UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Faculty of
Civil Engineering

NICHE AREA

FACULTY OF CIVIL ENGINEERING

PREFACE
DEAN

Assalamualaikum Warahmatullahi Wabarakatuh.

It is with immense pride and excitement that I present to you the new edition of the Niche Area Book, a distinguished compilation that highlights the pioneering field of the Faculty of Civil Engineering, UTM. This publication highlights our unwavering commitment to advancing the frontiers of knowledge and contributing to the betterment of society through cutting-edge research.

This edition encapsulates a diverse range of scholarly pursuits, showcasing groundbreaking research areas namely Smart and Resilient Structure, Geoengineering and Geohazard, Water Risk, Transportation Advancement and Sustainability. Each project exemplifies the ingenuity and dedication of our faculty members and researchers, addressing complex challenges with solutions that leave a positive and lasting impact on global communities.

I extend my deepest gratitude to the faculty, researchers, and students whose passion and perseverance have brought this edition to life. Your collective efforts underscore our shared vision of pushing the boundaries of Civil Engineering and exemplify the transformative power of collaboration and creativity.

As you immerse yourself in the pages of this Niche Area Book, I encourage you to draw inspiration from the visionary projects and innovative ideas presented. Together, let us continue to pioneer advancements, nurture partnerships, and create a legacy of excellence that shapes a sustainable and prosperous future for our communities and beyond.

Assoc. Prof. Dr. Suhaimi Abu Bakar
Dean
Faculty of Civil Engineering

PREFACE

DEPUTY DEAN *(RESEARCH, INNOVATION AND DEVELOPMENT)*

Alhamdulillah, I am grateful to Allah SWT that the Faculty of Civil Engineering (FKA) has successfully produced the new edition of Niche Area Book. It highlights all niche area at the faculty, representing 17 different research centers and groups. Since 2010, UTM was rewarded and established as a Research University. Research in UTM focuses on five major disciplines viz Frontier Materials, Innovative Engineering, Health and Wellness, Resource Sustainability, and Smart Digital Community. To keep up with the output demand, the task was cascaded to the Faculty of Civil Engineering to coordinate the activities.

In FKA, we focusing on five niche area namely Smart and Resilient Structure, Geoengineering and Geohazard, Water Risk, Transportation Advancement and Sustainability. By producing this niche book, more info can be disseminated to visitors, government agencies, and both public and private sectors on various research activities conducted by FKA staff. FKA welcomes cooperation with any interested parties/agencies regarding research and consultancy to work closely with our experts in various disciplines.

I want to acknowledge and extend my heartfelt appreciation to all Research Team Members and Research Centers and Groups for their involvement in producing this FKA-Niche Area book.

May this book be beneficial to the faculty and everyone else.

Prof. Ir. Ts. Dr. Ahmad Safuan A Rashid
Deputy Dean *(Research, Innovation and Development)*
Faculty of Civil Engineering

PREFACE
FKA NICHE AREA PROJECT LEADER

Assalamualaikum Warahmatullahi Wabarakatuh.

The field of Civil Engineering is continuously evolving, driven by advancements in technology, sustainability imperatives, and the pressing need for resilience in infrastructure. The Faculty of Civil Engineering at Universiti Teknologi Malaysia (UTM) has long been at the forefront of innovation, contributing significantly to research and development in various specialized areas of the discipline. This book, Niche Area - Faculty of Civil Engineering, serves as a comprehensive compilation of research initiatives undertaken by our esteemed research centers and research groups, organized under five key niche areas.

The first niche area focuses on Smart And Resilient Structure, featuring contributions from the UTM Construction Research Centre (UTM CRC), Forensic Engineering Centre (FEC), Construction Material Research Group (CMRG), Structural Assessment Forensic Engineering (SAFE), and the Reliability Engineering & Safety Assessment Research Group (RESA). These entities are dedicated to improving construction techniques, ensuring structural safety, and enhancing the durability and reliability of civil infrastructure through cutting-edge methodologies and forensic investigations.

The second niche area, Geoengineering & Geohazard, encompasses the Engineering Seismology & Earthquake Engineering Research (eSEER), Centre of Tropical Geoengineering (GEOTROPIK), and the Geotechnical Research Group (GRG). These research bodies address critical issues in geotechnical stability, seismic resilience, and earth structure sustainability, with a particular emphasis on vibration-based damage detection, seismic risk assessment, and integrated geophysical investigation techniques.

The third niche area, Water Risk, highlights research conducted by the Centre for River & Coastal Engineering (CRCE) and the Hydraulics & Hydrology Research Group (HHRG). Their work is crucial in mitigating flood risks, managing non-point source pollution, and advancing hydrological modeling for enhanced water resource management.

