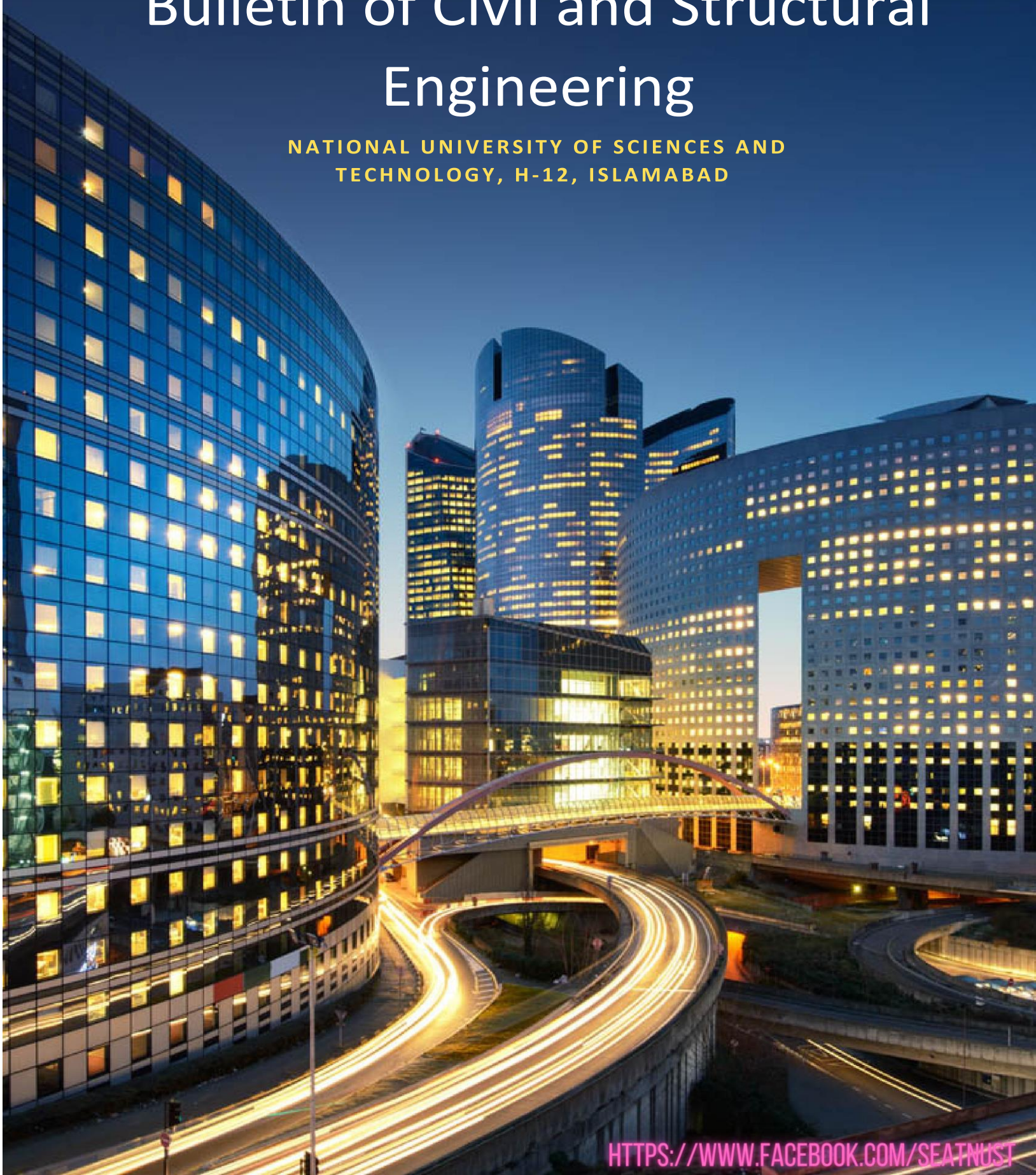
July 2022

Bulletin of Civil and Structural Engineering

NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY, H-12, ISLAMABAD



Structural Engineering @ NUST
National University of Sciences and Technology
Islamabad, Pakistan

NUST Institute of Civil Engineering (NICE), School of Civil and Environmental Engineering (SCEE), National University of Sciences and Technology (NUST), Sector H-12, Islamabad, Pakistan

