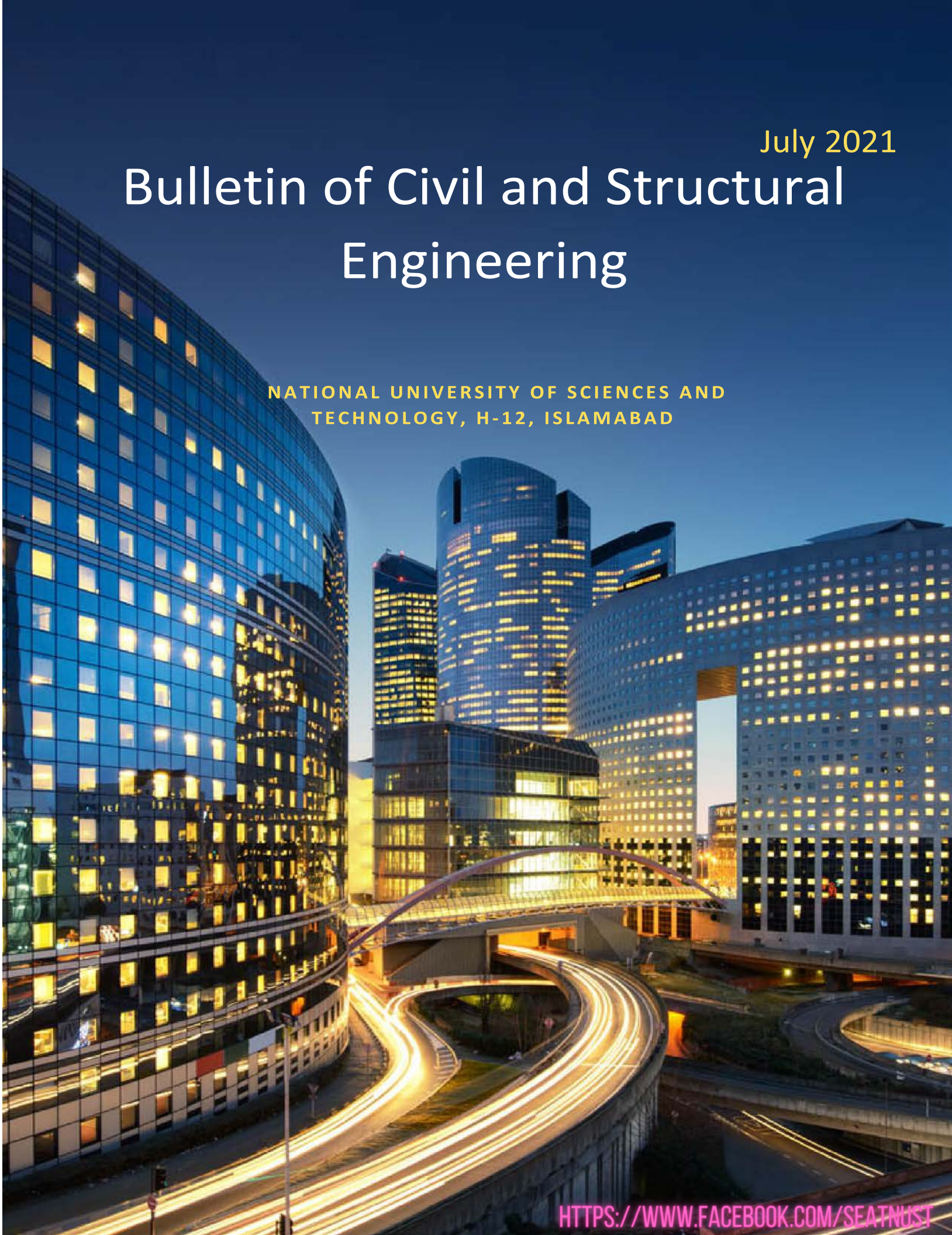
July 2021

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

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INSIDE THIS ISSUE

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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 30/09/2021. Submissions after the deadline will not be accommodated.

For further queries, contact us

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Email: *sshakil@nice.nust.edu.pk*

Muhammad Abubaker

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Editorial Board

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

"In the name of Allah, Most Gracious, Most Merciful"

INTRODUCTORY NOTE

The major focus of the courses offered by Structural Engineering Department at NUST Institute of Civil Engineering (NICE) is to train students in modern technologies and applications involved in the design and construction of state-of-the-art infrastructure. Our labs are equipped with the latest equipment that allows students to synchronize themselves with the methodologies currently followed around the world. Graduate program aims at finding job opportunities for its students in a very wide range of organizations encompassing design consulting firms, contractors, government, and public sector organizations. MoUs have been signed with different companies working in both public and private sector and the department provides solutions to their problems, and they provide employment opportunities to our students. The department is actively engaged in R&D activities and continues to hold international workshops, Symposia, and conferences in collaboration with NUST, HEC and DAAD. Consulting services are also offered to public and private sectors. Our students have excelled in their professional assignments.

This newsletter will highlight the design and research tasks undertaken by the students of the department as their Final Year Project in Year 2020-2021. These projects covered variety of the design and research problems associated with Civil Engineering Infrastructure.

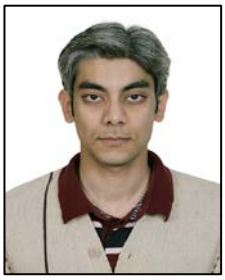
Department Faculty

Dr. Muhammad Usman

- Assistant Professor
- Expertise: Structural Health Monitoring, Vibration Control

Dr. Rao Arslan Khushnood

- Assistant Professor
- Expertise: Sustainable Construction Materials, bio Influenced Self-healing Cementitious materials



Dr. Ather Ali

- Assistant Professor
- Expertise: Masonry Structures

Dr. Fawad Ahmed Najam

- Assistant Professor
- Expertise: Structural Dynamics, Earthquake Engineering

Dr. Musaad Zaheer Nazir Khan

- Assistant Professor
- Expertise: Geopolymer Concrete, Blast resistant structures

Dr. Azam Khan

- Assistant Professor
- Expertise: Steel Structures, Offshore structures

Dr. Muhammad Usman Hanif

- Assistant Professor
- Expertise: Concrete Structures, Fracture Mechanics

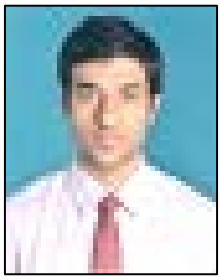
Dr. Sarmad Shakeel

- Assistant Professor
- Expertise: Light gauge Steel Structures, Earthquake Engineering

Dr. Hammad Anis Khan

- Assistant Professor
- Expertise: Concrete Technology, Durability of Concrete Structures

Sami Ullah Bangash



- Lecturer
- Expertise: Modelling and analysis of Steel Structures

Arslan Mushtaq

- Lecturer
- Expertise: Seismic vulnerability assessment of RC Structures

Sara Farooq

- Lecturer
- Expertise: Concrete Technology

EFFECT OF SOIL MODELLING ON STRUCTURAL RESPONSE

Arslan Amir

Usama Khurram

Ali Zafar

Muhammad Hasnain Haider

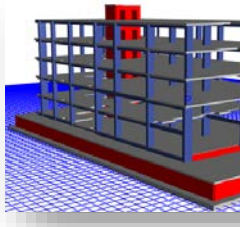
Supervisor: Dr. Fawad Ahmad Najam

In current general design office practice, the effect of soil is neglected in structural modelling and response of structure is evaluated against an idealized structural model having a fixed or hinge base. The present study aims to assess the effect by comparing the local and global responses of case study building models (with and without modelling the effects of foundation and local soil) under gravitational load analysis and seismic Analysis. For this we selected two case study buildings (4-Storey Luxury Residence and 7-Storey Commercial Building). These buildings are Frame Structures with RCC Walls to resist lateral loads and are representative of other buildings in our scope of work. Then we created models of selected buildings in ETABS. 3 different models for each building were created.

