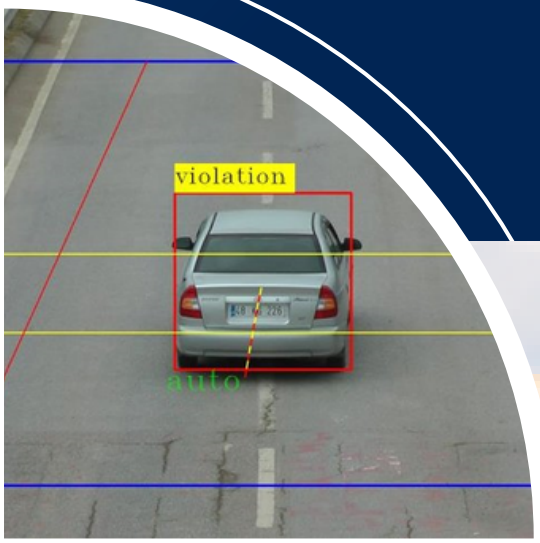
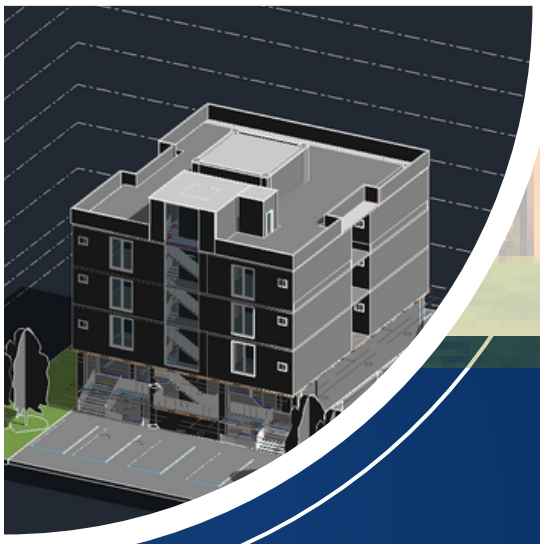
NUST
NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY

SCEE
SCHOOL OF CIVIL & ENVIRONMENTAL ENGINEERING

CIVIL ENGINEERING
FINAL YEAR DESIGN PROJECTS

YEAR 2025





NUST H-12 , Islamabad
https://scee.nust.edu.pk/

Table of Contents - FYDP Projects

SUSTAINABLE DRAINAGE USING RECYCLED PLASTIC

(INNOVATIVE SOLUTIONS FOR URBAN STORM WATER MANAGEMENT)

Supervisor.: Dr Zafar Iqbal

Group Members

1. Abdullah Awan
2. Muhammad Arsal Waheed
3. Shahzaib-Iqbal
4. Muhammad Abdullah

Research Area:

- **Eco-friendly stormwater drainage** using recycled plastics to combat flooding and pollution.
- **Recycled material performance** and cost-benefit analysis for sustainable urban solutions.

Problem Statement:

- ***Insufficient Capacity:*** Poor management of heavy downpour, thus causing floods, and destruction of property.
- ***Water quality:*** Storm water drainage occasionally transports silt, remnants of structures, chemical from industries and effluence from residences into water bodies and aquifers.
- ***Environmental impact:*** Standard drainage techniques negatively affect the ecological environment through increasing rates of erosion and destruction of habitats together with a decrease in the variety of species.

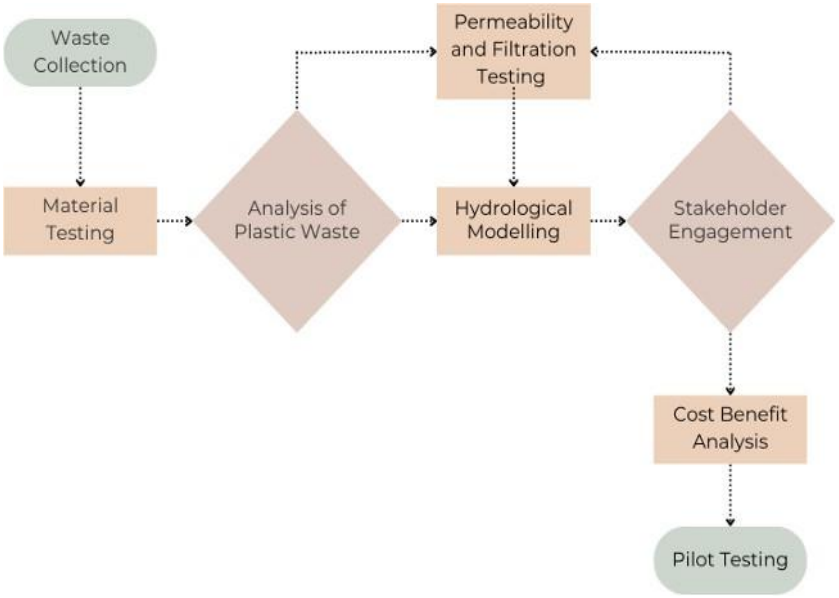
Objectives:

- ***Evaluate recycled materials for drainage applications:*** Investigate the possibility to use plastics (such as HDPE, PVC) and fabrics as well as other materials for storm drainage systems, considering their factors as durability, permeability, and filtration ability.
- ***Develop a sustainable drainage system design:*** Design the land use in a manner that the proposed design includes recycled materials, the design facilitates recharging of groundwater and explores ways of solving problems affecting urban areas such as flood, water pollution, and disruption of ecosystems.
- ***Investigate permeability and filtration properties:*** Evaluate the capacity of the proposed system on removal of pollutants and retarding water table fluctuations about

the efficiency affecting factors such as type of soil, intensity of rainfall and quality of water.

- ***Conduct cost-benefit analysis:*** Describe the economic and environmental advantages of using recycled materials in the construction of storm drainage systems through the analysis of the following areas: cost of raw materials, water quality and flood damages.

Methodology:



Findings:

The peak compressive strength is 10 MPa, Manning coefficients 0.0085, split tensile strength of 0.2 MPa, Water Absorption of 2.25% and Flexural Strength of 1.4MPa,Density of 1330 kg/m^3,void ratio of 2-3%,

Project Outcomes/ Relevance To Industry:

- **Eco-Friendly Drainage Solution**: Develops a stormwater system using recycled plastics, reducing waste and environmental impact while improving flood control and water quality.
- **Cost-Efficient Innovation**: Offers a lightweight, durable, and low-maintenance alternative to concrete, lowering construction costs and supporting sustainable urban infrastructure.

Construction of Masonry units through Integration of Building Information Modelling and Automation

Supervisor. Lec Abdullah Bin Ahmed

Co-Supervisor: Engr Malik Kamran Shakir

Group Members

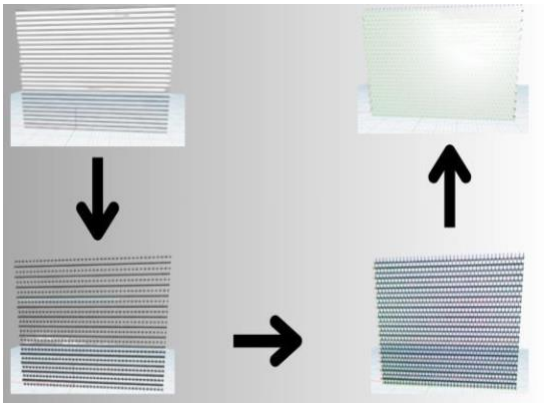
1. Ch. Muhammad Shahram Akbar
2. Awais Bashir
3. Asad Mehmood
4. Munam Ahmad

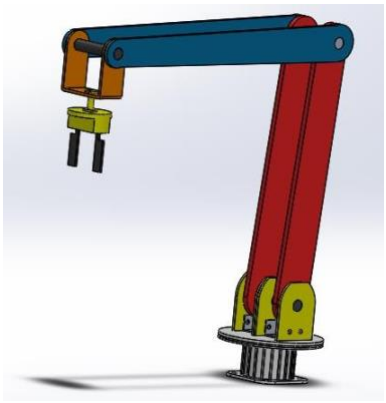
Research Area:

- Robotics in Construction
- Building Information Modelling
- Automation

Problem Statement.

The existing literature highlights a lack of focus on integrating Building Information



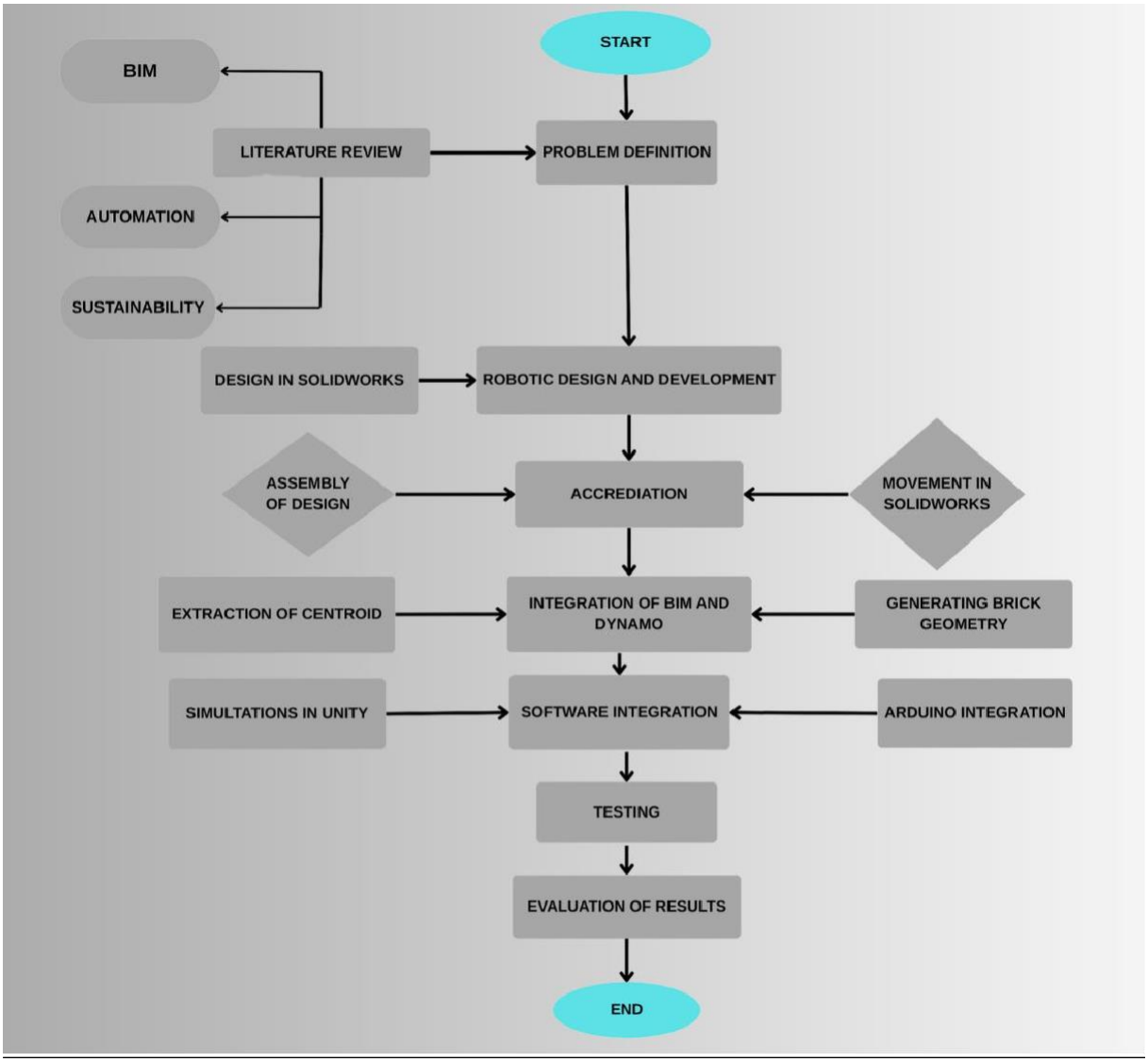


Modeling (BIM) with robotic arms for bricklaying activities, resulting in the underutilization of the extensive information BIM provides. Additionally, the cost-effectiveness and productivity of these robotic systems have not been adequately optimized, emphasizing the need for further research and development in this domain.

OBJECTIVES

- ROBOTIC SYSTEM DESIGN
- BIM INTEGRATION

METHODOLOGY



FINDINGS

The integration of a robotic arm with BIM via Dynamo successfully automated the bricklaying process with high precision and reduced manual intervention. The system demonstrated improved construction efficiency, accuracy, and potential for enhanced sustainability by minimizing material waste and labor dependency.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- **Boosts Productivity**: Automates bricklaying to reduce time and reliance on skilled labour.
- **Enhances Safety & Sustainability**: Minimizes on-site risks and material waste through BIM-driven precision.
- **Industry-Ready**: Offers a scalable, practical solution for integrating robotics into real-world construction.

DESIGN OF SMART RAINWATER HARVESTING DEVICE

Supervisor. Dr. Abdul Waheed

Co-Supervisor N/A

Group Members

1. Muhammad Hassaan Bilal
2. Raja Muhammad Affan

Research Area:

Water Resource Management, IoT-based Smart Systems, Sustainable Infrastructure, Smart City Applications

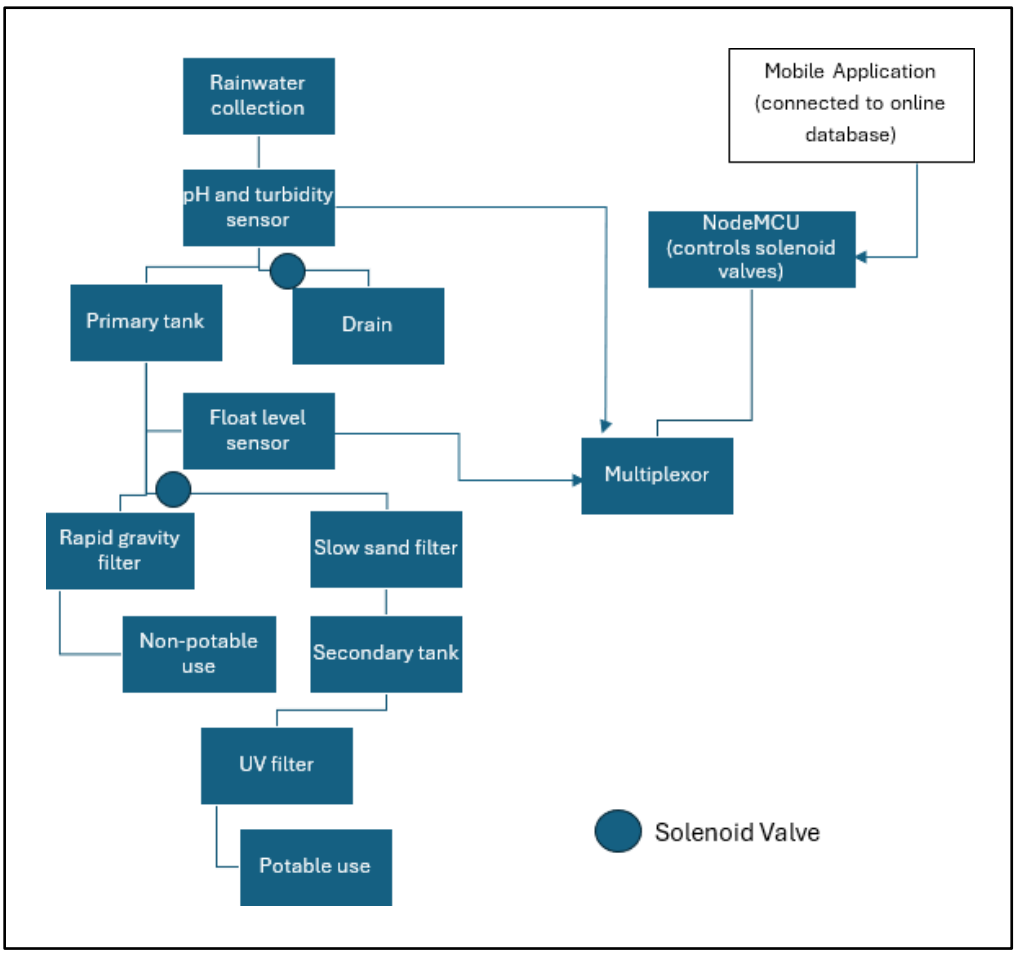
Problem Statement.

- Water shortage in Pakistan due to
- 60-70% of rainwater is lost as surface runoff
- Traditional rainwater harvesting systems are inefficient
- Improper management of water resources

OBJECTIVES

- Feasibility assessment of existing IoT-enabled RWH systems.
- Designing a cost-effective smart RWH unit.
- Real-time monitoring framework for improving water management.
- Assess factors influencing the acceptance of smart RWH systems in Pakistan.

METHODOLOGY



FINDINGS

The designed smart rainwater harvesting unit seemed to divert water according to the quality metrics It was also combined with a filtration system to make rainwater pure.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Supplementary source of water for various purposes
- Reduces surface runoff, decreasing burden on drain networks
- Efficient management of water resources by governing bodies

Automation of Foundation Design using BIM and ML

Supervisor. Lec Abdullah Bin Ahmed

Co-Supervisor Dr. Zain Maqsood

Group Members

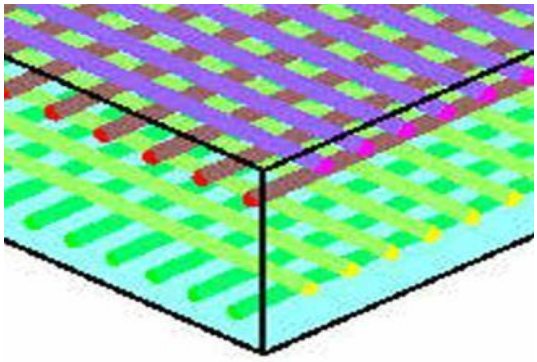
1. Hamza Iqbal (GL)
2. Itaat ullah Khan
3. Muhammad Jawad Younis
4. Muhammad Asad Sardar

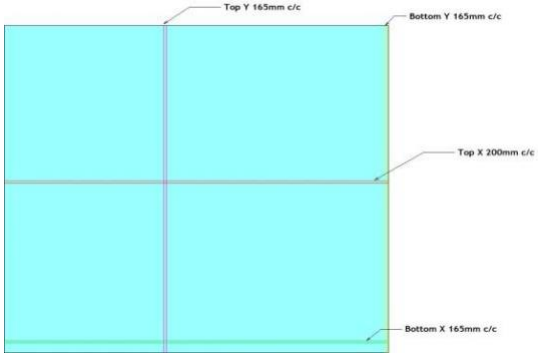
Research Area:

Foundation Design and Analysis
Building Information Modelling and AI

Problem Statement.

- Manual Design and Analysis of Foundations is a time consuming and challenging process which is prone to human errors.
- Autodesk Revit despite being a powerful BIM tool does not offer built-in structural design and analysis of foundations, forcing engineers to rely on external sources and manual calculations.
- Switching between multiple software platforms for modelling, analysis and design leads to a disjointed workflow and higher chance of data loss or errors.

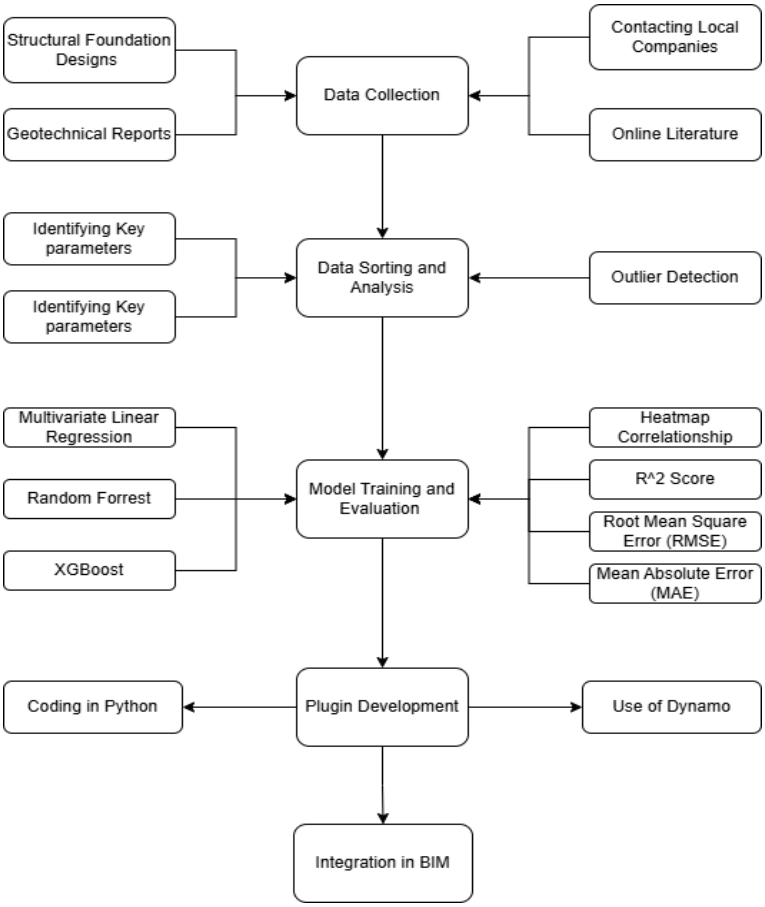




OBJECTIVES

- To develop a Revit plug-in that enables structural foundation design and analysis directly withing the Revit environment.
- To integrate Machine Learning for automating and optimizing foundation design based on structural and geotechnical parameters.
- To streamline the foundation design workflow by eliminating the need for external Softwares, ensuring a more efficient and BIM-compliant process.

