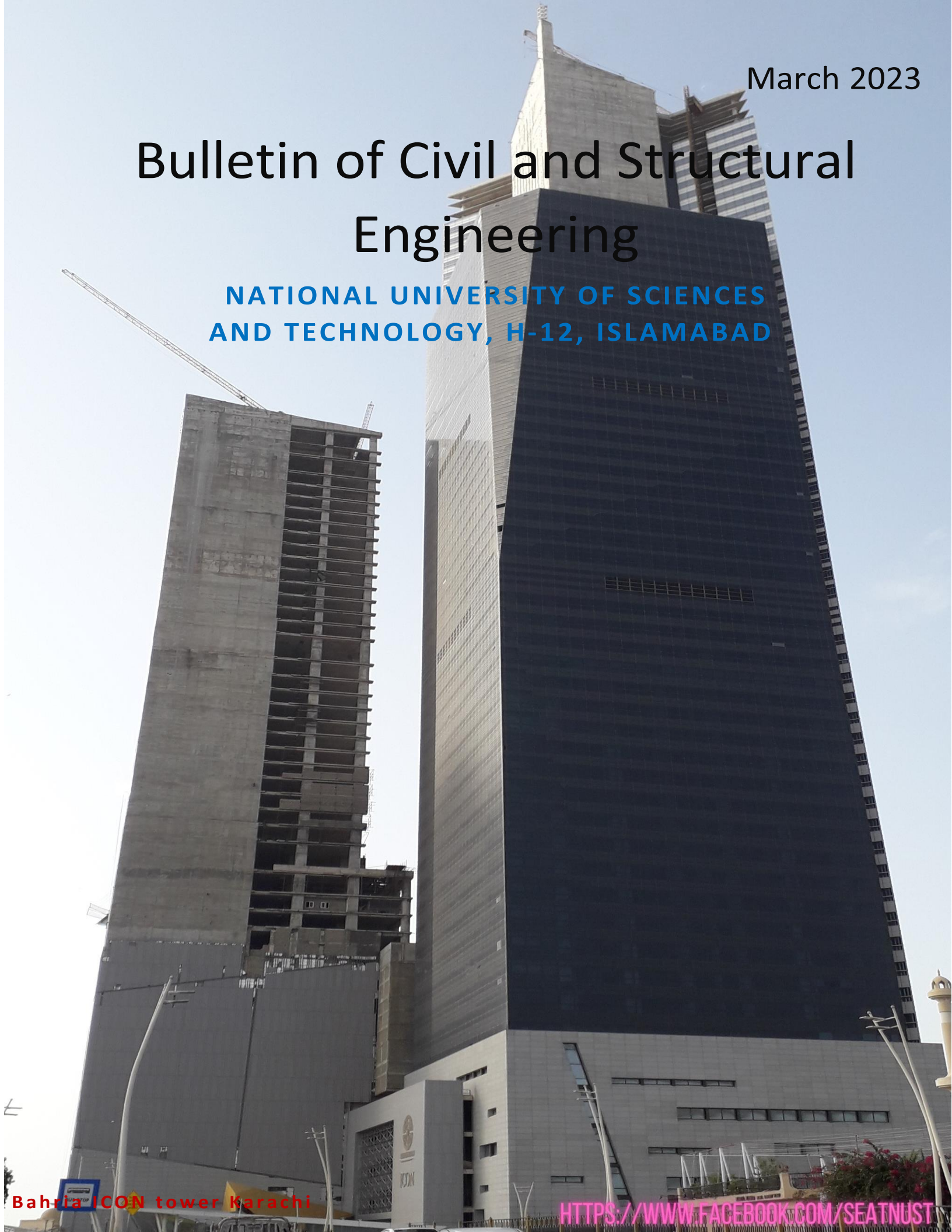
March 2023

Bulletin of Civil and Structural Engineering

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



Bahria ICON tower Karachi

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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MARCH 2023, Number IV

Centarus mall in Islamabad

INSIDE THIS ISSUE

NUST
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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 30/05/2023. Submissions after the deadline will not be accommodated.