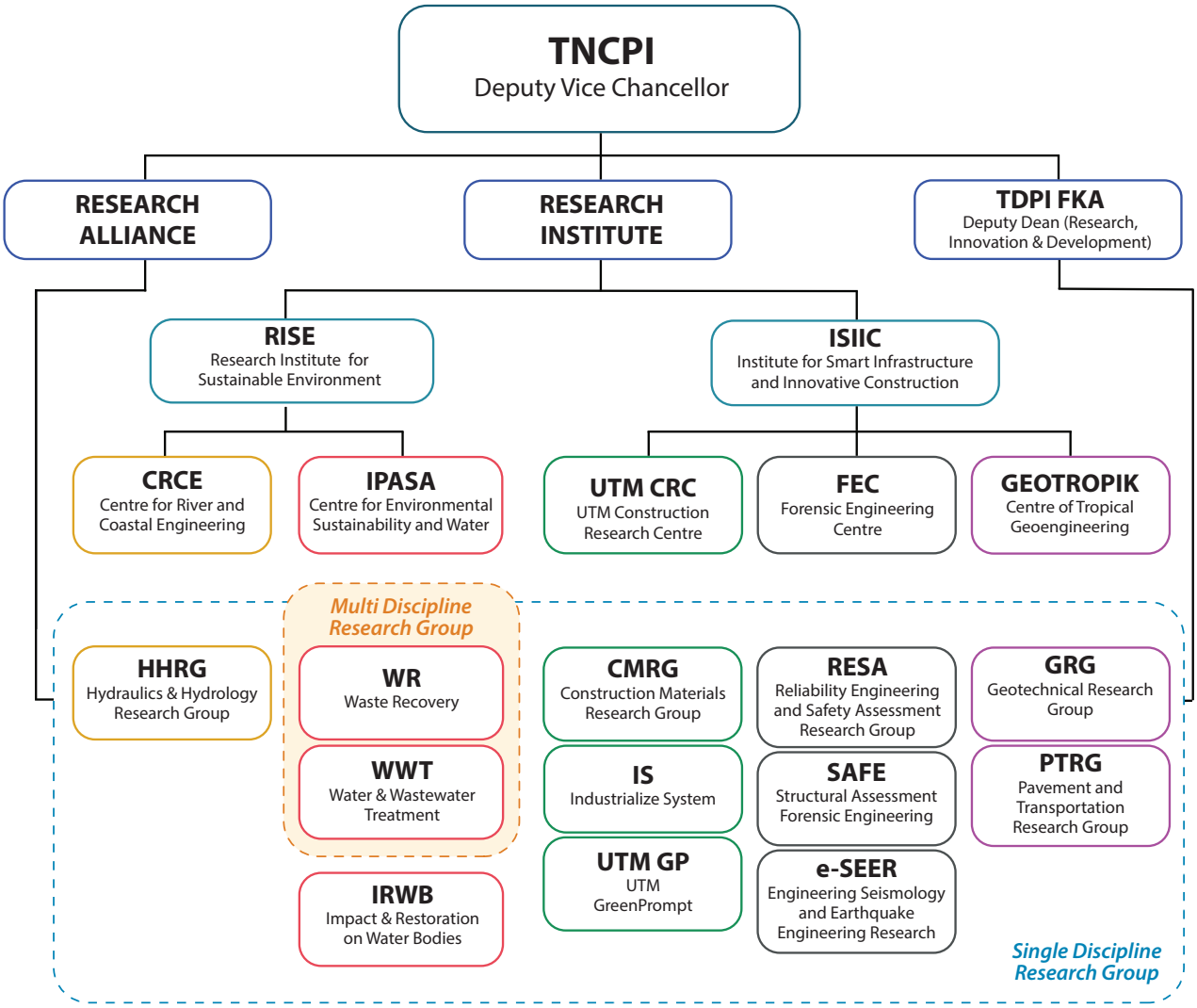
The fourth niche area, Transportation Advancement, is represented by the Pavement & Transportation Research Group (PTRG). Their research endeavors focus on sustainable road construction, transportation planning, and innovative pavement materials that enhance durability while minimizing environmental impact.

Finally, the fifth niche area, Sustainability, is championed by the Centre for Environmental Sustainability & Water Security (IPASA), the Water & Wastewater Treatment (WWT) research group, the Impact & Restoration of Water Bodies (IRWB) research group, and UTM GreenPrompt. These initiatives contribute to the development of sustainable water treatment solutions, the restoration of aquatic ecosystems, and the promotion of green infrastructure within urban landscapes.

As the editor of this book, I am proud to present the collective expertise and research achievements of our faculty members, whose dedication continues to advance civil engineering knowledge for the benefit of society. It is my hope that this book will serve as a valuable resource for researchers, practitioners, and students, inspiring further innovation and collaboration in the field of Civil Engineering.

Prof. Ir. Dr. Azlan Adnan
FKA Niche Area Project Leader
Faculty of Civil Engineering

FKA RESEARCH CENTRES & GROUPS STRUCTURE



RESEARCH TEAM

Prof. Ir. Ts. Dr. Ahmad Safuan A Rashid
Deputy Dean
(Research, Innovation and Development)

Ts. Dr. Mohd Idham Mohd Satar
Research Manager

Dr. Aidee Kamal Khamis
Research and Knowledge Manager

Mdm. Zurina Rosmani
Knowledge Management/
Research Consultation Officer

Mdm. Azura Abu Bakar
Office Secretary

TABLE OF CONTENTS

1. SMART AND RESILIENT STRUCTURE 9

1a. UTM Construction Research Centre (UTM CRC) 10

1b. Forensic Engineering Centre (FEC) 14

1c. Construction Materials Research Group (CMRG) 20

1d. Structural Assessment & Forensic Engineering (SAFE) 26

1e. Reliability Engineering & Safety Assessment Research Group (RESA) 30

2. GEOENGINEERING & GEOHAZARD 35

2a. Engineering Seismology & Earthquake Engineering Research (eSEER)

i) Seismic Risk and Monitoring of Structures in Urban Cities 36

ii) Integrated Geophysical Investigation and Seismic Fragility Analysis for Enhancing Earth Dam Resilience 40

iii) Vibration-Based Damage Detection (VBDD) for structural integrity assessment 44