METHODOLOGY



FINDINGS

The project identified a clear gap in Autodesk Revit's capabilities, specifically the absence of built-in tools for foundation design and analysis. By integrating machine learning with BIM through a custom Revit plugin, the project demonstrated the potential to automate design processes, reduce manual effort, and offer a cost-effective alternative to existing commercial solutions.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- By adding Foundation Design and Analysis capabilities directly into Revit, the plug-in aligns with industry needs for integrated and streamlined BIM workflows reducing the reliance on external Softwares.
- The plugin offers a low-cost alternative to high end structural design Softwares that fits into existing Revit-based workflows.
- The use of Machine Learning in foundation design reflects industry's shift towards data-driven solutions enhancing productivity and reducing design cycle times.

HYDRO OPTIMIZATION - RETHINKING WATER DISTRIBUTION SYSTEMS

Supervisor.: Dr Zafar Iqbal

Co-Supervisor:

Group Members

1. Saqlain Muhammad
2. Ashaf Bana
3. Saleem Jan
4. Zahir Ud Din

RESEARCH AREA

Water Distribution Network Modeling, Sustainable Water Resource Management, Urban Water Infrastructure Planning

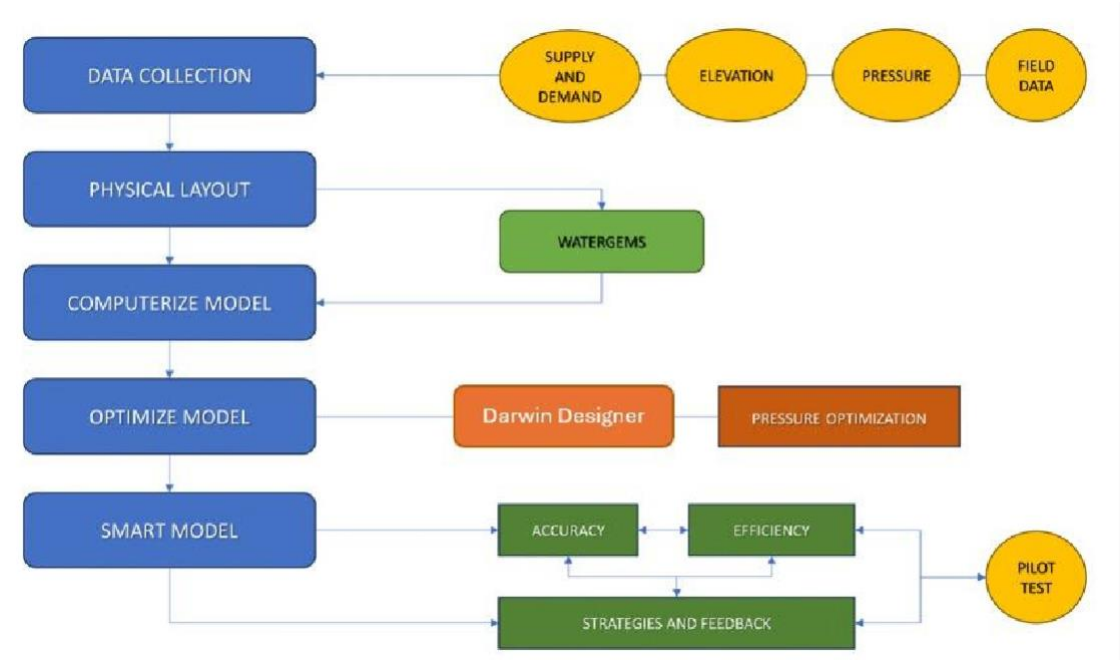
PROBLEM STATEMENT

- Insufficient water supply
- Poor infrastructure results in water loss
- Inefficient water distribution system, escalating operational cost

OBJECTIVES

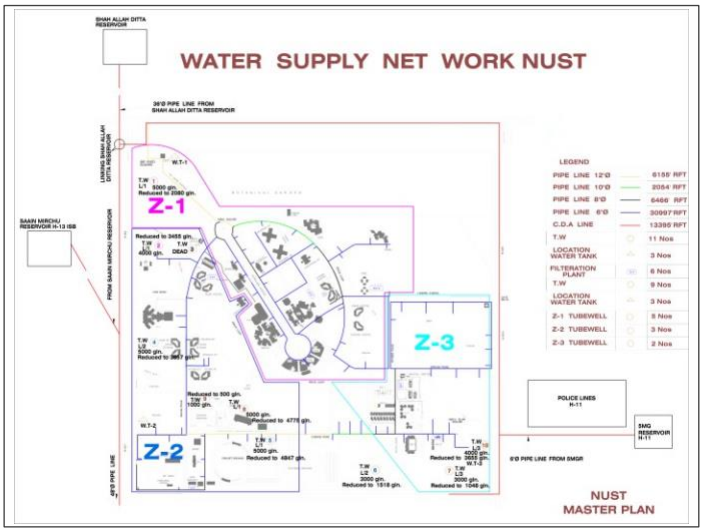
- To design and simulate a hydraulic model of NUST H-12 campus using WaterGEMS.
- Analysis and optimization of present configuration (pressure & velocity).
- Comparing baseline and optimized model and suggesting effective water management strategies.

METHODOLOGY

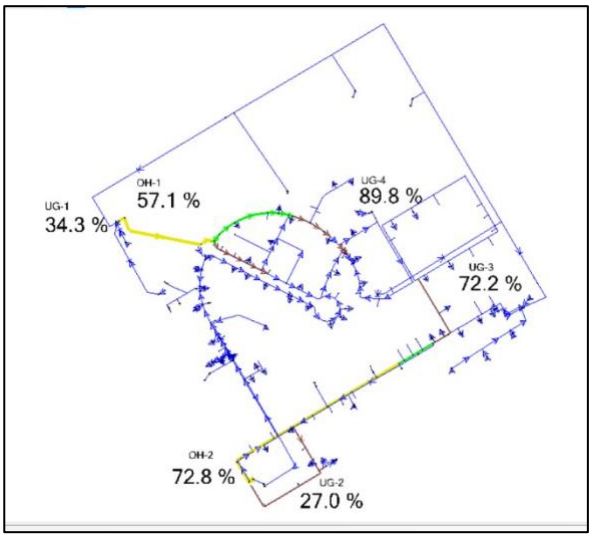


MODEL

NUST Water Supply System



WSS Model in WaterGEMS



FINDINGS

- Reduced maximum velocity from 34.41 ft/s to 14.92 ft/s and average velocity from 4.55 ft/s to 3.66 ft/s, minimizing erosion and water hammer risks.
- Stabilized pressures, decreasing maximum pressure from 158 psi to 123 psi and eliminating critical negative pressures (from -88 psi to -10 psi), improving system reliability.
- Lowered head loss gradient from 82.45 m/km to 17.78 m/km (with average head loss reduced to 0.46 ft/1000 ft), enhancing energy efficiency and reducing operational costs.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Validated the effectiveness of pipe resizing, pressure regulation, and head loss control strategies for real-world network applications.
- Offered a scalable framework for smart water systems, supporting future integration of real-time monitoring and adaptive control for dynamic, demand-responsive management.
- Directly addresses industry priorities like infrastructure resilience, operational savings, and sustainable, uninterrupted service delivery.

Smart Pedestrian Safely Analysis for Urban Road Using YOLOv8; A Deep Learning Risk Assessment Design Framework.

Supervisor.: Dr Sameer-ud-Din

Co-Supervisor: Dr Muhammad Asif Khan

Group Members

1. M. Saad Bin Arshad
2. M. Ahsan Khan
3. Syed M. Ali Kazmi
4. Zahra Noor

REASEARCH AREA

Traffic Safety Analysis, Smart Traffic Surveillance, Sustainable Urban Transport.

PROBLEM STATEMENT

Road traffic accidents (RTAs) are a significant public health concern in Rawalpindi, Pakistan, contributing to high morbidity and mortality rates. Despite various efforts to improve road safety, the incidence of RTAs remains alarmingly high. This project aims to investigate the underlying causes, patterns, and outcomes of RTAs in Rawalpindi by establishing surrogate measures.

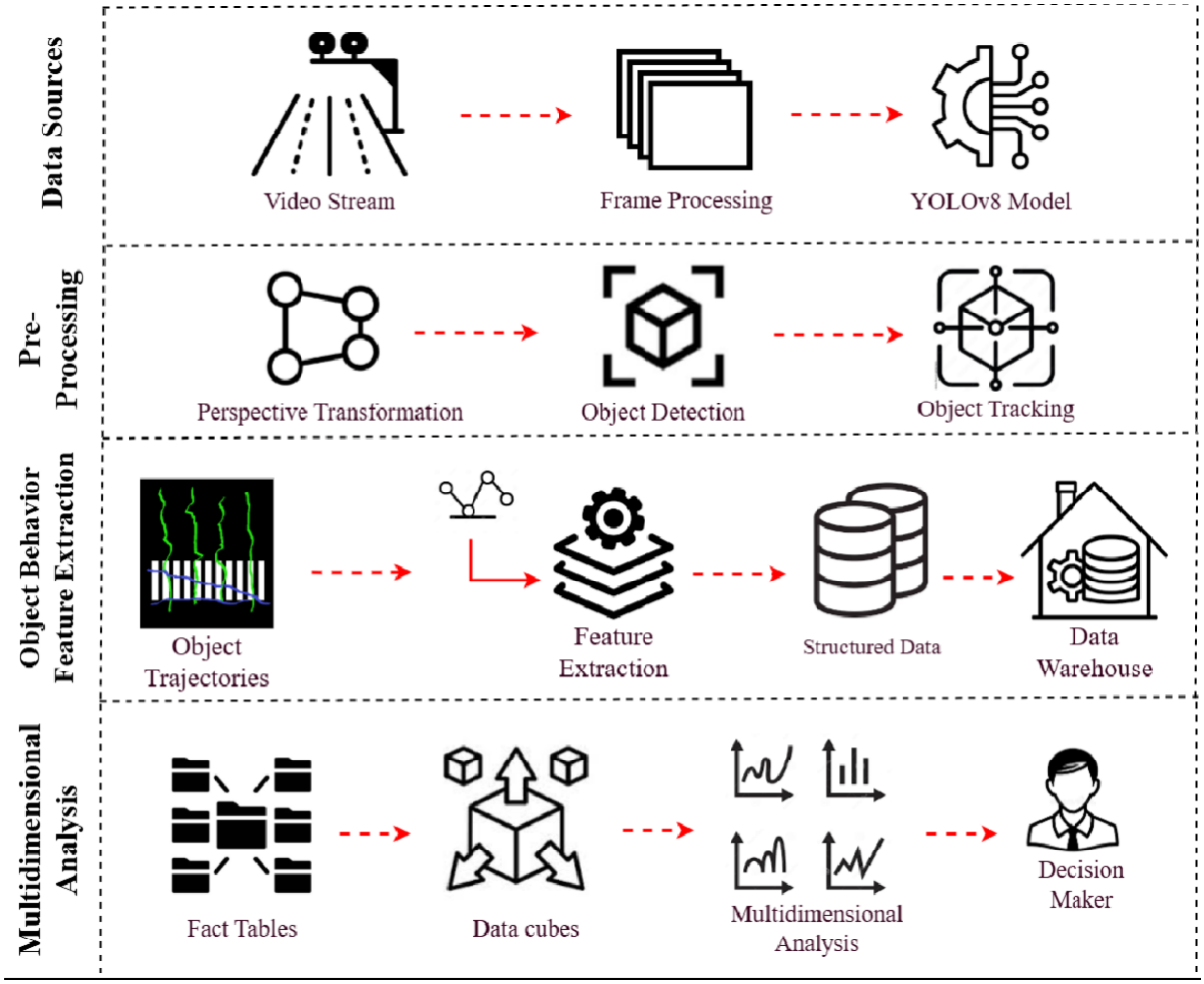
OBJECTIVES

- Detect high-risk pedestrian zones in urban areas, focusing on unmarked mid-block crossings.
- Use YOLOv8 for real-time detection and tracking of pedestrians and vehicles to study interaction patterns.
- Extract features such as speed, trajectory, and proximity from video data to evaluate pedestrian risk levels.
- Design an analytics dashboard to visualize risk patterns and support informed decision-making for urban planning.
- Develop a scalable framework that integrates with existing surveillance systems and can be applied nationally and globally.

METHODOLOGY

The proposed framework will utilize the latest technology, including YOLOv8 for object detection and tracking, to extract detailed data for scenario-based risk analysis. After extensive research, we have selected key features that provide insights into pedestrian-vehicle interactions. Cameras will be installed on overhead bridges to record footage, helping identify diverse traffic patterns and pedestrian

behaviors. The collected data will be carefully analyzed and transformed into actionable insights.



FINDINGS

Using our framework, we analyzed two urban locations by evaluating vehicle speed profiles, pedestrian safety margins, and other key factors. Based on this analysis, we identified and highlighted the relatively riskier location in terms of pedestrian safety.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Identification of high-risk zones based on both pedestrian behaviors and vehicular dynamics.
- A visual and interactive dashboard to help policymakers prioritize interventions in high-risk areas based on evidence and real-time data.

Real-Time Visualization and Analysis of Indoor Environmental Data using Digital Twin Technology

Supervisor.: Abdullah Bin Ahmed

Co-Supervisor: Dr. Khurram Iqbal

Group Members

1. Saad Ud Din
2. Gul Zaman
3. Atif Ali
4. Abdullah Sajjad

Research Area:

Digital Twin Technology, Indoor Environmental Quality, Building Information Modeling

Problem Statement.:

- No acceptance of modern technology.
- No framework for implementing Digital Twin in organizations in Pakistan.
- Poor indoor monitoring affects comfort and decision-making.

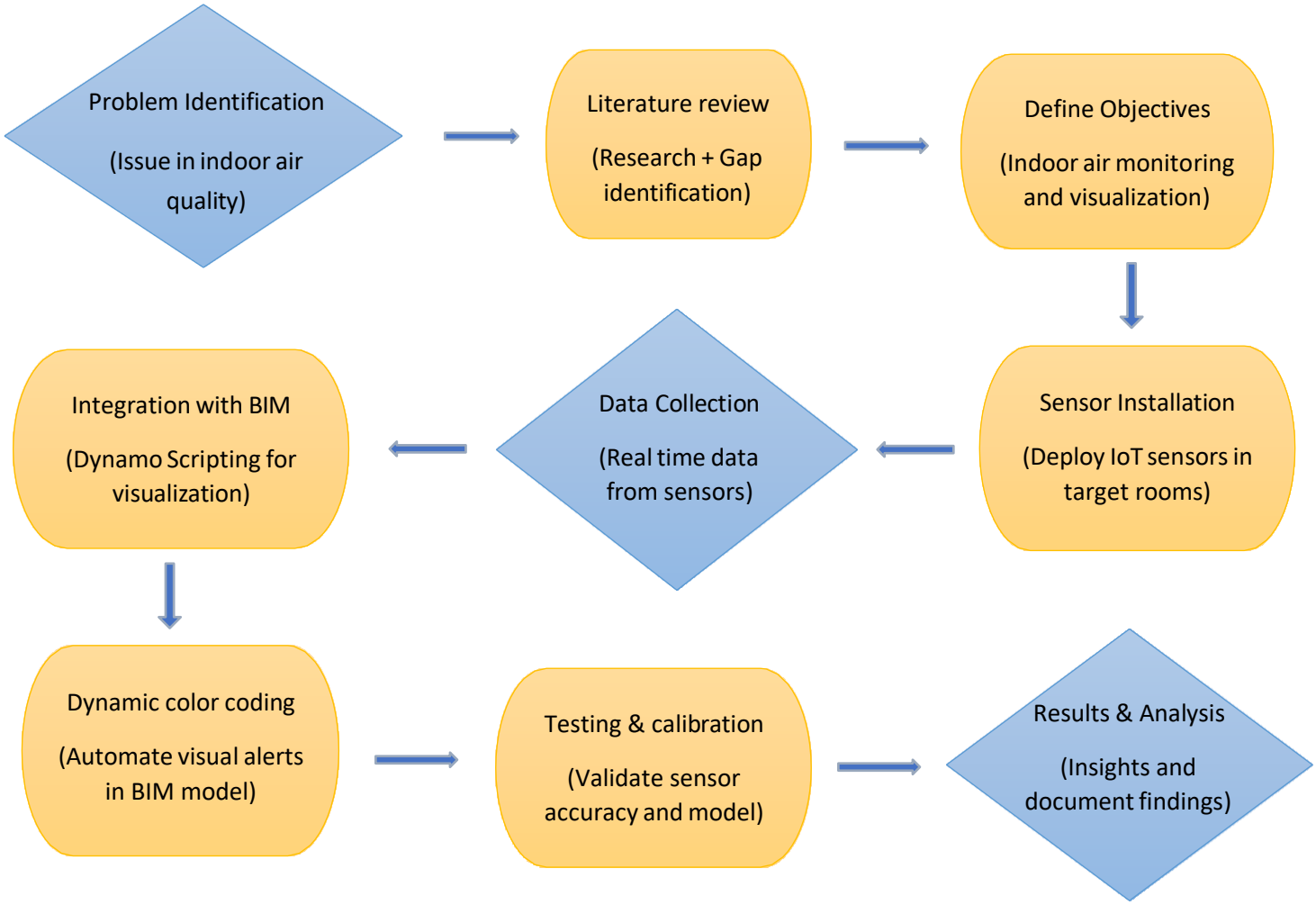
3D Model in Revit

Color Coding in Revit

OBJECTIVES

- Evaluating the Implementation of Digital Twins in Pakistan.
- Evaluating Indoor Air, Identifying Areas for Improvement.
- Working on real-time industry projects.

METHODOLOGY



FINDINGS

The integration of Digital Twin technology with Dynamo scripting enabled real-time monitoring and color-coded visualization of indoor air quality, enhancing environmental awareness and decision-making.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Implemented a real-time indoor air quality monitoring system in the NIT Building using Digital Twin and IoT integration
- Enabled dynamic, color-coded visualization through Dynamo, enhancing facility management and occupant awareness

Development and Application of SeaWater SeaSand Engineered Cementitious Composites (SS-ECC) for Sustainable Bridge Pier Construction

Supervisor.: Dr. Junaid Ahmad

Co-Supervisor: Engr. Sikandar Ali Khokhar
(Bendcrete Construction Services Pvt. Ltd.)

Group Members

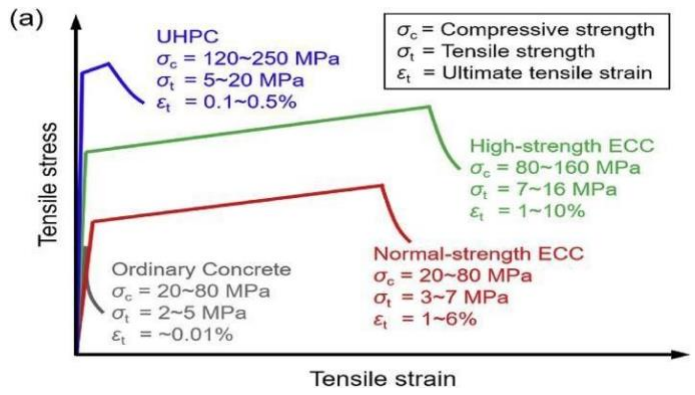
1. Uzair Ahmed Khaskheli
2. Ali Saleh
3. Kiran Fatima Leghari
4. Muhammad Hamas

Research Area:

Sustainable Concrete Materials, Structural Modeling & Simulation (FEA), Low-Carbon Construction Materials

Problem Statement.