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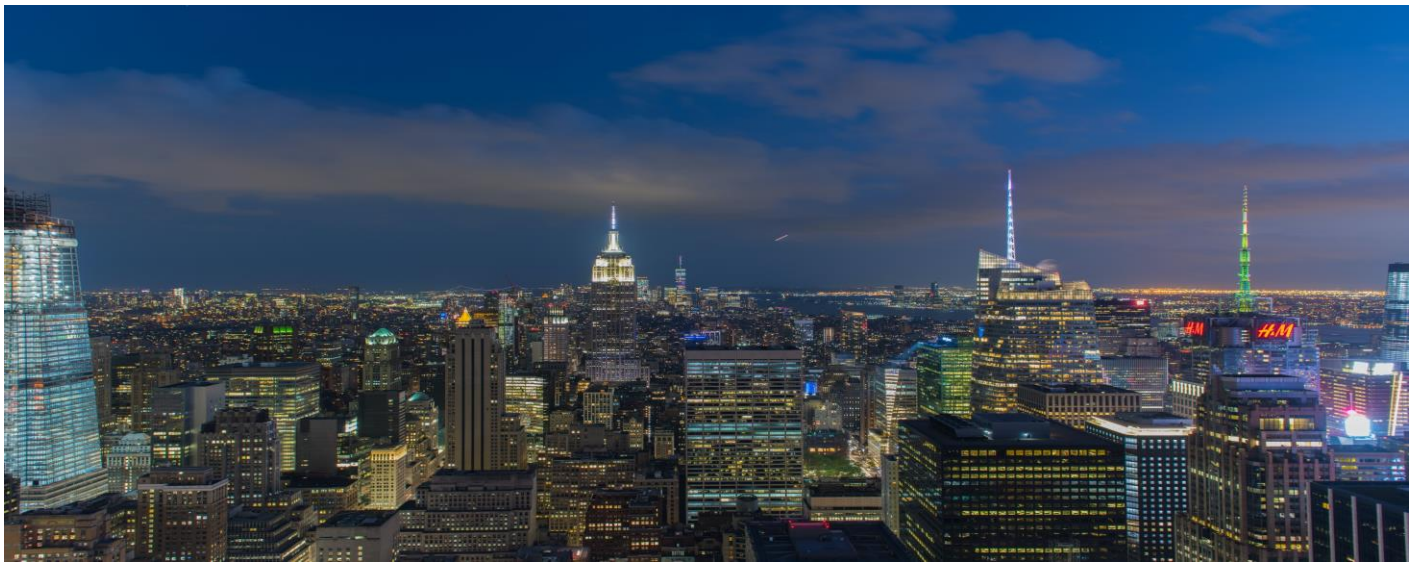

INSIDE THIS ISSUE

RESEARCH AT GLANCE YEAR 2021

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Bulletin of Civil and Structural Engineering

Call for Contributions

Become a part of the latest Issue

Faculty members, students and alumni are invited for the submission of

- Ideas, research topics and ongoing projects
- News items, conference items, etc.
- Brief articles – short, topical, news-oriented
- Award recognitions

Guidelines

- All articles must be submitted in Word format and include a title.
- Photos, images, or graphics are encouraged, and may be resized for placement.
- Please include links (URLs) to additional information.
- Word count:
  - News items, Affinity Group reports, and announcements – 50 to 200 words
  - All articles have a limit of up to 500 words.

Deadlines and Queries

The deadline for the submission of mentioned topics is 30/12/2022. Submissions after the deadline will not be accommodated.

For further queries, contact us

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Editorial Board

RESEARCH AT GLANCE YEAR 2022

Effect of Non-Structural Elements on the overall building seismic performance

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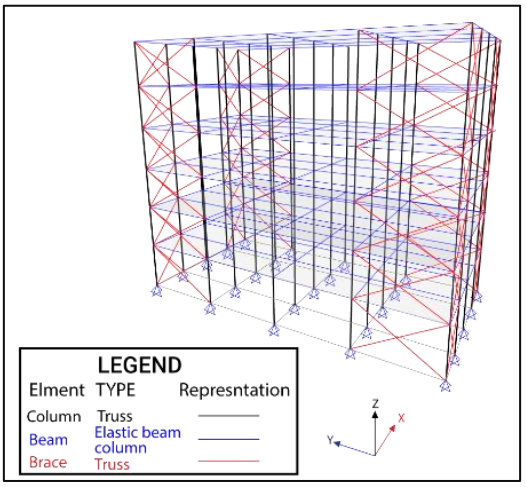
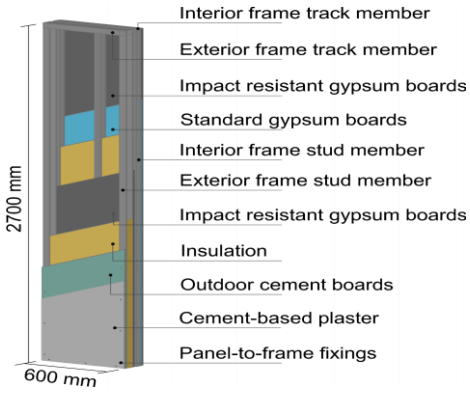
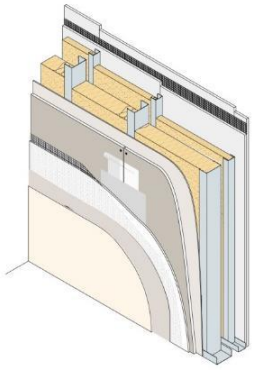


