.00	0.23	13.26	0.45	25.00	137.24
	1.00	0.23	5.03	0.45	25.00	13.03
	1.00	0.23	7.01	0.45	25.00	18.14
Weight of imposed Live Load (25%)	0.25	16.61	13.26	0.00	3.00	165.19
Weight of walls:						
All walls in X-direction:						
Internal walls: (½ x 3.00 Ht.)in floor 4	2.00	0.12	13.32	1.50	20.00	91.91
	1.00	0.12	2.44	1.50	20.00	8.42
	2.00	0.12	1.52	1.50	20.00	10.49
	2.00	0.23	2.44	1.50	25.00	42.09
External walls: (½ x 3.00 Ht.)in floor 4	2.00	0.23	16.61	1.50	20.00	229.22
All walls in Y-direction:						
Internal walls:	1.00	0.23	10.82	1.50	20.00	74.66
	2.00	0.23	2.44	1.50	25.00	42.09
	1.00	0.12	5.75	1.50	20.00	19.84
	2.00	0.12	13.26	1.50	20.00	91.49
External walls:	2.00	0.23	13.26	1.50	20.00	182.99
Total weight of 4th floor in KN :				**W4 =**		**2274.85**

Total seismic weight of the Building all 6 floors in KN	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**16892.29 KN**
	2004.40	**3153.3**	**3153.26**	**3153.26**	**3153.26**	**2274.85**	

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1)
(Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x17.75/√ 16.61 = 0.392 Sec.

Ty = 0.09h/√dy = 0.09x17.75/√ 13.26 = 0.439 Sec.

(Sa/g)x = (Sa/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore Ah = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = 16892.29 x 0.04 = **675.69 KN**

(VB)y = **675.69 KN**

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7. BRINDAVAN, LABBIPET, VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +

Weight of Beams (1) +

Weight of Slabs (1) +

½ Weight of Columns (1) +

½ Weight of Columns (2) +

½ Weight of Walls (1) +

½ Weight of Walls (2) +

Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm

Internal wall thickness: 115 mm

Specific weight of RCC: 25 KN / Cum

Specific weight of infill wall: 20 KN / Cum

Type of soil: Medium

Size of columns: 230x300 mm, 300x450mm and 300x600mm

Size of Beams: 230 x 375 mm

Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2

= ½ x (2.50-0.375) + ½ x (3.00-0.375) = **2.375 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2

= (½ x 2.50) + (½ x 3.00) = **2.75 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	12.42	17.27	0.13	25.00	670.29
Weight of columns	4.00	0.23	0.30	2.75	25.00	18.98
	8.00	0.30	0.45	2.75	25.00	74.25
	8.00	0.30	0.60	2.75	25.00	99.00
Weight of Beams:						0.00
All beams in X-direction	4.00	0.23	12.42	0.43	25.00	121.41
	2.00	0.23	1.52	0.43	25.00	7.43
All beams in Y-direction	4.00	0.23	17.27	0.43	25.00	168.81
	2.00	0.23	1.52	0.43	25.00	7.43
Weight of imposed Live Load (25%)	0.25	12.42	17.27	0.00	3.00	160.87
Weight of walls:						0.00

All walls in X=direction:						0.00
Internal walls:	2.00	0.23	3.54	2.38	20.00	77.35
	1.00	0.12	3.54	2.38	20.00	19.38
External walls:	1.00	0.23	3.54	2.38	20.00	161.87
All walls in Y-direction:						0.00
Internal walls:	1.00	0.23	5.43	2.38	20.00	59.45
External walls:	1.00	0.23	5.43	2.38	20.00	59.45
Total weight of 1st floor in KN :				**W1**		**1705.96**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd & 3rd FLOORS W2 & W3						
Weight of slab: (same as 1st floor)	1.00	15.35	17.40	0.15	25.00	1001.59
Weight of columns: (same as 1st floor)	24.00	0.30	0.50	3.66	25.00	329.40
Weight of beams: (same as 1st floor)	6.00	0.23	0.45	15.35	25.00	238.31
	4.00	0.23	0.45	17.40	25.00	180.09
Weight of imposed Live Load: (same as 1st floor)	0.25	15.35	17.40	0.00	3.00	200.32
Weight of walls:						
All walls in X=direction:						
Internal walls:	7.00	0.23	5.60	3.21	20.00	578.83
External walls:	4.00	0.30	5.60	3.21	20.00	431.42
	1.00	0.30	2.15	3.21	20.00	41.41
All walls in Y-direction:						
Internal walls:	2.00	0.23	2.94	3.21	20.00	86.82
	2.00	0.23	3.00	3.21	20.00	88.60
	4.00	0.23	3.20	3.21	20.00	189.00
	3.00	0.23	3.40	3.21	20.00	150.61
External walls:	2.00	0.30	2.94	3.21	20.00	113.25
	2.00	0.30	3.00	3.21	20.00	115.56
	4.00	0.30	3.20	3.21	20.00	246.53
	2.00	0.30	3.40	3.21	20.00	130.97
Total weight of 2nd & 3rd floors each in KN :			**W2 = W3 =**			**4122.71**
Step 3: CALCULATION OF SEISMIC WEIGHT OF 4th Floor W4						
Weight of slab: (same as 1st floor)	1.00	15.35	17.40	0.15	25.00	1001.59
Weight of beams: (same as 1st floor)	6.00	0.23	0.45	15.35	25.00	238.31
	4.00	0.23	0.45	17.40	25.00	180.09
Weight of imposed Live Load: (same as 1st floor)	0.25	15.35	17.40	0.00	3.00	200.32
Weight of Columns: = (½ x 3.66 Ht.)in floor 4	24.00	0.30	0.50	1.83	25.00	164.70
All walls in X=direction:						
Internal walls: (½ x 3.21 Ht.)in floor 4	7.00	0.23	5.60	1.61	20.00	290.32
External walls: (½ x 3.21 Ht.)in floor 4	4.00	0.30	5.60	1.61	20.00	216.38
	1.00	0.30	2.15	1.61	20.00	20.77
All walls in Y-direction:						
Internal walls: (½ x 3.21 Ht.)in floor 4	2.00	0.23	2.94	1.61	20.00	43.55
	2.00	0.23	3.00	1.61	20.00	44.44
	4.00	0.23	3.20	1.61	20.00	94.80
	3.00	0.23	3.40	1.61	20.00	75.54
External walls: (½ x 3.21 Ht.)in floor 4	2.00	0.30	2.94	1.61	20.00	56.80
	2.00	0.30	3.00	1.61	20.00	57.96
	4.00	0.30	3.20	1.61	20.00	123.65

	2.00	0.30	3.40	1.61	20.00	65.69
Total weight of 4th floor in KN :					**W4 =**	**2874.89**
Total seismic weight of the Building of all 4 floors		**W1**	**W2**	**W3**	**W4**	**14506.23 KN**
		3385.92	**4122.71**	**4122.71**	**2874.89**	

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1)
(Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

$T_x = 0.09h/\sqrt{dx} = 0.09x14.64/\sqrt{15.35} = 0.336$ Sec.

$T_y = 0.09h/\sqrt{dy} = 0.09x14.64/\sqrt{17.40} = 0.316$ Sec.