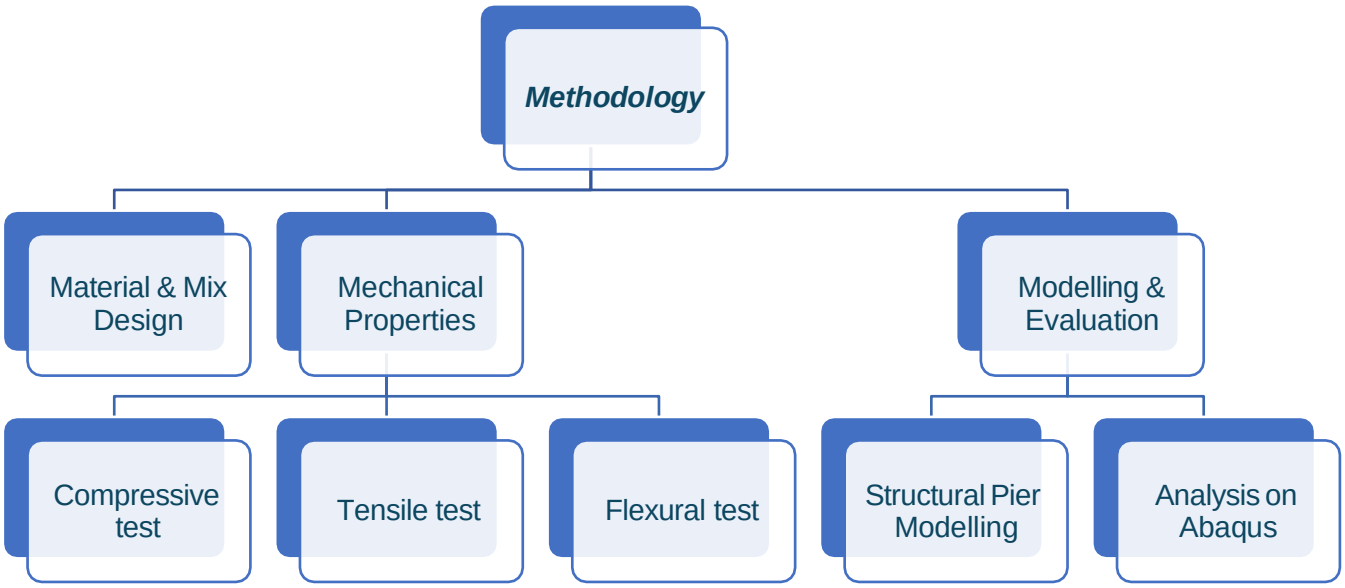
- Concrete in coastal bridges gets damaged quickly due to saltwater.
- Cracks let in harmful salts, making the structure weak and unsafe.
- It needs clean water and river sand, which are limited resources.
- Produces a high carbon footprint, making it unsustainable long-term.



OBJECTIVES

- To develop a sustainable SS-ECC mix using seawater, sea-sand, and PVA fibers
- To optimize fiber-matrix interaction for enhanced crack control and ductility.
- To assess the mechanical properties of SS-ECC.
- To assess the feasibility of SS-ECC in bridge pier construction through structural performance simulations.

METHODOLOGY



FINDINGS

The study developed a high-performance SS-ECC using seawater and sea sand, showing excellent compressive strength, tensile strain, and crack control. Finite Element Modelling confirmed its superior seismic performance in bridge piers. The use of local materials enhanced sustainability and reduced reliance on freshwater and river sand. A simplified design model was also proposed for coastal and seismic applications.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Developed an eco-friendly ECC mix suitable for coastal construction.
- Reduced lifecycle costs and material transport through local resource utilization.
- Improved structural resilience in seismic and aggressive coastal environments.
- Promote sustainable infrastructure practices in line with global environmental goals.
- Offers a viable alternative to traditional concrete in bridge and pier construction.

Effects of GFRP Coating over Reinforced Concrete Members Against Corrosion In Realistic Aggressive Environment

Supervisor.: Engr Arslan Mushtaq

Co-Supervisor: Engr Hamza Sabir

Group Members

1. Zain Ul Hassan
2. Affaq Ahmad
3. Danyal Ahmad
4. Kashif Arslan

Research Area:

Structural Engineering and Materials Science, Industry Innovation, Sustainable Energy Production

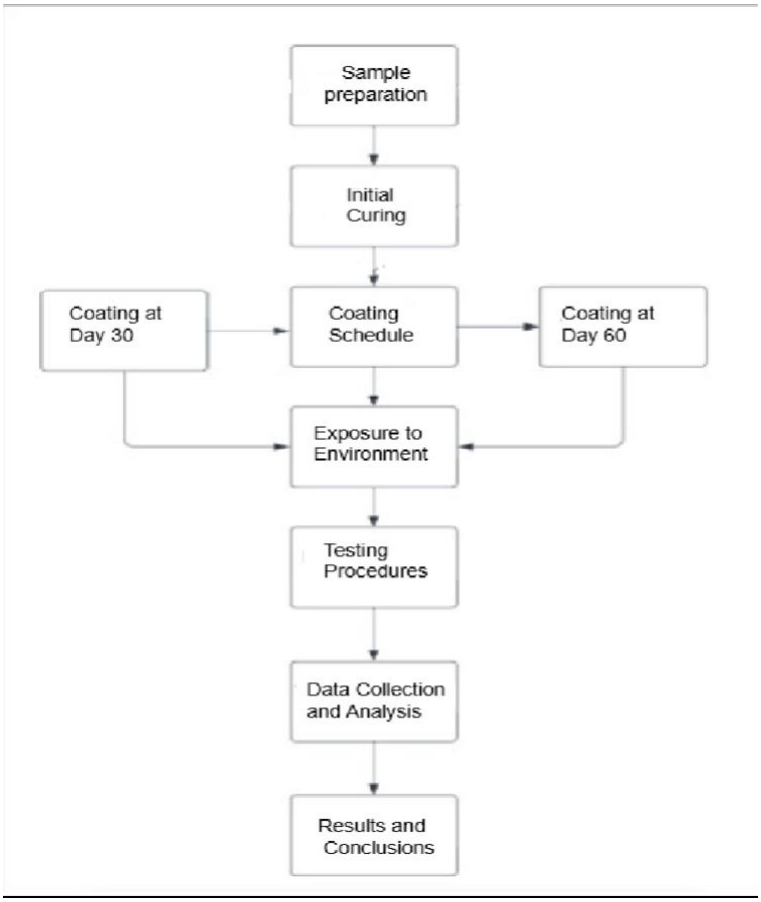
Problem Statement.

- Corrosion of RC structures in Coastal and Industrial Environments.
- Corrosion of Members can lead to reduced service life and safety risks.
- Traditional methods are often Labor-intensive and ineffective in long term.
- There is a need for a durable cost effective solution to enhance durability in Aggressive Environments.

OBJECTIVES

- To evaluate the effectiveness of FRP coatings in reducing corrosion of reinforced concrete.
- To compare performance of coated vs. uncoated samples under a 10% brine solution over 90 days.
- To measure changes in mass loss, chloride penetration, water absorption, and half-cell potential.
- To determine the optimal time of application for FRP to maximize corrosion resistance.

METHODOLOGY



FINDINGS

Early application of FRP coating significantly reduced corrosion in reinforced concrete exposed to chloride-rich environments. Samples coated on Day 0 experienced the least mass loss, water absorption, and chloride penetration, confirming the effectiveness of timely FRP protection in enhancing durability.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Demonstrated that early FRP coating significantly reduces corrosion in reinforced concrete.
- Validated FRP as an effective, long-term protective solution in chloride-rich environments.
- Offers a cost-efficient method for extending service life of RC structures. Supports construction and infrastructure industries in improving durability in harsh conditions.
- Provides practical insights for maintenance planning in marine, coastal, and industrial zones

DEVELOPMENT OF SUSTAINABLE COARSE AGGREGATES UTILIZING WASTE GLASS

Supervisor.: Dr Junaid Ahmad

Group Members

1. Muhammad Nauman Javaid
2. Usman Ashraf
3. Abdul Wasiue Shaikh
4. Samsam Ali

Research Area:

Sustainable construction, Waste management, Green Building Materials.

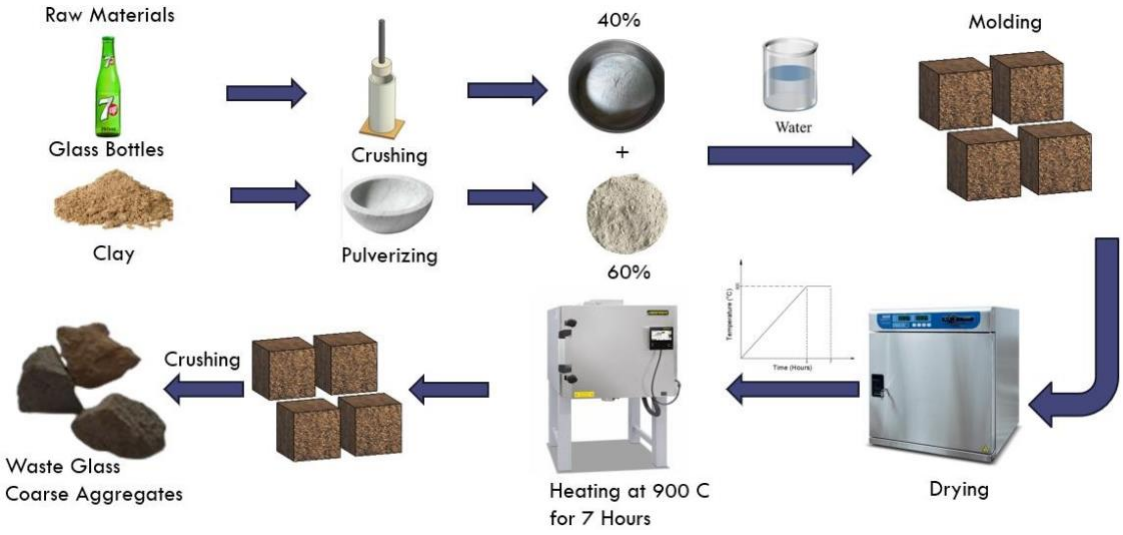
Problem Statement.

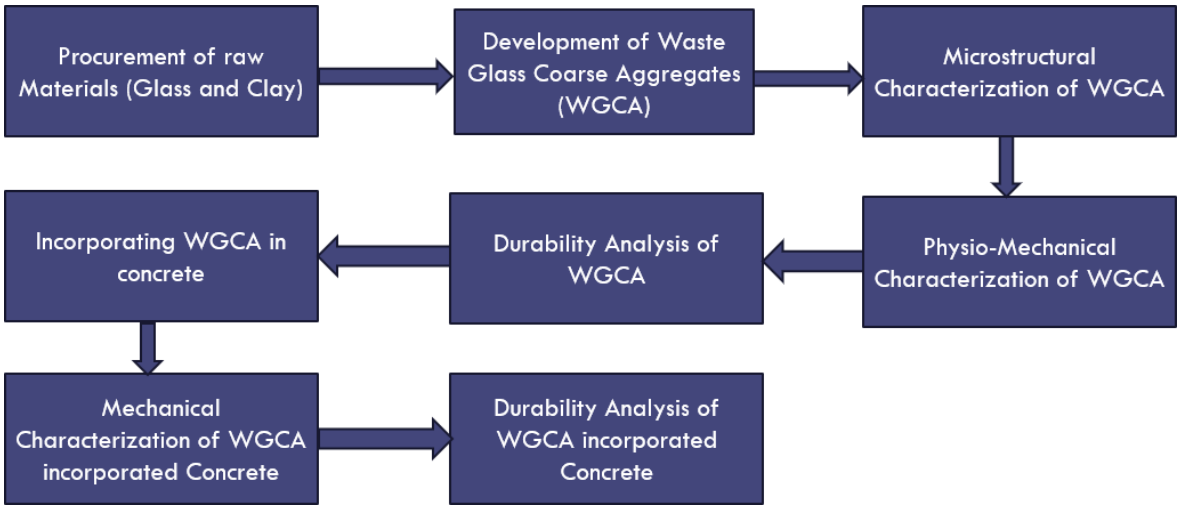
- Due to increasing construction demand, global production of concrete is increasing every year. Aggregates are the bulk component of concrete. Extraction of these aggregates come at the cost of **depletion of natural resources**, putting our future generations at stake. Glass is major component of Municipal Solid Waste. Due to its non-biodegradable nature, proper measures are required for its efficient recycling.

OBJECTIVES

1. **Characterization** of Raw materials and **Development** of Waste Glass Coarse Aggregates(WGCA)
2. **Mechanical and Micro-structural characterization** of developed WGCA.
3. **Durability analysis** of WGCA.
4. **Mechanical and Micro-structural characterization** of WGCA incorporated concrete.
5. **Durability analysis** of WGCA incorporated Concrete.

METHODOLOGY





FINDINGS

- Waste Glass Coarse aggregates (WGCA) showed 15% improvement in crushing value as compared to Natural coarse aggregates (NCA).
- Density of WGCA was found to be 40% less than that of NCA.
- No significant effect on Compressive strength of concrete was observed.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- This project developed sustainable coarse aggregates from waste glass and clay, offering a green alternative to natural aggregates. The aggregates met construction standards and performed well in concrete cylinders. This promotes circular economy and supports eco-friendly construction practices.

From Text to Blueprint: Leveraging LLMs for Generative Architectural Drafting

Supervisor: Lec. Abdullah Bin Ahmed

Co-Supervisor : Dr. Muhammad Usman

Group Members

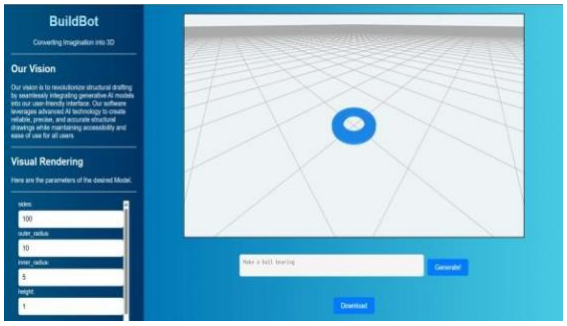
Hamas Naveed Gill (GL)
Aimen Khan
Irtaza Khalid
M. Dawood Asghar

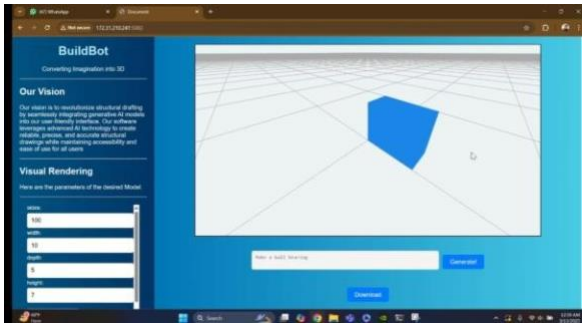
Research Area:

Artificial Intelligence, LLMs, 3D to 2D drawings, prompt visualization.

Problem Statement.

- The current process of development of Architectural Drawings is labor-intensive and often requires manual adjustments, which are time-consuming and can lead to errors.
- Additionally, traditional methods lack the flexibility needed for quick modifications or adjustments to drawings.
- Need for a more dynamic solution that can automate the drawing process.

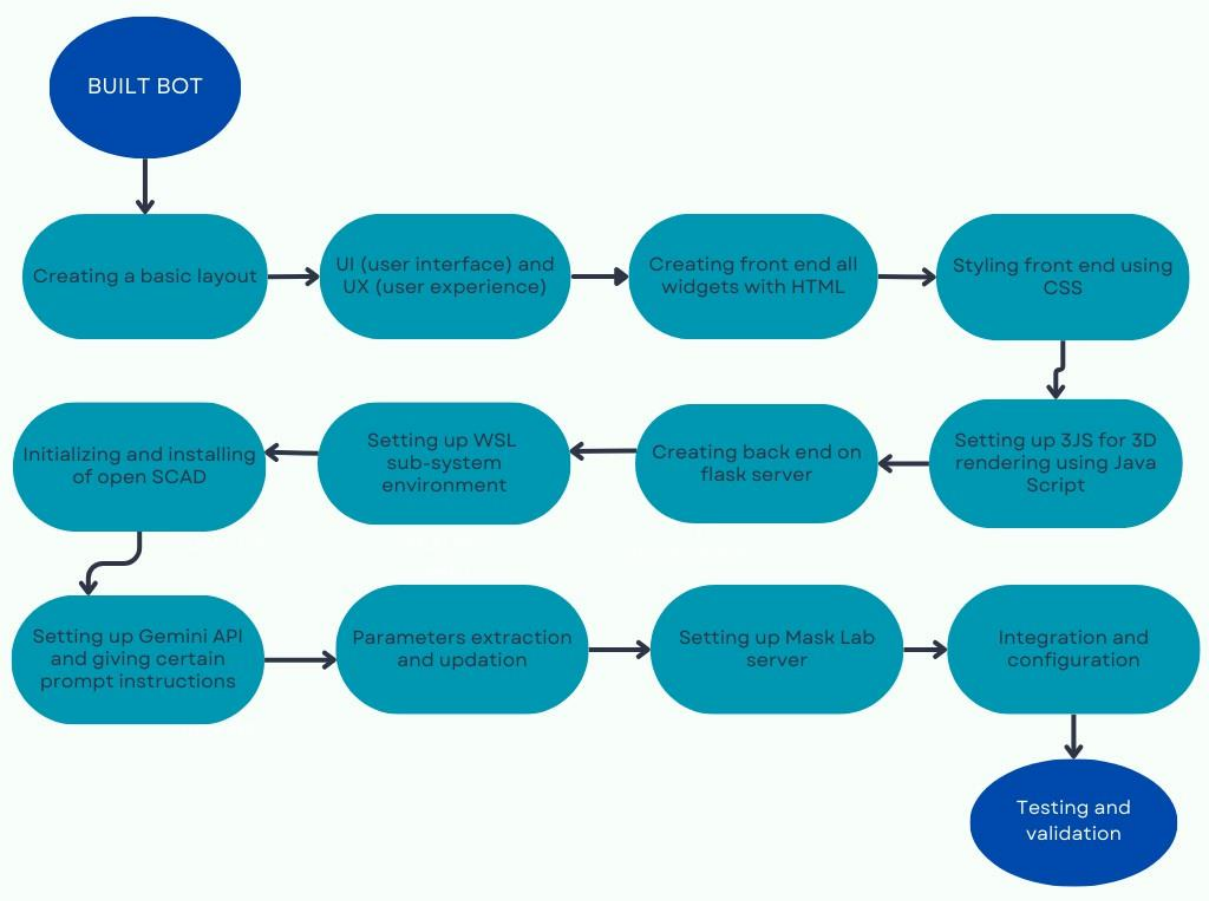




OBJECTIVES

1) Develop an AI-powered program that can generate real-time Architectural drawings based on user input.
2) Integrate 3D modeling capabilities so that users can create drawings such as stairs, slabs, footings, and columns with specified dimensions.
3) Ensure the program supports common file formats like DWG, which are widely used in the field of civil engineering.
4) Streamline the overall process, reducing the time spent on manual drafting while improving accuracy.
5) Provide a user-friendly interface where users can easily input prompts, even with minimal coding or design knowledge.

METHODOLOGY



FINDINGS

- Conversion of 3D Architectural drawings to CAD format.
- Architectural drawings on text input.
- Incorporating LLMs in automation of Architectural drawings.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- AI-driven program for real-time, accurate drafting pf drawings.
- Significant time savings and reduction in manual drafting.
- Simple text-based drawing commands with CAD compatibility.

Formulation of a Printable Mix Design for Prefabricated Beams

Group Members:

1. Muhammad Mughees Raza Kiyani (Group Leader)
2. Rajja Emaan
3. Muhammad Babar Kamal
4. Syed Muhammad Hussain

Supervisor:

1. Dr. Muhammad Usman

Co-Supervisors:

1. Engr. Raja Dilawar Riaz
2. Engr. Saif Ur Rehman

Research Area:

3D Concrete Printing (3DCP)

Problem Statements:

- Lack of affordable and accessible mix design that does not rely on rheological modifiers and expensive chemical admixtures.
- Printable mix design for 3D concrete printing largely relies on trial-and-error experimentation, with no established predictive models available to simulate printability or structural performance of beams, making the process time-consuming and inefficient.

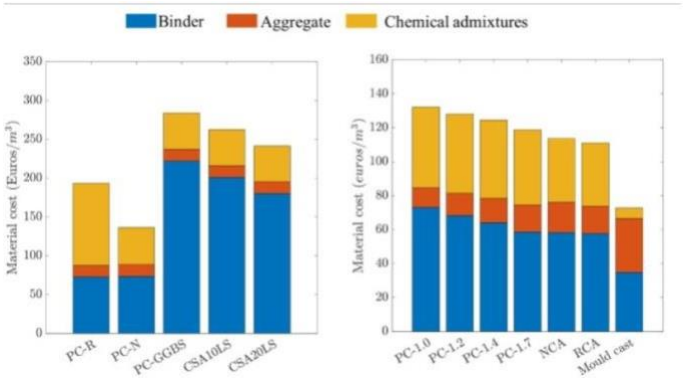


Fig. 1: High cost of printable mix designs

Objectives:

- To formulate a high-performance 3D printable mix design with locally available materials
- To develop a predictive model that enables a rapid, non-iterative approach for formulating 3DPC mix designs
- To conduct structural testing and finite element analysis of 3DPC beams.

