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# A Review on "Analysis and applications of an earthquake resistant non engineered building construction"

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**Abstract- India is a country that is quite vulnerable to earthquakes. Despite being developed at a sophisticated national and city level, the building design and construction codes for earthquake resistance have tended to be applied at the local level only occasionally rather than frequently. People used to construct their dwellings, especially in rural regions, utilising regional materials and conventional construction techniques without taking engineering concepts into account. Therefore, it is crucial to evaluate the actual physical condition of rural homes, estimate the level of risk, and put into practise simple, non-engineered construction procedures that may be used by both the local populace and construction employees. Physical surveys of rural housing's current condition have been conducted. These methods could serve as guidance for rural residents to build inexpensive earthquake-resistant homes and as a warning sign that engineered buildings are preferable to non-engineered ones. The main objective of the study is to improve regulations and develop more efficient technologies to minimise the vulnerability of developing countries like India to earthquakes by better understanding the current n on-engineered building practises in those countries.**

***Keywords*- Non-Engineered Building, Seismic Analysis, Vulnerability, Building Codes, Earthquake Resistant**

## I. INTRODUCTION

Building that isn't engineered: A conventional building that is erected haphazardly and without planning. The house owner is heavily involved in the design and construction process, as opposed to qualified technicians (engineers and architects). They almost probably weren't built or designed to resist earthquakes. Earthquakes are natural catastrophes in which damage to or the collapse of buildings and other man-made structures is the primary cause of the disaster. Non-engineered structures require particular care because they are regularly damaged by earthquakes. Most people in developing nations reside in what are known as non-engineered buildings, which are traditional structures created without much or no engineering input from architects or structural engineers during the design and construction phases. Building regulations that can withstand earthquakes have been developed at the national or local level. People used to construct their dwellings, especially in rural regions, utilising regional materials and conventional construction techniques without taking engineering concepts into account. As a result, it's crucial to comprehend the actual physical condition of rural dwellings in order to estimate the associated risk and to put simple, user-friendly, non-engineered construction procedures into practise for use by both the general public and construction employees. There will be research done on the situation of rural housing today. The problems with non-engineered, earthquake-resistant housing are identified from this data. Rural dwellings can be strengthened using sophisticated techniques to become earthquake-resistant structures.

**Non-engineered Construction in India:**

The vast majority of people in India reside in rural areas. Most of them are in abject poverty. Because of financial Problem The majority of families constructed their homes utilising inexpensive local materials and methods. The houses' inability to withstand storms and other natural disasters is due to the use of poor building materials and subpar construction methods. India's home construction and distribution patterns alter over time as a result of the changing requirements of the population at various phases of socioeconomic and cultural development while yet remaining subject to geographic control. In rural areas, homes are typically constructed using locally available materials including bamboo, jute sticks, straw, grass, leaves, mud, and corrugated iron sheet.

**Objectives:**

1. To research and compile a list of building seismic features.
2. To research and evaluate effective methods for managing earthquake risk in India.
3. To create an innovative framework for directing and tracking the seismic risk reduction of non-engineered structures in India.
4. To conduct a thorough assessment of how disaster management initiatives are being implemented in India.

## II. LITERATURE REVIEW

**1. Wind and Seismic Analysis of Pre-Engineered Building By Dr. J. N. Vyas. et al (2022)**

Using the software Staadprov8i, a pre-engineered steel structure will be designed and analysed for wind and seismic analysis with various characteristics as well as with various loads on the building, such as dead loads, wind loads, seismic loads, live loads and load combinations on structure. The major goal of this task is to comprehend PEB ideas, determine the structure's minimum weight, and determine the relevance of various displacements or forces acting in each direction to make the structure stable and safe. Pre-engineering and high-quality construction technologies are used in the pre-engineered construction idea to assist reduce time and cost usage.

**2. Analysis of Non-Parallel Lateral Force System Irregularity in RCC Structure Using ETAB By Meraz Ali. et al (2022).**

Because irregularities are a key concern in structural engineering, it is need to assess the impact of different irregularity types on the seismic response of structures more fully. It was discovered how non-parallel systems irregularity affects the torsional behaviour of RC buildings with non-parallel shear walls utilising nonlinear response spectrum analysis. The results show that non-parallel elements in lateral force resisting systems can improve the torsional response, which can significantly affect how seismically resilient a building is. The torsion ratio increased more dramatically in the direction of the shear wall than in the perpendicular direction in the tested models, it should be noted.