$(Sa/g)_x = (Sa/g)_y = 2.5$ (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore **Ah** = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = 14770.53 x 0.04 = **590.82 KN**

(VB)y = **590.82 KN**

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8. GPV-ECE Block, VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +
Weight of Beams (1) +
Weight of Slabs (1) +
½ Weight of Columns (1) +
½ Weight of Columns (2) +
½ Weight of Walls (1) +
½ Weight of Walls (2) +
Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm
Internal wall thickness: 230 mm
Specific weight of RCC: 25 KN / Cum
Specific weight of infill wall: 20 KN / Cum
Type of soil: Medium
Size of columns: 230x450 mm and 230x230 mm
Size of Beams: 230x600 mm and 230 x 450 mm
Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st Floor W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2
= ½ x (3.75-0.45) + ½ x (3.75-0.45) = **3.30 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2
= (½ x 3.75) + (½ x 3.75) = **3.75 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	10.53	52.46	0.15	25.00	2071.51
Weight of columns	34.00	0.23	0.45	3.75	25.00	329.91
	16.00	0.23	0.23	3.75	25.00	79.35
Weight of Beams:						0.00
All beams in X-direction	3.00	0.23	52.46	0.45	25.00	407.22
All beams in Y-direction	16.00	0.23	2.42	0.45	25.00	99.98
	16.00	0.23	8.33	0.60	25.00	459.82
Weight of imposed Live Load (25%)	0.25	10.53	52.46	0.00	3.00	414.30
Weight of walls:						0.00
All walls in **X=direction:**						
Internal walls:	1.00	0.23	47.36	3.30	20.00	718.92

External walls:	1.00	0.23	52.46	3.30	20.00	796.34
	1.00	0.23	47.36	3.30	20.00	718.92
All walls in **Y-direction:**						0.00
Internal walls:	6.00	0.23	7.70	3.15	20.00	669.44
External walls:	2.00	0.23	9.77	3.15	20.00	283.13
Total weight of 1st floor in KN :					**W1 ..**	**7048.85**
Step 2: CACULATION OF SEISMIC WEIGHT OF					**2nd Floor**	**W2**
Weight of slab: (same as 1st floor)	1.00	10.53	52.46	0.15	25.00	2071.51
Weight of columns: (same as 1st floor)	34.00	0.23	0.45	3.75	25.00	329.91
	16.00	0.23	0.23	3.75	25.00	79.35
Weight of beams: (same as 1st floor)						
All beams in X-direction	3.00	0.23	52.46	0.45	25.00	407.22
All beams in Y-direction	16.00	0.23	2.42	0.45	25.00	99.98
	16.00	0.23	8.33	0.60	25.00	459.82
Weight of imposed Live Load: (same as 1st floor)	0.25	10.53	52.46	0.00	3.00	414.30
Weight of walls:						
All walls in X=direction:						
Internal walls:	1.00	0.23	47.36	3.30	20.00	718.92
External walls:	2.00	0.23	52.46	3.30	20.00	1592.69
All walls in Y-direction:						
Internal walls:	6.00	0.23	7.70	3.15	20.00	669.44
External walls:	2.00	0.23	9.77	3.15	20.00	283.13
Total weight of 2nd floor in KN :					**W2**	**7126.27**
Step 3: CALCULATION OF SEISMIC WEIGHT OF				**3rd Floor**	**W3**	
Weight of slab: (same as 1st floor)	1.00	10.53	52.46	0.15	25.00	2071.51
Weight of beams: (same as 1st floor)						
All beams in **X-direction**	3.00	0.23	52.46	0.45	25.00	407.22
All beams in **Y-direction**	16.00	0.23	2.42	0.45	25.00	99.98
	16.00	0.23	8.33	0.60	25.00	459.82
Weight of imposed Live Load: (same as 1st floor)	0.25	10.53	52.46	0.00	3.00	414.30
Weight of Columns: = (½ x 3.75 Ht.)in floor 3	34.00	0.23	0.45	1.88	25.00	164.95
	16.00	0.23	0.23	1.88	25.00	39.78
Weight of walls:						
All walls in **X=direction:**						
Internal walls: (½ x 3.30 Ht.) in floor 3	1.00	0.23	47.36	3.30	20.00	718.92
External walls:(½ x 3.30 Ht.) in floor 3	2.00	0.23	52.46	3.30	20.00	1592.69
All walls in **Y-direction**:						
Internal walls: (½ x 3.15 Ht.) in floor 3	6.00	0.23	7.70	1.58	20.00	334.72
External walls: (½ x3.15 Ht.) in floor 3	2.00	0.23	9.77	1.58	20.00	141.57
Total weight of 3rd floor in KN :					**W3 =**	**6445.46**
Total seismic weight of the building of all 3 floors			**W1**	**W2**	**W3**	**20620.58 KN**
			7048.85	**7126.27**	**6445.46**	
Step 4: CALCULATION OF Ah						
Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**						
Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1) (Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)						
Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)						
Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)						

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x11.25/√52.46 = 0.140 Sec.

Ty = 0.09h/√dy = 0.09x11.25/√10.53 = 0.312 Sec.

(**S**a/g)x = (**S**a/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore **A**h = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: CALCULATION OF BASE SHEAR (VB)

(VB)x = W x Ah(x) = **20620.58** x 0.04 = **824.82 KN**

(VB)y = **824.82 KN**

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9. GPV - HOSTEL Block, VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +
Weight of Beams (1) +
Weight of Slabs (1) +
½ Weight of Columns (1) +
½ Weight of Columns (2) +
½ Weight of Walls (1) +
½ Weight of Walls (2) +
Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm
Internal wall thickness: 230 mm
Specific weight of RCC: 25 KN / Cum
Specific weight of infill wall: 20 KN / Cum
Type of soil: Medium
Size of columns: 230x380, 300X550, 500X500 mm and 300mm Dia.
Size of Beams: 230 x 450 mm and 300 x 380 mm
Response spectra: IS 1893(Part 1) : 2002
Assumption: Live Load 3.00 KN / Sqm
Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF W1 1st Floor

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2
= ½ x (3.18-0.45) + ½ x (3.18-0.45) = **2.73 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2
= (½ x 3.18) + (½ x 3.18) = **3.18 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	2.00	38.63	8.00	0.13	25.00	1931.50
	2.00	18.29	8.00	0.13	25.00	914.50
	2.00	7.54	3.45	0.15	25.00	195.10
Weight of columns	50.0	0.30	0.55	3.18	25.00	655.88
	8.00	0.50	0.50	3.18	25.00	159.00
	8.00	0.23	0.38	3.18	25.00	55.59
	16.0	0.30 dia.	0.00	3.18	25.00	89.95

Weight of Beams:						0.00
All beams in X-direction	4.00	0.23	38.63	0.45	25.00	399.82
	10.00	0.23	5.94	0.45	25.00	153.70
	2.00	0.23	7.54	0.45	25.00	39.02
	2.00	0.30	22.55	0.38	25.00	128.54
All beams in Y-direction	4.00	0.23	34.29	0.45	25.00	354.90
	12.0	0.23	5.94	0.45	25.00	184.44
	4.00	0.23	3.45	0.45	25.00	35.71
	2.00	0.30	18.29	0.38	25.00	104.25
Weight of imposed Live Load (25%)	0.25				5401.88	1350.47
Weight of walls:						0.00
All walls in **X=direction:**						
Internal walls:	1.00	0.23	38.63	2.73	20.00	485.12
	4.00	0.23	4.73	2.73	20.00	237.60
	2.00	0.23	17.32	2.73	20.00	435.01
	10.0	0.23	5.49	2.73	20.00	689.43
External walls:	1.00	0.23	38.63	2.73	20.00	485.12
	1.00	0.23	33.45	2.73	20.00	420.07
	2.00	0.23	5.49	2.73	20.00	137.89
All walls in **Y-direction:**						0.00
Internal walls:	2.00	0.23	17.55	2.73	20.00	440.79
	16.0	0.23	5.49	2.73	20.00	1103.09
External walls:	2.00	0.23	34.29	2.73	20.00	861.23
Total weight of 1st floor in KN :					**W1**	**12047.68**
Step 2: CACULATION OF SEISMIC WEIGHT OF				**2nd Floor**	**W2**	
Weight of Slab	2.00	38.63	8.00	0.13	25.00	1931.50
	2.00	18.29	8.00	0.13	25.00	914.50
	2.00	7.54	3.45	0.15	25.00	195.10
Weight of columns	50.0	0.30	0.55	3.18	25.00	655.88
	8.00	0.50	0.50	3.18	25.00	159.00
	8.00	0.23	0.38	3.18	25.00	55.59
	16.0	0.30 dia.	0.00	3.18	25.00	89.95
Weight of Beams:						0.00
All beams in X-direction	4.00	0.23	38.63	0.45	25.00	399.82
	10.0	0.23	5.94	0.45	25.00	153.70
	2.00	0.23	7.54	0.45	25.00	39.02
	2.00	0.30	22.55	0.38	25.00	128.54
All beams in Y-direction	4.00	0.23	34.29	0.45	25.00	354.90
	12.0	0.23	5.94	0.45	25.00	184.44
	4.00	0.23	3.45	0.45	25.00	35.71
	2.00	0.30	18.29	0.38	25.00	104.25
Weight of imposed Live Load (25%)	0.25				5401.88	1350.47
Weight of walls:						0.00
All walls in **X=direction:**						
Internal walls:	2.00	0.23	38.63	2.73	20.00	970.23