Summary

Full-scale experimental checks and corresponding modelling efforts have revealed that, even though the structures designed in line with current seismic requirements maintain the MCE stage earthquake shaking, there may be a high degree of in-determinism in reaction and conservatism within the layout. This is obtrusive from the consequences of shake table assessments, wherein the structure is supposed to undergo intense damage as in line with the design recommendations, however simplest superficial damages occur. This indeterminism/redundancy is delivered using the contribution of "so-referred to as" non-structural partition walls and cladding to the structural response at the system level. This paper investigates this impact by designing and modelling CFS buildings at numerous proportions of non-structural wall panels. A simplified model incorporating a zero-length spring element is generated in OpenSees. The response of a building to lateral loading without and with facades was compared by performing a pushover analysis. The results determined that incorporating facades increases the stiffness of the building and prolongs its behavior in the linear range.

Typical Façade Layout





Seismic Performance Evaluation of RC Buildings designed as per BCP-2007 and BCP-2021

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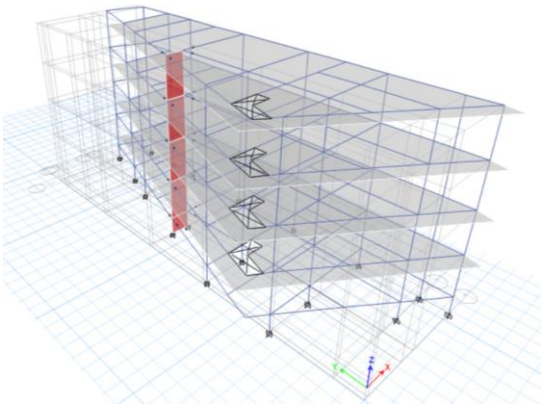

Summary

Pakistan is still striving for improvements in construction industry. Major construction in private sector is carried out is non-engineered. There are very few projects that are properly designed for gravity and lateral loads which is main cause behind deaths in major earthquakes. For example, Kashmir-Hazara (2005) earthquake caused deaths of 85.000 people. Nevertheless. after the Kashmir-Hazara (2005) earthquake, the government and engineering commission stressed on execution of a seismic code and introduced Seismic Provisions of Building Code of Pakistan-2007.

The same building code of BCP-2007 was being used till 2021 but now the government has introduced a new building code known as Building Code or Pakistan-2021.The major change that is adopted in new building is the change in seismic hazard parameters that is changed from peak ground Acceleration (PGA) to spectral acceleration. In previous code based on PGA values the whole country was divided into five zones whereas the new code gives short and long period acceleration for each city. The concept of risk category is introduced in the new building code which is utilized to find the seismic design category which is a new concept that was not there in the previous code. These changes will change the construction industry and these changes needs to be addressed by comparing design of both the codes.

Three sample buildings were selected 4, 8 and 13 story. All the three buildings were moment resisting frames which is a common practice in Islamabad. Our study is focused for the region of Islamabad. For the analysis of all three structures both BCP-2007 and BCP-2021 were utilized. Comparison of global and local responses was being made as per the load pattern of BCP-2007 and BCP-2021 the responses were greater for the latter. Further by utilizing the design actions as per both codes. All the three buildings were designed. After designing, the comparison of the quantities was made for all three structures that were designed as per both codes, quantities as per BCP- 2021 were more. 8 story structure was selected as representative building for non-linear seismic performance assessment. For this non-linear static pushover analysis was performed for both the designs that were as per BCP-2007 and BCP-2021. After doing Push-over analysis of these structures, the results showed weak behavior of BCP-2007 design which was quantified using the backbone curves of these structures.

Development of Sustainable Geopolymer Concrete Incorporating Agricultural Waste Ashes