2b. Centre of Tropical Geoengineering (GEOTROPIK) 48

2c. Geotechnical Research Group (GRG) 52

3. WATER RISK 59

3a. Centre for River & Coastal Engineering (CRCE) 60

3b. Hydraulics & Hydrology Research Group (HHRG) 66

4. TRANSPORTATION ADVANCEMENT 77

4a. Pavement & Transportation Research Group (PTRG) 78

5. SUSTAINABILITY 81

5a. Centre for Environmental Sustainability & Water Security (IPASA) 82

5b. Water & Wastewater Treatment (WWT) 86

5c. Impact & Restoration Water Bodies (IRWB) 90

5d. Industrialize System (IS) 96

5e. UTM GreenPrompt 100

UTM
UNIVERSITI TEKNOLOGI MALAYSIA
Faculty of Civil Engineering

1

SMART AND RESILIENT STRUCTURE

1a. UTM Construction Research Centre (UTM CRC)
1b. Forensic Engineering Centre (FEC)
1c. Construction Materials Research Group (CMRG)
1d. Structural Assessment & Forensic Engineering (SAFE)
1e. Reliability Engineering & Safety Assessment Research Group (RESA)

1. SMART AND RESILIENT STRUCTURE

1a. UTM Construction Research Centre (UTM CRC)

RG/RC Name: **UTM Construction Research Centre (UTM CRC)**

NICHE AREA:

- Construction Materials & Management

SUB NICHE:

- Concrete Technology
- Structural Steelworks
- Digital Construction & Management
- Sustainable Construction

SYNOPSIS:

About UTM CRC

Established in 2012, UTM CRC aims to stimulate and facilitate collaboration and information exchange between universities, government research institutes and organizations engaged in the building and construction sector. UTM CRC conducts advancement technological research and consultancy for organizations with particular construction concerns and specializes in research works in construction areas. The center has a number of staff in multi-disciplinary fields who are capable in conducting research & innovation, consultancy, training and teaching activities related to construction.

LEADER:

ASSOC. PROF. TS DR. ABDUL RAHMAN BIN MOHD. SAM
Email: abdrahman@utm.my
DIRECTOR

TEAM MEMBER: RESEARCH FELLOW & ASSOC.

ASSOC. PROF. IR. DR. SHEK POI NGIAN
Email: shekpoingian@utm.my

ASSOC. PROF. TS. DR. ARIZU BIN SULAIMAN
Email: arizu@utm.my

TS. DR. NOR HASANAH ABDUL SHUKOR LIM
Email: norhasanah@utm.my

DR. AIN NAADIA BINTI MAZLAN
Email: ainnaadia@utm.my

DR. SHAFIQ BIN ISHAK
Email: shafiq.ishak@utm.my

TS. DR. SUZILA BINTI MOHD
Email: suzila.mohd@utm.my

STAFF:

SITI ASMA ABD LATIF
Email:sitiasma@utm.my
RESEARCH OFFICER

MUHAMMAD FITRI RASHID
ASSISTANT ENGINEER

FATIMAH ZAHRA ZAKARIA
RESEARCH ASSISTANT

CONTACT:

Website : https://www.utm.my/utmcrc/
Facebook : https://www.facebook.com/utmcrc
Email : utmcrc@utm.my

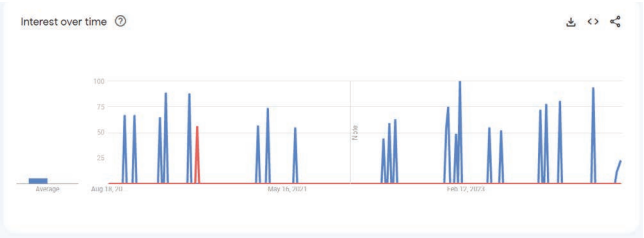
INTRODUCTION

The UTM Construction Research Centre (UTM CRC) specializes in cutting-edge research and development within the construction industry, focusing on sustainable and innovative building solutions. With a mission to drive advancements in Industrialized Building Systems (IBS) and integrated construction technologies, UTM CRC plays a crucial role in shaping the future of the built environment.

CONSTRUCTION RESEARCH CENTRE

NEEDS

The rapid urbanization and growing demand for efficient, sustainable construction solutions highlight the need for advanced building technologies. Conventional construction methods often lead to inefficiencies, increased waste, and extended project timelines. There is a pressing need for innovative solutions that can improve construction speed, quality, and sustainability.



APPLICATION & BENEFIT

UTM CRC's research is directly applicable to various sectors of the construction industry, including residential, commercial, and industrial projects. The implementation of IBS and integrated technologies leads to numerous benefits:

- Increased Efficiency: Accelerated construction timelines and reduced labor costs.
- Enhanced Quality: Standardized components result in higher quality and consistency.
- Sustainability: Reduction in construction waste and carbon footprint.
- Cost Savings: Economies of scale and reduced material wastage lower overall project costs.