For further queries, contact us

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Editorial Board

RESEARCH AT GLANCE YEAR 2023

Predicting the design strength of sheathing connection in CFS shear wall

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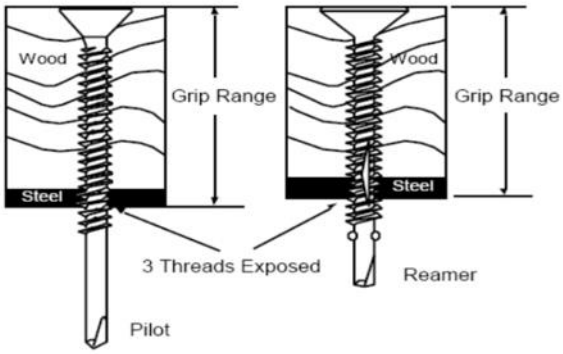
Summary

In cold form steel (CFS) buildings, seismic resistance is provided by sheathing braced & strap braced shear walls, which resist horizontal in-plane action. The walls are designed to resist lateral loads by in-plane shear. The shear strength and performance of such panels are determined by the sheathing connection between the sheathing panel (OSB, GWB, gypsum, wood etc.) and CFS frame. Fasteners (nails and screws) are used between the sheathing panel and CFS frame to develop resistance against lateral loads. The current design method by the American Iron and Steel Institute (AISI) lacks in accurately predicting the design shear strength of the sheathing braced shear walls through analytical design formula.

The objective of this research is to suggest the design criteria to evaluate the ultimate shear strength of the connection between the panel and steel frame utilizing the available experimental studies on them. The development of accurate design criteria will enable better design guidelines for structural engineers thereby leading to efficient use of CFS building systems.



Development of Lightweight Green Building Panels

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Supervisor: Dr. Rao Arsalan Khushnood
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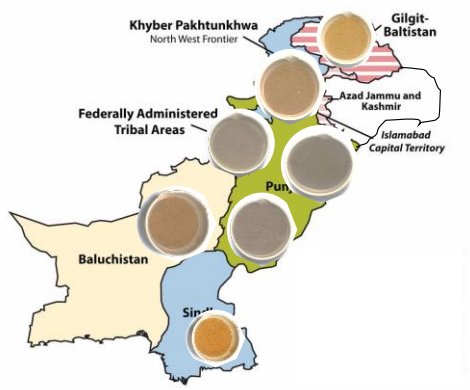
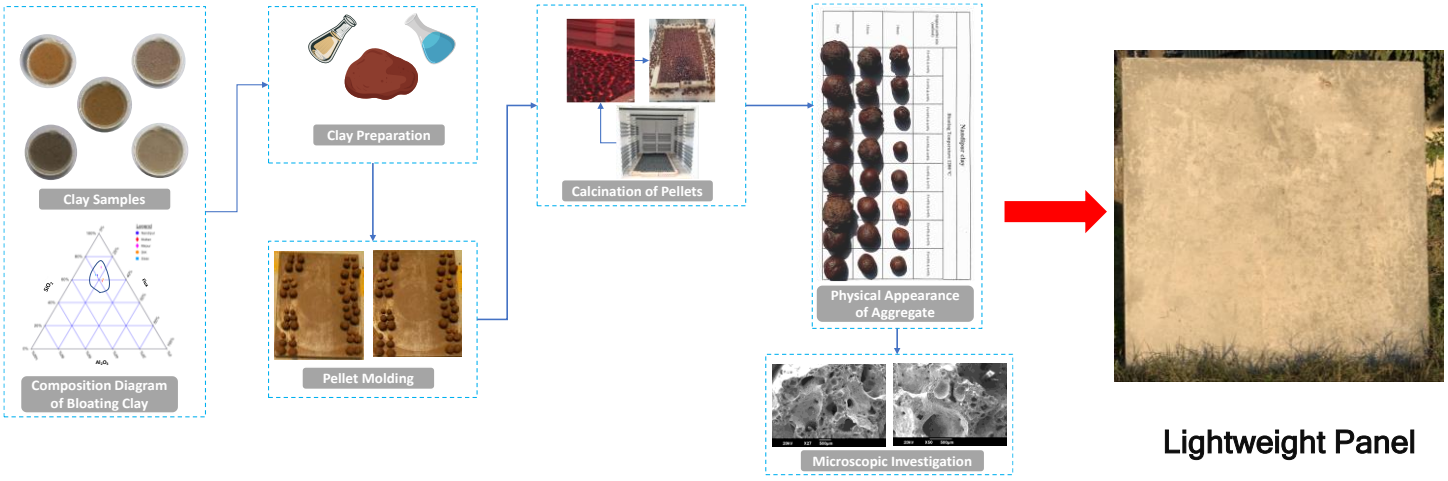