Methodology:

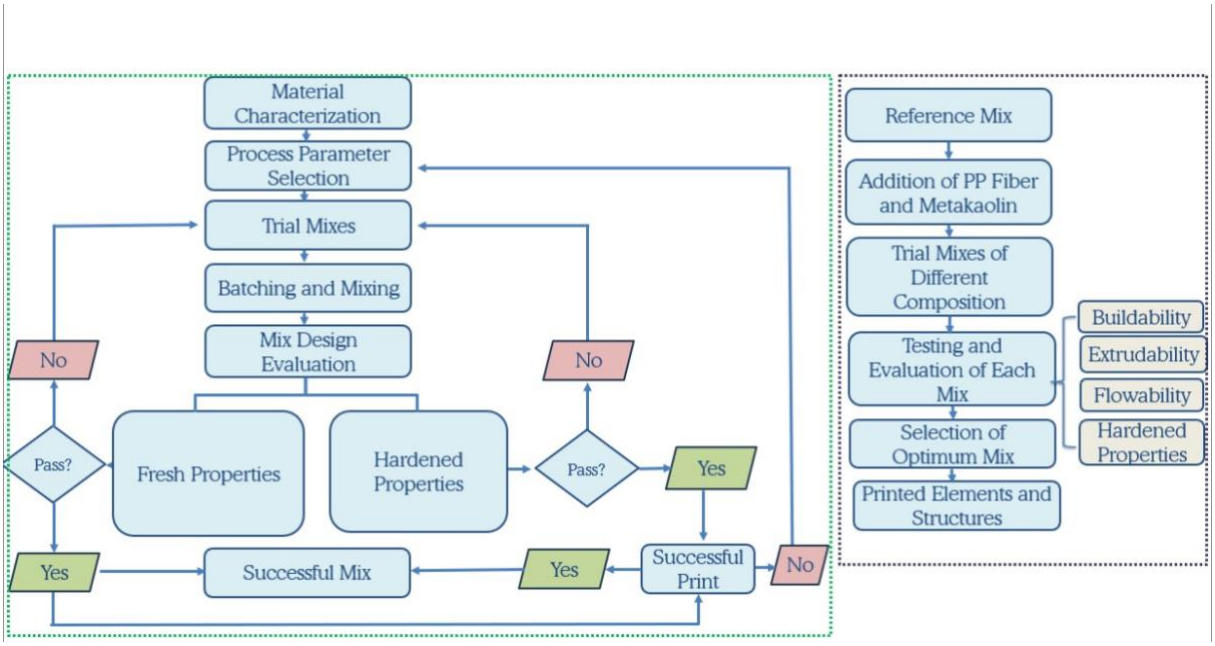


Fig. 2: Methodology for Phase-1

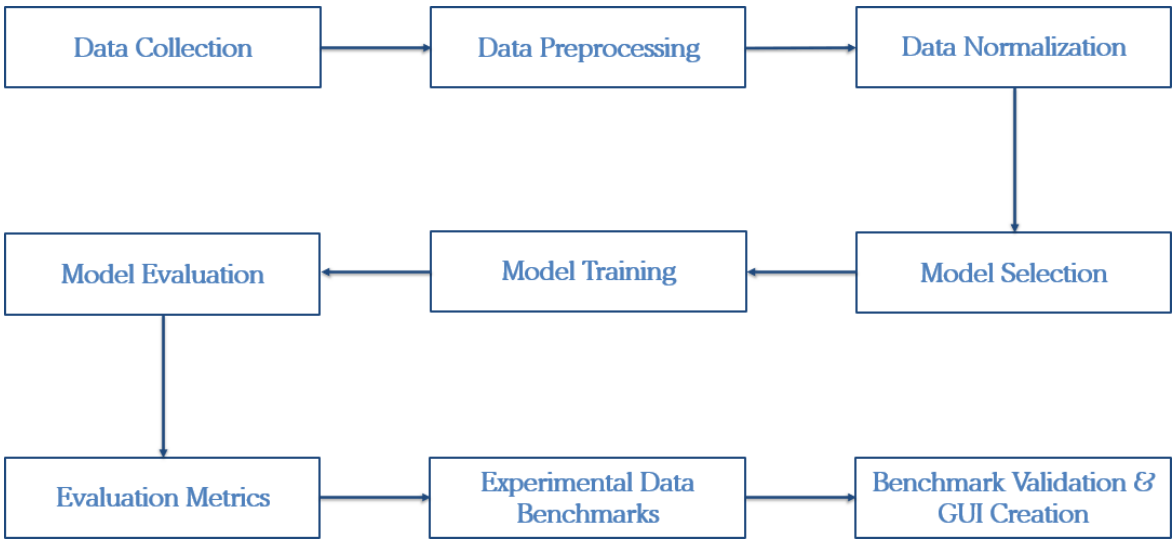


Fig. 3: Methodology for Phase-2

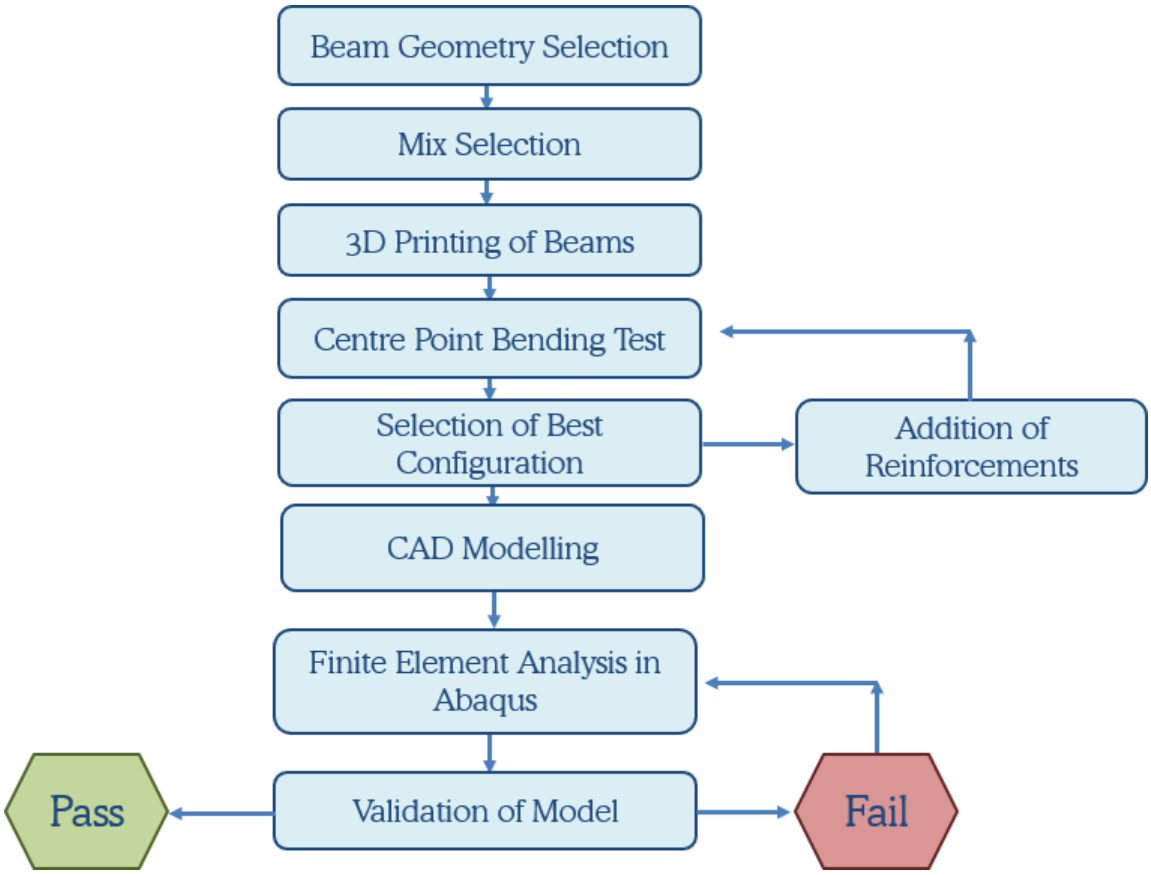


Fig. 4: Methodology for Phase-3

Findings:

- Printable mix designs can be formulated without the addition of complex admixtures and rheological modifiers.
- Addition of 5% metakaolin and 0.1% PP fibers improves the fresh and hardened properties of printed concrete.
- Artificial Neural Networks (ANNs) show the best performance in predicting 3DCP properties with an R^2 of 0.968.
- Arch beam with 0.1% PP fibers shows an 8.8% increase in the load carrying capacity and a 41% reduction in self-weight compared to a cast beam of similar dimensions.

Project Outcomes/Relevance to Industry:

- Introduced a sustainable, low-cost printable concrete mix using locally sourced metakaolin and fibers.
- Delivered a machine learning tool to quickly estimate mix properties, improving efficiency in mix design.
- Proposed optimized lightweight beam geometries suitable for faster and resource-efficient modular construction

Innovative EPS-Based Remedial Measures for Landslide-Prone Areas

Supervisor.: Dr Zain Maqsood

Co-Supervisor: Dr Junaid Ahmed

Group Members

1. Rehaan Khan
2. Urwah Ahmed Malik
3. Umer Farooq
4. Muhammad Zain

Research Area

Geotechnical Engineering, Sustainable Construction Materials, Slope Stabilization

Problem Statement.

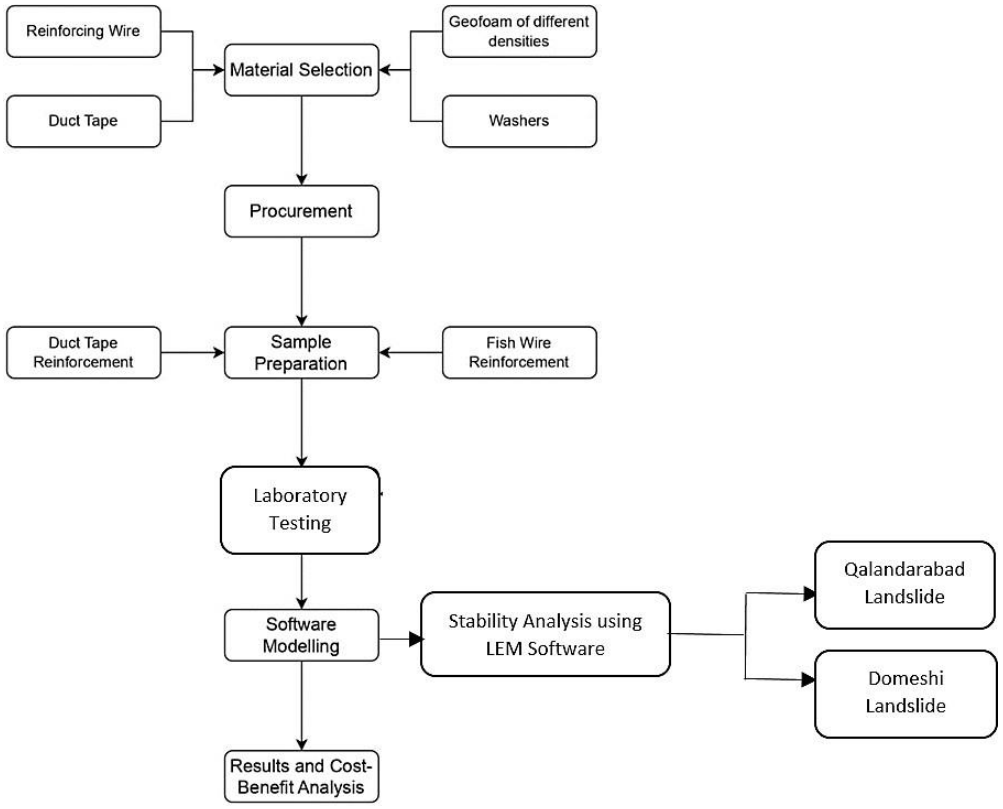
- Landslides cause significant losses in life, property, and tourism, yet cost-effective solutions like EPS geofoam are often overlooked in Pakistan due to traditional practices, underestimated risks, and a lack of innovation.

OBJECTIVES

- To investigate the mechanical behavior and performance characteristics of locally produced expanded polystyrene (EPS) geofoam.
- To explore various techniques for reinforcing EPS geofoam.
- To assess the feasibility and effectiveness of using locally produced EPS geofoam for slope stabilization applications in Pakistan.

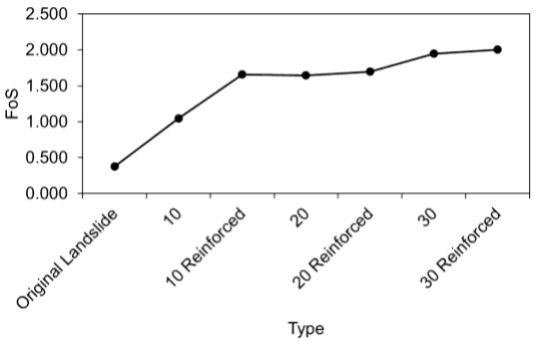
EPS Geofoam in use for slope stabilization in West Java, Indonesia.

METHODOLOGY



FINDINGS

- Reinforced geofoam with a density of 10 kg/m³ showed significant improvements in strength and modulus of elasticity, resulting in a much higher factor of safety (FoS).
- Despite these improvements, reinforced geofoam with a density of 10 kg/m³ remains significantly more cost-effective compared to higher-density alternatives, offering a more economical solution for slope stabilization and other infrastructure applications without compromising on performance.



Qalandarabad Landslide FoS Chart

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Locally produced EPS geofoam can be effectively used for slope stabilization, considering local soil conditions and its ease of transportation to remote areas in Pakistan.
- The findings can serve as a reference for civil and geotechnical engineers in adopting geofoam-based lightweight fill solutions for infrastructure projects, such as slope stabilization.

COMPUTATIONAL MODELLING OF BRICK MASONRY USING FINITE ELEMENT ANALYSIS

Group Members

- Hussain Shahzad
- Hammad Mehmood
- Kamran Hassan

Supervisor. Engr. Muhammad Hamza Sabir

Co-Supervisor Dr. Azam Khan

Research Area:

Structural Engineering, Computational Modelling, Masonry Structures

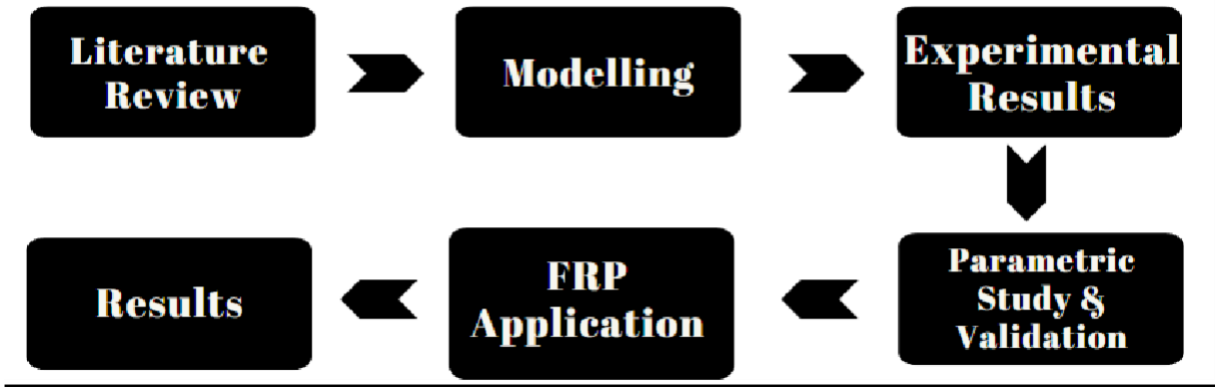
Problem Statement.

- Masonry Structures in Pakistan non-Engineered, unreinforced and vulnerable.
- Experimental analysis expensive, time consuming and limited.
- FEA Full-scale masonry wall has a high computation cost

OBJECTIVES

- Develop a reliable and Computationally Efficient Finite Element Model for 1/3 Scaled Masonry Walls
- Validate the model with experimental Results
- Extend the model to FRP-strengthened masonry walls

METHODOLOGY



FINDINGS

The **Simplified Micro-Modelling (SMM) approach** combined with **surface-based cohesive contact** proved to be highly effective in simulating masonry wall behavior under both **monotonic and cyclic lateral loading**. The model accurately captured crack patterns, failure modes, and load-displacement response when compared with experimental results.

In the case of **FRP-strengthened walls**, the use of **tie constraints** to bond the FRP to the masonry showed some **inaccuracy in the elastic range**, likely due to simplified interaction assumptions. However, the model demonstrated **good agreement in the plastic region** and effectively predicted the **peak load capacity**, indicating its potential for evaluating FRP retrofit strategies.

PROJECT OUTCOMES

- Developed a reliable and computationally efficient 1/3 scale Finite Element Model for masonry behavior simulation
- Validated the model using experimental results for accuracy
- Extended the model to simulate FRP-strengthened masonry walls.

BuildSmart: An integrated ERP for construction projects

Supervisor.: Dr Usman Hassan

Industrial Sponsor: Mr Raja Waqas

Group Members:

1) Suleman Khan
2) Khizar Hayat Khan
3) Saad Mehmmod Abbasi
4) Haider Hafeez

Research Area:

- Focuses on ERP implementation in the construction industry of developing countries like Pakistan.
- Emphasises user acceptance through the Technology Acceptance Model (TAM).

Problem Statement:

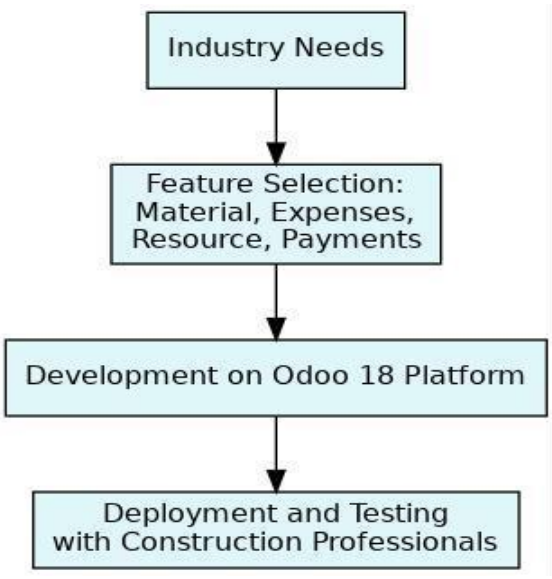
- The construction industry in Pakistan suffers from inefficiencies such as delays, cost overruns, and poor communication.
- Adoption of ERP systems is low due to high costs, complexity, and poor alignment with local workflows.
- There is a need for an affordable, locally tailored ERP system and a framework to assess user acceptance.

Objectives:

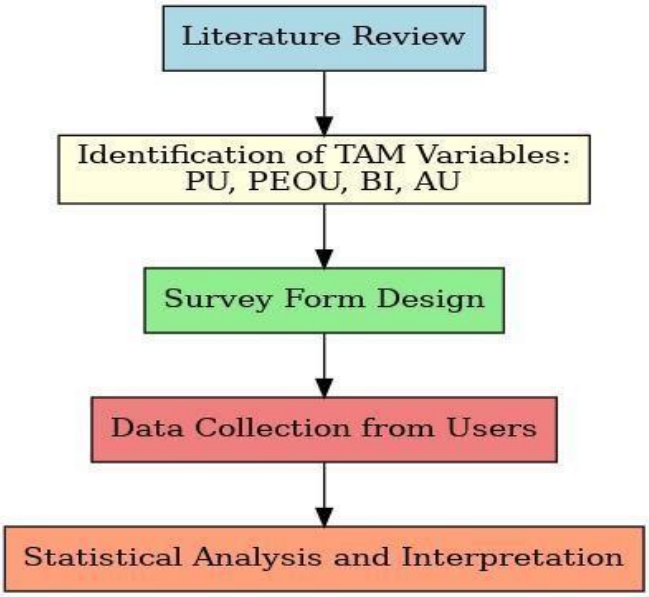
- Analyze ERP adoption challenges in Pakistan's construction sector and assess user acceptance using the Technology Acceptance Model (TAM).
- Design, implement, and evaluate a modular, construction-focused ERP system using Odoo 18 through surveys and case studies.

Methodology:

ERP Development



TAM-Based Acceptance Evaluation



Findings:

- Users found the ERP system useful and easy to use, highlighting efficiency gains and a user-friendly, mobile-compatible interface.
- Adoption was hindered by resistance to change, training gaps, and low digital maturity in smaller firms.
- Customizing ERP workflows to local construction practices was essential for acceptance and effectiveness.

Project Outcomes

- A working ERP prototype named **Built Smart**, developed on **Odoo 18**, targeting material, resource, expense, and payment management.
- Identification of key gaps in ERP research in Pakistan's SME construction sector, reinforcing the need for localized solutions.

Sustainable Utilization of Induction Furnace Slag (G-IFS) as Sand Replacement in Concrete

Supervisor.: Engr. Atif Mehmood

Co-Supervisor: Dr Junaid Ahmed

Group Members

1. Muhammad Hamza Khalid (GL)
2. Muhammad Mursaleen
3. Shehroz Ahmed
4. Ibtesam Bin Abdul Qadeer

Research Area:

Structural Engineering, Sustainable Construction, Waste Management

Problem Statement.

- The construction industry's over-reliance on natural river sand creates major environmental concerns, disrupting river ecosystems and causing erosion and flooding.
- Pakistan's steel industry generates around 0.58 million tons of slag annually, much of which is landfilled, contributing to land pollution.
- Sand reserves are diminishing due to slow natural replenishment, and increasing industrial waste remains underutilized.
- This project tackles both challenges by investigating the use of Induction Furnace Slag (IFS) as an eco-friendly substitute for river sand in concrete.