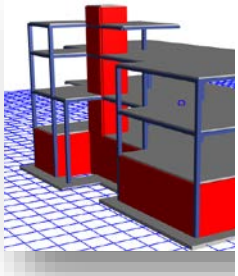
1. Baseline model (No foundation + No soil effect)
2. Model with actual geometry of foundations (No soil effect)
3. Model with actual geometry of foundations + Soil effect using modelling approach.

For modelling soil, we used Winkler soil modelling Approach.

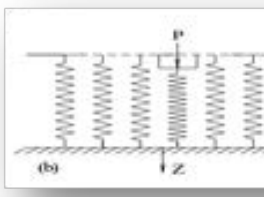
For each model created, we preformed modal analysis, Gravitational load analysis and seismic analysis (ELF procedure). We extracted Global and local responses of every model of each building. When we compared these responses, we observed that the responses for both buildings, the base model results and plots differ significantly from either the foundation model, soil model or both. Hence, it can be safely concluded that the inclusion of foundation and soil modeling into the basic design approach is important to obtain a better and improved design.



7-Storey Model.



3-Storey Model.



Representation of Winkler model.

PROGRESSIVE COLLAPSE ANALYSIS DUE TO SUDDEN REMOVAL OF COLUMN IN RC STRUCTURE

Syed Sayaf Hamdani

Muhammad Danish

Mashhud Hussain

Muhammad Saleem ullah

Supervisor: Dr. Fawad Ahmad Najam

MAIN GOAL:
To identify that either progressive collapse due to sudden removal of column in reinforced concrete structure should be a design criteria or not.

Methodology:

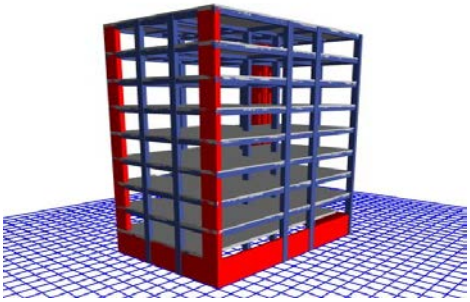
1. Collection of structural drawings of 3 case study RC frame structure buildings situated in Islamabad.
2. Making Model on ETABs Software.
3. Develop different column removal cases such as due to bomb blast, car crash, earthquake, repair work, fire etc.
4. Analysis performed is Model analysis, linear static (Gravity load), and linear dynamic (ELF).
5. Compare analysis results for both Global results and local results.

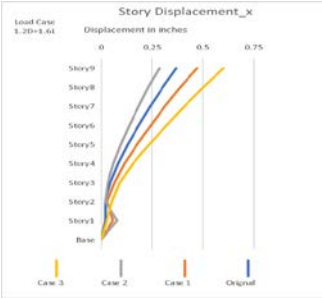
Outcomes:

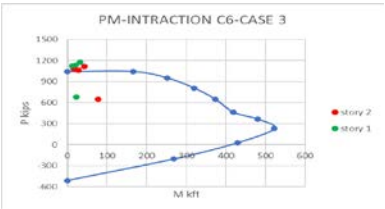
- Story moment and shear are not affected as they are based upon Mass of structure which has negligible change before and after column removal.
- Partial progressive collapse of a building can also be observed in case beams on one side have reached their capacity.
- In some cases columns start to exceed their capacity which lead to failure in different structural members and can lead to ultimate failure.

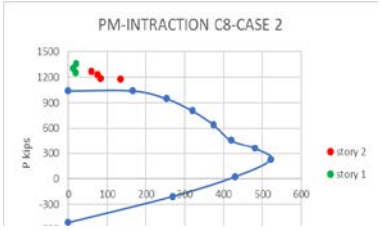
Conclusion:

Chain of failure may lead to full or partial collapse of building. So, at design phase Progressive Collapse due to Sudden Column removal should be considered. Which can be a failure criterion.









DEVELOPMENT OF RAPID RUNWAY REPAIR STRATEGIES

Muhammad Mubeen

Hamza Naveed

Qudees Tariq Kyani

Supervisor: Dr. Usman Hanif

The Airport infrastructure including approach runways, taxiways and aprons is the most important and extreme sensitive target to be attacked by the enemy during warfare. Damage to airfield pavements from sophisticated enemy munitions threatens sustained aircraft sorties until the airfield is repaired. Bombing infuses large craters into the airfield infrastructures approaching 20 feet width. Timely repair to immediate resume the flight operations is the topmost concern of the scenario. Numerous research in terms of materials, equipment and techniques are globally practiced in the backfill of crater followed by the placement of crown as prefabricated modular elements or in-situ repair with rapid setting and rapid hardening grout. However, there are multiple associated parameters with local conditions that enforce an optimized solution for a particular site. The project aims to analyze all the available alternatives to extract an optimal solution for the restoration of airfields back on operational status following enemy attack.

The Project methodology is divided into following five phases, depending upon the linkage between different activities, shown in figure here.

- Phase A - Technical review for selection of suitable RRR techniques
- Phase B - Lab analysis of selected RRR strategies
- Phase C - Field trials of laboratory optimized RRR techniques
- Phase D - Cost benefit analysis of optimized RRR techniques
- Phase E - Implementation plan & documentation

In this study, a robust variant of Genetic Programming (GP), namely GEP is utilized to formulate One Day Compressive Strength of Rapid Hardening Concrete. The results show that the GEP model has great potential for the prediction of Compressive Strength of Rapid Hardening Concrete. Among all input variables, amount of Magnesium Phosphate Cement and High Alumina Cement has higher impact on the Compressive Strength i.e. 29% each, while the impact of Fine aggregate, Coarse aggregate and HRWR is mild. The remaining input variables like OPC, Type 3 Cement, Accelerator, Retarder and Silica Fume has low impact on the compressive strength.