**3. Plain and Composite Shear Walls Are Considered in the Seismic Analysis of Different RCC Multistorey Structures by Prateek Jaiswal et al (2018).**

Buildings formed of shear walls are of high quality, greatly resist seismic and wind forces, and can even be based on weak-base soils by utilising various groundchange techniques. The most suitable structural forms in recent decades have been shear walls and shell structures, which have increased the height of concrete structures. As a result, structural behaviour in modern RC tall structures will be more complex than in the past. One of the lateral load-resisting systems most frequently utilised in multistory building structures is the shear wall layout.The current study examines three structural types—without shear walls, with plain shear walls, and with composite shear walls—and presents the findings using various multistory structures. A steel boundary frame is added to one side of the concrete shear wall to create the composite shear wall. STAAD.Pro software has utilised the response spectrum approach for seismic analysis. In this work, it is demonstrated that, when all structure types are compared and composite shear walls are taken into consideration at various locations, the least and minimum value is found in the composite shear wall at location 4 (composite shear walls at the corners).

**4. Examining Non-Engineered House Construction in Rural Himachal Submitted by Robin Mahajan et al (2018).**

The greatest method to combat the detrimental impacts of thoughtless development on our environment is to increase understanding of sustainable development. Building construction endangers the environment because of its increased capacity for waste generation and increased energy use. As a result, sensible planning and design, along with the appropriate technologies, encourage sustainable development. Natural calamities and environmental changes have not harmed traditional structures very much. Locally driven demands led to the creation of numerous structures that have stood the test of time and seen the development of human understanding. But in the modern era, new technological developments and the availability of building materials have overcome the geographical limits that existed in the past. Traditional techniques and materials are no longer required.

**5. Ferrocement-based Earthquake-Resistant Construction by Anna Maria Joy et al (2016)**

Structures that can withstand earthquakes can be built using ferrocement. Ferrocement is a versatile substance that can be used to create hollow slabs, hollow columns, and cavity walls. Hollow walls, slabs, and other structures should be filled with sand or water.columns. The same object will then exhibit seismic resistance. This paper discusses the design of hollow slabs, hollow columns, and cavity walls as well as their seismic effects.

**6. Evaluation of the Earthquake-Resistant Design Methodology for Mexican Buildings by Julián Carrillo et al (2014)**

Thanks to new requirements for earthquake-resistant structures, buildings may now be assured to function better when subjected to seismic action. It is convenient for the current building regulations to become conceptually explicit when defining the strength modification factors and assessing maximum lateral displacements so that structural engineers may comprehend the design process. This study aims to investigate the transparency of the earthquake-resistant design strategy for structures in Mexico through a thorough review of the factors for strength alteration and displacement amplification. The US approach to building design codes is also reviewed. We could conclude that earthquake resistant architecture in Mexico has improved.

**7. Seismic Risk Analysis of Urban Non Engineered Buildings: Use in a Mérida, Venezuela, Informal Settlement by A. Castillo et al (2011)**

An informal settlement in Mérida, Venezuela, which is representative of a significant number of metropolitan locations in earthquake-prone developing countries, has its own seismic risk scenarios. On a scale from 0 to 1, the buildings' vulnerability indices fall between 0.64 and 0.80. More than 32% of the buildings would sustain grade 4 (extensive) or worse damage in an earthquake of intensity IX. According to a structural examination of the structures in the research region, the seismic demands are greater than the structures' capacity to withstand gravity loads. These structures' seismic performance can be improved with relatively inexpensive and straightforward procedures, which can also reduce their vulnerability by roughly 51%. When buildings are retrofitted, the projected economic loss in an intensity IX earthquake scenario is US$0.39 million and 10 fatalities, compared to US$5.36 million and 275 fatalities prior to the retrofit. While reconstruction would cost US$19 million, retrofitting would only cost US$1.04 million.