	4.00	0.23	4.73	2.73	20.00	237.60
	10.0	0.23	5.49	2.73	20.00	689.43
External walls:	1.00	0.23	38.63	2.73	20.00	485.12
	1.00	0.23	33.45	2.73	20.00	420.07
	2.00	0.23	5.49	2.73	20.00	137.89
All walls in **Y-direction:**						0.00
Internal walls:	2.00	0.23	17.55	2.73	20.00	440.79
	16.0	0.23	5.49	2.73	20.00	1103.09
External walls:	2.00	0.23	34.29	2.73	20.00	861.23
Total weight of 2nd floor in KN :					**W2**	**12097.79**
Step 3: CALCULATION OF SEISMIC WEIGHT OF				**3rd Floor**		**W3**
Weight of Slab	2.00	38.63	8.00	0.13	25.00	1931.50
	2.00	18.29	8.00	0.13	25.00	914.50
	2.00	7.54	3.45	0.15	25.00	195.10
Weight of beams: (same as 1st floor)						
All beams in X-direction	4.00	0.23	38.63	0.45	25.00	399.82
	10.0	0.23	5.94	0.45	25.00	153.70
	2.00	0.23	7.54	0.45	25.00	39.02
	2.00	0.30	22.55	0.38	25.00	128.54
All beams in Y-direction	4.00	0.23	34.29	0.45	25.00	354.90
	12.0	0.23	5.94	0.45	25.00	184.44
	4.00	0.23	3.45	0.45	25.00	35.71
	2.00	0.30	18.29	0.38	25.00	104.25
Weight of imposed Live Load: (same as 1st floor)	0.25				5401.88	1350.47
Weight of Columns: = (½ x 3.18 Ht.)in floor 3	50.0	0.30	0.55	1.59	25.00	327.94
	8.00	0.50	0.50	1.59	25.00	79.50
	8.00	0.23	0.38	1.59	25.00	27.79
	16.0	0.30 dia.	0.00	1.59	25.00	44.97
Weight of walls:						
All walls in **X=direction:**						
Internal walls: (½ x 2.73 Ht.)in floor 3	2.00	0.23	38.63	1.37	20.00	485.12
	4.00	0.23	4.73	1.37	20.00	118.80
	10.0	0.23	5.49	1.37	20.00	344.72
External walls: (½ x 2.73 Ht.)in floor 3	1.00	0.23	38.63	1.37	20.00	242.56
	1.00	0.23	33.45	1.37	20.00	210.03
	2.00	0.23	5.49	1.37	20.00	68.94
All walls in **Y-direction:**						0.00
Internal walls: (½ x 2.73 Ht.)in floor 3	2.00	0.23	17.55	1.37	20.00	220.39
	16.0	0.23	5.49	1.37	20.00	551.55
External walls: (½ x2.73 Ht.)in floor 3	2.00	0.23	34.29	1.37	20.00	430.61
Total weight of 3rd floor in KN :					**W3 =**	**8944.86**
Total seismic weight of the Building of all 3 floors			**W1**	**W2**	**W3**	**33090.33 KN**
			12047.68	**12097.79**	**8944.86**	
Step 4: CALCULATION OF Ah						
Design horizontal seismic coefficient: Ah = Z/2 x I/R x Sa/g						

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1)
(Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x9.54/√38.63 = 0.138 Sec.

Ty = 0.09h/√dy = 0.09x9.54/√34.29= 0.147 Sec.

(**S**a/g)x = (**S**a/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore **Ah** = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: CALCULATION OF BASE SHEAR (VB)

(VB)x = W x Ah(x) = **33090.33 x 0.04 = 1323.61 KN**

(VB)y = 1323.61 KN

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10. MARK Residency, AS Ramarao Rd., VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +

Weight of Beams (1) +

Weight of Slabs (1) +

½ Weight of Columns (1) +

½ Weight of Columns (2) +

½ Weight of Walls (1) +

½ Weight of Walls (2) +

Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm

Internal wall thickness: 115 mm

Specific weight of RCC: 25 KN / Cum

Specific weight of infill wall: 20 KN / Cum

Type of soil: Medium

Size of columns: 230x450 mm

Size of Beams: 230 x 450 mm

Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2

= ½ x (2.75-0.450) + ½ x (3.00-0.450) = **2.425 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2

= (½ x 2.75) + (½ x 3.00) = **2.875 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	11.28	25.61	0.13	25.00	902.75
Weight of columns	26.00	0.23	0.45	2.75	25.00	185.01
Weight of Beams:						0.00
All beams in X-direction	7.00	0.23	11.28	0.45	25.00	204.31
	3.00	0.23	3.37	0.45	25.00	26.16
All beams in Y-direction	3.00	0.23	25.61	0.45	25.00	198.80
	2.00	0.23	11.74	0.45	25.00	60.75
	1.00	0.23	4.16	0.45	25.00	10.76
Weight of imposed Live Load (25%)	0.25	11.28	25.61	0.00	3.00	216.66

Weight of walls:						0.00
All walls in X=direction:						
Internal walls:	3.00	0.23	3.84	2.43	20.00	128.51
	2.00	0.23	2.07	2.43	20.00	46.18
External walls:	0.00	0.00	0.00	0.00	0.00	0.00
All walls in Y-direction:						0.00
Internal walls:	2.00	0.23	2.07	2.43	20.00	46.18
	2.00	0.23	2.64	2.43	20.00	58.90
External walls:	1.00	0.23	2.64	2.43	20.00	29.45
Total weight of 1st floor in KN :					**W1 ..**	**2114.42**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd, 3rd, 4th & 5th Floors W2, W3, W4 & W5						
Weight of slab: (same as 1st floor)	1.00	11.28	25.61	0.13	25.00	902.75
Weight of columns: (same as 1st floor)	26.00	0.23	0.45	3.00	25.00	201.83
Weight of beams: (same as 1st floor)						
All beams in X-direction	7.00	0.23	11.28	0.45	25.00	204.31
	3.00	0.23	3.37	0.45	25.00	26.16
All beams in Y-direction	3.00	0.23	25.61	0.45	25.00	198.80
	2.00	0.23	11.74	0.45	25.00	60.75
	1.00	0.23	4.16	0.45	25.00	10.76
Weight of imposed Live Load: (same as 1st floor)	0.25	11.28	25.61	0.00	3.00	216.66
Weight of walls:						
All walls in X=direction:						
Internal walls:	1.00	0.12	11.28	2.58	20.00	66.81
	2.00	0.23	11.28	2.58	20.00	267.22
	3.00	0.12	3.37	2.58	20.00	59.88
	2.00	0.12	2.69	2.58	20.00	31.86
	1.00	0.23	3.75	2.58	20.00	44.36
	3.00	0.12	4,13	2.58	20.00	76.72
	2.00	0.12	2.23	2.58	20.00	26.36
External walls:	2.00	0.23	11.28	2.58	20.00	267.22
All walls in Y-direction:						
Internal walls:	2.00	0.12	4.13	2.58	20.00	48.92
	1.00	0.12	3.27	2.58	20.00	19.37
	1.00	0.12	2.26	2.58	20.00	13.38
	1.00	0.12	2.76	2.58	20.00	16.35
	1.00	0.12	11.74	2.58	20.00	69.53
	1.00	0.12	10.10	2.58	20.00	59.82
	1.00	0.12	3.02	2.58	20.00	17.86
	2.00	0.23	2.10	2.58	20.00	49.75
External walls:	2.00	0.23	25.61	2.58	20.00	606.70
Total weight of 2nd, 3rd, 4th & 5th floors each in KN :					**W2=W3=W4=W5=**	**3564.12**
Step 3: CALCULATION OF SEISMIC WEIGHT OF 6th Floor W6						
Weight of slab: (same as 1st floor)	1.00	11.28	25.61	0.13	25.00	902.75
Weight of beams: (same as 1st floor)						
All beams in X-direction	7.00	0.23	11.28	0.45	25.00	204.31
	3.00	0.23	3.37	0.45	25.00	26.16
All beams in Y-direction	3.00	0.23	25.61	0.45	25.00	198.80
	2.00	0.23	11.74	0.45	25.00	60.75
	1.00	0.23	4.16	0.45	25.00	10.76
Weight of imposed Live Load: (same as 1st floor)	0.25	11.28	25.61	0.00	3.00	216.66