Sample Collection

Summary

Lightweight concrete panels developed using expanded clay aggregate (LECA) are a type of precast concrete panel that offers excellent insulation, fire resistance, and durability while being significantly lighter in weight than traditional concrete panels. The panels are made by mixing cement, LECA, water, and other additives and then pouring the mixture into molds to create the desired shape and size. Once cured, the panels can be used for a variety of applications, including building facades, interior partitions, and flooring systems. The use of LECA in the panels not only reduces the weight of the panels but also improves their thermal and acoustic insulation properties. Additionally, the production process for these panels is less energy-intensive and results in a lower carbon footprint compared to traditional concrete panels, making them an environmentally friendly alternative.



Feasibility Study of Modified Liquid Column Ball Dampers for Vibration Control of Structures

Student: Mati Ullah Shah

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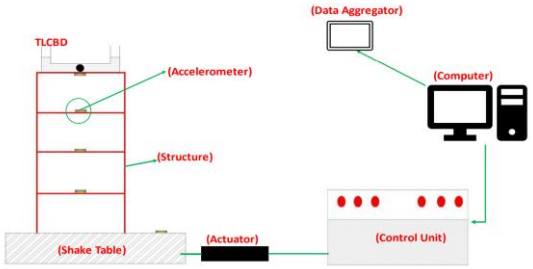
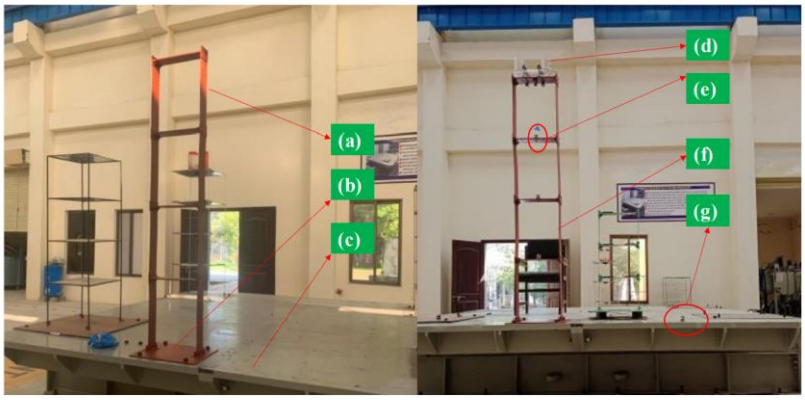