**8. Dr. M. Jahangir Alam, "Earthquake Resistant Non-Engineered Building Construction for Rural Areas in Bangladesh," et al (2008).**

Bangladesh is a country that is quite vulnerable to earthquakes. Despite being developed at a sophisticated national and city level, the building design and construction code for earthquake resistance has tended to be applied at the local level only occasionally rather than frequently. People used to construct their dwellings, especially in rural regions, utilising regional materials and conventional construction techniques without taking engineering concepts into account. Therefore, it is crucial to determine the genuine physical condition of rural homes, estimate the level of risk involved, and put into practise simple, approachable, non-engineered construction approaches for use by the local populace and construction employees. Physical surveys have been done to determine the state of rural dwellings today. Respectfully, this data is used to identify problems.

**9. Teddy Boen Earthquake Resistant Design of Non- Engineered Buildings in Indonesia. et al. (2003).**

Despite the devastating consequences that earthquake catastrophes have on the local economy and development virtually every year in different parts of Indonesia, it appears that not nearly enough is being done to prepare for, avert, or mitigate their repercussions. This article examines non-engineered structures in both urban and rural settings, and it seeks to gather information that will enable researchers to connect analysis and actual damage.

**10. Non-Engineered Construction in Developing Nations: A Method for Predicting Earthquake Risk by Anand S. Arya et al (2000)**

The paper starts off by going over a few topics related to reducing earthquake risk for non-engineered buildings, including: managing earthquake risk in developing nations; the IDNDR-Yokoyama message's emphasis on preparedness and pre-disaster mitigation; earthquake damage reduction initiatives like creating building codes and guidelines; and disaster mitigation for sustainable development. The main reasons for the substantial damage seen in non-engineered buildings during previous earthquakes are then briefly discussed, and important components that must be included in new projects are noted. The author introduces a method for seismic retrofitting stone houses that was created, put into practise, and field-tested. The costs and advantages of earthquake protection strategies are then highlighted. Finally, a workable and financially sound plan for the construction of earthquake-resistant new buildings and the seismic retrofitting of dangerous old structures is presented.

## III. PROPOSED METHODOLOGY

Advanced technology is needed to reduce the vulnerability of low-income households to earthquakes, but getting people to use it would be difficult. New technologies must be developed to improve the performance of buildings during earthquakes. Earthquakes are the worst and most damaging natural disasters and people have always feared them. Despite the fact that seismic codes undoubtedly exist in countries of high seismic risk to save lives and reduce human suffering, the collapse of many poorly designed, non-seismically resistant buildings in developing countries like India is a significant factor. in tragic events with a high death toll caused by earthquakes. Applying seismic rules is the best technique for earthquake safety in unconstructed buildings. Such implementation is not really simple, as it involves a number of interdisciplinary and multidisciplinary links at different levels of understanding, commitment and skills. This fact indicates that a widely accepted framework can help harmonize different viewpoints. As a result, this project aims to create an integrated framework that will act as a road map and monitoring tool for reducing earthquake risk in unconstructed buildings in Nagpur, India using a risk management strategy and retrofit technology.

**STUDY AREA-** Nagpur Rural Areas (Kalmeshwar): Consider Nagpur Urban Areas to study upgrading of non-engineered structures as per seismic criteria.