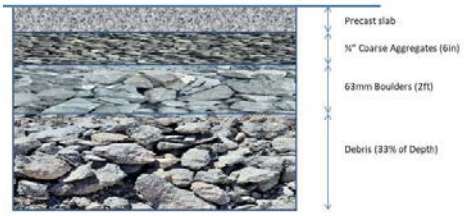
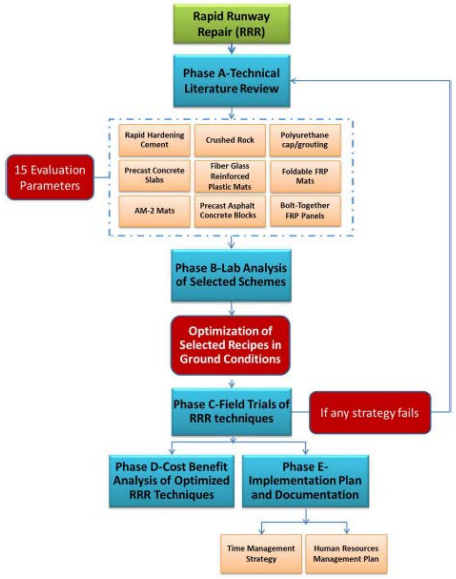
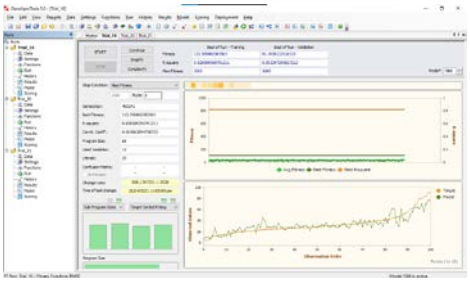


Fig. 3. Crater repairing by pre-cast slab units





ANALYSIS OF A CONCRETE BRIDGE USING BIM AND 3D RECONSTRUCTION TECHNIQUE

Mudassir Ahmad

Hamza Tariq

Ghufran Ahmad

Muhammad Waleed Afzal Khan

Supervisor: Dr. Usman Hanif

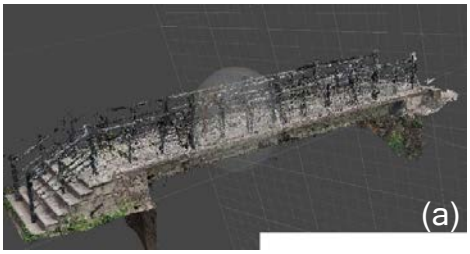
Visual inspections are the initiating procedures for any structural health assessment method. In civil engineering structures, visual inspections become more challenging because of the massiveness of the structures. In case of bridges, which are constantly exposed to dynamic loads (such as wind and traffic loads), the health inspection procedures involve heavy machinery which involves, disrupting the traffic flow. This research was aimed at addressing the said challenge by using Building Information modeling and 3D reconstruction technique, which not provide data for visual inspection, but also provides a 3D finite element model for static or dynamic analysis.

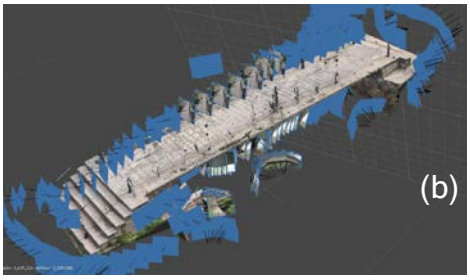
During our field data collection, we identified the constraints of carrying out the research (weather conditions). Geometric dimensions were measured as a reference for scaling the 3D model. A 4k camera mounted on a drone was used to acquire image data of the bridge using standard procedures (photogrammetry). However, due to difficulty in operating the drone in closed spaces, the procedure was supplemented by using a smartphone camera at those places.

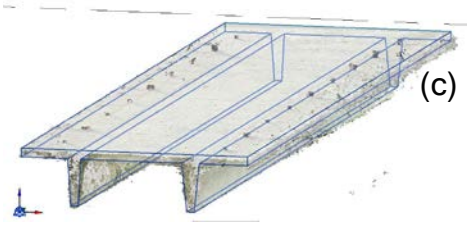
For 3D reconstruction, which is the process of acquiring a 3D model based on the raw data, 3DF Zephyr and Agisoft Metashape were used. The reconstruction process resulted in two components that make up the 3D Model: Point Cloud (a) and Mesh Model (b).

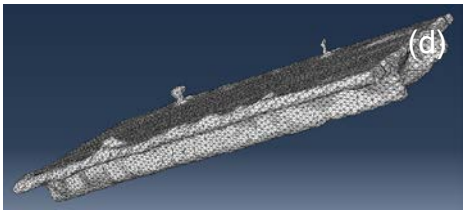
Two types of models were developed i.e. the manual model as well as the automated model. The manual model(c) was traced by using the Point Cloud as a reference, drawing the BIM model of the bridge in Revit and then using it as a reference to make the structural model in Abaqus. The automated model(d) was generated by converting the texture mesh into a solid body and was imported directly in Abaqus. Both models were analyzed using 1D modal analysis after assigning material properties.

The resulting dimensions acquired from the Photogrammetric method corresponded to actual dimensions of bridge and the result of the modal analysis matched with the reference paper which showed that 3d reconstruction has great potential in its applications in civil engineering.









ANALYSIS OF STEEL FRAME

Hafiz Muhammad Ahmad

Tahir Ali Khan

Naimat Ali Sheikh

Usama Fazal

Supervisor: Lec: Sami Ullah

Main Goal:

Our project is an attempt to prepare user friendly MATLAB program for Structure Analysis and A document for student learning guide for computer application. The code can solve 3D- frames and provide results in linear Elastic range. We adopt Direct Stiffness Matrix (DSM) method for our analysis. The direct stiffness method is the most common implementation of the Finite Element Method (FEM).

Methodology:

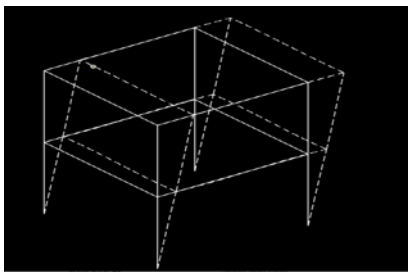
In stiffness method for an element, we obtain the relationship between nodal displacements (linear and angular) and nodal forces. Initially, we divided the structure into elements. The second step is to identify the nodes or joints between elements and to number consecutively those nodal coordinates that are not constrained. The third step is to obtain systematically the stiffness matrix for each element in the system and to add the element stiffness coefficients appropriately to obtain the system stiffness matrix. This method of assembling the system stiffness matrix is called the direct method. Lastly, we created Graphical User Interface by using App Designer tool which allow us to drag and drop different menus like nodal Coordinates, material and sectional properties, etc.

Outcome:

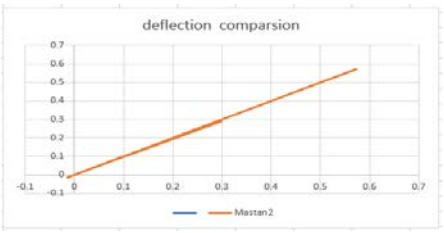
Complex engineering structures are very difficult and hectic to solve by hand and consume a lot of time This program will help to analyze 3D frames in linear elastic range quickly without any laborious work.

Conclusion:

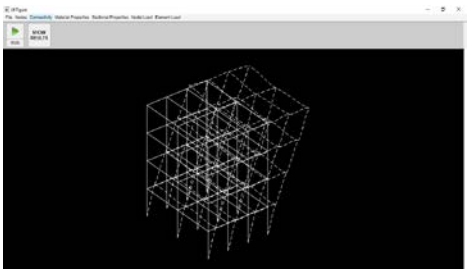
We have compared the results with MASTAN2 which is MATLAB based GUI and the results are overlapping which shows our code is correct.