Experimental setup schematic view

Summary

This study presents modified versions of tuned liquid column ball damper (TLCBD) known as tuned liquid column ball spring sliding damper (TLCBSSD) and tuned liquid column ball spring rolling damper (TLCBSRD). In these modified versions the ball inside the horizontal section of the damper has been attached with spring. In TLCBSSD the ball attached with spring can translate only. While in TLCBSRD the ball attached with spring can translate as well as rotate. Mathematical models and optimum design parameters are formulated for both types. The performance of these new modified damper versions is assessed numerically and subjected to harmonic, seismic, and impulse loadings. The results show that the performance of the newly proposed dampers is relatively better than traditional TLCBDs in harmonic and seismic excitations. After numerical study, for experimental validation a series of shake table testing are performed. Both the dampers' performance has been evaluated on 4 story frame structure under harmonic and seismic excitations. The damper was placed on the top of the fourth story in each experimental setup. The RMS acceleration, displacement, and inter-story drift of each story have been calculated at harmonic and seismic loadings for uncontrolled structure, structure with TLCBD, with TLCBSSD, and with TLCBSRD. Compared to uncontrolled structure both TLCBSSD and TLCBSRD reduced the RMS response of the structure at resonant and seismic excitations. At harmonic loadings including frequency 0.65 Hz, 1.17 Hz, 1.30 Hz, 1.43 Hz, and 1.95 Hz, the RMS responses of the structure with TLCBSSD and TLCBSRD have been reduced against structure with TLCBD. The maximum reduction in the responses of TLCBSSD and TLCBSRD over TLCBD has been observed at resonant loading. Moreover, at seismic loading, the decrease in the RMS responses with TLCBSSD and TLCBSRD over TLCBD is slightly lesser than reduction efficiency at resonant loading. Overall, the performance of TLCBSSD and TLCBSRD is outstanding than the performance of TLCBD under both harmonic and seismic loadings.



Experimental setup

Digital Image Processing for Precise Evaluation of Crack Repair in Concrete using Bio-Inspired Strategies

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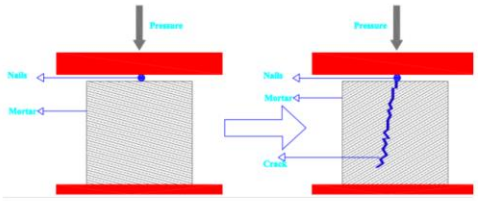
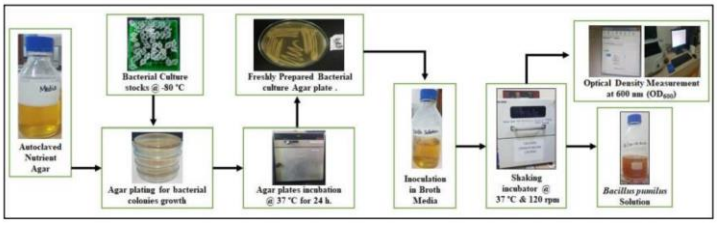


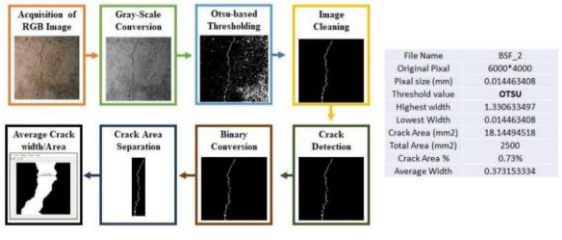
A schematic of crack formation in mortar sample.

Summary

Inadequacy of surface coatings and deleterious action to the environment by epoxy-based solution for surface treatment have received the attention for more sustainable techniques for concrete repairs. This study investigated the adequacy of Microbially induced calcite precipitate for mortar crack repair by using a non-ureolytic (avoid production of ammonia) alkaliphilic bacterial strain (high pH of cementitious matrix) with calcium source. Biological metabolic activity of Bacillus pumilus with Calcium lactate were used for crack repair. As Bacillus pumilus was first time reported for concrete repair, so germination and growth characteristics were evaluated in control microbiology laboratory before application. The healing potency by bacterially mediated calcium carbonate was precisely investigated by Digital image processing using OTSU method of thresholding. Crack healing of 99 – 100% was achieved by biological repair for mortar samples having average crack width varying from 0.29 to 1.55 mm. The efficacy of crack repair by both bacterial repair and conventional treatments was evaluated through water permeability, water tightness, ultra-sonic measurement and compressive strength recovery of. Sample treated with bacterial treatments exhibited enhance permeability and water tightness comparable to any other conventional treatments. The bacterial repaired mortar samples shown enhanced values of ultra-sonic measurement and recovered compressive strength equivalent to conventional repair. The enhanced durability of bacterially repaired mortar sample is due to presence of dense precipitated of CaCO3 by metabolic activity of bacteria. Micro-structural evaluation was done for CaCO3 confirmation from collected precipitate inside healed crack by biological repair. Raman spectroscopy of precipitates revealed presence of CaCO3 single peak corresponding to the Ag internal mode at 1085 cm-1 from v1 symmetric stretching of carbonate ion. X-Ray diffraction analysis of precipitate exhibit intense peaks of CaCO3 at 2-theta (2θ) orientation of 29.45°. Micrographs obtained from Scanning electron Microscopy (SEM) shown dense CaCO3 crystal where composition of crystals was confirmed by Spot Energy dispersive X-ray (Spot-EDX). Thermogravimetric analysis results of bacterial healing precipitate shown significant weight loss between 600°C and 750°C, confirming presence of CaCO3. All these Micro-structural, chemical and physical analysis confirmed enhanced durability of bacterially treated mortar specimen is due to CaCO3 deposition inside crack.