Weight of Columns: = (½ x 3.00 Ht.)in floor 6	26.00	0.23	0.45	1.50	25.00	100.91
Weight of walls:						
All walls in **X=direction:**						
Internal walls: (½ x 2.55 Ht.)in floor 6	1.00	0.12	11.28	1.29	20.00	33.40
	2.00	0.23	11.28	1.29	20.00	133.61
	3.00	0.12	3.37	1.29	20.00	29.94
	2.00	0.12	2.69	1.29	20.00	15.93
	1.00	0.23	3.75	1.29	20.00	22.18
	3.00	0.12	4,13	1.29	20.00	76.72
	2.00	0.12	2.23	1.29	20.00	13.18
External walls: (½ x 2.55 Ht.)in floor 6	2.00	0.23	25.61	1.29	20.00	303.35
All walls in **Y-direction**:						
Internal walls: (½ x 2.55 Ht.)in floor 6	2.00	0.12	4.13	1.29	20.00	24.46
	1.00	0.12	3.27	1.29	20.00	9.68
	1.00	0.12	2.26	1.29	20.00	6.69
	1.00	0.12	2.76	1.29	20.00	8.17
	1.00	0.12	11.74	1.29	20.00	34.77
	1.00	0.12	10.10	1.29	20.00	29.91
	1.00	0.12	3.02	1.29	20.00	8.93
	2.00	0.23	2.10	1.29	20.00	24.87
External walls: (½ x2.55 Ht.)in floor 6	2.00	0.23	25.61	1.29	20.00	303.35
Total weight of 6th floor in KN :					**W6 =**	**2800.26**

Total seismic weight of the Building of all 6 floors	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**19171.16 KN**
	2114.42	**3564.12**	**3564.12**	**3564.12**	**3564.12**	**2800.26**	

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1)
(Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x17.75/√8.86 = 0.537 Sec.

Ty = 0.09h/√dy = 0.09x17.75/√25.61 = 0.316 Sec.

(Sa/g)x = (Sa/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore **Ah** = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = **19171.16** x 0.04 = **766.846 KN**

(VB)y = **766.846 KN**

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11. AB Plaza, Krishna Lanka, VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +
Weight of Beams (1) +
Weight of Slabs (1) +
½ Weight of Columns (1) +
½ Weight of Columns (2) +
½ Weight of Walls (1) +
½ Weight of Walls (2) +
Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 200 mm
Internal wall thickness: 200 mm
Specific weight of RCC: 25 KN / Cum
Specific weight of infill wall: 20 KN / Cum
Type of soil: Medium
Size of columns: 650x350; 500x350; 500x450; 250x250; 350x450; 750x900 mm
Size of Beams: 250x450; 250x300; 650x600 mm
Response spectra: IS 1893(Part 1) : 2002
Assumption: Live Load 3.00 KN / Sqm
Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2
= ½ x (2.50-0.30) + ½ x (3.05-0.45) = **2.40 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2
= (½ x 2.50) + (½ x 3.05) = **2.775 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	19.23	24.03	0.13	25.00	1443.83
Weight of columns	5.00	0.65	0.35	2.78	25.00	78.91
	23.00	0.50	0.35	2.78	25.00	279.23
	1.00	0.50	0.45	2.78	25.00	15.61
	3.00	0.25	0.25	2.78	25.00	13.01
	2.00	0.35	0.45	2.78	25.00	21.85
	1.00	0.75	0.90	2.78	25.00	46.83
Weight of Beams:						0.00

All beams in X-direction	4.00	0.25	19.23	0.45	25.00	216.34
	6.00	0.25	8.64	0.45	25.00	145.80
	1.00	0.25	2.92	0.45	25.00	8.21
	2.00	0.25	4.02	0.45	25.00	22.61
	1.00	0.25	1.96	0.30	25.00	3.68
All beams in Y-direction	2.00	0.25	24.03	0.30	25.00	90.11
	2.00	0.25	19.81	0.30	25.00	74.29
	1.00	0.25	13.37	0.30	25.00	25.07
	1.00	0.25	5.48	0.30	25.00	10.28
	1.00	0.25	2.75	0.30	25.00	5.16
	1.00	0.25	4.27	0.38	25.00	10.01
	4.00	0.25	4.27	0.45	25.00	48.04
	3.00	0.65	7.77	0.60	25.00	227.27
Weight of imposed Live Load (25%)	0.25	19.23	24.03	0.13	25.00	2887.66
Weight of walls:						
All walls in X=direction:						
Internal walls:	1.00	0.20	3.71	2.40	20.00	35.62
	2.00	0.23	2.13	2.40	20.00	47.03
External walls:	1.00	0.23	4.44	2.40	20.00	49.02
All walls in Y-direction:						
Internal walls:	2.00	0.23	5.00	2.40	20.00	110.40
	2.00	0.23	3.00	2.40	20.00	66.24
	2.00	0.23	2.13	2.40	20.00	47.03
External walls:	1.00	0.23	3.00	2.40	20.00	33.12
Total weight of 1st floor in KN :					**W1 =**	**6062.24**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd to 5th FLOORS W2, W3, W4, & W5						
Weight of slab: (same as 1st floor)	4.00	11.73	8.64	0.13	25.00	1266.84
	1.00	22.02	1.96	0.13	25.00	140.27
Weight of columns	3.00	0.65	0.35	3.05	25.00	52.04
	24.00	0.50	0.35	3.05	25.00	320.25
	1.00	0.50	0.45	3.05	25.00	17.16
	3.00	0.25	0.25	3.05	25.00	14.30
	2.00	0.35	0.45	3.05	25.00	24.02
Weight of beams: (same as 1st floor)						
All beams in X-direction	4.00	0.25	19.23	0.45	25.00	216.34
	6.00	0.25	8.64	0.45	25.00	145.80
	1.00	0.25	2.92	0.45	25.00	8.21
	2.00	0.25	4.02	0.45	25.00	22.61
	1.00	0.25	1.96	0.30	25.00	3.68
All beams in Y-direction	2.00	0.25	24.03	0.30	25.00	90.11
	2.00	0.25	19.81	0.30	25.00	74.29
	1.00	0.25	13.37	0.30	25.00	25.07
	1.00	0.25	5.48	0.30	25.00	10.28
	1.00	0.25	2.75	0.30	25.00	5.16
	1.00	0.25	4.27	0.38	25.00	10.01
	4.00	0.25	4.27	0.45	25.00	48.04
	3.00	0.65	7.77	0.60	25.00	227.27
Weight of imposed Live Load: 25% (same as 1st floor)	0.25	0.00	0.00	0.00	1407.11	351.78
Weight of walls:						0.00
All walls in **X=direction:**						0.00