3D frame before and after loading 1



comparison with MASTAN2



Our GUI

STABILITY ANALYSIS OF STEEL STRUCTURES

Shabir Ahmad

Ahmad Irtaza Khan

Abdul Rafay Karim

Saud Afzal

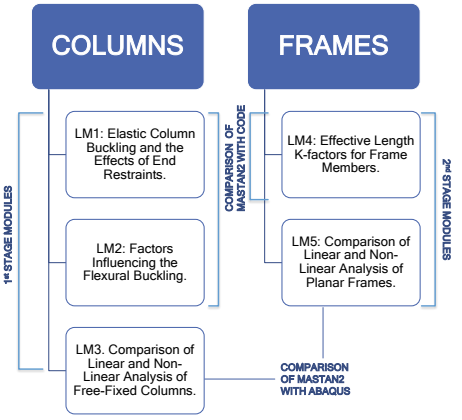
Supervisor: Lec: Sami Ullah

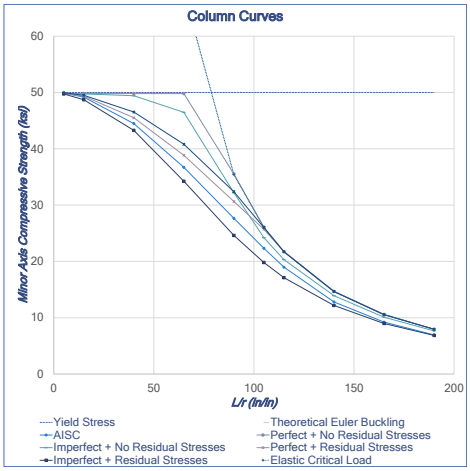
Steel structures are regularly analyzed, designed and its various stability aspects are checked as a regular activity in structural engineering practice yet it can be a complex structural engineering problem. To solve such structural engineering problems, different analysis techniques and commercial software packages are available and in practice. Steel Structures may be analyzed by various methods such as: Critical Load Analysis, 1st and 2nd Order, Elastic and Inelastic Analysis

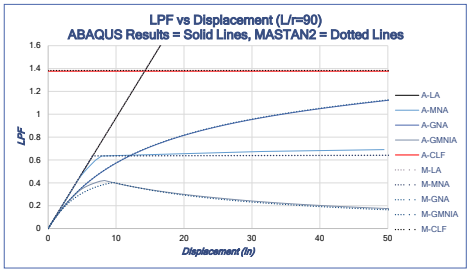
As we all know, Industrial buildings, convention centers, and warehouse facilities are usually tall single-story steel structures. which leads to the necessity of performing second order analysis, which is a rigorous process, even when performed by codes or software such as ABAQUS. MASTAN2 is a more efficient software to perform such analysis. The main objectives of the study are: (1) To perform stability analysis of steel structure using linear and non-linear analysis techniques and investigating the effects of these methods on the load-displacement response. (2) To investigate columns and planar frames stability. (3) To investigate the conformity of results of MASTAN2 with AISC specifications and ABAQUS. With all these things in mind we have devised different stability modules which can be used by students and researchers to investigate different stability areas and it can also be implemented as a course on UG level. All the modules covered in this study are given on the right in Figure 1.

All Modules are performed using MASTAN2 preprocessing, analysis and post processing capabilities. The Elastic, Inelastic, 1st and 2nd order analysis techniques are implemented to achieve all objectives. MASTAN2 and ABAQUS both are used for comparison of linear and non-linear analysis.

From the observations of the results of module no. 1, 2 & 4, we conclude and recommend that there is no significant difference between MASTAN2 computational analysis and AISC specifications. Hence MASTAN2 computational analysis can be effectively performed instead of hand base analysis calculation based on AISC specifications which are much more time consuming. Similarly, the MASTAN2 results of Module 3 & 5 show conformity with ABAQUS results. As ABAQUS is a much more complicated software and modeling on it takes relatively much more effort. MASTAN2 is recommended to be used to save both time and money.







ANALYSIS OF A SUSTAINABLE HIGHRISE BUILDING INCORPORATING BAWT

Syed Agha Shah Ali

Usama Ali Khan

M. Obada Ajaz

M. Hassan Mujtaba

Supervisor Dr. Muhammad Usman

Main Goals:

Observe the effects of wind in the form of velocity and pressure on existing and proposed high rise buildings having wind turbines augmented in an attempt to make the infrastructure sustainable.

Methodology:

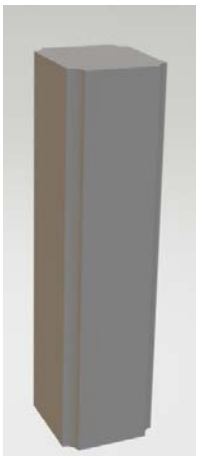
Analyzing existing building against the maximum wind loads on ETABs and running CFD analysis for wind speeds blowing throughout the year and finally computing the energy harvested from a single turbine placed at the most optimum location.

Outcomes:

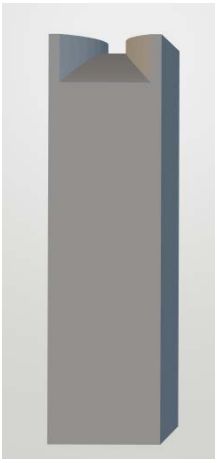
The cavity in the face of the existing building is not sufficient to bring about the desired wind speeds and that the turbines are to be placed on the roof to harness the wind energy. The revised facades having better aerodynamic shapes give better velocities to generate sufficient energy about 3.71 kW of energy per turbine at an ambient velocity of 7 m/s.

Conclusions:

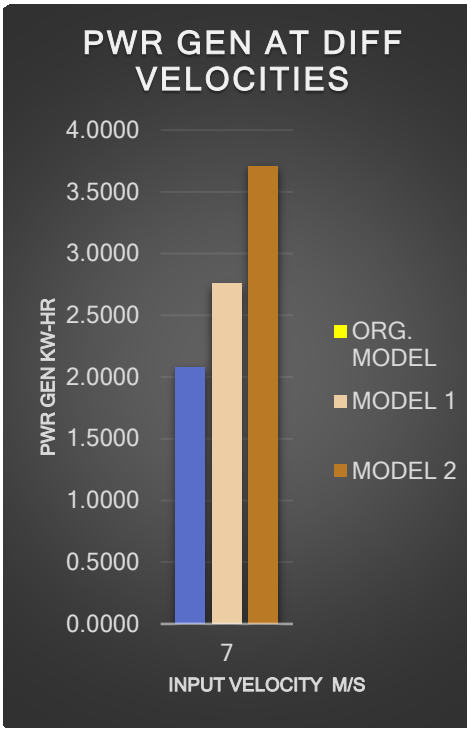
The aerodynamics of a building plays an important role in modifying the velocities and pressure on the surface of building. Hence the façade should be designed as such to allow maximum of wind to flow, allowing us to harness wind energy whilst making our infrastructure innovative and at the same time sustainable leading towards a greener revolution.



Model 1



Model 2



FEASIBILITY STUDY ON USE OF NICKEL & COBALT AS FILLER IN SMART ISOTROPIC MR ELASTOMERS

Behram Khan Mahsud

Umer Majid

Jahanzaib Shahzad

Talha Abid

Supervisor Dr. Muhammad Usman

Earthquake is the shaking and vibration at the surface of the earth resulting from the underground movement along a fault plane or from the volcanic activity. To negate the effect of these earthquakes, structures resistant to such shakings and vibrations should be built using several techniques. Many techniques have been in use and base isolation technique using smart materials is now catching the attention."Base isolation" is a technique that separates the structure and its components from the dangerous earthquake ground motion. Base isolation is achieved by mounting the superstructure on the system of supports that are stiff and strong with respect to vertical forces and are showing low stiffness in the horizontal direction.