POTENTIAL MARKET

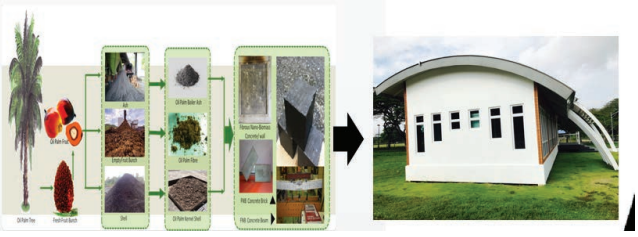
The potential market for UTM CRC's innovations is vast, encompassing both local and international construction sectors. With a growing focus on sustainability and efficiency, there is significant demand from residential developers, commercial builders, and government projects worldwide.

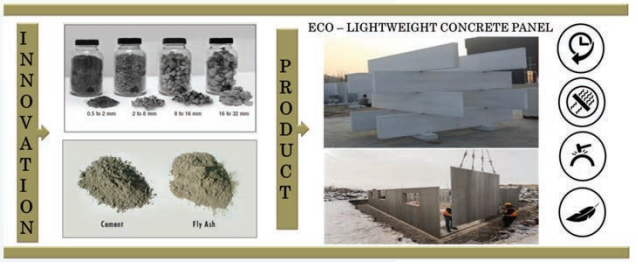
Sustainable constructon

Conventional constructon

NOVELTY

The UTM Construction Research Centre (UTM CRC) brings a fresh perspective to the construction industry by pioneering the integration of Industrialized Building Systems (IBS) with advanced technologies from Industry 4.0. This combination is a groundbreaking approach that sets UTM CRC apart in the field of construction innovation. The novelty lies in the seamless fusion of traditional construction practices with cutting-edge digital tools such as Building Information Modelling (BIM). These innovations not only enhance efficiency and accuracy but also enable sustainable construction practices. Additionally, UTM CRC's focus on environmental technology and sustainable waste materials contributes to a unique, eco-friendly approach that addresses modern construction challenges while promoting sustainability.





PRODUCT FEATURES

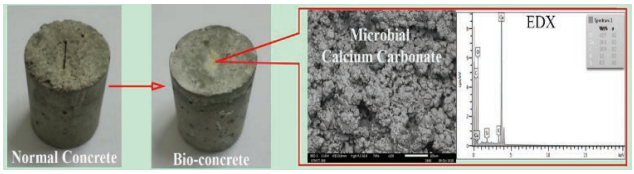
The product offerings from UTM CRC are characterized by a blend of advanced technology and sustainable construction practices. Key features include:

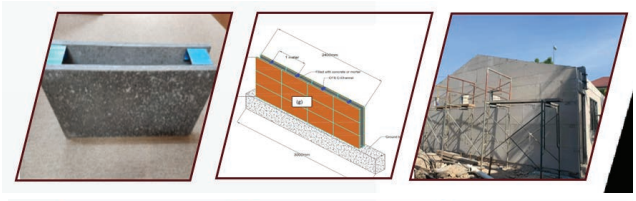
- Integrated Digital Construction Tools: Utilizing BIM and other digital platforms to enhance the design, planning, and execution phases, ensuring precision and reducing errors.

- Advanced Concrete Technology: High-strength and high-performance concrete solutions that improve durability and lifespan of structures.

- Sustainable Materials and Practices: Development and application of environmentally friendly materials such as interlocking hollow brick systems and technologies for waste material utilization, aimed at reducing the carbon footprint of construction projects.

- Customization and Flexibility: Providing tailored IBS components and systems that can be adapted to the specific requirements of different construction projects, ensuring versatility and client satisfaction.





1. SMART AND RESILIENT STRUCTURE

1b. Forensic Engineering Centre (FEC)

RG/RC Name: **Forensic Engineering Centre**

TITLE:

Forensic Engineering Solutions: Failure Investigation, Structural Assessment, Material Testing & Retrofit Services.

SYNOPSIS:

The Forensic Engineering Centre (FEC) at UTM is a leading institution specializing in forensic engineering solutions, focusing on failure investigation, structural assessment, material testing, and structural retrofit services. As Malaysia's construction and infrastructure sectors continue to expand, the FEC plays a critical role in ensuring the safety, reliability, and longevity of structures across the country. By investigating the root causes of structural failures, assessing the integrity of buildings and infrastructure, and offering material testing services, FEC supports the industry in meeting high safety and quality standards.

Additionally, FEC provides innovative retrofit solutions to strengthen aging or compromised structures, contributing to Malaysia's commitment to sustainable and resilient infrastructure. Through its consultancy, training, and professional services, FEC equips industry professionals and stakeholders with the knowledge and tools needed to prevent failures and enhance construction quality nationwide.

DIRECTOR:

ASSOC. PROF. DR. ARIZU SULAIMAN
DIRECTOR

TEAM MEMBER: RESEARCH FELLOW & ASSOC.

ASSOC. PROF. TS. DR. IZNI SYAHRIZAL IBRAHIM

ASSOC. PROF. IR. TS. DR. MA CHAU KHUN

ASSOC. PROF. IR. DR. MOHD AZREEN MOHD ARIFFIN

IR. DR. NOOR NABILAH SARBINI

DR. KHAIRUL HAZMAN PADIL

CONTACT:

Address : Forensic Engineering Centre
Level 2, Block D04
Faculty of Civil Engineering
Universiti Teknologi Malaysia
81310, Johor Bahru
Johor.
Website : https://research.utm.my/fec
Phone : 017-654 4297

INTRODUCTION

FEC aims to be a leading centre of excellence in forensic engineering, providing a comprehensive range of services and promoting research and education in this field. The centre will offer advisory and consultancy services to both public and private agencies on forensic engineering issues, while also disseminating knowledge through conferences and postgraduate academic programs.