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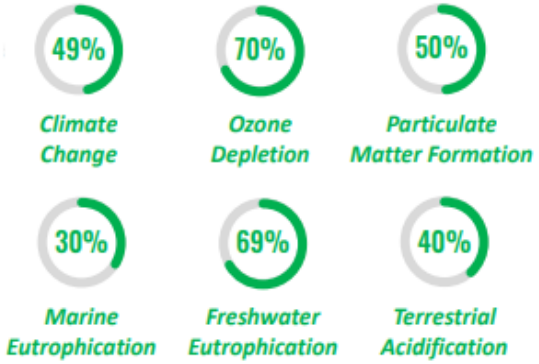
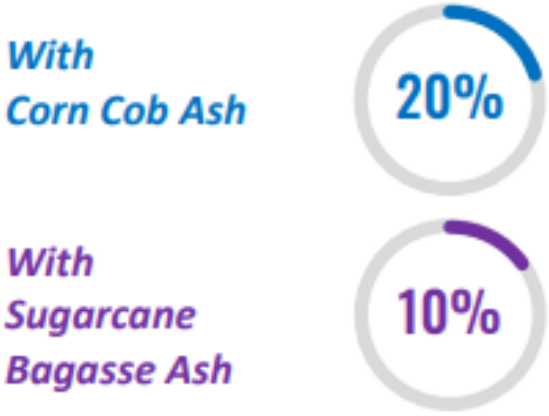
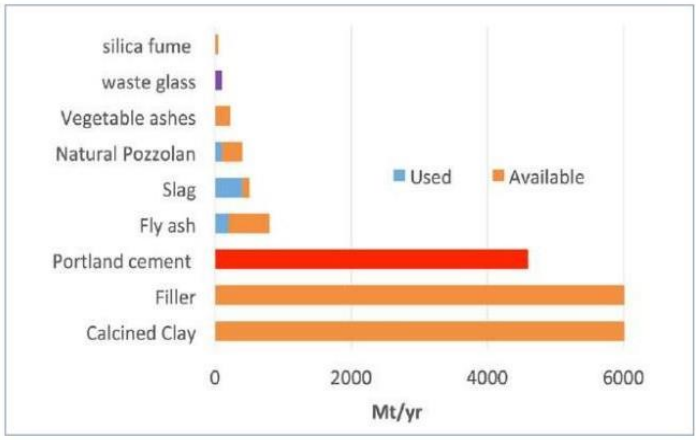


Summary

Although concrete is most widely used construction material across the world, production of one of its main ingredients i.e., Portland Cement, causes havoc to the environment and there is an exigent need to replace cement with an environmentally friendly material. In this regard, geopolymer cements have the potential to make concrete clean, however their future is highly dependent on suitable supply of alumina-silicate (Al-Si) source materials, since they replace clinker altogether. Unfortunately, scanty amounts of currently used Al-Si materials as compared to cement utilization, imposes a challenge to large scale application of geopolymer concrete. Previous studies have shown that agricultural waste ashes can also be used as Al-Si source material. In this study two agricultural waste ashes i.e., sugar cane bagasse ash and corn cob ash were utilized in fly ash and ground granulated blast furnace slag based geopolymer concrete. The results showed that mechanical properties remained intact for up to 20% and 10% replacement of fly ash with CCA and SCBA respectively. Life cycle assessment was also performed as per ISO guidelines. Geopolymer concrete with AGWA proposed in this study reduced greenhouse gas emission by 49%. A significant decrease in other impact categories such as ozone depletion, marine eutrophication, particulate matter formation and terrestrial acidification were observed.





Development of Structural Lightweight Concrete by Coarse rigid Polyurethane Foam waste

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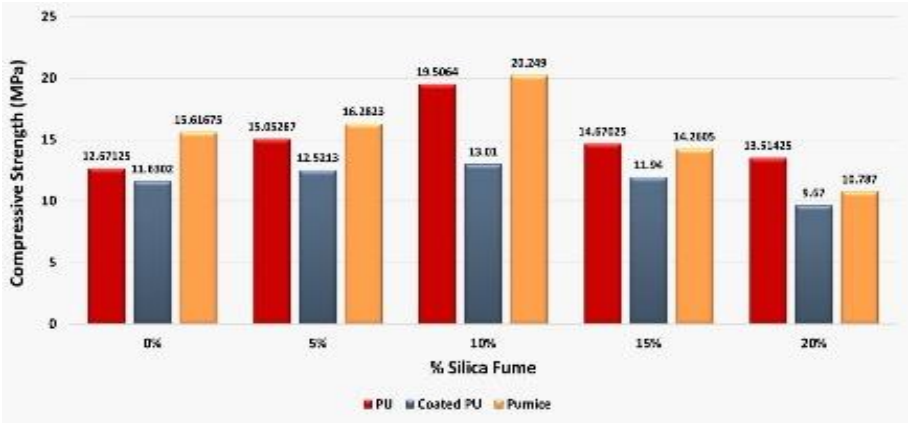
Summary

Lightweight Concrete enables to reduce dead load of structures besides reducing the size of foundation. In 2015, the total annual production of PU-based products was 11.5 million tons in the Asia Pacific region and demand is growing. 29.7% PU waste is recycled, landfill is unfortunately, the first choice in many countries with a 30.8% of total waste. Due to Diverse Climatic conditions in Pakistan buildings face the below-mentioned issues: In regions of high temperature, conventional buildings face the issue of indoor heating via thermal conductivity. In extremely low temperatures, Freeze and Thaw result in internal structural damage, and maintenance is required. A construction material is needed that can serve the purpose of structural use as well as thermal insulation keeping the economy in perspective. The objectives were to make structural lightweight concrete, to recycle PU foam waste, to provide thermal insulation (Energy Conservation), to develop a concrete with good freeze and thaw resistance and better durability. Results: 24 % reduction in weight of concrete was noted. Maximum Strength that was achieved is 19.5 MPa. It has better electrical resistivity and thermal resistance than conventional concrete as well as better performance in freeze thaw action. From economic perspective 12.5 % reduction in cost at structural level was estimated. Its applications are it can be used in floors in steel frame buildings, Concrete frame buildings & parking structures, lightweight precast & prestressed concrete elements, dampers, heat insulation on roofs and decks of long span bridges