Main Goal:

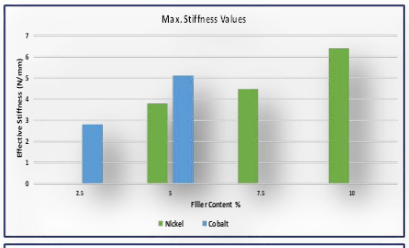
- To study the effect of using micro sized Nickel and Cobalt particles as filler materials on the dynamic shear properties of Magnetorheological Elastomers.
- To study the Magnetorheological Effect of MRE using different ratios of filler particles under Shear Loading.
- To compare the Magnetorheological Effect between the MREs reinforced with Nickel and Cobalt.

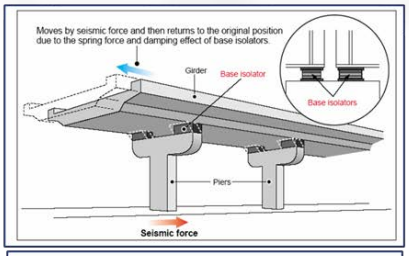
Methodology:

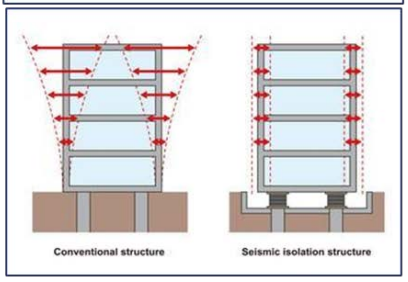
1. Characterization of metallic powders to determine size of particles and check for impurities.
2. Casting of MRE samples.
3. Micro-image analysis of casted MREs.
4. Finally, the dynamic shear testing on the casted samples and the analysis of obtained results.

Outcome:

The outcome of this research work was that for Nickel and Cobalt higher MR effect was observed at lower filler percentages and also higher MR effect was observed for Nickel based MREs then for Cobalt based MREs.







TO QUANTIFY THE IMPROVED RESPONSE OF STEEL PLATE EMBEDDED AND JACKETED R.C.C. BEAM IN SHEAR AND TORSION

Anas Aftab

Muhammad Shafin Khan

Syed Muhammad Sohaib

Muhammad Arslan

Supervisor: Lec. Arslan Mushtaq

In Construction Projects, it is sometimes seen that the design load is changed at the last moment, and due to feasibility factors, we cannot always change the cross sections of the load taking element, i.e., beams, columns etc.

So, for this purpose, we must devise clever engineering methods to enhance the strength of the members (in our case the beams).

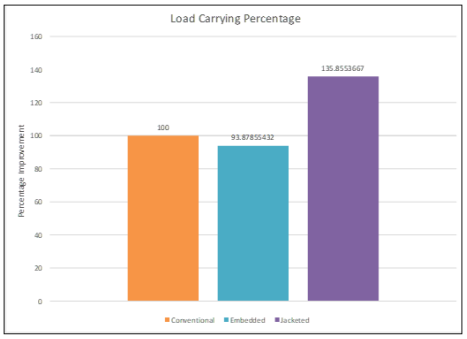
In our case the design load of an under-construction silo was increased at the final moments and the formwork was already in place and could not be removed. So, some methods were introduced and then compared with simple RCC beams to check the overall serviceability and enhanced strength.

Total 9 beams were casted; three simple beams, three beams with embedded u-shaped steel sheet in them, and three with an external u-shaped steel jacket bolted to them.

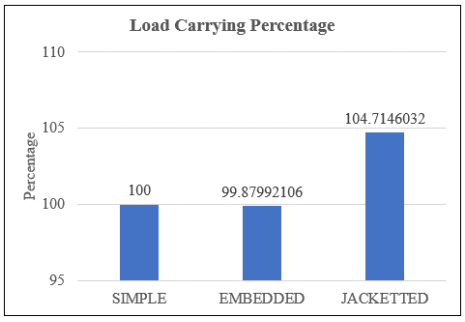
The beams were then tested in flexure, shear and torsion and the results of the embedded and jacketed beams were then compared with that of simple beams.

In flexure, the jacketed beam showed 35% more load capacity, embedded showed 6% less load capacity but showed more ductility as compared to jacketed. In shear, all showed almost same strength with jacketed beam showing a slight 4% more capacity. Both embedded and jacketed beams showed ductility thus failure was not brittle. In torsion, embedded beam showed 12% more capacity whereas jacketed showed an overwhelming 147% more strength. The response of both beams was ductile.

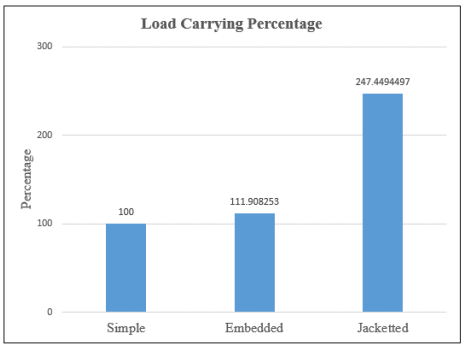
In conclusion, for our case jacketed beam is the best option, whereas embedded beam can be used in an earthquake prone region to make a structure resilient.



Comparison in Flexure



Comparison in Shear



Comparison in Torsion

EFFECT OF SURFACE PREPARATION ON PERFORMANCE OF RC COLUMNS RETROFITTED WITH RC JACKETING

Faizan Ahamd Nadeem

Muhammad Nashit Bhatti

Muhammad Husnain Ali

Badar-Ul-Hunain Khan

Supervisor: Lec. Arslan Mushtaq

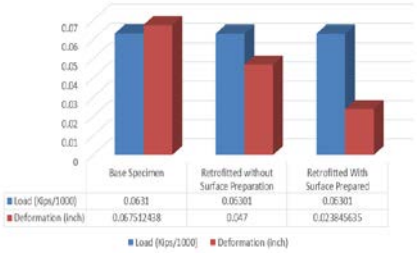
Main Goal:

Addressing the prevailing problems like Variations in design loading type due to client requirements, poor construction practices due to the absence of skilled engineer's supervision, the desire of the owner for vertical expansion above the previous construction and structural strengthening by introducing seismic retrofitting strategies due to old construction (without seismic provisions),

Methodology:

We did a research on advancing the prevailing conventional technique of RC Jacketing and for better performance and axial strength, we tested the RC retrofitted technique with surface being prepared (Removal of cover) of the base specimen and compared the axial strength of specialized RC retrofitted column with the conventional RC Jacketed column.

Load Deformation Interaction (Comparison)



Conclusions:

There was 12% more axial strength for our surface prepared column.

AN EXPERIMENTAL STUDY ON GRAPHENE NANOPLATELETS REINFORCED CONCRETE

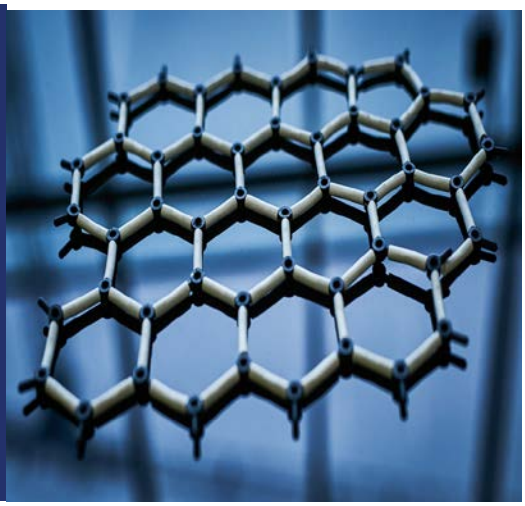
Rana Sufyan Hakeem

Hassan Ali

Daniel Javed Chaudhary

Bilal Ahmed Khan

Supervisor: Dr. Musaad Zaheer



Goals:

Construction industry is in dire need of a revolution to produce concrete that is not only cheaper but also environmentally friendly. Keeping in view the Sustainable Development Goals set by the United Nations, our Final Year Project was based on harnessing the potential of a novel nanomaterial called Graphene in concrete mix to increase the strength of concrete and consequently reducing the volume of concrete required for a given design strength.