Internal walls:	8.00	0.15	8.64	2.60	20.00	539.14
	6.00	0.15	5.00	2.60	20.00	352.78
	2.00	0.15	1.33	2.60	20.00	20.75
	4.00	0.20	8.64	2.60	20.00	359.42
External walls:	2.00	0.20	19.23	2.60	20.00	399.98
All walls in **Y-direction:**						353.78
Internal walls:	8.00	0.15	4.27	2.60	20.00	266.45
	4.00	0.20	3.66	2.60	20.00	152.26
	8.00	0.15	3.96	2.60	20.00	247.10
	2.00	0.20	24.03	2.60	20.00	354.78
External walls:	2.00	0.20	24.03	2.60	20.00	499.82
Total weight of 2nd, 3rd, 4th & 5th floors each in KN :					**W2 = W3 = W4 = W5 =**	**6619.77**
Step 3: CALCULATION OF SEISMIC WEIGHT OF			**6th Floor**	**W6**		
Weight of slab: (same as 1st floor)	4.00	11.73	8.64	0.13	25.00	1266.84
	1.00	22.02	1.96	0.13	25.00	140.27
Weight of columns	3.00	0.65	0.35	1.53	25.00	26.02
	24.00	0.50	0.35	1.53	25.00	160.13
	1.00	0.50	0.45	1.53	25.00	8.58
	3.00	0.25	0.25	1.53	25.00	7.15
	2.00	0.35	0.45	1.53	25.00	12.01
Weight of beams: (same as 1st floor)						
All beams in X-direction	4.00	0.25	19.23	0.45	25.00	216.34
	6.00	0.25	8.64	0.45	25.00	145.80
	1.00	0.25	2.92	0.45	25.00	8.21
	2.00	0.25	4.02	0.45	25.00	22.61
	1.00	0.25	1.96	0.30	25.00	3.68
All beams in Y-direction	2.00	0.25	24.03	0.30	25.00	90.11
	2.00	0.25	19.81	0.30	25.00	74.29
	1.00	0.25	13.37	0.30	25.00	25.07
	1.00	0.25	5.48	0.30	25.00	10.28
	1.00	0.25	2.75	0.30	25.00	5.16
	1.00	0.25	4.27	0.38	25.00	10.01
	4.00	0.25	4.27	0.45	25.00	48.04
	3.00	0.65	7.77	0.60	25.00	227.27
Weight of imposed Live Load: 25% (same as 1st floor)	0.25	0.00	0.00	0.00	1407.11	351.78
All walls in **X=direction:**						
Internal walls:	8.00	0.15	8.64	1.30	20.00	269.57
	6.00	0.15	5.00	1.30	20.00	352.78
	2.00	0.15	1.33	1.30	20.00	10.37
	4.00	0.20	8.64	1.30	20.00	179.71
External walls:	2.00	0.20	19.23	1.30	20.00	199.99
All walls in **Y-direction:**						353.78
Internal walls:	8.00	0.15	4.27	1.30	20.00	133.22
	4.00	0.20	3.66	1.30	20.00	76.13
	8.00	0.15	3.96	1.30	20.00	123.55
	2.00	0.20	24.03	1.30	20.00	354.78
External walls:	2.00	0.20	24.03	1.30	20.00	249.91
Total weight of 4th floor in KN :					**W6 =**	**5163.43**

Total seismic weight of the Building of all 6 floors	W1	W2	W3	W4	W5	W6	37704.75 KN
	6062.24	6619.77	6619.77	6619.77	6619.77	5163.43	

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1) (Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x17.75/√14.20 = 0.424 Sec.

Ty = 0.09h/√dy = 0.09x17.75/√16.10 = 0.398 Sec.

(**S**a/g)x = (**S**a/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore **A**h = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = **37704.75 x 0.04 = 1508.19 KN**

(VB)y = **1508.19 KN**

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12. RANGANATH Residency, VIJAYAWADA (Mogalrajapuram)

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +
Weight of Beams (1) +
Weight of Slabs (1) +
½ Weight of Columns (1) +
½ Weight of Columns (2) +
½ Weight of Walls (1) +
½ Weight of Walls (2) +
Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm
Internal wall thickness: 115 mm
Specific weight of RCC: 25 KN / Cum
Specific weight of infill wall: 20 KN / Cum
Type of soil: Medium
Size of columns: 350x700; 300x700; 300x650; 300x500 mm
Size of Beams: 230x425; 230x600 mm
Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2
= ½ x (2.75-0.425) + ½ x (3.00-0.425) = **2.45 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2
= (½ x 2.75-0.125) + (½ x 3.00-0.125) = **2.75 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	2.00	17.85	10.77	0.13	25.00	1249.59
	1.00	11.22	2.13	0.13	25.00	77.67
Weight of columns	1.00	0.70	0.35	2.75	25.00	16.84
	11.00	0.70	0.30	2.75	25.00	158.81
	7.00	0.65	0.30	2.75	25.00	93.84
	3.00	0.50	0.30	2.75	25.00	30.94
Weight of Beams:						0.00
All beams in X-direction	7.00	0.23	17.85	0.30	25.00	215.54
	3.00	0.23	3.72	0.30	25.00	19.25

	2.00	0.23	3.90	0.30	25.00	13.46
All beams in Y-direction	4.00	0.23	10.77	0.30	25.00	74.31
	7.00	0.23	10.77	0.45	25.00	195.07
	5.00	0.23	2.13	0.30	25.00	18.37
Weight of imposed Live Load (25% of 1327.26 slab wt.)	0.25	1.00	1327.26	1.00	1.00	331.82
Weight of walls:						0.00
All walls in X=direction:						0.00
Internal walls:	2.00	0.23	5.11	2.45	20.00	115.18
	1.00	0.23	3.08	2.45	20.00	34.71
	1.00	0.23	1.43	2.45	20.00	16.12
	1.00	0.12	4.88	2.45	20.00	27.50
External walls:	1.00	0.12	4.88	2.45	20.00	27.50
All walls in Y-direction:						0.00
Internal walls:	1.00	0.23	2.13	2.45	20.00	24.01
	2.00	0.12	4.77	2.45	20.00	53.76
External walls:	1.00	0.12	4.77	2.45	20.00	26.88
	1.00	0.23	2.13	2.45	20.00	24.01
Total weight of 1st floor in KN :					**W1 =**	**2845.17**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd to 5th FLOORS W2, W3, W4, & W5						
Weight of slab: (same as 1st floor)	2.00	17.85	10.77	0.13	25.00	1249.59
	1.00	11.22	2.13	0.13	25.00	77.67
Weight of columns	1.00	0.70	0.35	2.88	25.00	17.61
	11.00	0.70	0.30	2.88	25.00	166.03
	7.00	0.65	0.30	2.88	25.00	98.11
	3.00	0.50	0.30	2.88	25.00	32.34
Weight of beams: (same as 1st floor)						0.00
All beams in X-direction	7.00	0.23	17.85	0.30	25.00	215.54
	3.00	0.23	3.72	0.30	25.00	19.25
	2.00	0.23	3.90	0.30	25.00	13.46
All beams in Y-direction	4.00	0.23	10.77	0.30	25.00	74.31
	7.00	0.23	10.77	0.45	25.00	195.07
	5.00	0.23	2.13	0.30	25.00	18.37
Weight of imposed Live Load: 25% (same as 1st floor)	0.25	1.00	1327.26	1.00	1.00	331.82
Weight of walls:						0.00
All walls in **X=direction:**						0.00
Internal walls:	1.00	0.23	17.85	2.88	20.00	236.48
	1.00	0.23	12.20	2.88	20.00	161.63
	1.00	0.12	17.85	2.88	20.00	118.24
	1.00	0.12	5.69	2.88	20.00	37.69
	2.00	0.12	4.54	2.88	20.00	60.15
	2.00	0.12	6.00	2.88	20.00	79.49
	1.00	0.12	6.16	2.88	20.00	40.80
	2.00	0.12	2.10	2.88	20.00	27.82
External walls:	2.00	0.23	17.85	2.88	20.00	472.95
All walls in **Y-direction:**						0.00
Internal walls:	1.00	0.23	5.92	2.88	20.00	78.43
	1.00	0.23	2.13	2.88	20.00	28.22
	4.00	0.12	10.77	2.88	20.00	285.36
	2.00	0.12	6.72	2.88	20.00	89.03

	3.00	0.12	2.00	2.88	20.00	39.74
	2.00	0.12	4.42	2.88	20.00	58.56
External walls:	2.00	0.23	10.80	2.88	20.00	286.16
	1.00	0.23	5.55	2.88	20.00	73.53
	1.00	0.23	3.56	2.88	20.00	47.16
	1.00	0.12	7.00	2.88	20.00	46.37
	1.00	0.12	5.00	2.88	20.00	33.12
Total weight of 2nd, 3rd, 4th & 5th floors each in KN :				**W2 = W3 = W4 = W5 =**		**4810.08**
Step 3: CALCULATION OF SEISMIC WEIGHT OF			**6th Floor**		**W6**	
Weight of slab: (same as 1st floor)	2.00	17.85	10.77	0.13	25.00	1249.59
	1.00	11.22	2.13	0.13	25.00	77.67
Weight of columns	1.00	0.70	0.35	1.44	25.00	8.82
	11.00	0.70	0.30	1.44	25.00	83.16
	7.00	0.65	0.30	1.44	25.00	49.14
	3.00	0.50	0.30	1.44	25.00	16.20
Weight of beams: (same as 1st floor)						0.00
All beams in X-direction	7.00	0.23	17.85	0.30	25.00	215.54
	3.00	0.23	3.72	0.30	25.00	19.25
	2.00	0.23	3.90	0.30	25.00	13.46
All beams in Y-direction	4.00	0.23	10.77	0.30	25.00	74.31
	7.00	0.23	10.77	0.45	25.00	195.07
	5.00	0.23	2.13	0.30	25.00	18.37
Weight of imposed Live Load: 25% (same as 1st floor)	0.25	1.00	1327.26	1.00	1.00	331.82
All walls in **X=direction:**						0.00
Internal walls:	1.00	0.23	17.85	2.88	20.00	236.48
	1.00	0.23	12.20	2.88	20.00	161.63
	1.00	0.12	17.85	2.88	20.00	118.24
	1.00	0.12	5.69	2.88	20.00	37.69
	2.00	0.12	4.54	2.88	20.00	60.15
	2.00	0.12	6.00	2.88	20.00	79.49
	1.00	0.12	6.16	2.88	20.00	40.80
	2.00	0.12	2.10	2.88	20.00	27.82
External walls:	2.00	0.23	17.85	2.88	20.00	472.95
All walls in **Y-direction:**						0.00
Internal walls:	1.00	0.23	5.92	2.88	20.00	78.43
	1.00	0.23	2.13	2.88	20.00	28.22
	4.00	0.12	10.77	2.88	20.00	285.36
	2.00	0.12	6.72	2.88	20.00	89.03
	3.00	0.12	2.00	2.88	20.00	39.74
	2.00	0.12	4.42	2.88	20.00	58.56
External walls:	2.00	0.23	10.80	2.88	20.00	286.16
	1.00	0.23	5.55	2.88	20.00	73.53
	1.00	0.23	3.56	2.88	20.00	47.16
	1.00	0.12	7.00	2.88	20.00	46.37
	1.00	0.12	5.00	2.88	20.00	33.12