Investigating Damage in Reinforced Concrete Members using a Vibrating Wire Strain Gauge

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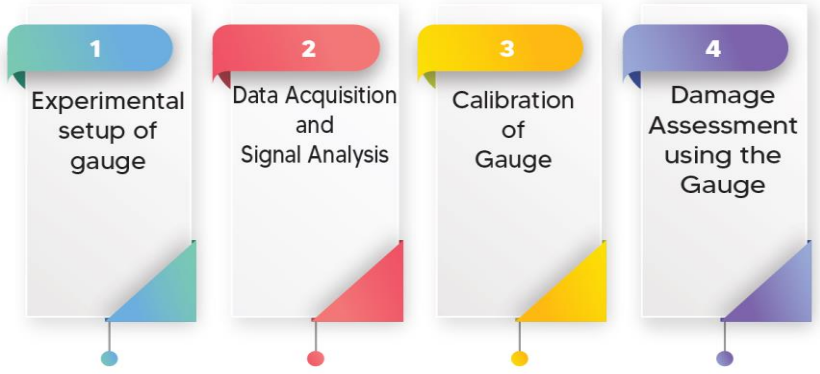
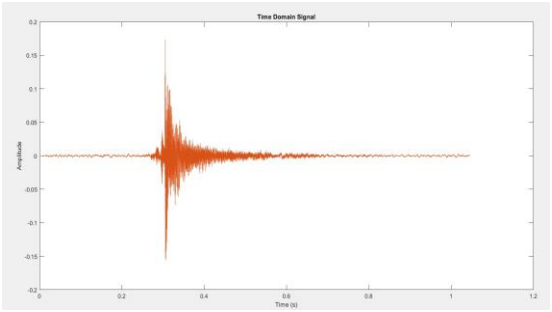
Summary

Recently the use of vibrating wire strain gauges has increased to find out the damage in a reinforced concrete structure. The assembly and functioning of this acoustic strain gauge are presented. This gauge provides numerous benefits including its sensitivity to measure strain (up to 1micron) and its property of being easily attached on any concrete surface. The gauging apparatus can be made in a lab due to its low cost which gives it an edge over the conventional systems. The vibrating wire strain gauge allows for frequency-based structural health monitoring. It can be constructed using readily available cheap materials and can provide strains accurate to 1 micron. A co-relation is developed between the frequency of the guitar string (the wire) and the strain in the structure which can then be used to assess the damage in a structure. The gauge was calibrated after considering the variations in temperature. Vibrating wire strain gauges are commercially available and are used on structures like piles, bridges, dams etc.





Effect of Reduced Material Strength due to Poor Execution of Code Compliant Structures and Studying the Incorporated Redundancy Afterwards

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Muhammad Usman
Muhammad Waleed Mushtaq

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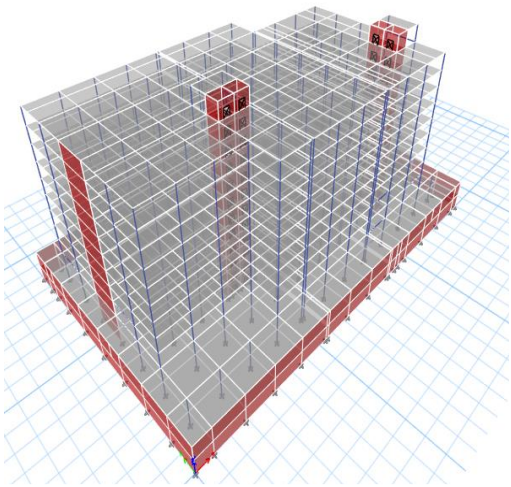
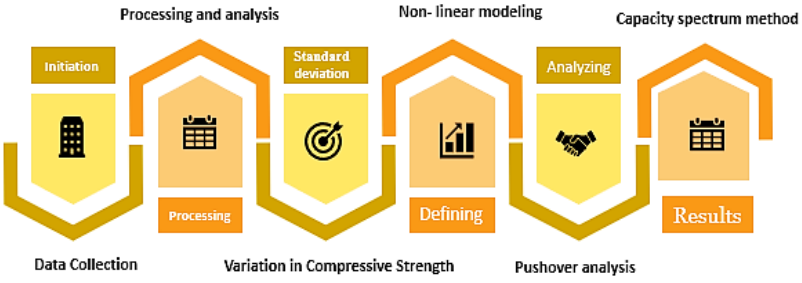
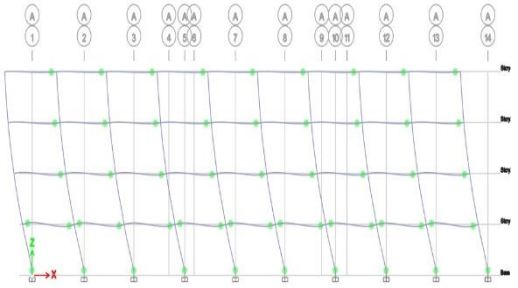