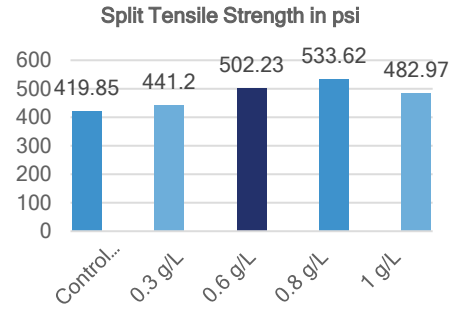
Methodology:

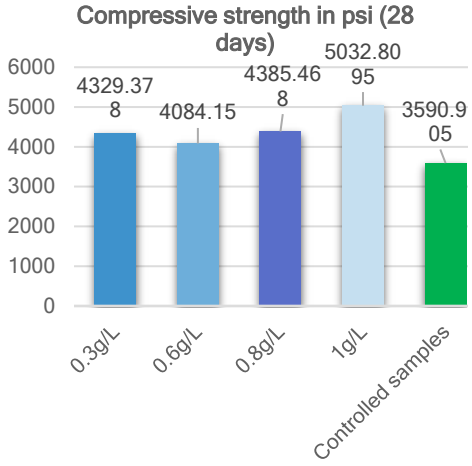
We used economically synthesized Graphene Nano Platelets provided by our collaborator Dr. Sofia from SCME Nano Synthesis Lab and used different concentrations of Graphene Nano Platelets (GNPs) for our beams and cylinders which was compared with a control group.

Conclusions:

There was a clear improvement in various parameters of concrete quality. An increase in compressive strength upto 40% was noted and Split tensile strength increased upto 27%, increase in toughness, reduced rate of steel reinforcement corrosion as well as reduced porosity.

We are really inspired by these results and strongly believe in the great prospects of Graphene in concrete. We hope to see such nanotechnology being applied in construction industry for a Green Revolution.





DEVELOPMENT OF SUSTAINABLE CONCRETE WITH INCORPORATION OF GFRP BARS

Muhammad Sohaib Raza

Abdul Rafey Nawaz

Muhammad Fahad

Rafia Abid

Supervisor: Dr. Musaad Zaheer

Goals:

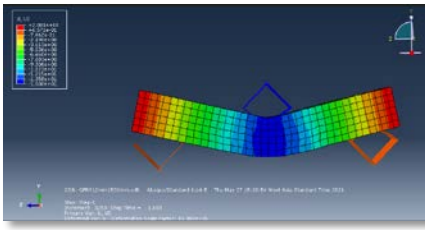
Initially the goal was to develop sustainable concrete and for this purpose we utilized recycled aggregate as an alternative of natural aggregate and replacement in range of 10%-30% was taken along with 7% silica fume to achieve a high-performance sustainable concrete. It was observed concrete silica fume enhanced the cooperative strength of concrete. There was a minimum decrease in concrete strength after 20% RCA substitute and this was then selected as the optimum formulation.

Methodology

This sustainable concrete formulation was employed to cast concrete beams of two different spans integrated with GFRP rebars. The experimental testing of the beams under three-point bending were carried out and subsequent analysis was performed. The research was then extended to model the beams in ABAQUS and calibrating it. An investigation on the effect of reinforcement ratio, size was studied.

Conclusions:

It was observed that an increase in reinforcement ratio led towards concrete crushing failure whereas a decrease in GFRP reinvestment size resulted in FRP rupture. A detailed cost analysis was performed that concluded that the effect of using RCA and GFRP bars in concrete resulted in 9.1% savings in cost of concrete. The GFRP Reinforced beam strength which was predicted by the ACI design guidelines was seen harmonious into the resistance obtained experimentally.



PRECAST CONCRETE SANDWICH PANELS AS INNOVATIVE BUILDING SYSTEMS FOR RESIDENTIAL CONSTRUCTION

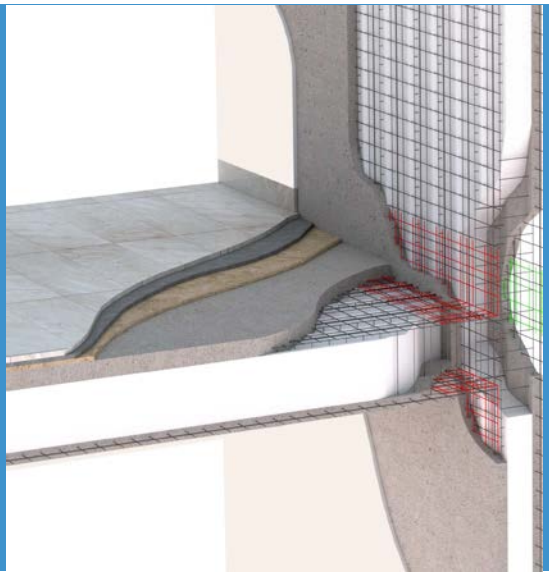
Umair Abid Mughal

Malik Nouman Anwar

Muhammad Uzair Khan

Faizan Masood

Supervisor: Dr. Rao Arslan Khushnood



The aim of this project was to research different parameters which influence the design of sandwich panels and fabricate a panel which is applicable for rapid construction of residential homes for Naya Pakistan Housing Program (NPHP).

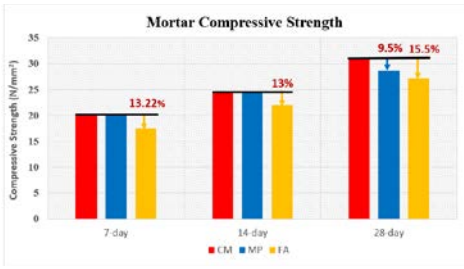
The first phase of the project was aimed towards developing mix-recipe for mortar-wythes, using indigenous materials. Three mix recipes consisting of fly ash and waste marble powder replaced at 15% by weight of cement and control mix-recipe were tested for compressive strength, flexural strength, carbonation, chloride-ion penetration, drying shrinkage and flowability.

The results revealed that all the mix-recipes yielded a compressive strength of 25+MPa and satisfied the criteria for carbonation, chloride ion penetrability, drying shrinkage and flowability, making it suitable for our use.

The second phase of this project consisted of fabricating sandwich panels. To optimize the design, ABAQUS, a finite element modelling software was used to vary following parameters: (thickness of mortar-wythes), (spacing, angle and diameter of connectors), (spacing and diameter of wire-mesh). Using the results of software, the optimized panel was casted at 1/4th scale and tested in flexure, compression, shear, fire resistance and thermal conductivity.