Total weight of 6th floor in KN :						**W6 =**	**4653.31**
Total seismic weight of the Building of all 6 floors	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**26738.80 KN**
	2845.17	**4810.08**	**4810.08**	**4810.08**	**4810.08**	**4653.31**	

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1) (Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x17.75/√13.54 = 0.434 Sec.

Ty = 0.09h/√dy = 0.09x17.75/√18.31= 0.373 Sec.

(**S**a/g)x = (**S**a/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore Ah = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = **26738.80 x 0.04 = 1069.55 KN**

(VB)y = **1069.55 KN**

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13. CHAKRADHAR, No.5 Route, ITI Rd., VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +
Weight of Beams (1) +
Weight of Slabs (1) +
½ Weight of Columns (1) +
½ Weight of Columns (2) +
½ Weight of Walls (1) +
½ Weight of Walls (2) +
Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm
Internal wall thickness: 230 mm and 115 mm
Specific weight of RCC: 25 KN / Cum
Specific weight of infill wall: 20 KN / Cum
Type of soil: Medium
Size of columns: 230 x 500 mm
Size of Beams: 230 x 600; 350x375; 230x350; 350x525 mm
Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2
= ½ x (2.75-0.0.60) + ½ x (3.00-0.60) = **2.275 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2
= (½ x 2.75) + (½ x 3.00) = **2.875 M**

Description of Items		**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab		1.00	12.80	19.28	0.13	25.00	771.20
Weight of columns		12.00	0.23	0.50	2.88	25.00	99.19
Weight of Beams:							0.00
All beams in X-direction		2.00	0.23	0.60	11.58	25.00	79.90
		1.00	0.23	0.60	4.04	25.00	13.93
		5.00	0.35	0.53	6.86	25.00	157.57
		1.00	0.35	0.38	4.04	25.00	13.25
		1.00	0.23	0.35	4.04	25.00	8.13
All beams in Y-direction		1.00	0.23	0.43	18.06	25.00	44.13
		1.00	0.23	0.60	5.56	25.00	19.18

		1.00	0.35	0.53	5.71	25.00	26.23
		1.00	0.35	0.53	6.10	25.00	28.02
		1.00	0.23	0.60	18.06	25.00	62.30
Weight of imposed Live Load (25%)		0.25	12.80	19.28	0.00	3.00	185.09
Weight of walls:							
All walls in X=direction:							
Internal walls:		3.00	0.23	4.04	2.28	20.00	126.77
External walls:		1.00	0.23	4.04	2.28	20.00	42.28
All walls in Y-direction:							
Internal walls:		1.00	0.23	10.06	2.28	20.00	105.51
External walls:		1.00	0.30	11.74	2.28	20.00	160.60
Total weight of 1st floor in KN :						**W1**	**1943.28**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd, 3rd, 4th & 5th FLOORS W2,W3,W4 & W5							
Weight of slab: (same as 1st floor)		1.00	12.80	19.28	0.13	25.00	771.20
Weight of columns: (same as 1st floor)		12.00	0.23	0.50	3.00	25.00	103.50
Weight of beams: (same as 1st floor)							
All beams in X-direction		2.00	0.23	0.60	11.58	25.00	79.90
		1.00	0.23	0.60	4.04	25.00	13.93
		5.00	0.35	0.53	6.86	25.00	157.57
		1.00	0.35	0.38	4.04	25.00	13.25
		1.00	0.23	0.35	4.04	25.00	8.13
All beams in Y-direction		1.00	0.23	0.43	18.06	25.00	44.13
		1.00	0.23	0.60	5.56	25.00	19.18
		1.00	0.35	0.53	5.71	25.00	26.23
		1.00	0.35	0.53	6.10	25.00	28.02
		1.00	0.23	0.60	18.06	25.00	62.30
Weight of imposed Live Load: (same as 1st floor)		0.25	12.80	19.28	0.00	3.00	185.09
Weight of walls:							
All walls in X=direction:							
Internal walls:		2.00	0.23	4.04	2.40	20.00	89.16
		2.00	0.12	3.81	2.88	20.00	50.39
External walls:		2.00	0.23	11.58	2.65	20.00	282.32
All walls in Y-direction:							
Internal walls:		1.00	0.23	5.56	2.40	20.00	61.38
		1.00	0.12	6.71	2.88	20.00	44.45
External walls:		2.00	0.23	18.06	2.65	20.00	440.30
Total weight of 2nd to 5th floors each in KN :						**W2=W3=W4=W5=**	**2480.43**
Step 3: CALCULATION OF SEISMIC WEIGHT OF 6th Floor W6							
Weight of slab: (same as 1st floor)		1.00	12.80	13.64	0.13	25.00	545.60
Weight of beams: (same as 1st floor)							
All beams in X-direction		1.00	0.35	0.38	4.04	25.00	13.26
		1.00	0.23	0.35	4.04	25.00	8.13
		1.00	0.23	0.60	4.04	25.00	13.94
		1.00	0.23	0.60	11.58	25.00	39.95
		4.00	0.35	0.53	6.86	25.00	126.05
All beams in Y-direction		2.00	0.23	0.60	12.12	25.00	83.63
		1.00	0.23	0.60	5.56	25.00	19.18

	1.00	0.35	0.53	5.71	25.00	26.23
Weight of imposed Live Load: (same as 1st floor)	0.25	12.80	13.64	0.00	3.00	130.94
Weight of Columns: = (½ x 3.00 Ht.) in floor 6	9.00	0.23	0.50	1.50	25.00	38.81
Weight of walls:						
All walls in X=direction:						
Internal walls: (½ x 3.00 Ht.) in floor 6	1.00	0.23	11.58	1.50	20.00	79.90
	1.00	0.12	6.82	1.50	20.00	
External walls: (½ x 3.00 Ht.) in floor 6	2.00	0.23	11.58	1.50	20.00	159.80
All walls in Y-direction:						
Internal walls: (½ x 3.00 Ht.) in floor 6	1.00	0.23	5.56	1.50	20.00	38.36
	3.00	0.12	5.64	1.50	20.00	58.37
External walls: (½ x 3.00 Ht.) in floor 4	1.00	0.23	13.64	1.50	20.00	94.12
	1.00	0.23	5.56	1.50	20.00	38.36
	1.00	0.12	5.64	0.00	20.00	13.56
Total weight of 6th floor in KN :					**W6 =**	**1528.21**

Total seismic weight of the Building of all 6 floors	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**13393.21 KN**
	1943.28	**2480.43**	**2480.43**	**2480.43**	**2480.43**	**1528.21**	

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1) (Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x17.75/√ 11.58 = 0.469 Sec.

Ty = 0.09h/√dy = 0.09x17.75/√ 18.06 = 0.376 Sec.