To foster innovation and collaboration, FEC will accelerate, encourage, and enhance research programs in forensic engineering related areas, with a particular focus on failure investigation, structural assessment, and repair. Additionally, FEC will facilitate collaboration across the faculties at UTM, and relevant agencies and institutions in Malaysia, through the creation of research interests and consultancy services to the society.

To support professional development and postgraduate studies, FEC will provide facilities for strengthening training programs and courses related to forensic engineering. Finally, FEC will offer technical programs in the field of forensic engineering to meet the evolving needs of the industry and society.

NEEDS

The need for forensic engineering arises from various factors, including the desire to prevent failures, resolve legal disputes, ensure regulatory compliance, and effectively manage assets.

By identifying potential failure mechanisms and implementing preventive measures, forensic engineering can help avoid tragic incidents and protect property. In the event of property damage or loss, forensic engineering experts can provide valuable testimony and analysis to support insurance claims.

Additionally, forensic engineering can be instrumental in resolving legal disputes involving construction defects or structural failures by conducting thorough investigations and providing expert evidence. To ensure compliance with building codes and safety regulations, forensic engineering can be used to conduct structural assessments and material testing.

Finally, by proactively monitoring and maintaining the structural integrity of assets, forensic engineering can help extend their lifespan and reduce maintenance costs, leading to more efficient and cost-effective asset management.

APPLICATION & BENEFIT

Forensic engineering services are applicable to a wide range of industries, providing valuable solutions to various challenges. In the construction sector, forensic engineering can be used to investigate construction defects, assess the structural integrity of buildings, and develop retrofit solutions to improve safety and performance. For manufacturing companies, forensic engineering can help evaluate material properties and implement quality control measures to enhance product reliability. In the legal field, forensic engineering can support legal cases involving construction disputes by providing expert testimony and analysis.

Furthermore, governments can rely on forensic engineering to ensure compliance with building codes and safety regulations, protecting public safety and promoting sustainable development.

POTENTIAL MARKET

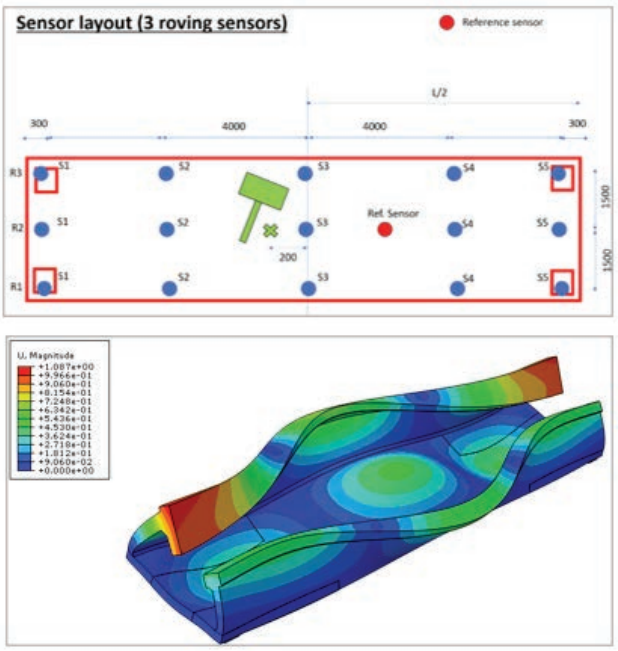
- Construction companies
- Manufacturer
- Government agencies
- Property owners and managers

NOVELTY

FEC UTM's forensic engineering services offer several unique advantages that set us apart from other providers in the Malaysia market. With a deep understanding of Malaysia's construction industry and its specific challenges, FEC can provide tailored solutions that address the unique needs of each client.

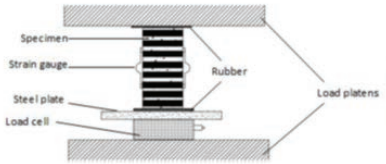
By utilizing advanced technologies and drawing on the expertise of highly qualified engineers and scientists, FEC can deliver reliable analysis. FEC's committed to offer rigorous quality control standards and transparent reporting.

By combining these elements, FEC provides an excellent level of forensic engineering services, contributing to the safety, sustainability, and success of Malaysia's construction industry.



Vibration Based Damage Detection

Steel strapping confinement (a) Steel straps; (b) Confined specimens; (c) Tensioner



Compression setup

Concrete Repair Technique using Pre-tensioned Steel Straps Confinement

PRODUCT FEATURES

FEC UTM offers a comprehensive engineering solutions, including innovative products and services that address various aspects of failure assessment, structural assessment, material testing, and structural retrofit.

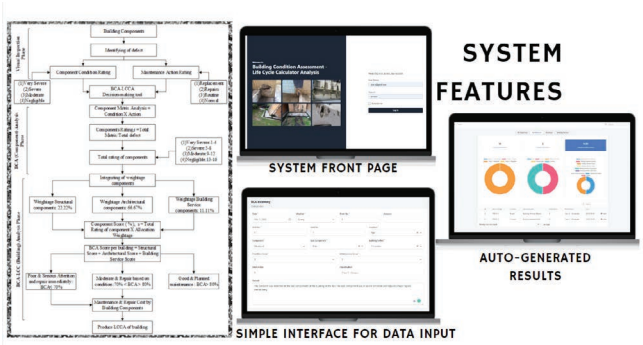
- Building Condition Assessment Online System (BCA-OS): This online platform enables efficient assessment of building conditions, providing valuable data for failure analysis and structural evaluation.