Today, this construction method is mainly used by rural people with limited income. Mud is the main component of this type of building. A mixture of clay soil, straw, cow dung and sandy sand is used as mud. Mud houses are more susceptible to earthquakes than any other traditional building form due to their fragility and lack of lateral force resistance mechanism, as evidenced by many past earthquakes. To improve the mud house, you can use metal straps at the joints and wooden stiffeners at the corners of the beams. A mud house can be improved by moving the roof trusses to the right place, sealing excess openings, using cement mortar in the walls and adding new walls. In addition, bamboo poles can be installed both inside and outside walls. The bamboos were attached to the concrete base at ground level. Holes are then drilled into the walls with bamboo spatulas and wire to connect the bamboo posts inside and outside of the walls. To reduce bending, there are horizontal supports between the bamboo posts. These bamboo poles would be connected to the top of the wall by a half-bamboo bridge in a lattice arrangement. The result is that the whole house acts as an earthquake-resistant rigid box. Mud houses are more vulnerable to earthquakes. Those types of homes sustained significant damage even with moderate intensity. Cement-stabilized soil can be used to reduce the impact of water. It is necessary to create a strong foundation and it is best if the foundation is made of bricks and cement mortar. The use of cement mortar at plinth level reduces the impact of water on the building. It has a vertical reinforcement in the form of a bamboo net or posts and a horizontal bar placed on top of the wall to support the lateral load of the building. If roofs are required to cover the opening, reinforced roofs must be constructed. Recently, RCC construction has become popular in rural and urban areas due to its greater strength and durability. In rural areas, these structures are often built by a local builder without technical planning. In the construction process, there are no objections to lateral loading or connection details. Unplanned RCC buildings can be strengthened by adding concrete rings to the existing beams and columns, limiting the reinforcement, removing the old steel deck and then welding to the old steel to strengthen the weak points of the RC column. and radius. One of the most well-known, reliable and generally recognized building materials are reinforced concrete. Even if they perform poorly during earthquake tremors due to lack of understanding of proper construction. Withstanding earthquakes simply requires proper planning and careful construction.

## CONCLUSION

As there is a lack of sufficient information on the earthquake risk, all housing is built using locally available materials and traditional construction methods. The structural defects of the current residences were found. A cost-effectiveness analysis of all types of residential layouts was analyzed under the National Building Code of India. Engineering research has developed techniques to strengthen all types of existing buildings based on locally available building materials and construction methods to make rural houses earthquake resistant. In addition, there is an estimated cost of approval.

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## REFERENCES

[1] Dr. J. N. Vyas," Wind and Seismic Analysis of Pre-Engineered Building", International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538 Volume 10 Issue XII Dec 2022

[2] Meraz Ali, Barkha Verma. (2022). Analysis of Non-Parallel Lateral Force System Irregularity in RCC Structure Using ETAB. *Mathematical Statistician and Engineering Applications*, *71*(4), 9630–9642.

[3] Seismic Analysis of Different RCC Multistorey Structure by Considering Plain and Composite Shear Wall · P. Jaiswal, Anisha Mire, Shubham Dashore · Published 2018

[4] Robin Mahajan, Sanjay K. Sharma, vimalpreet, 2018, Analysis of Non Engineered Construction of Houses in Rural Himachal, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) RTCEC – 2018 (Volume 6 – Issue 11)

[5] Anna Maria Joy, beenuthampy, Livy Vinodraj, Reshma T. S, Er. Shwethasaju, 2016, Earthquake Resistant Construction using Ferrocement, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) ICCEECON – 2K16(Volume 4 – Issue 13)

[6] Analysis of the Earthquake-Resistant Design Approach for Buildings in Mexico by Carrillo Julián, Ingeniería Investigación y Tecnología, volumen XV (número 1), enero-marzo 2014: 151-162 ISSN 2594-0732 FI-UNAM

[7] Seismic risk analysis of urban non-engineered buildings: Application to an informal settlement in Mérida, Venezuela November 2011

[8] Alam, Dr. M. Jahangir et al. "EARTHQUAKE RESISTANT NON-ENGINEERED BUILDING CONSTRUCTION FOR RURAL AREA IN BANGLADESH." (2008).

[9] Boen, Teddy, Manual, Repair and Strengthening of Buildings Damaged During the Flores Earthquake, December, 1992 (in Indonesian).

[10] Boen, Teddy, Detailer's Manual for Small Buildings in Earthquake Areas, January, 1978.

[11] NON-ENGINEERED CONSTRUCTION IN DEVELOPING COUNTRIES –AN APPROACH TOWARD EARTHQUAKE RISK PREDUCTION Anand S ARYA 2000

[12] IS 1893- Calculation of Seismic forces

[13] IAEE Committee on Non-Engineered Construction, Guidelines for Earthquake Resistant Non-Engineered Construction, The International Association for Earthquake Engineering, October, 1986.

[14] Arya A.S., Masonry & Timber Structures including Earthquake Resistant Design, New Chand & Brothers.