Bacterial Solution Preparation.



Flow Chart of Image Processing Results.

Structural Performance of An Limestone Calcined Clay Cement (LC3) Concrete

Group members: Khawar Tufail
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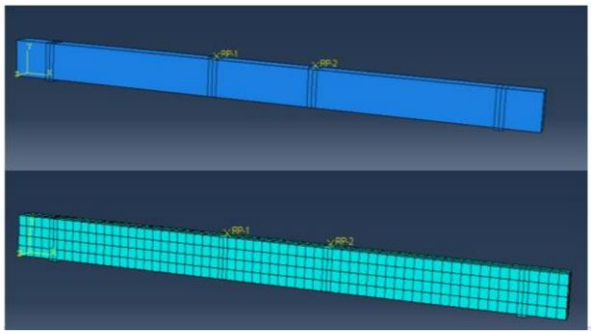

Summary

This thesis is on a breakthrough technology to reduce CO_2 emissions from cementitious material that is limestone calcined clay cement (LC3). The use of SCMs to replace the part of clinker in cement is the most successful strategy to reduce CO2 emissions in global cement industry. The only type of material available in the quantities needed to meet the demand is clay containing kaolinite, which can be calcined to produce an effective SCM. As discussion proceeds workability, hydration and chemistry of LC3 is discussed followed by its durability properties. At the end suggestions for further research.LC3 is family of cement in which clinker content is replaced by calcined clay and lime stone with some proportion of CC: LS (2:1). In this paper kaolinite content of different clays were investigated and more than 40% kaolinitic clay were chosen in replacement of OPC along with Limestone. After that Kaolinite clay were grinded, passed from #200 sieve and heated at a temperature of 850 C0 for 1 hour. Hardened properties such as compressive strength, split tensile strength, flexural strength, modulus of elasticity of concrete using Limestone calcined cement were investigated by taking W/B ratio 0.5 constant. The experimental program was deal with mechanical properties of LC3 concrete with the following combination of LC3 -30, LC3 -50, LC3 -65, and LC3-80 along with normal OPC. Based on the experimental results it was noted that replacement less than or equal to 50% with conventional cement we can get the ultimate strength approximately equal to OPC. After that best mechanical properties showing sample were taken into structural level testing like four point bending test along with experimental results FEA were also carried out on same beams having OPC, LC3 -50 , LC3 -65 , LC3 -80 beams. Load vs deflection , comparison of peak loads ,comparison of ultimate deflection both experimentally and FEA deflection , crack width , number of cracks , minimum spacing of cracks , maximum spacing of cracks , average spacing of cracks these were the testes carried out on each beam and lastly comparison of carbon footprint were also carried out in a form of percentage difference of CO2 emission with respect to normal ordinary Portland cement and percentage difference of energy consumed with respect to normal ordinary Portland cement (OPC).