Summary

Construction of high-rise building is a new trend, as they cover lesser area and provide maximum space to live in. But current construction practices in Pakistan are not up to the standard because of poor quality control and human error which cause variation in the concrete compressive strength. This study is focused to find out that variation and its effects on overall structure performance. A Case study region i.e., the Islamabad is considered, consisting of many high-rise and commercial buildings. Being an earthquake-prone area, it is necessary to perform seismic Vulnerability Assessment of buildings, influenced by variation in material strength. This study is only focused on post code structures located in the region, designed according to BCP 2007. Compression test results (Year 2010 - 2021) from different testing labs truly representing the region were taken. Data were organized and analyzed using different software's, to find mean and Standard Deviation (SD) in compressive strength of various structural members. Considering the variation, three models at Design (D), D+SD, D-SD compressive strengths, of sample buildings in the region were modelled on CSI ETABS-18. Nonlinear static pushover analysis is performed to get the building response curve. These curves were compared to find the final response. Structure in field is compliant with code and have redundancy to bear the variation in compressive strength of concrete.





Development of a Low-Cost Solution for Remote Structural Health Monitoring

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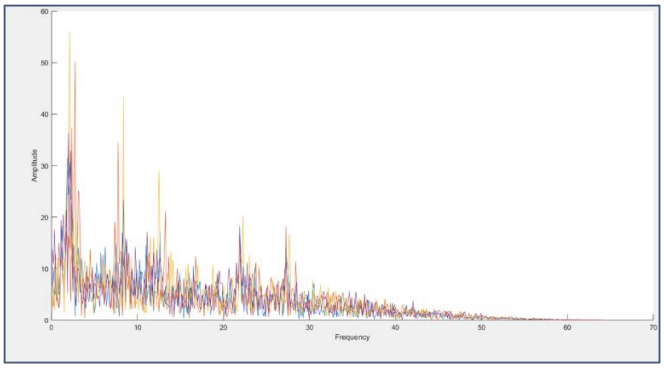
Summary

In the modern world, the need for the development of new infrastructure is at a historic high. Although with the modernization of construction techniques, this need is being amply met, however increasing maintenance costs of existing structures is still a critical issue. Early damage detection through continuous health monitoring instead of conventional periodic inspection, is the promising way forward for healthy structures with the least maintenance requirement. Considering the immense scale of civil infrastructure, currently available structural health monitoring systems are not feasible for mass application as they are prohibitively expensive. Our proposed system utilized a vibration-based structural health monitoring approach and extracted dynamic parameters (fig. 2) from acceleration data. The system consists of a node (fig. 1) tasked with data collection and transmission and a server tasked with data post-processing and display. The node comprises of: ESP32 as a microcontroller unit and ADXL345 as an accelerometer. The system was developed with the capability of multiple node integration, onboard data storage to eliminate sampling rate inconsistencies, dual trigger modes to achieve a high signal to noise ratio (SNR), power usage optimization to prolong stand-by time, wireless data transmission along with automated post-processing



Seismic Vulnerability Of Partially Completed Rc Structures In Horizontal Direction

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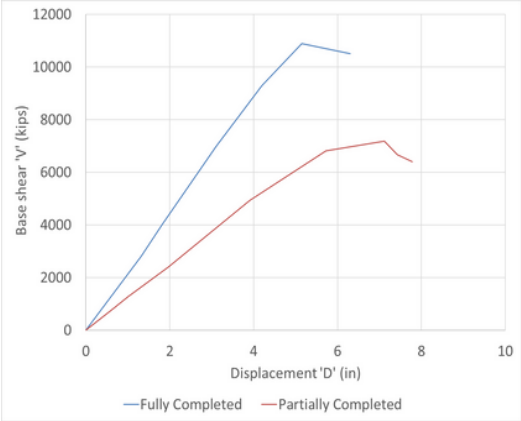
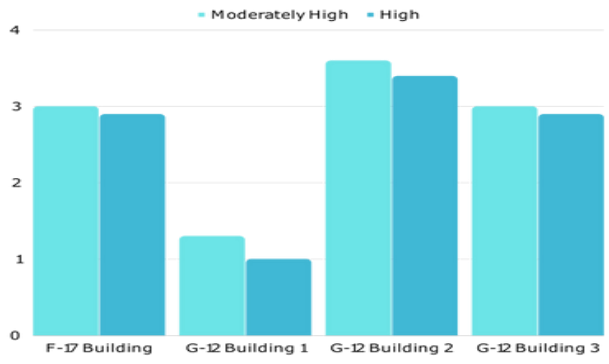