Induction Furnace Slag

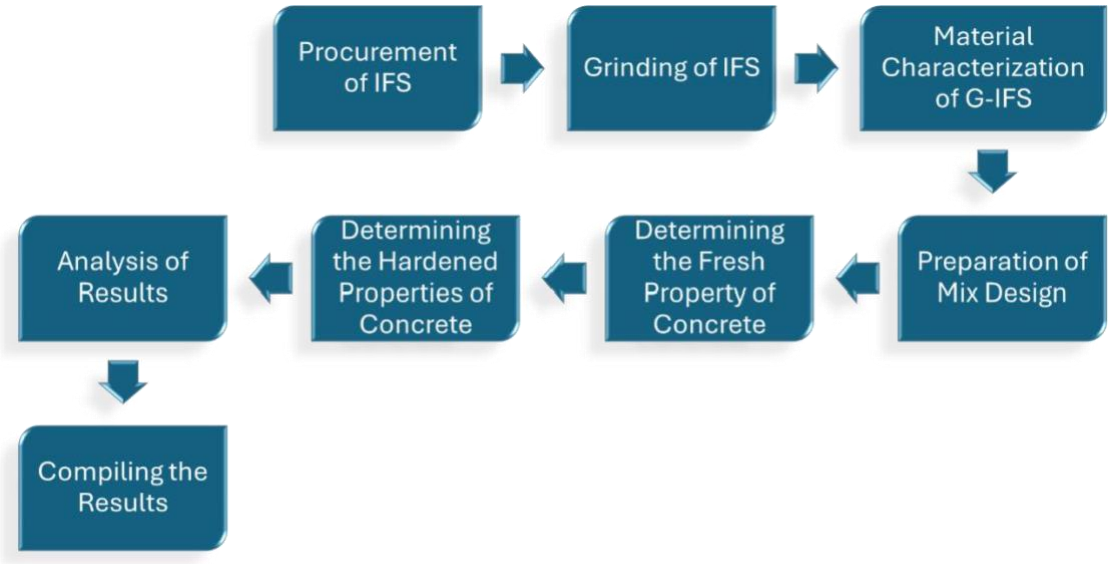
Ground Induction Furnace Slag

OBJECTIVES

- To evaluate the fresh and hardened properties of concrete incorporating Ground Induction Furnace Slag (G-IFS) as a fine aggregate substitute.
- To determine the optimal G-IFS replacement percentage that yields the best mechanical properties.

- To compare the performance of G-IFS based concrete with that of traditional concrete.
- To analyze the environmental and economic impact of using G-IFS in place of river sand.
- To promote sustainable engineering solutions through industrial waste reuse.

METHODOLOGY



FINDINGS

Experimental results showed that 100% G-IFS replacement yielded the best mechanical properties. The enhanced performance is attributed to the better packing and bonding characteristics of G-IFS. Life Cycle Assessment (LCA), through openLCA, deemed 100% G-IFS replacement as more sustainable than conventional concrete (control).

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Demonstrated feasibility of using Induction Furnace Slag (G-IFS) as a full replacement for river sand in concrete.
- Helps solve two major challenges: depleting natural sand resources and industrial waste disposal.
- Potential to revolutionize sustainable construction in Pakistan by lowering environmental damage from sand mining.
- Industrial-scale adoption could reduce material costs and inspire policy development for eco-friendly construction materials.

Development and Application of Sustainable UHPC for Structures and Retrofitting

Supervisor: Dr Muazzam Ghous

Co-Supervisor: Dr Atif Mehmood

Group Members

1. Jawad Hussain (GL)
2. Muhammad Uzair
3. Muhammad Rayyan Ali
4. Malik Danial Farid

Research Area:

Sustainable Construction, Waste Material Utilization and Structural Retrofitting

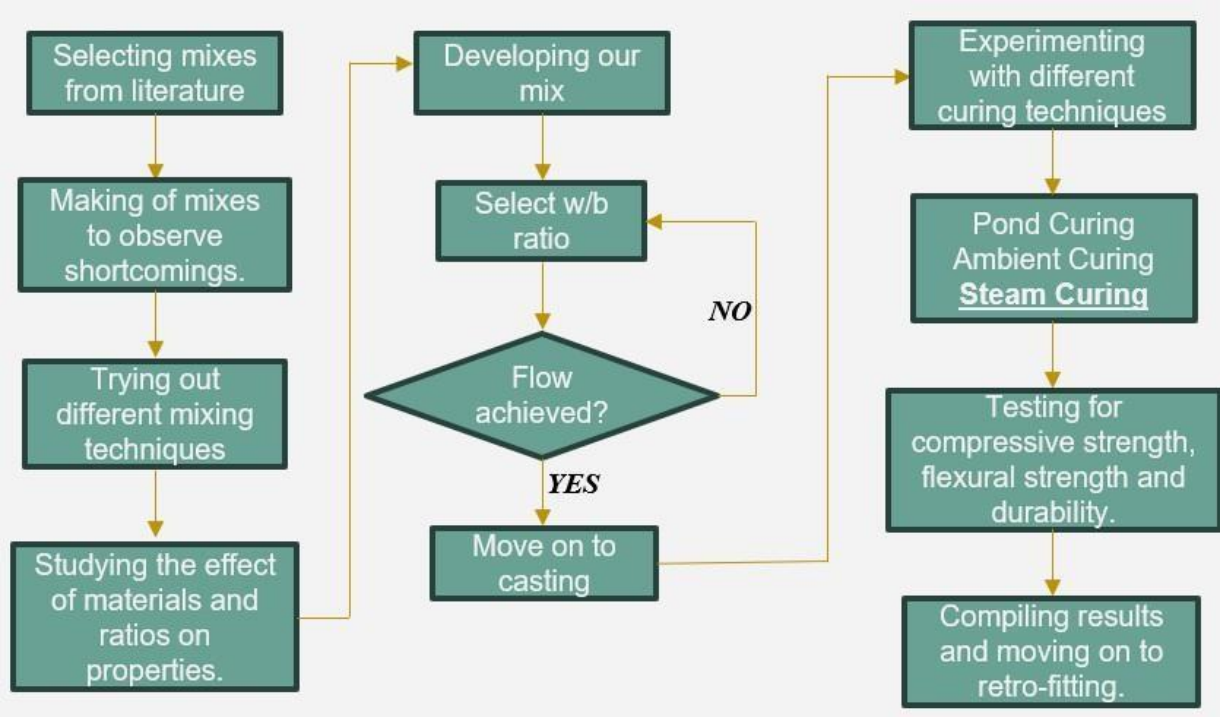
Problem Statement:

- High cement content in UHPC increases both cost and environmental impact.
- Global rise in greenhouse gas emissions due to traditional construction practices.
- Large quantities of Rice Husk Ash (RHA) and Ceramic Tile Waste are not effectively utilized.
- Aging and earthquake-damaged structures require effective retrofitting solutions.

OBJECTIVES:

- Develop a cost-effective Ultra-High-Performance Concrete (UHPC) mix using alternative materials.
- Incorporate sustainable materials like Rice Husk Ash (RHA) and ceramic tile waste to minimize environmental impact.
- Ensure the developed mix maintains the strength, durability, and resilience required for structural retrofitting.
- Achieve overall cost reduction without compromising structural integrity for retrofitting applications.

METHODOLOGY:



FINDINGS:

The developed sustainable UHPC incorporating RHA and ceramic tile waste demonstrates excellent performance with only a 4% reduction in compressive strength while achieving a 12.34% increase in flexural strength at 15% cement replacement. Retrofitting applications showed remarkable results with up to 19.05% strength increase in beams reinforced after 70% loading and 10.95% increase after 80% loading. The material maintains durability with minimal porosity increase (0.2%) compared to control UHPC, while offering substantial cost benefits of 10% savings without fibers and 60% with fibers. Environmental benefits are significant, with a 20% reduction in carbon emissions when using sustainable mix with synthetic PP fibers instead of steel.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY:

- Provides a cost-effective alternative for the construction industry with 10-60% cost reduction while maintaining essential mechanical properties required for structural applications.
- Offers practical and effective solutions for retrofitting deteriorated or earthquake damaged structures, with demonstrated strength improvements of up to 19% in retrofitted beams.
- Supports sustainable construction practices through reduced carbon emissions (20%), utilization of waste materials, and decreased cement consumption.

EXPERIMENTAL ANALYSIS OF CFSTS USING VARIABLE THICKNESS OF STEEL TUBES

Supervisor: Dr. Sara Farooq

Co-Supervisor: Dr. Moazzam Ghous

Group Members

1. M. Rehan Ahmed (GL)
2. Abeera Ahmed
3. M. Tayyab Khan
4. Ahsan Habib

Research Area:

CFSTs, structural concrete, material performance, cost analysis

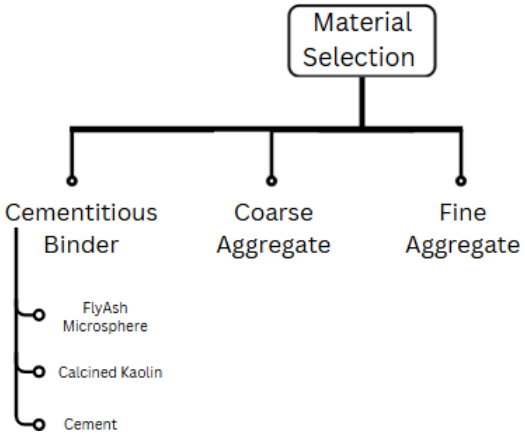
Problem Statement.

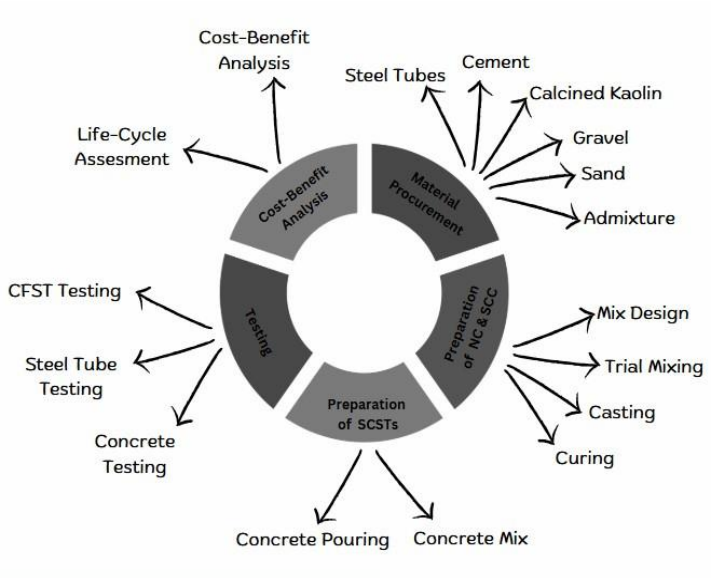
- RCC limitations in strength and speed
- CFSTs not widely used locally
- No direct SCC vs NSC comparison
- Tube thickness impact underexplored
- Missing cost and LCA data for CFSTs

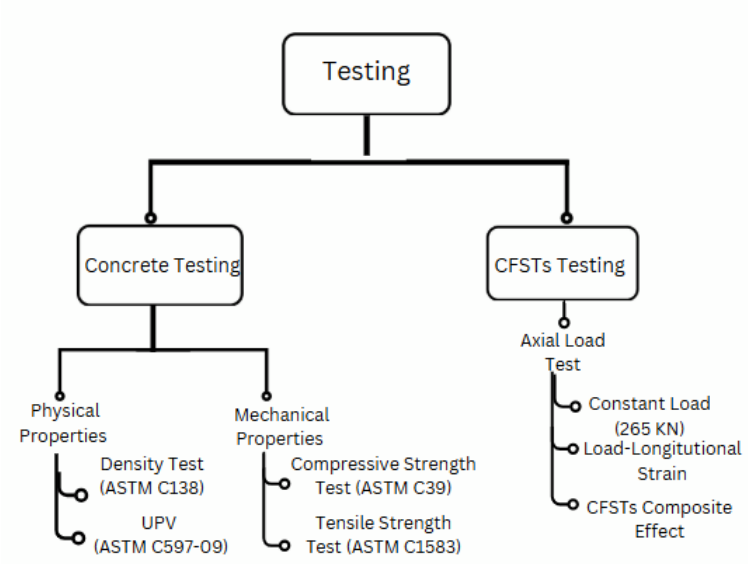
OBJECTIVES

- Compare CFSTs filled with SCC and NSC
- Study the effect of 2.7 mm and 3.2 mm thick mild steel tubes
- Measure strength, stiffness, buckling under axial load
- Assess construction effort and cost for each variant
- Run a cost-benefit and LCA model for SCC vs NSC

METHODOLOGY







Concrete (kg/m³)								
Material	**Cement**	**Sand**	**Coarse**	**Water**	**Metakaolin**	**Fly ash**	**Admixture**	**Total**
M40-SCC	720.23	784.25	633.8	222.47	40.01	40.01	9.2	2450
M22	400	588	1188	224	nil	nil	nil	2400

Steel Tubes (SCCFSTs)				
Concrete	Normal Concrete	Normal Concrete	SCC M40 Concrete	SCC M40 Concrete
Steel	14 Gauge	10 Gauge	14 Gauge	10 Gauge
SCCFST Samples	2	2	2	2

FINDINGS

- **Steel Thickness Impact:** Thicker tubes (3.2 mm) improved load capacity, offering better axial performance than thinner tubes (2.7 mm).
- **NSC vs SCC Performance:** The composite action of SCC and CFSTs is better than that of NCFSTs. Moreover, SCC gains advantage over Normal Concrete in CFSTs due to its self-compaction properties which are absent in NC.
- **Cost-Benefit Insight:** SCC costs more initially but delivers better long-term value due to higher performance, reduced defects, and lower maintenance as compared to RCC.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

SCC offers faster casting with fewer labor steps. CFSTs with SCC showed better performance in early-stage lab tests. This model can help structural engineers and builders assess whether CFSTs with SCC are worth adopting in mid- to high-rise projects compared to RCC.

Effect of Sand Size, Different SCMs, and Fibers on Strain Hardening of ECC and Its Applications

Introduction & Objectives

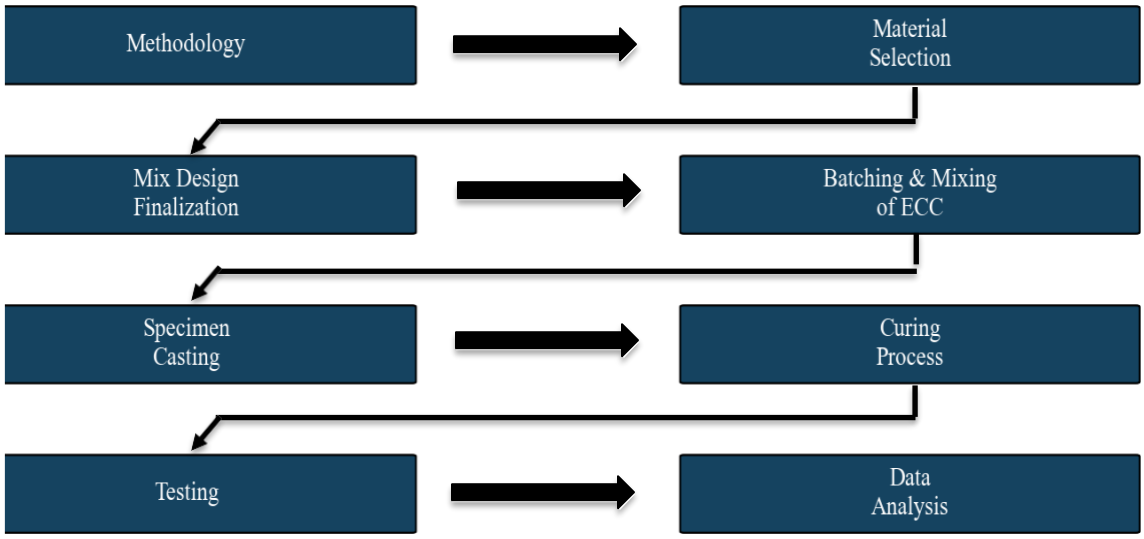
Introduction:

Engineered Cementitious Composites (ECC) are advanced fiber-reinforced concrete solutions, known for their strain-hardening behavior and durability. ECC properties are influenced by factors like sand size, fiber type, and Supplementary Cementitious Materials (SCMs). This research aims to optimize ECC mixes by studying the effect of these factors, focusing on PP and PVA fibers, using Limestone Powder (LSP) and sand size variation.

Objectives:

1. Investigate the effect of sand size on ECC's properties.
2. Analyze the influence of Limestone Powder (LSP) on ECC's properties.
3. Study the impact of PP and PVA fibers on strain-hardening behavior.
4. Develop an optimized ECC mix combining strength and sustainability.

Research Methodology



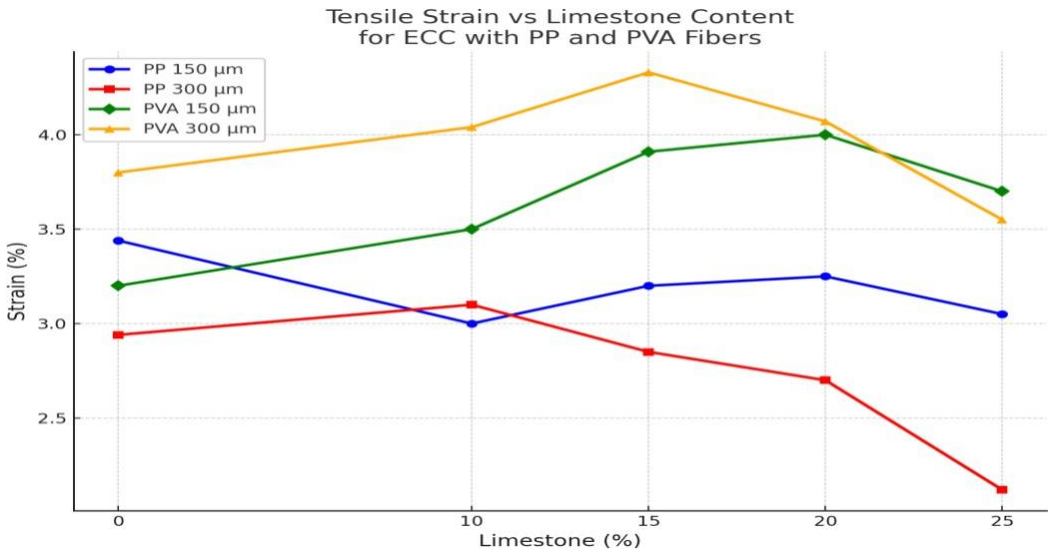
Results & Discussion

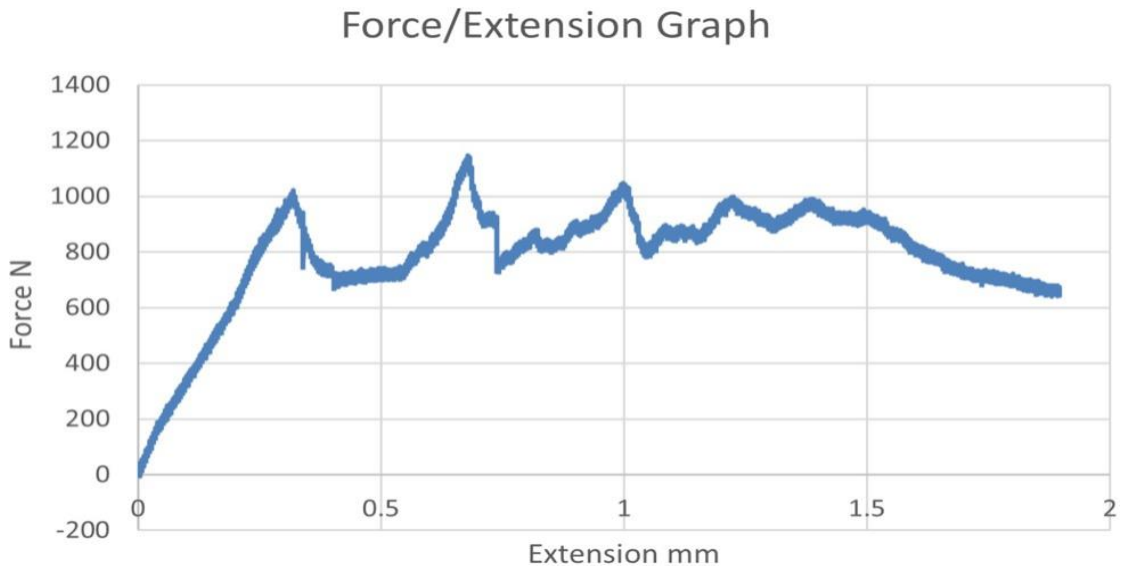
At 10% LSP, ECC mixes with PVA fibers showed minimal decrease in compressive strength and a slightly improved strain behavior, highlighting enhanced workability without significant detriment to strength. However, at 15% LSP and higher, both PP and PVA fiber mixes exhibited a significant drop in strength. This decline can be attributed to the dilution effect of the cement binder, where LSP's filling ability is outpaced by the lack of sufficient binder material. Strain-hardening behavior also decreased, especially in

PP fiber ECC mixes, where higher LSP contents led to less fiber bonding, diminishing the matrix's ability to withstand tension and enhance post-crack behavior.