(Sa/g)x = (Sa/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore Ah = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = 13393.21 x 0.04 = **535.73 KN**

(VB)y = **535.73 KN**

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14. HIGH SCHOOL Rd., PATAMATA, VIJAYAWADA

Seismic weight & Base Shear Calculations

- **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

- **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +
Weight of Beams (1) +
Weight of Slabs (1) +
½ Weight of Columns (1) +
½ Weight of Columns (2) +
½ Weight of Walls (1) +
½ Weight of Walls (2) +
Appropriate imposed (Live) Load.

- **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm
Internal wall thickness: 230 and 115 mm
Specific weight of RCC: 25 KN / Cum
Specific weight of infill wall: 20 KN / Cum
Type of soil: Medium
Size of columns: 560x270; 560x350; 480x270 and 230x230 mm
Size of Beams: 230 x 450 mm
Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF 1st FLOOR W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2
= ½ x (2.75-0.30) + ½ x (3.00-0.30) = **2.575 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2
= (½ x 2.75) + (½ x 3.00) = **2.875 M**

Description of Items	Nos.	Width M	Length M	Height M	Sp.Wt. KN/Cum	TotalWt. KN
Weight of Slab	1.00	8.11	14.89	0.15	25.00	452.84
Weight of columns	2.00	0.27	0.56	2.88	25.00	21.74
	4.00	0.35	0.56	2.88	25.00	56.35
	2.00	0.27	0.48	2.88	25.00	18.63
	3.00	0.23	0.23	2.88	25.00	11.41
Weight of Beams:						0.00
All beams in X-direction	3.00	0.23	0.45	8.11	25.00	62.95
	1.00	0.23	0.45	3.33	25.00	8.62
	2.00	0.35	0.30	8.11	25.00	42.58
All beams in Y-direction	3.00	0.23	0.45	14.89	25.00	115.58
Weight of imposed Live Load (25%)	0.25	8.11	14.89	0.00	3.00	90.57
Weight of walls:						

All walls in X=direction:						
Internal walls:	3.00	0.23	3.33	2.58	20.00	118.33
External walls:	1.00	0.23	3.33	2.58	20.00	39.44
	1.00	0.12	3.33	2.58	20.00	19.72
All walls in Y-direction:						
Internal walls:	1.00	0.23	2.00	2.58	20.00	23.69
	1.00	0.23	3.77	2.58	20.00	44.66
External walls:	1.00	0.23	3.77	2.58	20.00	44.66
	1.00	0.23	2.00	2.58	20.00	23.69
Total weight of 1st floor in KN :					**W1**	**1195.45**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd FLOOR						**W2**
Weight of slab: (same as 1st floor)	1.00	8.11	14.89	0.15	25.00	452.84
Weight of columns: (same as 1st floor)	2.00	0.27	0.56	2.88	25.00	21.74
	4.00	0.35	0.56	2.88	25.00	56.35
	2.00	0.27	0.48	2.88	25.00	18.63
	3.00	0.23	0.23	2.88	25.00	11.41
Weight of Beams:						0.00
All beams in X-direction	3.00	0.23	0.45	8.11	25.00	62.95
	1.00	0.23	0.45	3.33	25.00	8.62
	2.00	0.35	0.30	8.11	25.00	42.58
All beams in Y-direction	3.00	0.23	0.45	14.89	25.00	115.58
Weight of imposed Live Load (25%)	0.25	8.11	14.89	0.00	3.00	90.57
Weight of walls:						
All walls in X=direction:						
Internal walls:	1.00	0.23	8.11	2.70	20.00	100.73
	1.00	0.12	3.33	2.70	20.00	20.68
External walls:	1.00	0.12	3.33	2.70	20.00	20.68
	1.00	0.23	8.11	2.70	20.00	100.73
All walls in Y-direction:						
Internal walls:	2.00	0.12	2.00	2.70	20.00	24.84
External walls:	2.00	0.23	12.66	2.70	20.00	314.47
Total weight of 2nd floor in KN :					**W2**	**1463.39**
Step 3: CALCULATION OF SEISMIC WEIGHT OF 3rd & 4th Floors W3 &W4						
Weight of slab: (same as 1st floor)	1.00	8.11	14.89	0.15	25.00	452.84
Weight of columns: (same as 1st floor)	2.00	0.27	0.56	2.88	25.00	21.74
	4.00	0.35	0.56	2.88	25.00	56.35
	2.00	0.27	0.48	2.88	25.00	18.63
	3.00	0.23	0.23	2.88	25.00	11.41
Weight of Beams:						0.00
All beams in X-direction	3.00	0.23	0.45	8.11	25.00	62.95
	1.00	0.23	0.45	3.33	25.00	8.62
	2.00	0.35	0.30	8.11	25.00	42.58
All beams in Y-direction	3.00	0.23	0.45	14.89	25.00	115.58
Weight of imposed Live Load (25%)	0.25	8.11	14.89	0.00	3.00	90.57
Weight of walls:						
All walls in X=direction:						
Internal walls:	1.00	0.23	8.11	2.70	20.00	100.73
	1.00	0.12	2.30	2.70	20.00	14.28
	2.00	0.12	8.11	2.70	20.00	100.73
External walls:	1.00	0.12	3.33	2.70	20.00	20.68

	1.00	0.23	8.11	2.70	20.00	100.73
All walls in Y-direction:						
Internal walls:	2.00	0.12	3.54	2.70	20.00	43.97
External walls:	1.00	0.12	3.77	2.70	20.00	23.41
	1.00	0.12	5.73	2.70	20.00	35.58
Total weight of 3rd & 4th floors each in KN :					**W3 & W4 =**	**1321.37**
Step 4: CACULATION OF SEISMIC WEIGHT OF 5th FLOOR						**W5**
Weight of slab: (same as 1st floor)	1.00	8.11	14.89	0.15	25.00	452.84
Weight of columns: (same as 1st floor)	2.00	0.27	0.56	2.88	25.00	21.74
	4.00	0.35	0.56	2.88	25.00	56.35
	2.00	0.27	0.48	2.88	25.00	18.63
	3.00	0.23	0.23	2.88	25.00	11.41
Weight of Beams:						0.00
All beams in X-direction	3.00	0.23	0.45	8.11	25.00	62.95
	1.00	0.23	0.45	3.33	25.00	8.62
	2.00	0.35	0.30	8.11	25.00	42.58
All beams in Y-direction	3.00	0.23	0.45	14.89	25.00	115.58
Weight of imposed Live Load (25%)	0.25	8.11	14.89	0.00	3.00	90.57
Weight of walls:						
All walls in X=direction:						
Internal walls:	1.00	0.23	3.33	2.70	20.00	41.36
	2.00	0.12	3.33	2.70	20.00	41.36
	1.00	0.12	8.11	2.70	20.00	50.36
External walls:	1.00	0.12	3.33	2.70	20.00	20.68
	1.00	0.23	8.11	2.70	20.00	100.73
	1.00	0.23	4.32	2.70	20.00	53.65
All walls in Y-direction:						
Internal walls:	2.00	0.12	3.77	2.70	20.00	46.82
	1.00	0.12	1.86	2.70	20.00	11.55
External walls:	2.00	0.23	8.66	2.70	20.00	215.11
	1.00	0.12	1.87	1.00	20.00	4.30
	1.00	0.12	1.86	2.70	20.00	11.55
	1.00	0.12	3.54	2.70	20.00	21.98
Total weight of 5th floor in KN :					**W5 =**	**1500.73**
Total seismic weight of the Building of all 5 floors	**W1**	**W2**	**W3**	**W4**	**W5**	**6802.31 KN**
	1195.45	**1463.39**	**1321.37**	**1321.37**	**1500.73**	
Step 5: CALCULATION OF Ah						
Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**						
Zone Factor: **Z** = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1) (Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)						
Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)						
Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)						
Fundamental Time Period:						
Tx = 0.09h/√dx = 0.09x14.75/√8.11=0.466 Sec.						
Ty = 0.09h/√dy = 0.09x14.75/√12.66=0.373 Sec.						
(Sa/g)x = (Sa/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)						
Therefore Ah = 0.16/2 x 1.0/5.0 x 2.5 = 0.04						
Step 6: CALCULATION OF BASE SHEAR (VB)						
(VB)x = W x Ah(x) = 6802.31 x 0.04 = **272.09 KN**						
(VB)y = **272.09 KN**						

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Seismic weight & Base Shear Calculations

· **Seismic weight of a floor (W1)** (Cl. 3.26, IS 1893:2016)

It is the sum of dead load of the floor, appropriate contributions of weights of columns, walls and any other permanent elements from the storeys above and below, finishes and services, & appropriate amounts of specified imposed load on the floor.