Summary

There is a common trend in Pakistan to leave the building partially completed but its vulnerability assessment is not done so we have done the vulnerability assessment of partially buildings using empirical approach(fema-154) and analytical assessment (pushover analysis). The Empirical vulnerability assessment relates to the outcome of macro seismic studies and the development of intensity scales. Rapid Visual Screening (FEMA-154) is a qualitative method that estimates the seismic vulnerability of a large number of buildings based on correlations between buildings predicted seismic performance and building typology. RVS utilizes a scoring system to evaluate and estimate the level of risk using FEMA-154 forms. Analytical Vulnerability Assessment is a detailed method to assess the vulnerability of buildings. Modelling is done on software. It provides us with moreprecise results. Pushover analysis is a static procedure that uses a simplified nonlinear technique to estimate seismic structural deformations. Structures redesign themselves during earthquakes. As individual components of a structure yield or fail the dynamic forces on the building are shifted to other components. The conclusion of this research is partially completed buildings are more vulnerable to seismic forces Completed buildings have less ductility than partially completed ones. Seismic assessment for partially completed buildings should also be done.

Building Name	FEMA Score (Moderately High)	FEMA Score (High)	Damage State Classification
F-17 Building	3	2.9	D1-D2
G-12 Building 1	1.3	1	D2-D3
G-12 Building 2	3.6	3.4	D0-D1
G-12 Building 3	3	2.9	D1-D2



Development and Analysis of Rapid Runway Repair Techniques

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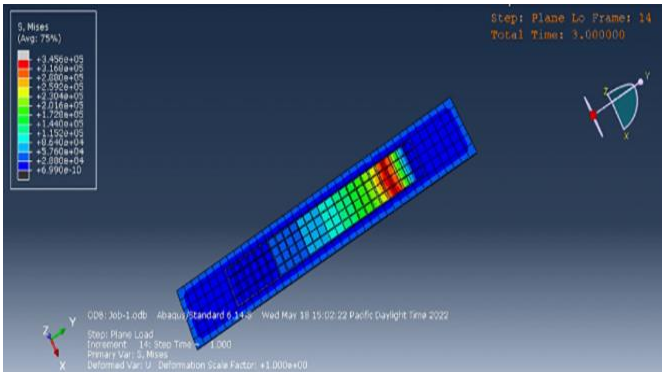
Summary

To address the emergency runway repair in state of war, the fundamental theme of this research is to explore and develop the Rapid Runway Repair Methods (RRRM) for outright rehabilitation in an airfield having durable, long lasting and high early strength. For this problem we have used the High Alumina cement due to its strength and proven durability, with NaOH and fibers to improve the flexural and tensile strengths. Moreover, to verify results through non-linear FEM analysis using the ABAQUS software. The runway pavement can be most rapidly repaired with 0.5 % w/w NaOH in fiber-reinforced High Alumina Cement. Finally, we have obtain the following results:

1. Final Setting Time was reduced to just 19 minutes
2. The compressive strength of novel cement was doubled
3. Flexural strength was improved by more than 20 %



A simplified framework for member level Performance Based Design

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Shazeb Memon
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Moazan Ahmad