- Forensic Engineering Centre Condition Assessment (FECCA): FECCA offers expert services in forensic engineering, including detailed investigations, failure analysis, and recommendations for structural repair or retrofit.

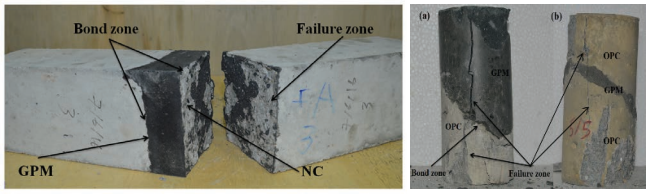
- Geopolymer Concrete/Mortar: This sustainable and durable alternative to traditional concrete/mortar provides enhanced performance and resistance to deterioration, making it suitable for various structural applications and repair projects.

- System and Method to Repair a Pre-Damaged Concrete Column: FEC has developed a specialized system and method for repairing pre-damaged concrete columns ensuring effective and long-lasting structural rehabilitation.

By combining these products and services, FEC provides an inclusive approach to addressing a wide range of forensic engineering challenges, from initial failure assessment to structural repair and retrofit.



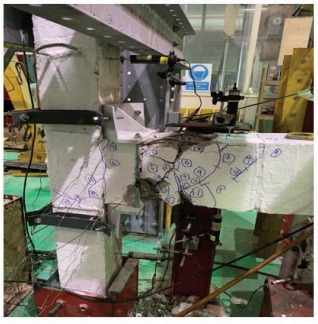
BCA-OS



Geopolymer Mortar as a repair material

a. Control

b. Large Pre-tensioned Stiffened Steel Angles



c. Large Pre-tensioned Stiffened Steel Angles

RG/RC Name: **Construction Materials Research Group**

TITLE:

Advanced Sustainable Construction Materials Towards Low Embodied Carbon and High-Performance Properties for Various Range of Applications.

SYNOPSIS:

Concrete and steel, being the most abundantly used construction material, is the focus of the Construction Materials Research Group (CMRG). Leveraging on the vast array of expertise available within CMRG; from construction technology to structural modelling; CMRG has placed itself at the cutting edge of concrete and steel material research and development. Securing of grants and signing of MoUs and MoAs, demonstrate the willingness of CMRG to work in tandem with governmental and private agencies toward achieving a common goal.

CMRG has also collaborated with multi-disciplined research groups from within and outside of UTM to ensure that problems discovered, and solutions uncovered are wide-ranging and innovative. Realizing its role as the disseminator of knowledge and utilizing its expertise, CMRG has conducted seminars and workshops at various levels. For the community at large, CMRG has engaged them by going to the ground and conducting "hands-on transfer of technology" activities, thus empowering the community through their acquired knowledge in construction material technology.

LEADER:

TS. DR. NOR HASANAH ABDUL SHUKOR LIM
HEAD OF RESEARCH GROUP

TEAM MEMBER

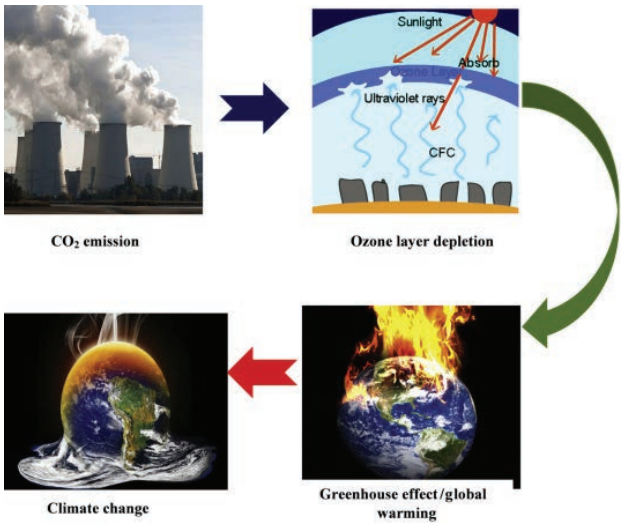
1.  **ASSOC. PROF. TS. DR. ABDUL RAHMAN MOHD SAM**
(Concrete Technology, Advanced Composite Materials)
2.  **ASSOC. PROF. DR. SUHAIMI ABU BAKAR**
(Numerical Analysis, Structural Modeling)
3.  **ASSOC. PROF. DR. ARIZU SULAIMAN**
(Structural Analysis And Design, Hot Rolled And Cold Formed Steel Structures)
4.  **ASSOC. PROF. TS. DR. TAN CHER SIANG**
(Steel & Composite Structures, Modular Construction)
5.  **ASSOC. PROF. IR. DR. SHEK POI NGIAN**
(Steel Structures, Storage Racking System)
6.  **ASSOC. PROF. DR. ROSLLI NOOR MOHAMED**
(Prestressed Concrete, Fibre Reinforced)
7.  **DR. AHMAD AZIM SHUKRI**
(Strengthening of Structures, Ultra High-Performance Concrete)
8.  **DR. SHAFIQ ISHAK**
(Low-Carbon Cement, Phase Change Materials)
9.  **DR. MOHAMAD DINIE KHALIS AWALLUDDIN**
(Bamboo, Geopolymer Concrete)
10.  **DR. NUR HAFIZAH ABD KHALID**
(Advanced Concrete & Composite Materials,Carbon Capture Utilise and Storage-CCUS)
11.  **DR. NOR FAZLIN ZAMRI**
(Composite Materials and Reinforced Concrete Design)