The sand size plays a significant role in the workability, fiber-matrix bonding, and overall performance of Engineered Cementitious Composites (ECC). Our study focused on comparing fine sand (150 µm) and coarse sand (300 µm) in mixes reinforced with PP and PVA fibers. Fine sand (150 µm) mixes generally resulted in higher compressive strength in PP fiber ECC's, as the finer particles provided better packing and a denser matrix that enhanced fiber-matrix bonding. In contrast, coarse sand (300 µm) mixes exhibited better strain-hardening behavior and post-crack performance, especially for PVA fibers. The larger sand particles allowed for better fiber distribution, which improved stress distribution and enhanced crack resistance.

Strain Variation with Limestone Content





“Sustainable Blocks: Design of sustainable compressed Earth blocks from agro-waste. A novel practical approach for the construction industry.”

Group Members

Syed Lakht-e-Hassan
M. Saad Sarfraz
Zohaib Zaheer Rao
Mudassar Iqbal

Supervisor: Dr Badee Alshameri

Research Area:

Sustainable Construction, Eco-friendly Building Materials, Low-carbon Technologies

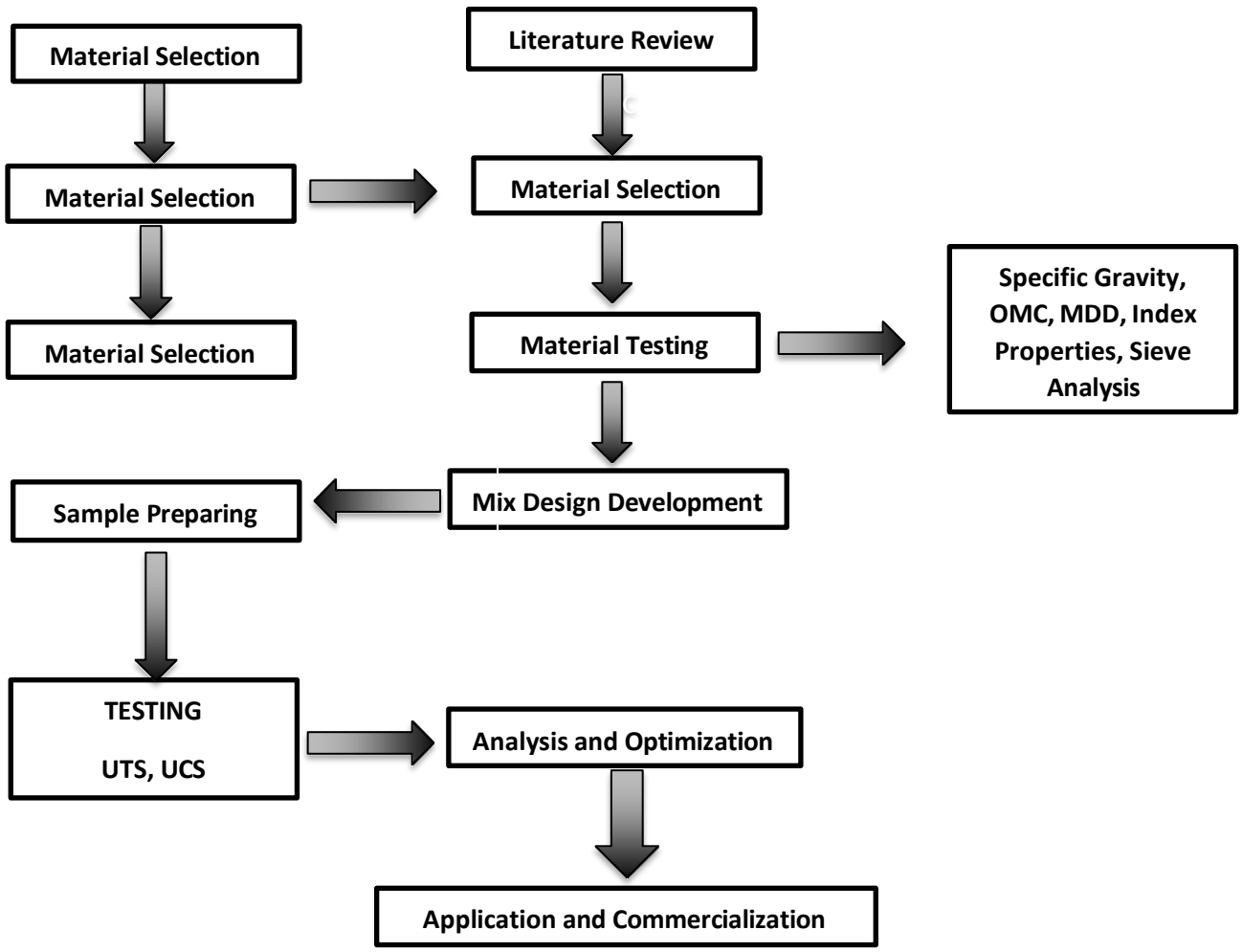
Problem Statement.

- Traditional brick manufacturing in Pakistan relies on energy-intensive kilns, contributing significantly to air pollution (CO_2, PM2.5) and health hazards.
- Burnt clay bricks and cement-based materials are unsustainable and costly, making affordable housing inaccessible for low-income communities.
- Existing alternatives like Compressed Stabilized Earth Blocks (CSEBs) still use cement and lime, which are not fully eco-friendly.

OBJECTIVES

- Develop sustainable, low carbon compressed earth blocks (CEBs) with comparable strength to conventional bricks.
- Optimize material composition using marble dust (MD), and corn straw fibres for enhanced strength and durability.
- Evaluate the environmental impact and carbon footprint reduction of CEBs compared to traditional bricks.
- Provide a cost-effective, scalable manufacturing process suitable for rural and urban construction.

METHODOLOGY



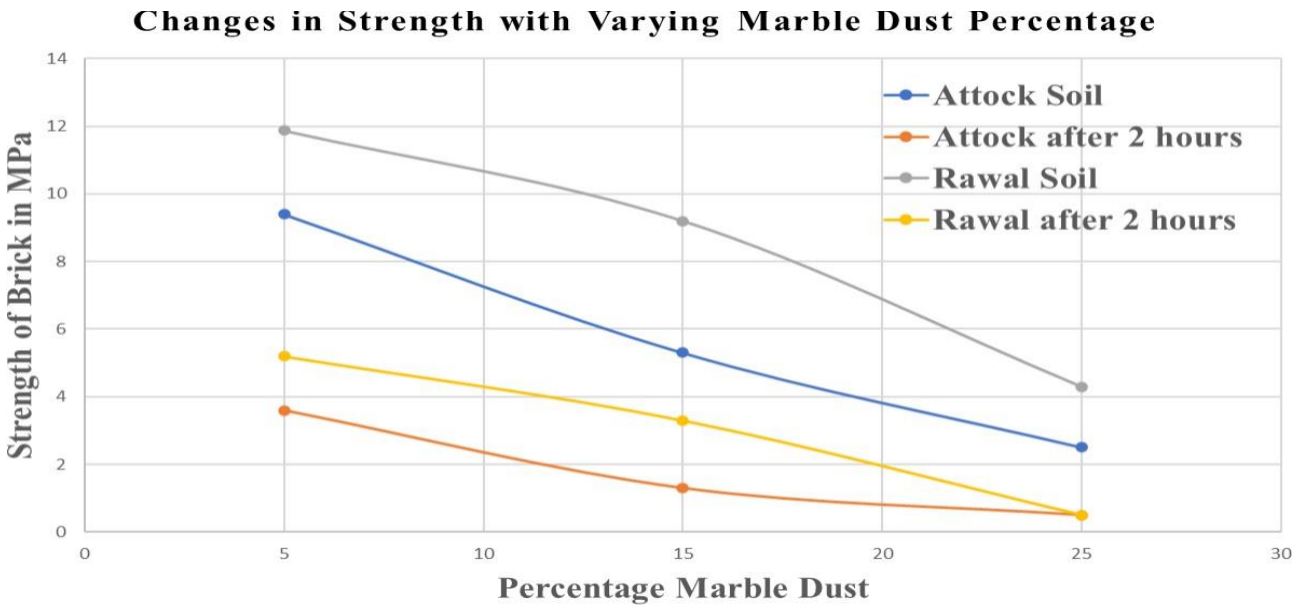
FINDINGS

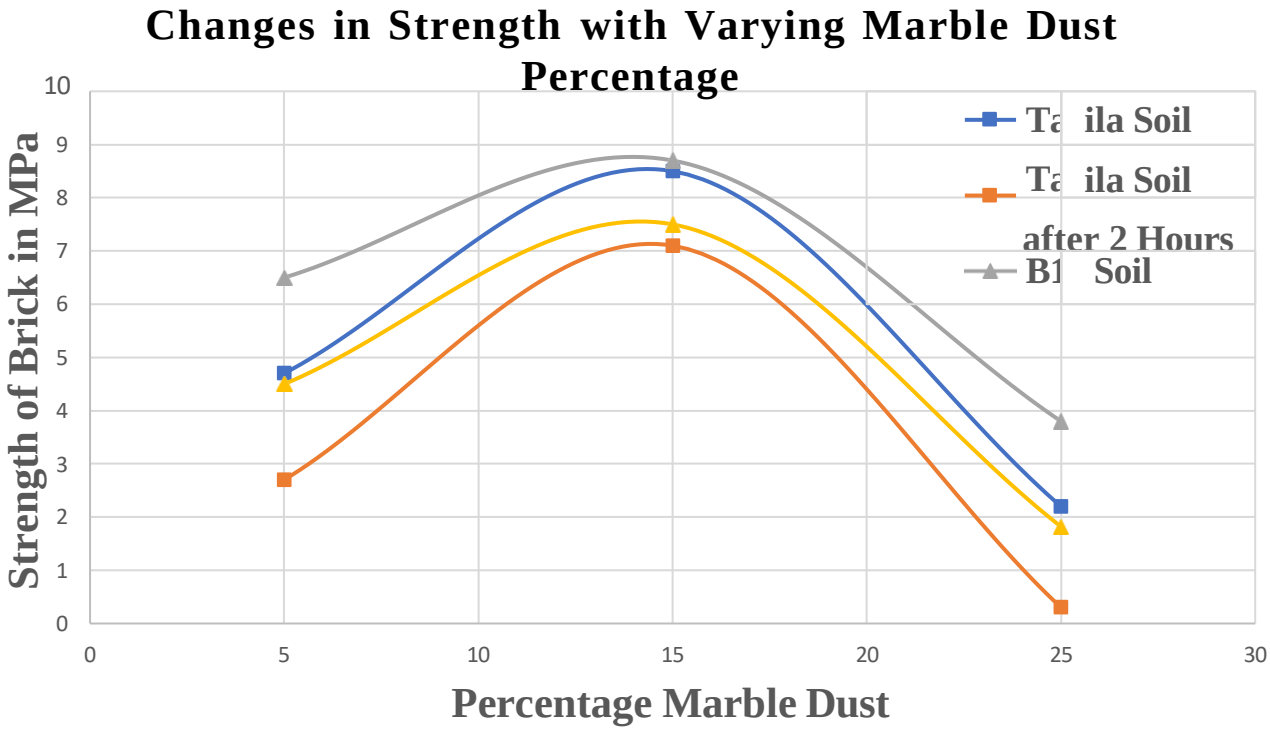
- For medium plastic Soils, Marble Dust with 15% yielded best results.
- For high plastic soils, Marble dust with 5% yielded best results.
- Increasing Marble dust beyond a certain point can cause the strength to decrease.
- Surface Hardness is not a good way to predict compressive strength.
- The Schmidt hammer Test helps us with durability of blocks. Medium Plasticity Soil blocks are more durable than high plasticity blocks.
- Cohesion from clay nature of particles is necessary for binding which gives brick its strength after compression
- The optimum and recommended design for these bricks are medium plasticity soil with 15% Marble dust and 5% fibers.
- Temperature Regulation since soils are cooler in the day due to natural thermal properties. No skilled labor required.
- Cheaper and environmentally friendly as compared to traditional Brick. Air dried in 3 days.
- It can be made using moulds or a machine. Only requires compression under load.
- No burning hence carbon footprint.
- All materials used are waste materials.

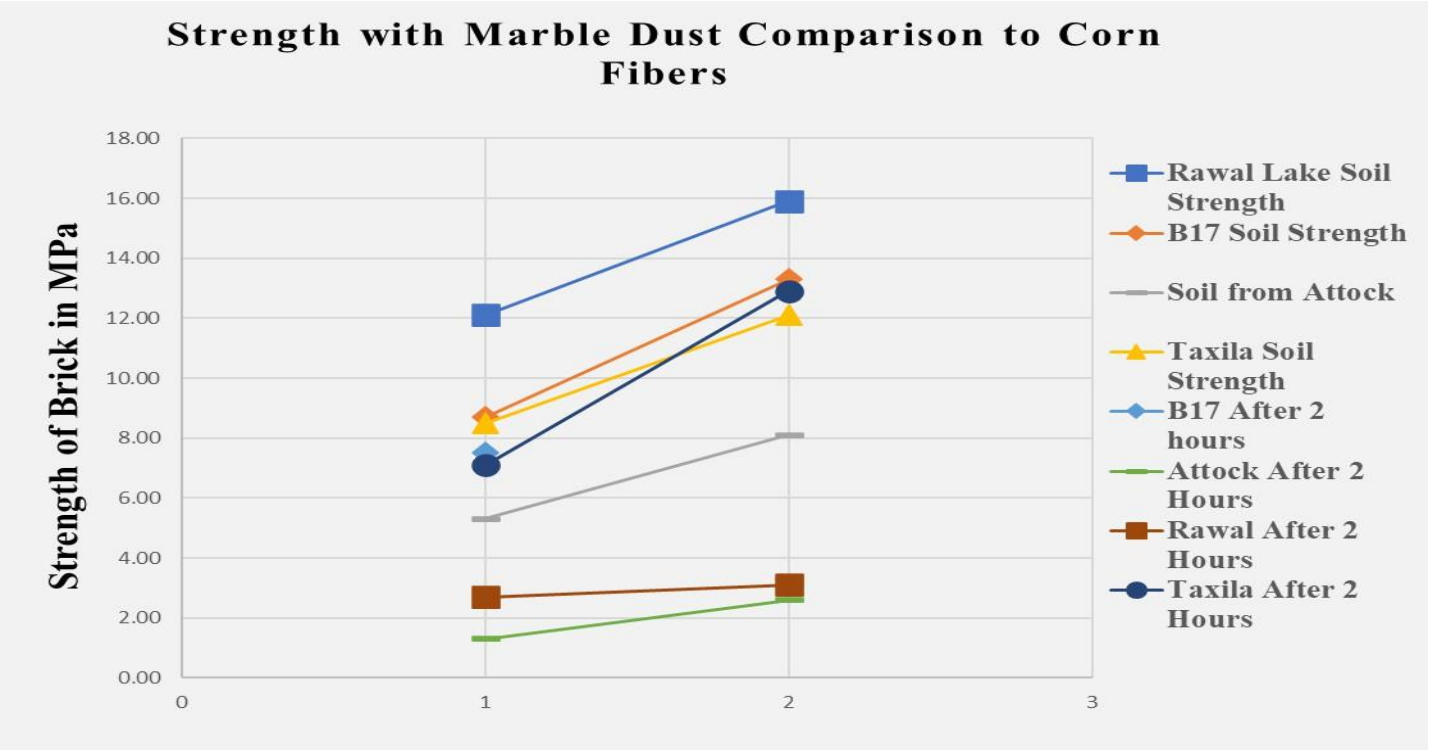
	Traditional Brick	CSEB with Cement	Our Best Product
Dimensions	3” x 4.5” x 9”	4” x 6” x 12”	4” x 6” x 12”
Weight	3.2 kg	10 kg	8.81kg
Burned	Yes	No	No
Compressive Strength	8 MPa	14MPa	12 MPa
Number required to make 100sq.ft wall	534	267	267
Cost of one Brick in Pkr (Economical)	Rs 18	Rs 100	Rs 9 (90% reduced Cost)
Schimdt Hammer Strength	16MPa	14 MPa	14 MPa
Thermal Insulation	No	Yes	Yes
Environment Friendly	No	No	Yes

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- A sustainable, low-cost alternative to traditional bricks, addressing Pakistan’s housing and environmental challenges.
- Potential for widespread adoption in rural and urban construction, aligning with global sustainability goals.
- Published research to guide future innovations in eco-friendly building materials.


Changes in Strength with Varying Marble Dust Percentage
Strength of Brick in MPa
Percentage Marble Dust
Attock Soil
Attock after 2 hours
Rawal Soil
Rawal after 2 hours
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30


Changes in Strength with Varying Marble Dust Percentage
Strength of Brick in MPa
Percentage Marble Dust
Ta ila Soil
Ta ila Soil after 2 Hours
B1 Soil
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30


Strength with Marble Dust Comparison to Corn Fibers
Strength of Brick in MPa
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
1
2
3
Rawal Lake Soil Strength
B17 Soil Strength
Soil from Attock
Taxila Soil Strength
B17 After 2 hours
Attock After 2 Hours
Rawal After 2 Hours
Taxila After 2 Hours

Design and Performance evaluation of bendable concrete for rehabilitation of rigid pavements

Supervisor. Dr Arshad Hussain

Co-Supervisor: -

Group Members

1. Hifz U Rehman (GL)
2. Abdul Rahman Irshad
3. Saad Azim
4. Muhammad Huzaifa

Research Area: Pavement Engineering, Sustainable Rehabilitation, High-Performance Concrete, ECC

Problem Statement.

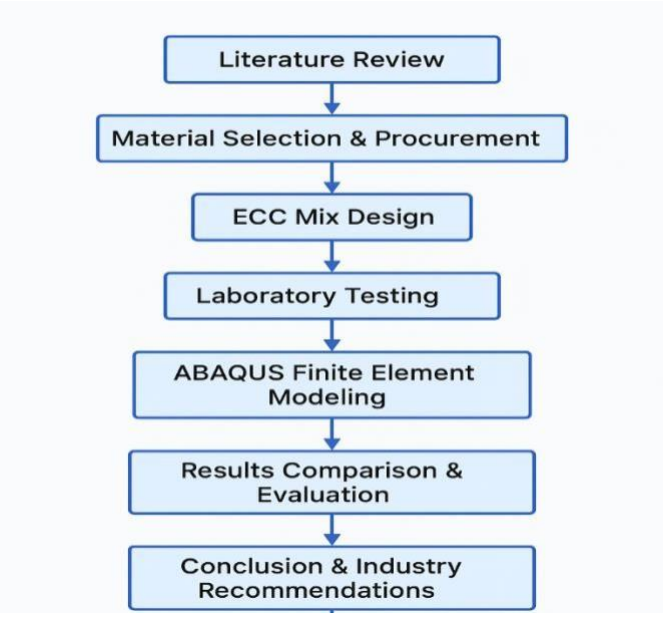
Pakistan's highway network relies mostly on rigid pavements because of their durability and extended service life.
These pavements are prone to early-age cracking, faulting, joint failure, and corner breaks caused by excessive axle loads, subgrade distress, and climatic conditions.
Conventional concrete overlays during rehabilitation exhibit reflective cracks caused by inability to allow movement from the underlying slab.
Recurring overlay failures result in excessive maintenance expenses and frequent road closures, which impede mobility and the national economy.
There is no locally deployed, long-lasting, and adaptable overlay solution that can extend pavement life and decrease lifecycle cost.
There is a demand for a cost-efficient and high-performance material to manage cracking and enhance rehabilitation benefits — e.g., ECC with PPE fibers.

OBJECTIVES

1. To design and evaluate Engineered Cementitious Composite (ECC) using locally available Polypropylene (PPE) fibers.
2. To simulate overlay behavior under traffic loading using Finite Element Modeling (ABAQUS).
3. To carryout cost analysis and comparison with traditional overlays.

METHODOLOGY

1. Selection and procurement of materials (OPC, PPE fibers, fly ash, admixtures).
2. Mix design and laboratory testing (compressive strength, flexural strength, tensile ductility).
3. Numerical modeling using ABAQUS to assess stress distribution and crack behavior in overlays.
4. Comparative analysis of ECC and traditional concrete overlays.



FINDINGS

1. **Compressive Strength:**
   ECC with PPE fibers demonstrated higher compressive strength than traditional concrete overlays, making it structurally sound for pavement rehabilitation.
2. **Tensile Strength:**
   The ECC mix showed significantly higher tensile capacity with strain-hardening behavior, allowing it to sustain stress without brittle failure.
3. **Flexural Strength:**
   Our ECC achieved a flexural strength of 13.98 MPa, which is more than twice the typical value of traditional concrete (~5–6 MPa), proving its superior performance under bending and load repetition.
4. **Overlay Thickness (FEM Modeling):**
   Finite Element Modeling in ABAQUS indicated that ECC overlays can be applied at a reduced thickness compared to traditional concrete, while still achieving better performance. This contributes to material savings and sustainability.
5. **Durability and Cost-Effectiveness:**
   ECC overlays are long-lasting and require fewer repairs due to their ability to control cracking. This leads to reduced lifecycle costs, minimized traffic disruption, and overall economic benefit for infrastructure agencies like NHA and FWO.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

1. Demonstrated the feasibility of using cost-effective, locally available PPE fibers to enhance pavement durability.
2. Offers a practical solution for NHA, FWO, and CPEC-related road infrastructure facing reflective cracking issues.
3. Supports sustainable infrastructure practices through reduced material use and long-term performance.