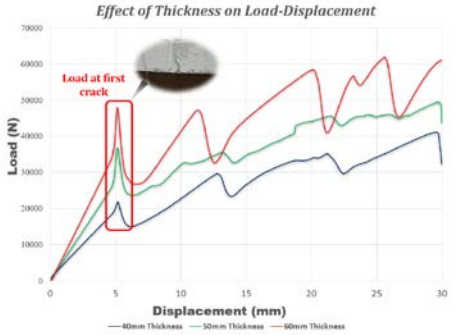
Results from ABAQUS revealed wire-mesh diameter, mortar-wythes thickness and shear-connector spacing to be the most influential factors. Inaddition, the results of thermal conductivity were used to conduct thermal analysis of the proposed panels using EcoTect software and results revealed over 47.5% reduction in cooling loads, electricity costs, and CO_2 emissions during life-cycle of building and over 44.7% reduction in CO_2 emissions during manufacturing phase.

In conclusion, sandwich panel is a versatile technology which can be designed for various applications by varying its design parameters and can bring about considerable savings in life-cycle costs and CO_2 emissions for green building construction.



Building Type	Cooling Loads per year (KWh)
Conventional	2117.617
Light Weight Panel	1124.45

Building Type	Cooling load (MWh)	CO_2 Emission/year	CO2 Emission in life cycle
Conventional	2.117	1.497 ton of CO_2	59.88 ton of CO_2
Light Weight Panels	1.124	0.786 ton of CO_2	31.46 ton of CO_2



CARBON DIOXIDE INHALING BIO HEALABLE INTERLOCKING COMPRESSED EARTH BRICKS

Talha Jamal Ghori

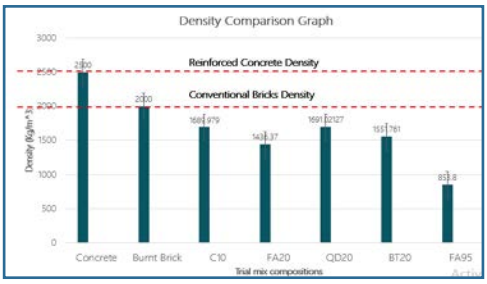
Muhammad Hamza bin Daud

Muhammad Ammar Khalid

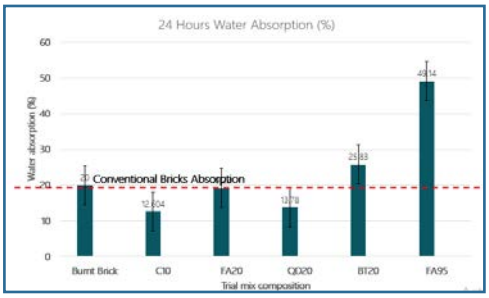
Muhammad Hashir Aziz

Supervisor: Dr. Rao Arslan Khushnood

Interlocking Compressed Earth Bricks is the name of innovation in the world of Bricks where bricks do not require days to get burn for manufacturing, instead a press machine can wholly serve the purpose. In our society, bricks are considered as a nonstructural element. Interlocking Compressed Earth Bricks not only modify this concept (ICEBs are structural bricks) but also proved beneficial during Earthquake loading owing to its shape (presence of shear keys) and reinforcement provided.

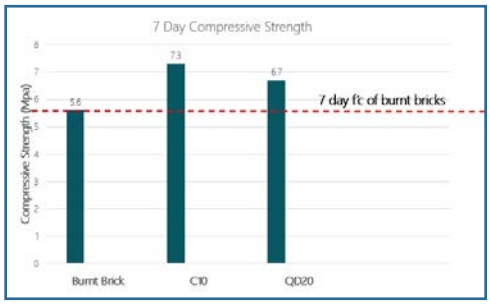


Due to the elimination of burning process completely, there arises the long term durability issues concerned with the interlocking compressed earth bricks. To address this issue, usage of indigenous bacteria that are already present in the soil is our main point in which Microbially Induced Calcite Precipitation is the result of metabolic activity takes place inside bricks when the bacteria are provided with suitable amount of broth and bacterial food to serve as the bio cement and facilitates healing activity.



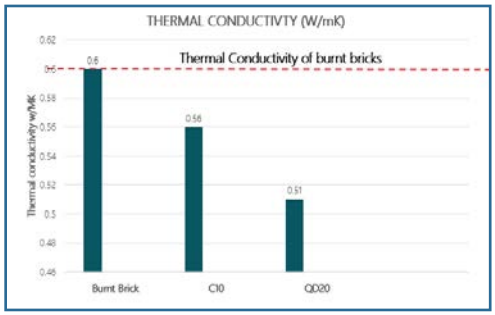
Our main goals include:

1. To devise a suitable recipe and design shape of eco-friendly Interlocking Compressed Earth Brick with adequate structural properties
2. To invoke inherent stabilization using Bio Enriched Calcite Precipitation to ensure long term durability
3. To predict the behavior of Brick Wallet using Micro Numerical Modelling in ABAQUS.



Our methodology comprises of:

1. Material Characterization (Soil Testing, X-Ray Diffraction etc.)
2. Mix compositions (Based on the effects of raw materials from literature review, we selected 5 trial mix compositions including C10, FA20, QD20, BT20, FA95)
3. Element Testing for the selection of best optimized recipe out of 5 mentioned above (found C10 and QD20 giving best results)
4. Casting of bricks for the optimized mix composition
5. Detailed testing of the casted bricks.



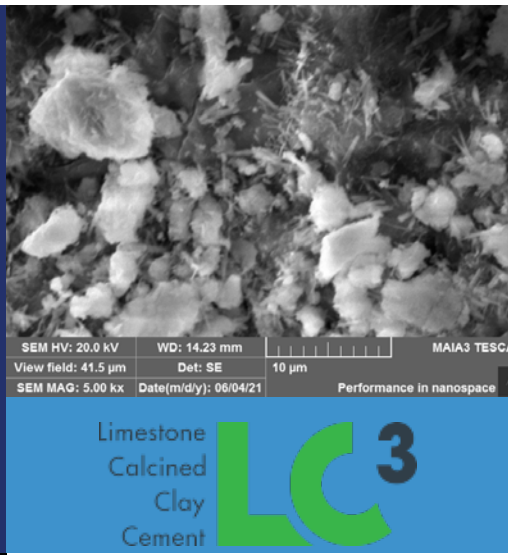
DEVELOPMENT OF AN OPTIMUM LIMESTONE CALCINED CLAY CEMENT (LC^3)

Fatima Imran

Humairah Maqbool

Wasiq Akram

Supervisor: Dr. Hammad Anis Khan



Goal:

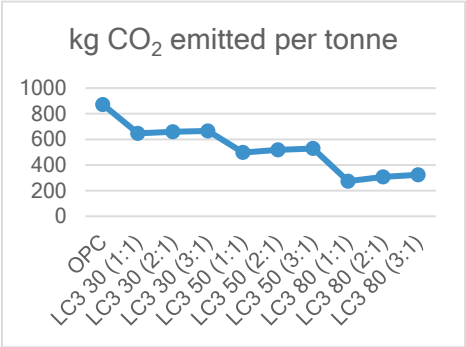
This project presents innovation to make a combined substitution of cement with calcined clay and limestone powder to prepare the Limestone Calcined Clay Cement (LC^3). The aim was to overall assess the performance of these new binders having higher levels of clinker substitution. This substitution of cement will not only reduce the carbon footprint of these blends but will also utilize the locally available abundant and cheap supplementary cementitious materials (SCMs).