CONTACT:

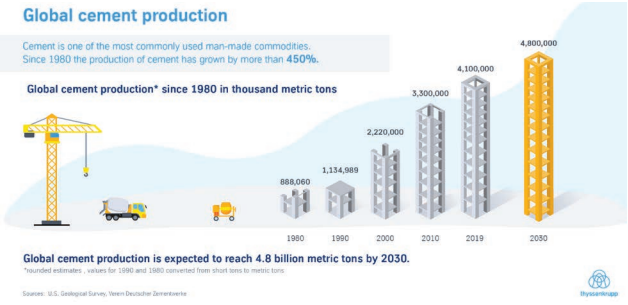
Address : D04, Structure and Material Laboratory, Faculty of Civil Engineering
Phone : +6012-7973374
Email : norhasanah@utm.my
Website : https://sites.google.com/utm.my/cmrg/home

INTRODUCTION

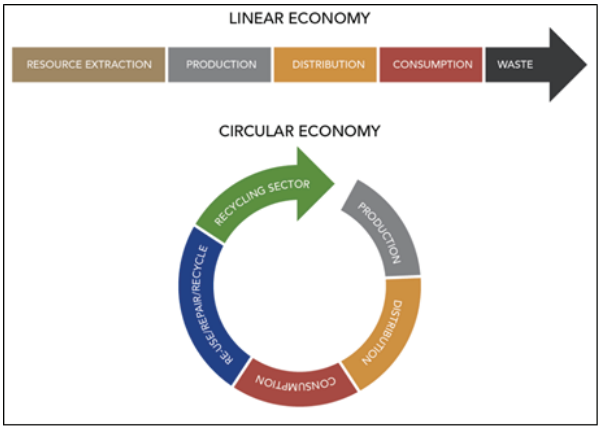
The construction industry is at a pivotal moment, facing the dual challenge of meeting global infrastructure demands while minimizing environmental impact. Traditional construction materials contribute significantly to carbon emissions and resource depletion. As the world seeks sustainable solutions, there is an urgent need for innovative materials that not only reduce the carbon footprint but also enhance the performance and durability of structures. **Advanced Sustainable Construction Materials** represent a groundbreaking development in this domain, engineered to achieve low embodied carbon and high-performance properties across a wide range of applications.



Global carbon emission



Global cement production



Steel and the circular economy

NEEDS

The construction sector is one of the largest contributors to global greenhouse gas emissions, primarily due to the extensive use of conventional materials like cement and steel, which have high embodied carbon. With increasing regulatory pressures and growing awareness of climate change, there is a critical need for materials that can reduce the carbon footprint of construction projects. Furthermore, the industry requires materials that offer superior durability, strength, and versatility to meet the demands of modern infrastructure, particularly in areas prone to extreme weather conditions and environmental stressors.

Depletion of natural resources

Deterioration of existing structures

Complex structural steelwork

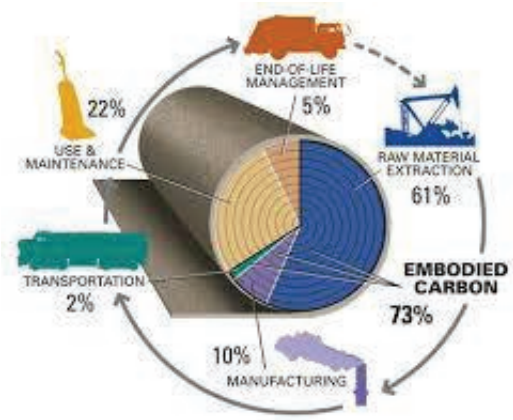
APPLICATION & BENEFIT

Applications:

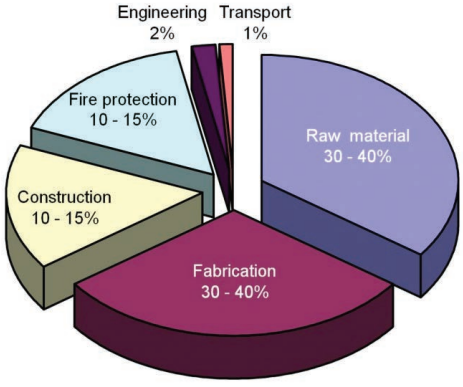
- Residential Construction
- Commercial Buildings
- Infrastructure Projects
- Industrial Facilities
- Retrofitting & Rehabilitation

Benefits:

- **Low Embodied Carbon:** Significantly reduces the carbon footprint of construction projects, contributing to global sustainability goals.
- **High-Performance Properties:** Offers superior strength, durability, and resistance to environmental stressors such as moisture, heat, and chemical exposure.
- **Energy Efficiency:** Enhances the thermal performance of buildings, leading to reduced energy consumption and lower operational costs.
- **Resource Efficiency:** Utilizes recycled and locally sourced materials, minimizing waste and reducing reliance on non-renewable resources.
- **Cost-Effective:** Lowers the long-term costs associated with maintenance and repair, providing economic benefits alongside environmental advantages.