Improving the properties of Self-healing Concrete and predicting its performance using machine learning

Supervisor.: Dr Sara Farooq

Co-Supervisor: Dr. Muazzam Ghous Sohail

Group Members

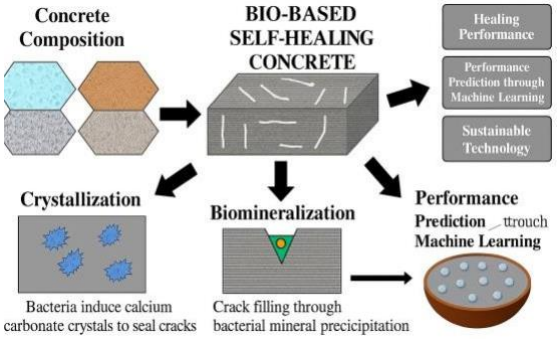
1. Muhammad Ali Mir (GL)
2. Ajmal Hassan
3. Maryam Alvi
4. Jahangir Hassan

Research Area:

Smart Concrete Materials, Machine Learning in Construction, Sustainable Building Technologies, Bio Healing with Bacteria

Problem Statement.

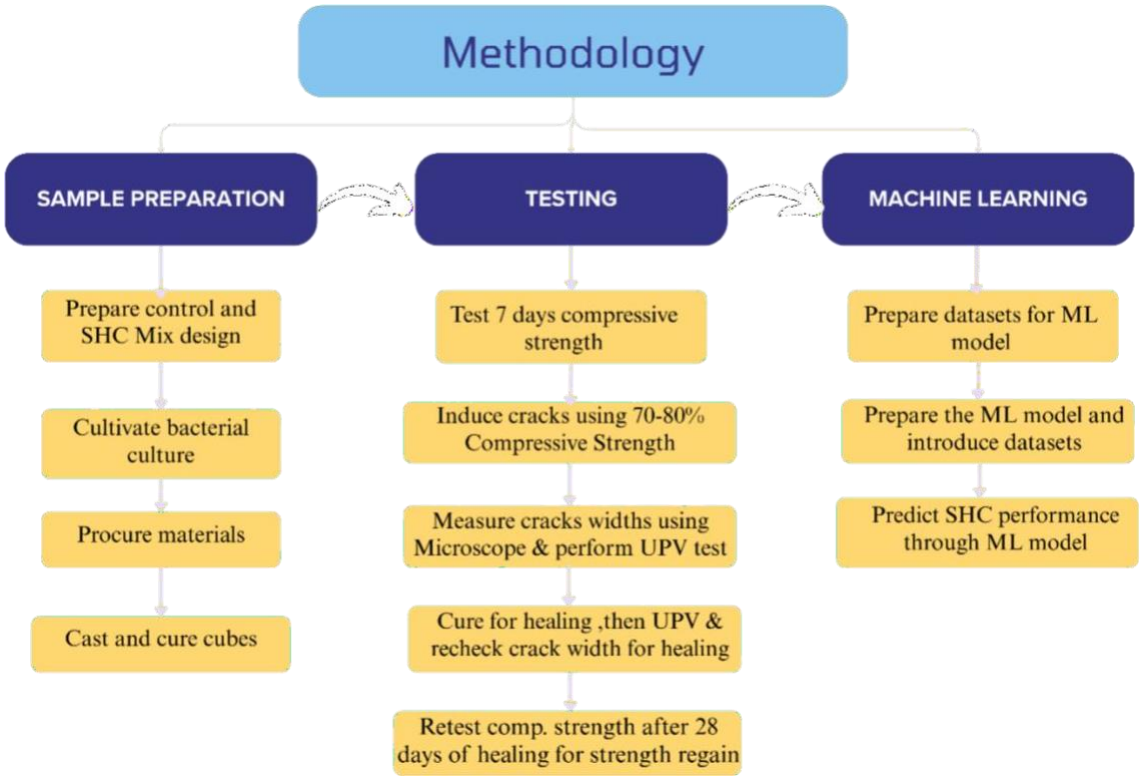
- Limited large-scale adoption of Self-Healing Concrete due to suboptimal mix designs.
- Reduced workability and strength from bacterial healing agents
- SHC often sacrifices mechanical strength for self-healing
- Limited data on SHC properties hinders its optimization.
- The complex behavior of SHC needs better understanding for practical use



OBJECTIVES

- Develop SHC mix that balances workability, healing, and strength performance.
- Optimize the concentration of Fly Ash for better performance of SHC.
- Develop ML models to optimize SHC performance through different machine learning approaches.

METHODOLOGY



FINDINGS

15% Fly Ash enhances strength, durability, and workability of self-healing concrete while reducing the maintenance. Machine Learning integration enhances efficiency and accuracy in property prediction making the project more sustainable and cost effective.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Identification of optimum Fly Ash content for improved strength, workability, and self-healing in concrete using experimental and ML-based analysis.
- This study can serve as a foundation for future sustainable and smart concrete solutions under organizations like NHA, NESPAK, and FWO, promoting the use of AI/ML in construction materials.

Albedo Effect and Thermal Shield Mortar

Supervisor.: Engr. Atif Mehmood

Co-Supervisor: N.A

Group Members

1. Muhammad Dawood Butt
2. Muhammad Awais Amjad
3. Affaz Abuzar
4. Muhammad Irtiza

Research Area:

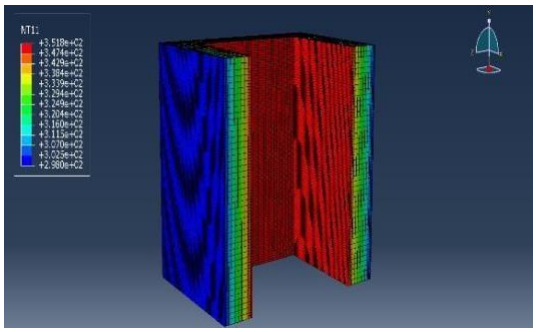
Thermal Shield Mortar, Albedo Effect significance, Sustainable Construction, Industrial Waste Utilization

Problem Statement.

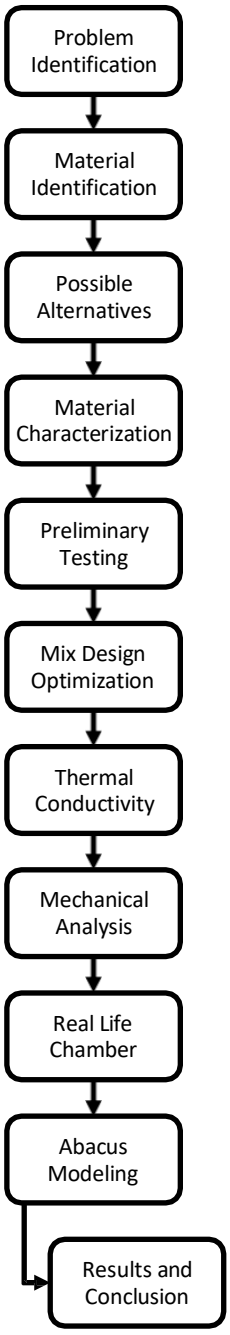
- Excessive Heat Retention of traditional mortar
- Increased cooling demand of Buildings
- High carbon footprint leading to environmental degradation
- Limited recycling of industrial waste

OBJECTIVES

- Improving the Thermal performance of Mortar by Adding Marble Waste and Poly Vinyl Acetate (PVAc)
- Utilizing Albedo Effect to mitigate the Urban Heat Island Effect
- Studying the Real-Life thermal Performance of 3ft x 3ft physical model with various Mix design plaster
- Stimulated Thermal Performance analysis of the Digital model created using Abacus
- Analysing and improving the corresponding Effect on the compressive strength of Mortar



METHODOLOGY



FINDINGS

The thermal conductivity value of Marble Powder incorporated mortar and Marble Powder plus PVAc incorporated mortar decreased as compared to traditional mix design.

In the small-scale thermal testing chamber, the temperature decreased significantly for the Marble plaster, Marble plus PVAc plaster and Marble plus PVAc plaster plus Coating from that of Control plaster.

The compressive strength of the mortar increased for the Marble Powder and increased further for the Marble Powder plus PVAc mix design respectively.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- In Pakistan alone, about 30% to 40% of marble waste generate annually by the industry can be utilized, reducing the Urban Heat Island Effect.
- Various firms like SOBER Technologies, NIPPON Paint and DIAMOND Paint are producing weather resistant paints. But these paints are not entirely solar resistant. Our study can help them further in developing their product.

2D FLOOD INNUNDATION MODELLING BASED ON THE 2022 FLOOD EVENT FOR LARKANA DISTRICT SINDH

Supervisor.: Dr. Shakil Ahmad

Co-Supervisor: Dr. Zafar Iqbal

Group Members

1. Muhammad Abdullah Khalid (GL)
2. Muhammad Humayun
3. Muhammad Taha Ghauri
4. Rafeh Khan Baloch

Research Area:

2D flood inundation modeling; flood frequency analysis; flood hazard maps.

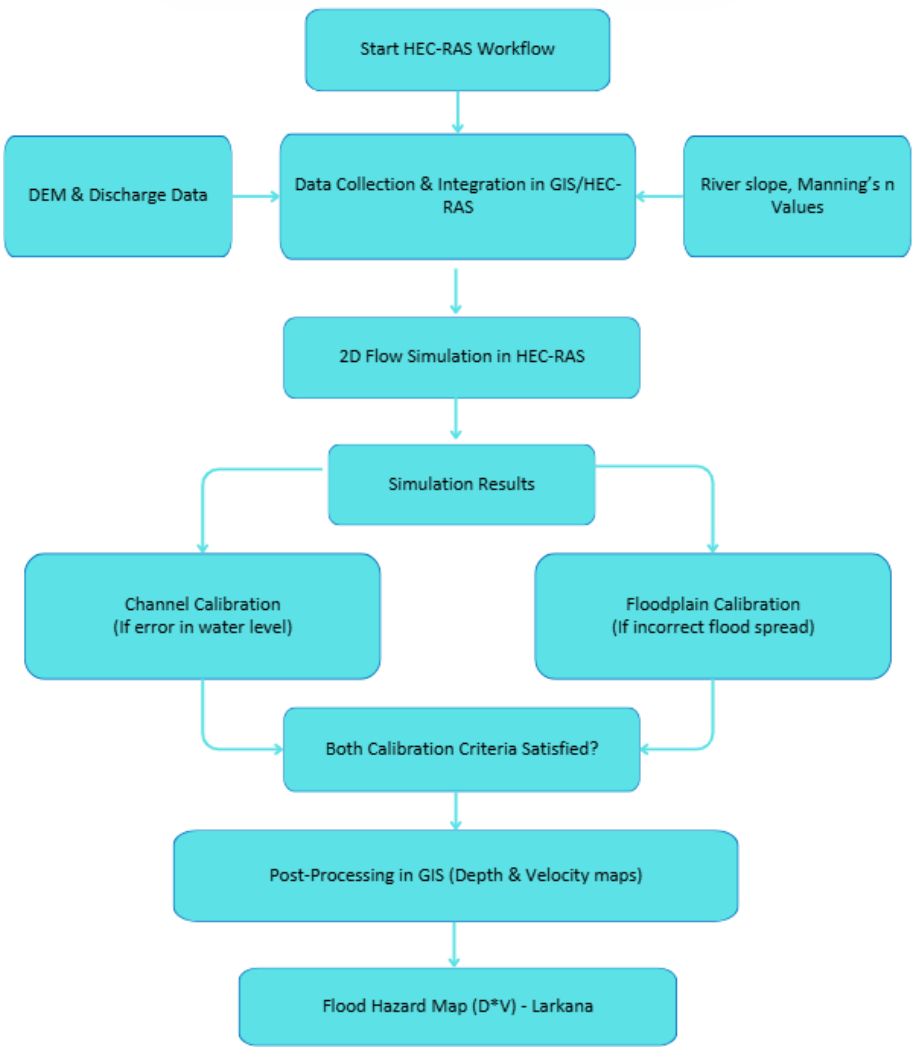
Problem Statement.

- Pakistan has experienced devastating floods in recent years, such as in 2010 and 2022, causing significant losses.
- Effective flood management relies on accurate flood modeling.
- There is a need for detailed and high-resolution flood inundation modeling for the entire country. Our work is based on Larkana District as it was the most impacted from the 2022 flood event.
- Understanding the frequency and magnitude of future flood events is crucial for preparedness.
- The lack of this information (detailed modeling and frequency analysis) hinders effective disaster preparedness, mitigation, and sustainable development planning in the region.

OBJECTIVES

- Simulate the 2022 flood event over Larkana using 2D HEC-RAS models.
- Conduct flood frequency analysis to estimate the return periods of future flood events.
- Develop flood hazard maps for Larkana to enhance awareness and preparedness.

METHODOLOGY



FINDINGS

- Depth and Velocity maps for different future flow values estimated through Flood Frequency Analysis
- Hazard maps based on these same values for future events to aid in preparedness and planning.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Simulated 2D flood inundation models using HEC-RAS for the 2022 flood event.
- Conducted a flood frequency analysis (FFA) using historical flow data at Sukkur Barrage, identifying the magnitude and probability of extreme flood events impacting the Larkana district.
- Generated high-resolution flood hazard maps integrating satellite-based DEMs and remote sensing data.

Impact of U-Turns on Srinagar Highway Islamabad on Traffic Flow- A Redesigning of U-Turns to Improve the Traffic Flow

Supervisor.: Engr Malik Kamran Shakir

CoSupervisor: Dr Kamran Ahmed

Group Members

1. Imran Maqsood
2. Arslan Ahmed
3. Sheeraz Ahmad
4. Mehboob Akram

Research Area:

Traffic Engineering, Traffic Simulations, Geometric Design

Problem Statement.

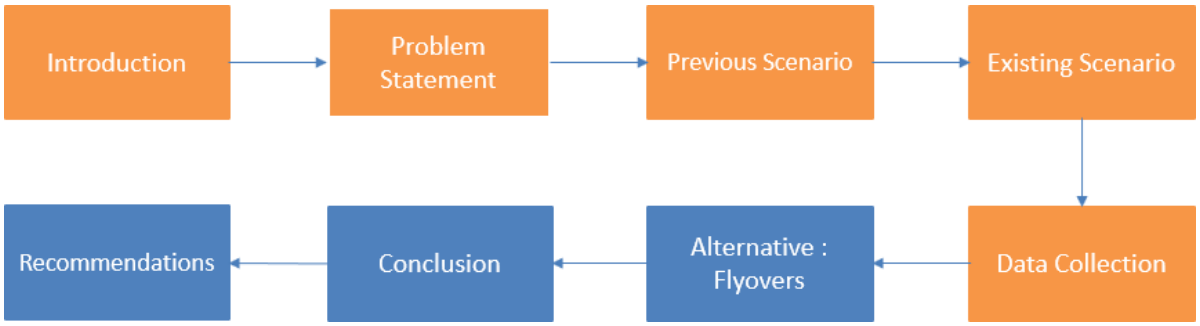
- U-turns at 3x Locations (NUST, G-10 & Police Lines) on Srinagar Highway, Islamabad, are causing significant congestion during peak traffic hours.
- The current design leads to traffic bottlenecks, increased delays, and road safety concerns.
- There is a need to redesign these U-turns to enhance efficiency/safety and traffic flow
- The proposed solutions aim to reduce congestion and improve overall road network performance.


Police Line U-Turn Simulation on PTV VISSIM

OBJECTIVES

- To analyze the impact of existing U-turn designs on traffic congestion during peak hours.
- To identify key factors contributing to traffic delays and safety issues at U-turn locations.
- To develop and propose efficient U-turn redesign and Flyover alternatives for improved traffic flow.
- To evaluate the effectiveness of each proposed alternatives through traffic simulation on PTV VISSIM software.

METHODOLOGY



FINDINGS

The analysis of the flyover scenario reveals notable improvements in traffic performance compared to the existing U-turn setup. Vehicle delays are significantly reduced, enhancing overall travel time during peak hours. The partial cloverleaf flyover achieves better Level of Service (LOS) grades at both G-10 and G-11 intersections, indicating smoother traffic flow. Additionally, traffic efficiency is improved by reducing congestion and fewer stops per vehicle. This not only increases fuel efficiency but also helps reduce vehicular emissions. Overall, the intersection's traffic handling capacity is substantially enhanced, making the flyover a more effective solution.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

The project offers a practical solution to reduce congestion and delays at critical U-turn intersections. It supports CDA/NHA in improving urban mobility through efficient infrastructure redesign. Enhanced traffic flow and decreased emissions align with national sustainability and efficiency goals. The findings provide a data-driven basis for future planning and policy decisions in road network development.

Blockchain based Smart Contract's Application for Decentralized Tendering of Construction Projects in Pakistan

Supervisor.: Dr Muhammad Usman Hassan

Co-Supervisor: Lecturer Qurat ul Ain Babar

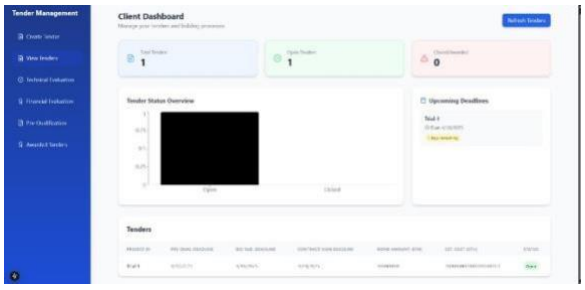
Members:
Muhammad Khuzaima Qureshi (G.L)
Mujtaba Haider
Malik Ahmad Mukhtar
Syed Muhammad Ali Abbas

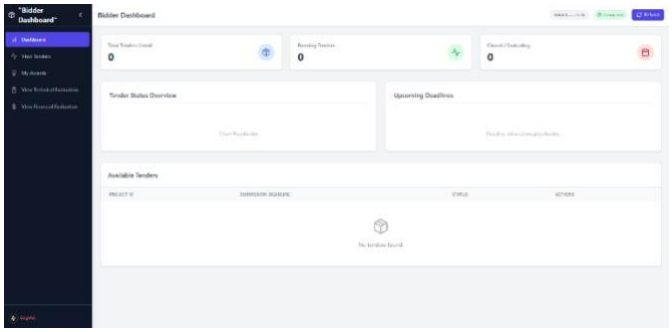
Research Area:

Blockchain, Construction Procurement, Smart Contracts

Problem Statement:

"The construction sector lacks an e-tendering system that ensures full-proof security and transparency, and provides a single source of truth for conducting and managing tendering of construction projects while accessing all related information and documents"

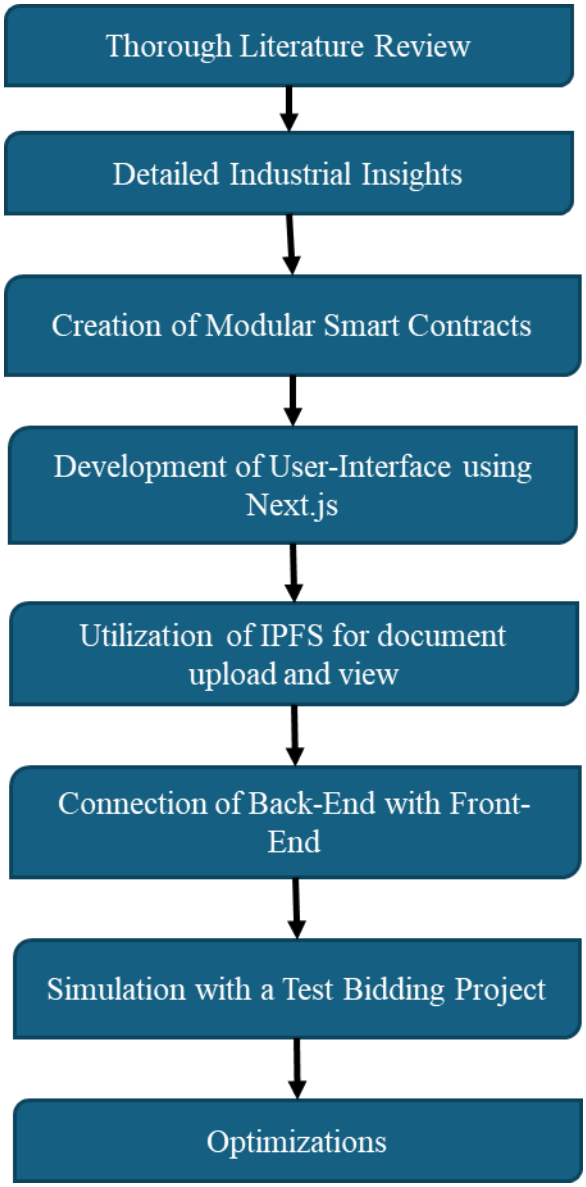




OBJECTIVES:

- To develop a decentralized web application to address tendering issues like document forgery, cybersecurity threats in the Pakistani construction tendering industry.
- To understand the impact of our final prototype by experts in the construction industry of Pakistan.