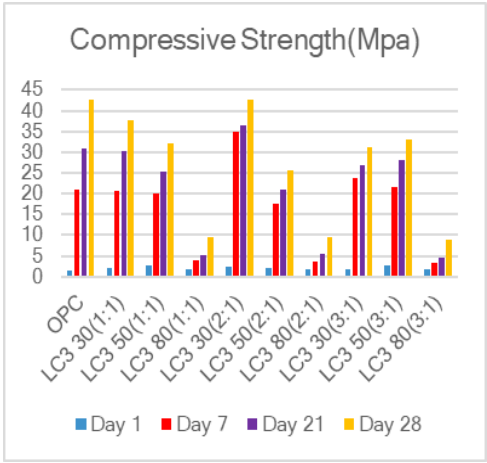
Methodology:

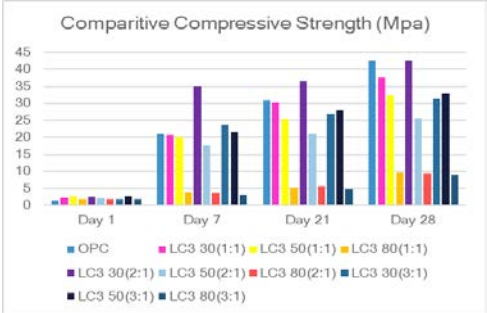
The optimum blended mix was developed by studying the effect of the amount of clinker replacement, the ratio of the calcined clay to limestone powder, and the mineralogical composition of the clay system based on fresh properties, rheological characteristics and physio-mechanical properties of these blends was evaluated. Scanning electron microscopy (SEM) with Energy-dispersive X-ray (EDX) and X-Ray diffraction (XRD) spectroscopies were also employed to see the morphological and mineralogical structure of the material.

Results

The replacement of cement ranged from as low as 30% to as high as 80% with variation in calcined clay to limestone powder ratio from 1:1, 2:1, and 3:1. Loss in strength and physical performance is observed when the replacement of clinker is increased beyond 50%. The blend of LC^3-30(2:1) showed the best results for compressive and flexure strengths and reduced the CO_2 emission and energy consumption by 24.3% and 15.4% respectively. The blend of LC^3-50(2:1) took the least time to set and has the lowest absorption rate. LC^3-80 showed lowest strength but highest decrease in CO2 emission and energy consumption hence it can be useful for non-structural purposes,







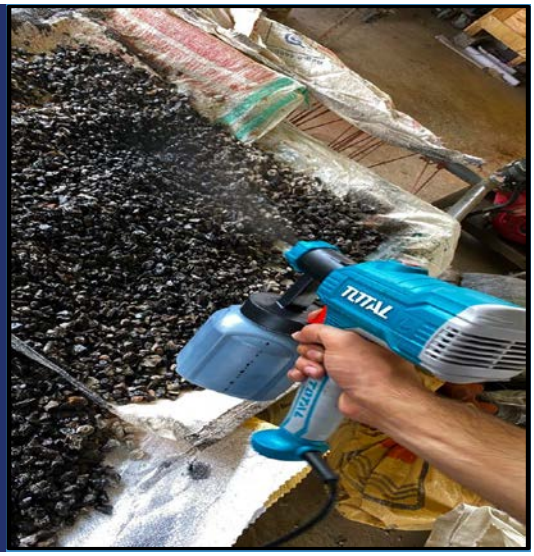
NANO ENGINEERED SELF-SENSING CONCRETE FOR SMART STRUCTURES

Muhammad Hanzla Rafaqat

Ahmad Naseem

Muhammad Faisal Rauf

Supervisor: Dr. Hammad Anis Khan

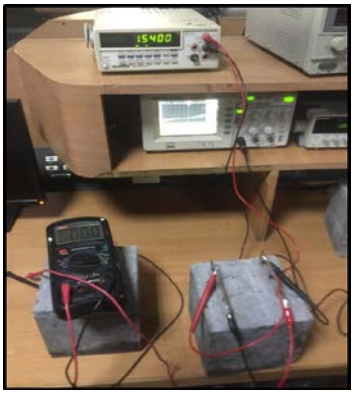


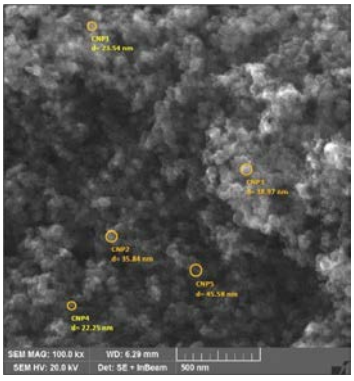
Goal:

This study aims to design a multifunctional cement composite that can bear loads and possess electromechanical properties by integrating structural health monitoring (SHM) systems within the concrete.

Methodology:

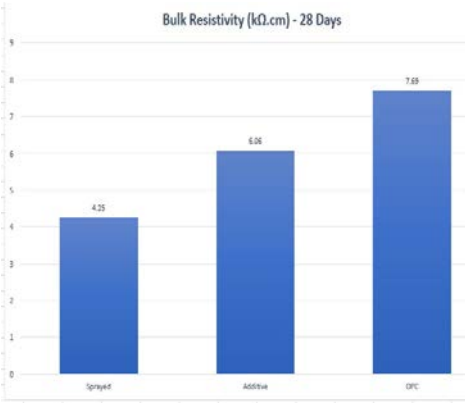
Traditionally, dispersive conductive fillers were a common technique utilized. However, this process was costly and involved complex variables challenging and affecting structural integrity. We aim to leverage this approach's weakness and introduce a new SHM technique in which carbon fiber-based ink solution is sprayed on the cement-aggregate interface which is less costly and offers less complex dispersion. A well-defined conductive network was established on the spray's drying, forming electrically conductive, thin film-coated aggregates. The thin film-coated aggregates were used to cast multiple concrete cylinders and beam specimens to validate conductivity and concrete's mechanical properties.





Conclusions

The SEM shows the carbon particle size to be in the range 20-38nm. It was demonstrated experimentally, that this procedure yielded specimens that showed 50% better conductivity compared to normal concrete and 27% as compared to the additive technique. Compressive strength tests yielded comparable results. It also had electrical properties that varied in response to applied loads. Thus, our process enabled the self-sensing properties of the film, enhancing the concrete within a budget while limiting the challenging variables associated with the previous technique.



STUDY OF ASR IN GEOPOLYMER MORTAR

Mohammad Azeem Khan

Muhammad Daniyal Raja

Fahad Ali

Muhammad Ahmed Ittifaq

Supervisor: Lec. Sara Farooq

Goal:

An experimental investigation for alkali silica reaction (ASR) between reactive aggregates and the geopolymer matrix.

Methodology:

Specimens were prepared using Class Ffly ash stockpiles and slag. AMBT ASTM C1260 test was performed on the specimens. Results suggest that the extent of ASR reaction due to the presence of reactive aggregates in fly ash-based geopolymer concretes is substantially lower than in the case of ordinary Portland cement-based concrete, and well below the ASTM specified threshold. Furthermore, geopolymer concrete specimens appeared to undergo a densification process in the presence of alkali solutions, resulting in reduced permeability and increased mechanical strength.

Results:

Utilizing ASR-vulnerable aggregates in the production of geopolymer concrete products could contribute to the economic appeal and sustainability of geopolymer binders in regions that suffer from insufficient local supply of high-quality aggregates.