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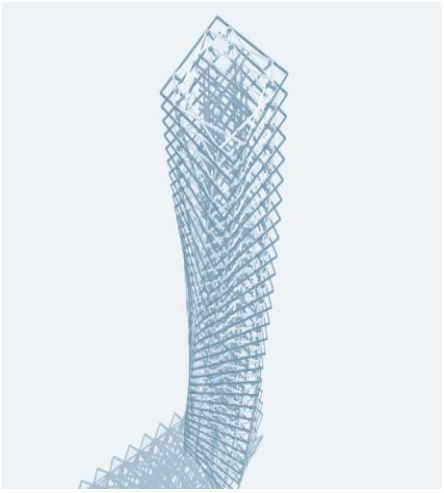
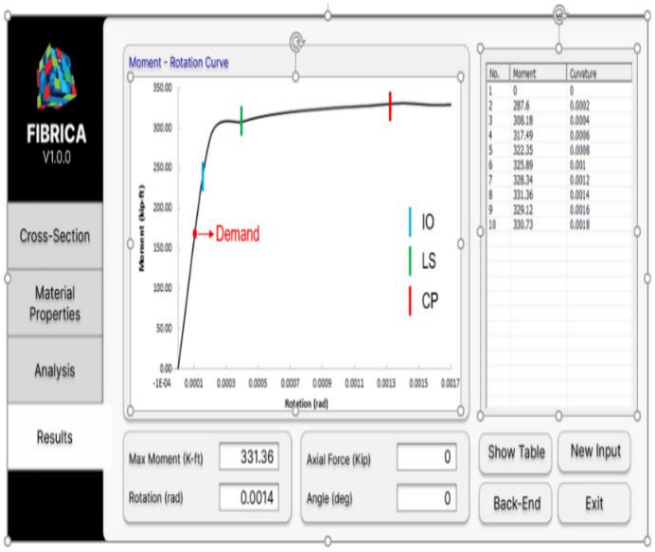
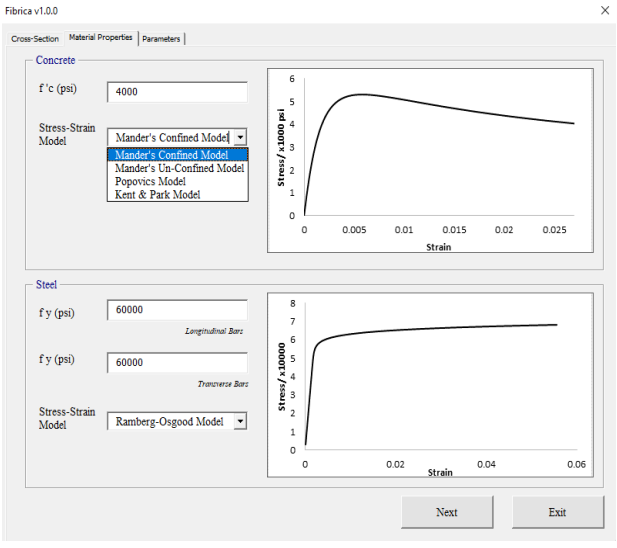


Summary

This project offers a new and a simplified solution to the complex and time taking procedure of Performance-based Design (PBD). This is achieved by assessing element level performance instead of the structure level performance. This new approach makes Performance-based Design (PBD) more adaptable in the field of structural engineering, especially in developing countries like Pakistan. Specifically, the simplified framework is provided through development of a computer software coded in Excel VBA. The solution is validated against the complicated and time taking Non-Linear Time History Analysis (NLTHA) procedure and its results. The proposed approach to Performance-based Design (PBD) has achieved Reduced complexity, and requirement of skill/understanding level for quick performance evaluation using only the linear analysis results. An entry level professional with lesser knowledge of PBD can perform this process using our software. It also reduced computational resources, analysis time and data processing. This makes the whole process which can take up to days a lot faster. It resulted in efficient initial sizing and preliminary design of RC components (for fresh structural engineers). For entry level professional who do not know much about how to size this would prove to be very helpful in efficient sizing. It reduced number of iterations (or design revisions) while performing the detailed performance-based design procedure.

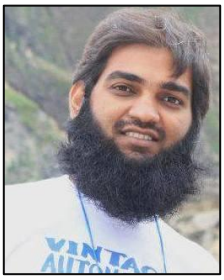




DEPARTMENT NEWS

- The first PhD student from department: Dr Nafeesa Shaheen completed her doctoral studies and defended her thesis successfully. Dr. Rao Asralan Khushnood have advised her throughout this journey. Special thanks to Dr. Syed Ali Rizwan, Dr. Fazal Adnan, Dr. Shazim Ali Memon, Dr. Adnan Nawaz, Dr. Sajjad Ahmed Dr. Hammad Anis Khan and others who have contributed to this success story.
- Mr Sikandar Ali Khokhar, a BE Civil Engineering Student of department has received Associate Membership of the American Concrete Institute's (ACI) Committee 544. Mr Sikandar is the first Pakistani to become the Associate Member of Committee 544 which is focused on developing standards for a novel type of construction material termed Fiber Reinforced Concrete (FRC).
- Three faculty members from the department: Dr. Fawad Ahmad Najam, Dr Sarmad Shakeel and Dr Usman Hanif won research grants under HEC-NRPU program worth total of more than 10 million PKR.
- Dr. Musaad Zaheed Khan and Dr. Usman Hanif left the department for research exchanges in Korea and Australia.
- A guest lecture on Modeling and Analysis of Tall Buildings and Bridges" presented by Dr. Naveed Anwar (Vice President of Asian Institute of Technology (AIT), Thailand) was conducted.
- A live webinar on Prevention through design (PtD) Dr Zia Uddin from University of Houstan, USA was conducted
- Dr. Fawad Ahmad Najam from department was awarded with the best teacher award.

FACULTY AT STRUCTURAL ENGG. DEPT



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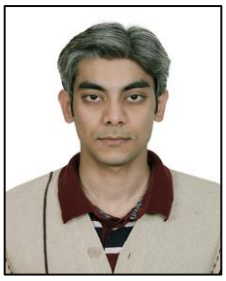

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