METHODOLOGY:



FINDINGS

A decentralized web application (DApp) was developed using **smart contracts**, **IPFS**, and **Next.js** to automate the tendering workflow—covering prequalification, technical, and financial evaluations. The system ensures tamper-proof documentation, real-time transparency, and automatic contract awards.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- This E-Tendering System provides an immutable audit trail, enhancing transparency and potentially aiding dispute resolution processes.
- It serves as a steppingstone towards more advanced blockchain applications in construction procurement and management.
- Industrial feedback from RADC and Siemens Gamesa validated the system's practical relevance and impact on improving governance, trust, and efficiency in public procureme

SWAT Hydrological Modeling of Soan River

METHODOLOGY

Supervisor:: Dr Hamza Farooq Gabriel

Co-Supervisor: Dr Zafar Iqbal

Group Members

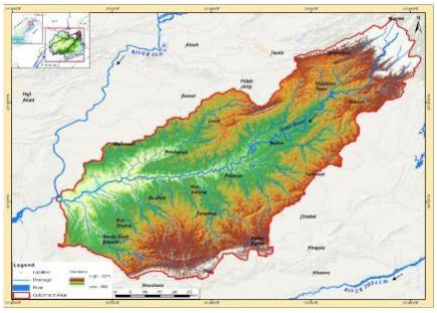
1. Razaq Ahmad Kamran
2. M. Umer
3. M. Usman Aslam
4. M. Haroon Zahid

Research Area:

Hydrological modeling, Soan River Basin, SWAT, water flow, sediment transport, land use, urbanization, runoff, watershed management.

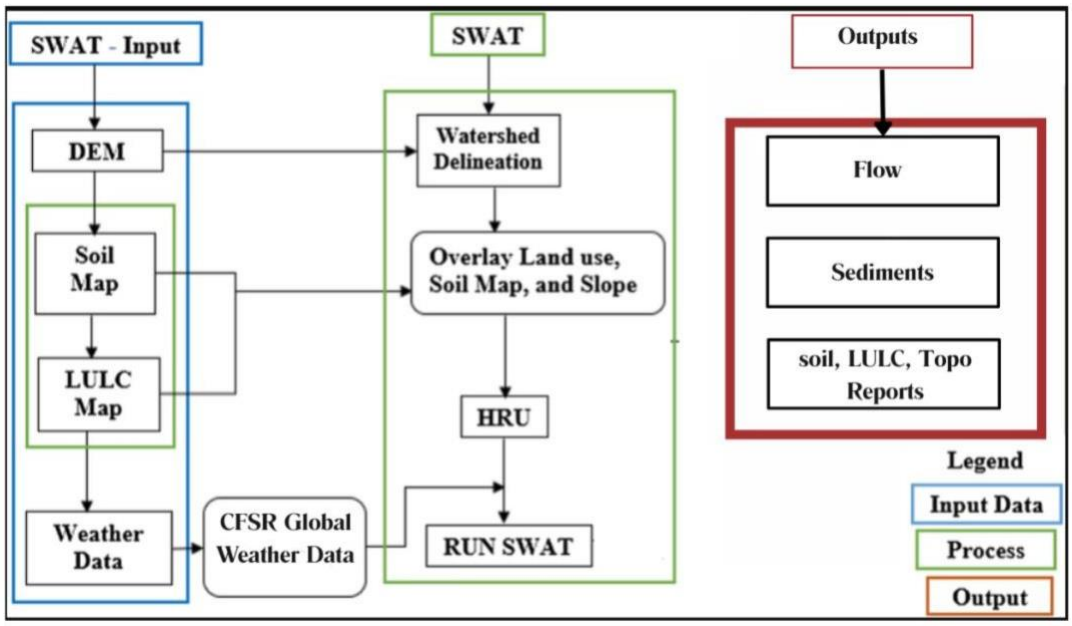
Problem Statement.

- Urbanization altering hydrological regime.
- Deforestation and land degradation impacting water flow.
- Unregulated agricultural runoff causing pollution.
- Increased flood risks, soil erosion, and water scarcity.



OBJECTIVES

- Simulate the hydrological behavior of the Soan Basin using SWAT from 2010 to 2023.
- Analyze the impacts of land use, soil, slope, and elevation on water flow.
- Evaluate surface runoff, sediment yield, and subbasin performance from 2010 to 2023.



FINDINGS

The project found an 11% increase in flow 2010 to 2023 due to urbanization and runoff, a 7.5% rise in sediment despite reduced agriculture, and increases in nitrogen (6.3%) and phosphorus (4%) from urban runoff. Soil type Be73-2c (Loam, Silt Clay Loam) impacted infiltration rates. Urban and agricultural land use contributed to higher runoff and sediment, with high-urban subbasins needing priority management.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

The project provides insights for sustainable watershed management, flood risk mitigation, and urban planning, offering valuable strategies for agriculture, construction, and environmental policy industries.

Blockchain-Based Cloud Storage System for Contract Documents

METHODOLOGY

Supervisor:

Dr. Khurram Iqbal Ahmad Khan

Group Members

1. Hamza Inayat (GL)
2. Anwaar ul Haq
3. Mohsin Mushtaq
4. Fayyaz Ahmad

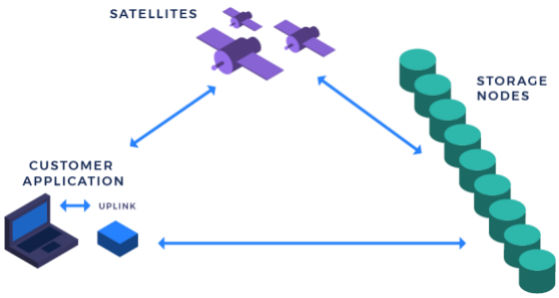
Research Area:

Decentralization, Cost economy, Sustainable infrastructure

Problem Statement.

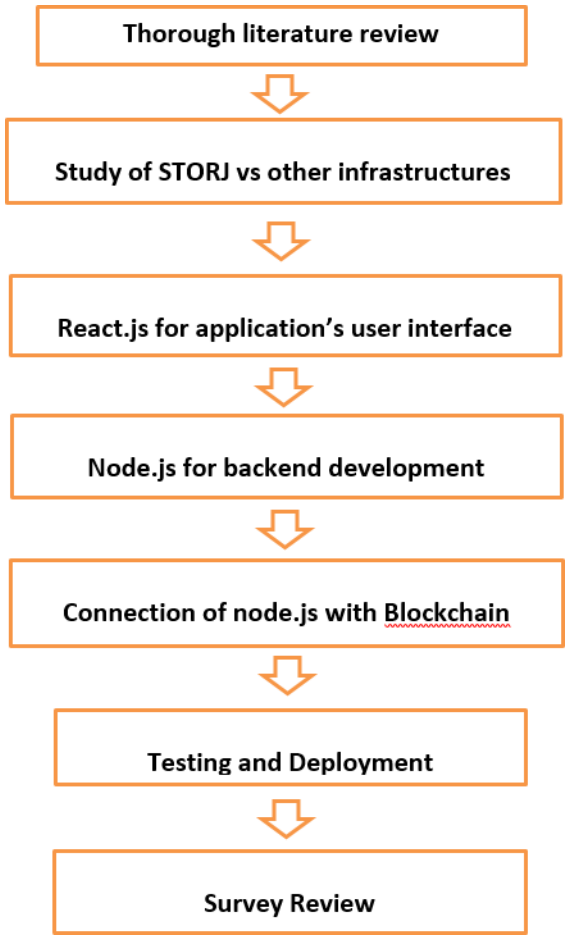
Centralized providers often have control over data management practices, which can lead to:

- Data corruption or loss due to human error,
- System failures,
- or even intentional manipulation which needs to be addressed.



OBJECTIVES

- Statistical literature review based on factor analysis.
- Development of a blockchain-backed cloud storage application.
- Develop a questionnaire to gauge market awareness of decentralized cloud storage.



FINDINGS

The prototype application **DocDepot** offers most affordable pricing as low as 0.005$ (~2.00 PKR) per contract document. Contracts are encrypted and stored on multiple nodes reducing hardware and bandwidth usage. Carbon footprint is reduced by ~80%.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Since there is no need for expensive central infrastructure, companies can save on hosting, server maintenance, and data storage fees.
- The government organizations like National Highway Authority (NHA) can ensure confidentiality of sensitive contracts, improving accountability and streamline collaboration with contractors and stakeholders.

METHODOLOGY Enhancement of Acoustic Performance of Sandwich Panels

Supervisor.: Engr. Muhammad Hamza Sabir

Co-Supervisor: Dr Junaid Ahmed

Group Members

1. Ahmed Faraz
2. Muhaddis Sultan
3. Hasnain Khan
4. M. Bilal Mirza

Research Area:

Construction Materials, Acoustics in Buildings, Green Energy, Energy Efficiency in Buildings

Problem Statement.

- Conventional concrete panels have poor sound insulation.
- Not suitable for noise-sensitive environments.
- Growing need for acoustically efficient building materials.
- **Engineering Problem**
  - Sound Proofing
- **Environmental Problem**
  - Natural Resource Depletion
  - Dumping of Waste Material

OBJECTIVES

- Sound proofing of sandwich panels
- Optimization of acoustic performance and compressive strength
- Recycling of waste materials
- Comparison of modified panels with conventional wall panels

METHODOLOGY

[1. Planning & Conceptualization]
  ├──▶ Problem Identification
  ├──▶ Objectives Definition
  └──▶ Literature Review
  ↓
[2. Materials Procurement]
  ├──▶ Crumb Rubber (CR)
  ├──▶ Bagasse Ash (SCBA)
  └──▶ Powdered Glass (GP)
  ↓

[3. Mix Design Development]
- Control Mix A: SCBA 10%, GP 20%, CR 0%
- Mix B: SCBA 10%, GP 20%, CR 20%
- Mix C: SCBA 10%, GP 20%, CR 40%
- Mix D: SCBA 10%, GP 20%, CR 60%

↓

[4. Panel Fabrication]
- Mold Design & Setup
- Casting
- Curing

↓

[5. Experimental Testing]
- Compressive Strength
- Acoustic Testing
  - Apparent Transmission Loss (ATL)
  - Apparent Sound Transmission Class (ASTC)
- Surface Density

↓

[6. Analysis & Evaluation]
- Data Comparison
- Cost-Benefit Analysis

↓

[7. Documentation & Presentation]
- Report Writing
- Final Presentation

FINDINGS

The developed concrete sandwich panels incorporating 40% rubber demonstrated effective sound insulation and adequate compressive strength for non-structural applications. Compared to conventional walls, these panels are lighter, more sustainable, and acoustically superior.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- Successfully developed sustainable concrete sandwich panels with enhanced acoustic performance.
- Identified a cost-effective, lightweight alternative to conventional brick walls and panels for non-structural applications with high level soundproofing.
- Relevant to the construction industry facing growing challenges of urban noise pollution, especially in high-rise buildings.

DEVELOPMENT OF A CONSTRUCTION PLAN LAYOUT ROBOT USING BIM INTEGRATION

Supervisor: Dr Khurram Iqbal

Co-Supervisor: Lec Abdullah Bin Ahmed

Group Members

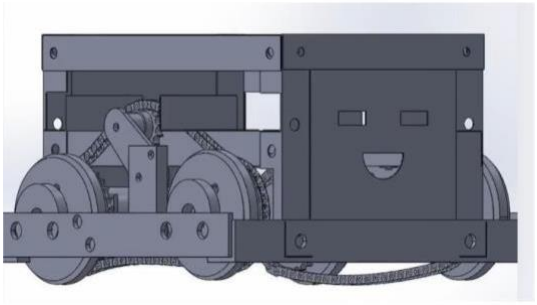
1. Haseeb Ahmad
2. M Afsar Yaqub
3. Muhammad Huzaifah
4. Haroon Rasheed

Research Area:

Construction Automation, Robotics in Construction, Digital Construction Technologies, Building Information Modeling (BIM), Industry 4.0 in Construction.

Problem Statement:

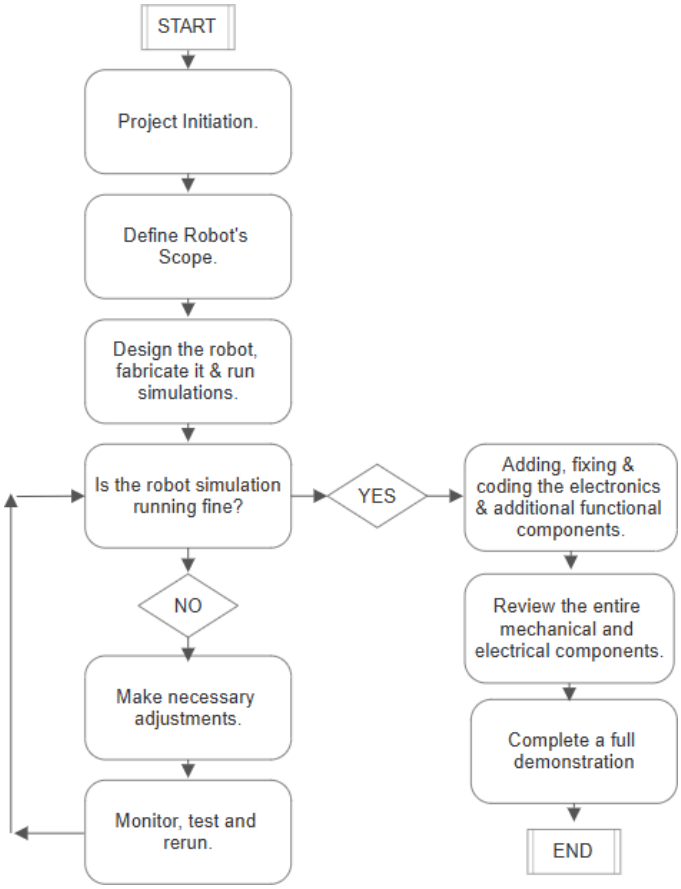
- Manual layout methods lead to errors from human judgment, environmental distractions and fatigue.
- These errors cause misalignments and deviations from design intent.
- Traditional techniques lack consistency and scalability on fast-paced sites.
- Inefficiencies impact structural accuracy and workflow, leading to additional cost of rework.



OBJECTIVES

- Minimize human errors in site layout.
- Design and fabricate a four-wheel autonomous robot to print 2D plans on-site.
- Improve speed, consistency, and labor efficiency.
- Integrate BIM by converting digital layouts into robot-executable path.

METHODOLOGY:



FINDINGS:

The robot executed the layout with considerable efficiency, printing a 184-meter perimeter in less than 30 minutes, which is an impressive improvement compared to the 1.5–2 hours it would take manually. It currently prints straight lines on smooth surfaces, but its performance can be further improved by incorporating efficient components. Cost analysis revealed that this robot can be a cost-effective alternative to traditional surveying method.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY:

This project not only proves the technical feasibility of an automated layout robot but also highlights its potential real-world application and long-term benefits to the construction industry. Professionals from industry have acknowledged the product and see its potential to reshape the construction industry. This further validates automation tools significantly enhancing productivity, accuracy and cost-efficiency on construction site.

Design of CO_2 Admixed Sustainable High-Performance Concrete

Supervisor.: Prof. Dr. Muhammad Nasir Amin

Group Members (Batch 2021)

1. Abdullah
2. Faheem Hasssan
3. Sikandar Iqbal
4. Makhdoom Zada Sameer

Research Area:

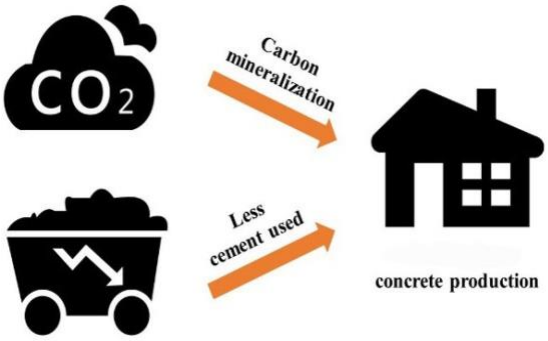
CO_2 Admixed Concrete, Sustainable Construction Materials, Carbon Footprint Reduction, Compressive Strength Enhancement

Problem Statement.

- Lack of controlled environment to inject gaseous CO_2 into concrete during mixing
- Discrepancies on increment of compressive strength of CO_2 admixed concrete

OBJECTIVES

- To reduce carbon footprint by utilizing CO_2 in concrete (GCCA,2023)



- To produce sustainable and high-performance concrete by adding dry ice (solid form of CO_2) into concrete.

SCHOOL OF CIVIL & ENVIRONMENTAL ENGINEERING (SCEE)

METHODOLOGY

1. **Material Selection**: Includes cement, water, aggregates, dry ice (CO_2), and admixtures (superplasticizer)
2. **Mix Design**: 36 samples with the same mix design ratio, including 9 samples each with 0%, 5%, 10%, and 15% CO_2 admixture
3. **CO_2 Injection**: Dry ice/gaseous CO_2 is added during mixing under controlled conditions
4. **Testing**:
    - **Micro Tests**: XRF (cement composition), XRD (mineral phases), TGA (consumption of CO_2)
    - **Macro Tests**: Compressive strength, pH measurement
5. **Analysis**: Compressive strength comparison, CO_2 emission reduction, and cost savings due to cement reduction

FINDINGS

The 28-day compressive strength of concrete with 15% CO_2 admixture increased by 22% compared to the control concrete. The pH of the concrete remained largely unaffected by the addition of dry ice. Additionally, CO_2 emissions per unit strength decreased by 18% as the dry ice content rose from 0% to 15%. This process also reduces the amount of cement required to achieve the same concrete strength.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- The research shows that CO_2-admixed concrete can enhance compressive strength, making it a stronger and more durable material
- Concrete plants can use this technology to produce more sustainable concrete by reducing cement content and minimizing CO_2 emissions
- The reduction in cement usage, while maintaining the required strength, leads to significant cost savings for concrete manufacturers

Assessing Risk Mitigation Strategies for Supply Chain Risks in Building Construction using BIM; A Case Study of NUST Medical Centre

Supervisor.: Dr. Khurram Iqbal Ahmad Khan

Co-Supervisor: Lec. Abdullah Bin Ahmed

Group Members

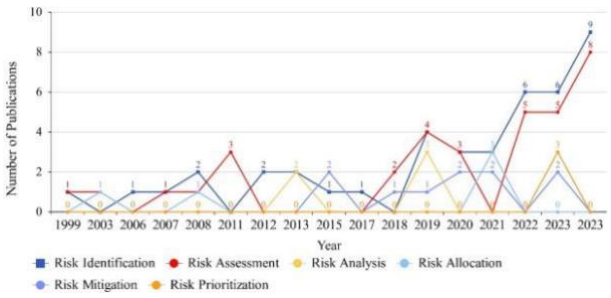
1. Waleed Bin Saqib
2. Shan ul Rehman
3. Mohibullah

Research Area:

Construction Supply Chain Risk Management, Multi Criteria Decision Making (AHP), Building Information Modelling (BIM)

Problem Statement.

- Researchers have primarily focused on risk identification and prioritization, with limited attention to the mitigation phase in Construction Supply Chain Risk Management (CSCRM).
- Most studies use single or double MCDM approaches (e.g, AHP) but fail to link mitigation strategies to overall supply chain resilience.
- There is a lack of practical integration between BIM and structured decision-making frameworks for active risk mitigation.



OBJECTIVES

- To create an AHP-based model for supply chain risk detection and mitigation in a building construction project.
- To conduct a case study of the NUST Medical Centre to evaluate BIM implementation in risk management.
- To identify and visualize effective supply chain risk mitigation strategies in building construction.

METHODOLOGY

1. • **Literature Review** – To identify existing gaps in risk mitigation within CSCRM.
2. • **Data Collection** – Surveys and expert inputs for identifying and ranking risks and strategies.
3. • **AHP Modelling** – Manual matrix input and priority scoring for risks and mitigations.
4. • **BIM Integration** – 3D modelling in Revit and development of automated inventory tracking using Dynamo.
5. • **Visualization** – Color-coded risk zones linked to BIM-based QTO.

FINDINGS

- Analysis revealed a research gap in the risk mitigation phase of CSCRM from 1999 to 2023.
- Inventory-related risks were ranked highest; BIM-based QTO emerged as the most effective mitigation strategy.
- Integration of AHP with Dynamo allowed for risk-prioritized visual tracking within the BIM environment.

PROJECT OUTCOMES/ RELEVANCE TO INDUSTRY

- The framework bridges a critical gap in CSCRM by integrating BIM for proactive risk mitigation.
- Offers an automated system for inventory monitoring, reducing human error and delays.
- Demonstrates how decision-making tools (AHP) can enhance BIM applications beyond visualization.
- Aligns with industry trends toward digital transformation and supports SDG 9 (Resilient Infrastructure).