Calcined Clay

Flexural test of Beam

Enhance Fire Endurance of PCM Embedded Energy-Efficient Concrete Using Melamine Formaldehyde Encapsulation

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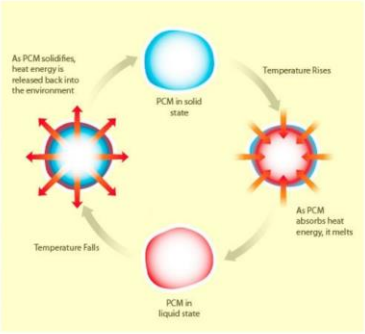
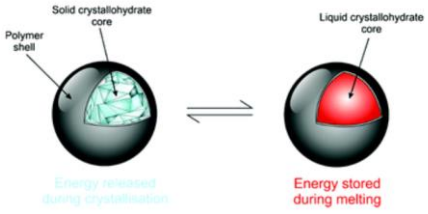


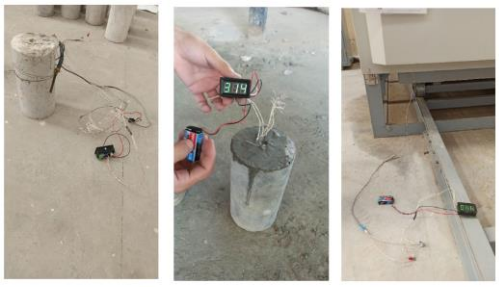
Working of Phase Change Material

Summary

Phase change materials (PCMs) are the latent thermal storage materials that can store a large amount of thermal energy while changing their phase and are usually incorporated in concrete for improving its thermal properties. However, the fire performance of concrete incorporated with PCMs is adversely affected due to high temperatures. This research is focused on improving the fire performance of concrete incorporated with a PCM that was intruded into the lightweight aggregate (LWA) pores using the vacuum impregnation technique. Macro encapsulation holds the PCM inside the LWA pores. Two encapsulation layers were coated to prevent PCM from fire. First encapsulation of epoxy sealed the paraffin inside the pores of LWA at ambient conditions, while the melamine-formaldehyde second layer prevented the leakage of PCM into the concrete matrix at elevated temperatures and consequently inhibited the flammable reaction of PCM with oxygen. The fire performance of PCM embedded concrete was assessed through its residual fracture properties after being exposed to elevated temperatures. By retarding the flammable reaction of PCM, the fire performance of concrete was improved, and it rendered PCM inside concrete completely functional up to 250°. Different tests were conducted which helped to evaluate the behavior of PCM modified concrete. It was observed that single Encapsulated (SE) specimens retain around up to 32% of their compressive strength at 200°C, while Double Encapsulated (DE) specimens retain up to 60% of their strength by inhibiting the flammability of PCM.



Encapsulation of Phase Change Material



Thermal Conductivity

Cracking of Cylinders Split Tensile Test

Differential Scanning Calorimeter

DEPARTMENT NEWS

- Pakistan's first 3D Concrete printer developed by students of the Structural Engineering Department at NICE - NUST led by Raja Dilawar Riaz under the supervision of Dr. Muhammad Usman.

- Department of Structural Engineering (SCEE) took top position at the Pakistan Engineering Council Capstone Expo 2022 which recorded participation by 35 universities from across Pakistan, with an exhibition of 200 projects.

- Structural engineering program gained much higher ranks in QS World University rankings.

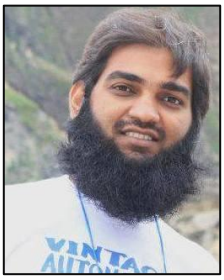
- Our second ever PhD candidate Dr. Muhammad Zain successfully defended his thesis. Dr. Muhammad Usman advised him throughout this journey.

- Two FYP's of Structural Engineering department were awarded with best Final Year Design Project Award.

Who joined and who left

- Dr. Fawad Ahmad Najam joined University of British Columbia as post-doctoral researcher. We wish him best of luck for his future research endeavors.
- Engr. Saif ur Rehman joined as Lab engineer in Structural Engineering Laboratory.

FACULTY AT STRUCTURAL ENGG. DEPT



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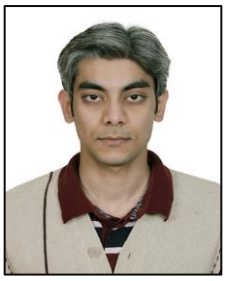

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