· **Seismic weight of a Structure (W)** (Cl.3.27, IS 1893:2016)

It is the sum of seismic weights of all floors.

W1 = Dead load of floor 1 +

Weight of Beams (1) +

Weight of Slabs (1) +

½ Weight of Columns (1) +

½ Weight of Columns (2) +

½ Weight of Walls (1) +

½ Weight of Walls (2) +

Appropriate imposed (Live) Load.

· **Base Shear (VB)** (Cl.4.7 IS 1893:2016)

It is the horizontal lateral force in the considered direction of earthquake shaking that the structure shall be designed for.

VB = Ah x W & Ah = Z/2 x I/R x Sa/g

Considerations:

External wall thickness: 230 mm

Internal wall thickness: 115 mm

Specific weight of RCC: 25 KN / Cum

Specific weight of infill wall: 20 KN / Cum

Type of soil: Medium

Size of columns: 380x680 mm

Size of Beams: 300x450; 300x300 230x300 mm

Response spectra: IS 1893(Part 1) : 2002

Assumption: Live Load 3.00 KN / Sqm

Referring to Table 8, IS 1893:2002; Cl.7.3.1. Page 24; the percentage of imposed load

Step 1: CACULATION OF SEISMIC WEIGHT OF FLOOR - 1 W1

Height of wall:

= ½ x Ht.of wall of Fl.1 + ½ x Ht.of wall of Fl.2

= ½ x (2.75-0.60) + ½ x (3.00-0.60) = **2.275 M**

Height of Column:

=½ x Ht. of Col. in Fl.1 + ½ x Ht. of Col.in Fl.2

= (½ x 2.75-0.15) + (½ x 3.00-0.15) = **2.725 M**

Description of Items	**Nos.**	**Width M**	**Length M**	**Height M**	**Sp.Wt. KN/Cum**	**Total Wt. KN**
Weight of Slab	1.00	22.80	9.60	0.15	25.00	820.80
Weight of columns	13.00	0.38	0.68	2.73	25.00	228.85
Weight of Beams:						0.00
All beams in X-direction	1.00	0.30	9.60	0.45	25.00	32.40
	2.00	0.30	9.60	0.30	25.00	43.20
	1.00	0.30	4.10	0.30	25.00	9.23
	4.00	0.23	9.60	0.30	25.00	66.24
	1.00	0.23	4.10	0.30	25.00	7.07
All beams in Y-direction	3.00	0.30	20.80	0.45	25.00	210.60
	4.00	0.23	2.00	0.30	25.00	13.80

	1.00	0.23	5.00	0.30	25.00	8.63
Weight of imposed Live Load (25% of 820.80 slab wt.)	0.25	1.00	820.80	1.00	1.00	205.20
Weight of walls:						0.00
All walls in X=direction:						0.00
Internal walls:	2.00	0.23	3.11	2.28	20.00	65.09
	2.00	0.23	1.24	2.28	20.00	25.95
External walls:	0.00	0.00	0.00	0.00	0.00	
All walls in Y-direction:						0.00
Internal walls:	1.00	0.23	1.77	2.28	20.00	18.52
External walls:	1.00	0.23	1.77	2.28	20.00	18.52
Total weight of 1st floor in KN : W1 =						**1774.10**
Step 2: CACULATION OF SEISMIC WEIGHT OF 2nd to 5th FLOORS W2, W3, W4, & W5						
Weight of slab: (same as 1st floor)	1.00	22.80	9.60	0.15	25.00	820.80
Weight of columns	13.00	0.38	0.68	2.85	25.00	239.34
Weight of Beams:						0.00
All beams in X-direction	1.00	0.30	9.60	0.45	25.00	32.40
	2.00	0.30	9.60	0.30	25.00	43.20
	1.00	0.30	4.10	0.30	25.00	9.23
	4.00	0.23	9.60	0.30	25.00	66.24
	1.00	0.23	4.10	0.30	25.00	7.07
All beams in Y-direction	3.00	0.30	20.80	0.45	25.00	210.60
	4.00	0.23	2.00	0.30	25.00	13.80
	1.00	0.23	5.00	0.30	25.00	8.63
Weight of imposed Live Load (25% of 820.80 slab wt.)	0.25	1.00	820.80	1.00	1.00	205.20
Weights of walls:					0.00	
All walls in X=direction:					0.00	
Internal walls:	5.00	0.12	9.60	2.85	20.00	293.76
	2.00	0.23	9.60	2.85	20.00	251.71
External walls:	2.00	0.23	9.60	2.85	20.00	251.71
All walls in Y-direction:						0.00
Internal walls:	1.00	0.12	9.60	2.85	20.00	62.93
	1.00	0.12	14.50	2.85	20.00	95.05
	1.00	0.23	2.00	2.85	20.00	26.22
External walls:	2.00	0.23	22.80	2.85	20.00	597.82
Total weight of 2nd, 3rd, 4th & 5th floors each in KN : W2 = W3 = W4 = W5 =						**3235.70**
Step 3: CALCULATION OF SEISMIC WEIGHT OF 6th Floor W6						
Weight of slab: (same as 1st floor)	1.00	22.80	9.60	0.15	25.00	820.80
Weight of columns	13.00	0.38	0.68	1.43	25.00	119.67
Weight of Beams:						0.00
All beams in X-direction	1.00	0.30	9.60	0.45	25.00	32.40
	2.00	0.30	9.60	0.30	25.00	43.20
	1.00	0.30	4.10	0.30	25.00	9.23
	4.00	0.23	9.60	0.30	25.00	66.24
	1.00	0.23	4.10	0.30	25.00	7.07
All beams in Y-direction	3.00	0.30	20.80	0.45	25.00	210.60
	4.00	0.23	2.00	0.30	25.00	13.80

		1.00	0.23	5.00	0.30	25.00	8.63
Weight of imposed Live Load (25% of 820.80 slab wt.)		0.25	1.00	820.80	1.00	1.00	205.20
Weights of walls:						0.00	
All walls in **X=direction:**						0.00	
Internal walls:		5.00	0.12	9.60	1.43	20.00	293.76
		2.00	0.23	9.60	1.43	20.00	251.71
External walls:		2.00	0.23	9.60	1.43	20.00	251.71
All walls in **Y-direction:**							0.00
Internal walls:		1.00	0.12	9.60	1.43	20.00	31.46
		1.00	0.12	14.50	1.43	20.00	47.52
		1.00	0.23	2.00	1.43	20.00	13.11
External walls:		2.00	0.23	22.80	1.43	20.00	298.91
Total weight of 6th floor in KN : =						**W6**	**2725.02**
Total seismic weight of the Building of all 6 floors	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**17441.92 KN**
	1774.10	**3235.70**	**3235.70**	**3235.70**	**3235.70**	**2725.02**	

Step 4: **CALCULATION OF Ah**

Design horizontal seismic coefficient: **Ah = Z/2 x I/R x Sa/g**

Zone Factor:Z = 0.16 (Ref:Fig.1, Page 5 of IS 1893:2002 (Part 1) (Ref:Table 2, Cl.6.4.2 of IS 1893:2002 (Part 1)

Importance Factor: **I** = 1.00 (Ref: Table 6, Cl.6.4.2 of IS 1893:2002 (Part 1)

Response Reduction Factor: **R** = 5.00 (Ref: Table 7, Cl.6.4.2 of IS 1893:2002(1)

Fundamental Time Period:

Tx = 0.09h/√dx = 0.09x17.75/√9.60 = 0.516 Sec.

Ty = 0.09h/√dy = 0.09x17.75/√18.31= 0.335 Sec.

(Sa/g)x = (Sa/g)y = 2.5 (Ref:Cl.6.4.5, Page 16 of IS 1893:2002 (1)

Therefore Ah = 0.16/2 x 1.0/5.0 x 2.5 = 0.04

Step 5: **CALCULATION OF BASE SHEAR (VB)**

(VB)x = W x Ah(x) = **17441.92 x 0.04 = 697.68 KN**

(VB)y = **697.68 KN**

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