Reduced embodied carbon



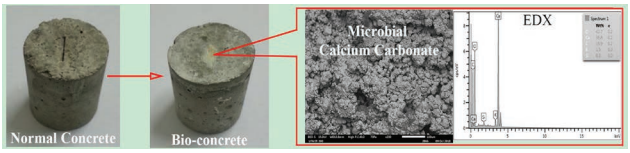
Breakdown of steel frame costs

POTENTIAL MARKET

- **Real Estate Developers:** Looking for sustainable solutions to meet regulatory requirements and market demand for eco-friendly buildings.
- **Construction Companies:** Seeking materials that offer performance benefits while reducing environmental impact.
- **Government & Municipalities:** Engaged in public infrastructure projects aiming to achieve sustainability targets.
- **Architects & Engineers:** Designing innovative structures that require advanced materials with specific performance characteristics.

NOVELTY

The novelty of Advanced Sustainable Construction Materials lies in their unique combination of low embodied carbon and enhanced performance properties. Unlike conventional materials, these advanced products are designed with a holistic approach to sustainability, incorporating waste by-products, renewable resources, and cutting-edge manufacturing processes. This innovation not only addresses the environmental challenges posed by traditional construction methods but also provides a material solution that is adaptable to various applications, from residential buildings to large-scale infrastructure projects.



PRODUCT FEATURES

- **Low Embodied Carbon:** Achieved through the use of recycled materials and innovative manufacturing techniques.
- **High Strength & Durability:** Engineered to withstand extreme conditions, including high loads, temperature fluctuations, and chemical exposure.
- **Enhanced Thermal Insulation:** Provides superior energy efficiency, contributing to lower heating and cooling costs.
- **Moisture & Chemical Resistance:** Offers protection against water ingress, corrosion, and other environmental factors that can degrade traditional materials.
- **Versatility:** Suitable for a wide range of applications, from structural components to decorative elements, ensuring broad applicability in various construction scenarios.

PRODUCT FEATURES

- **Ease of Use:** Designed for compatibility with existing construction practices, facilitating smooth integration into current projects without the need for specialized equipment or training.

1. SMART AND RESILIENT STRUCTURE

1d. Structural Assessment & Forensic Engineering (SAFE)

RG/RC Name: **Structural Assessment and Forensic Engineering (SAFE)**

TITLE:
Scalable Modular 3D Concrete Printer (PrintCrete)

SYNOPSIS:

3D Concrete Printing

- Extrude printable concrete without pumps
- Precise printer movement
- Adjustable speed
- Build-up concrete layer-by-layer
- Rapid construction without mould/formwork

Customizable design

- To be tailored to specific project needs
- Adapted for lab-scale, medium-scale, or other specialized uses

LEADER:

IR. DR. NOOR NABILAH SARBINI

TEAM MEMBER:

ASSOC. PROF. IR. TS. DR. MA CHAU KHUN

ASSOC. PROF. IR. DR. MOHD AZREEN MOHD ARRIFIN

TS. DR. CHIN CHEE LOONG

DR. KHAIRUL HAZMAN PADIL

CONTACT:

Contact Person : Assoc. Prof. Ir. Ts. Dr. Ma Chau Khun
Email : machaukhun@utm.my
Tel : 016-836 6360

INTRODUCTION

Unique customizable design

- Addresses the gap between large-scale, expensive industrial printers and smaller, less capable alternatives.
- Allow users to customize the size and specifications to meet their specific needs
- The affordable pricing for lab-scale and medium-scale usage sets it apart

NEEDS

The important customer and market value

- Affordability
- Customizability
- Ease of Use
- Efficiency and Precision
- Construction automation

APPLICATION & BENEFIT

- Automation construction
- Cost-effective and affordable alternative
- Accessibility for educational institutions
- Reachability for SMEs
- Exposure to state-of-the-art technology
- Customizability and flexibility of concrete
- Rapid process of printing
- Omit cost for formwork

POTENTIAL MARKET

- **Benefits per cost (the customer value)**
  Cost effectiveness, flexibility and accessibility

- **Market analysis**
  Target Industries:
  Contractor and developer Precast Concrete Manufacturer Research academia.

  Market Trends:
  Increasing adoption of automated construction technologies Growth in the additive manufacturing sector Rising demand for customized and complex architectural elements

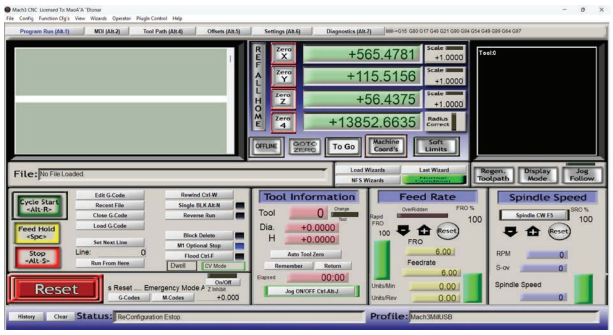
- **Marketing Strategies**
  Educational marketing, target advertising, partnership and collaborations

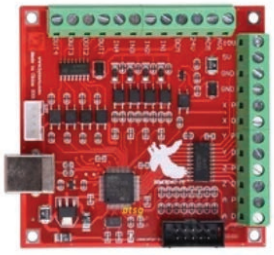
- **Potential size and value**
  Increasing growth in automated construction that complies with Industrial Revolution 4.0

NOVELTY

1) The important customer and market value
   - Affordability
   - Customizability
   - Ease of Use
   - Efficiency and Precision
   - Construction automation

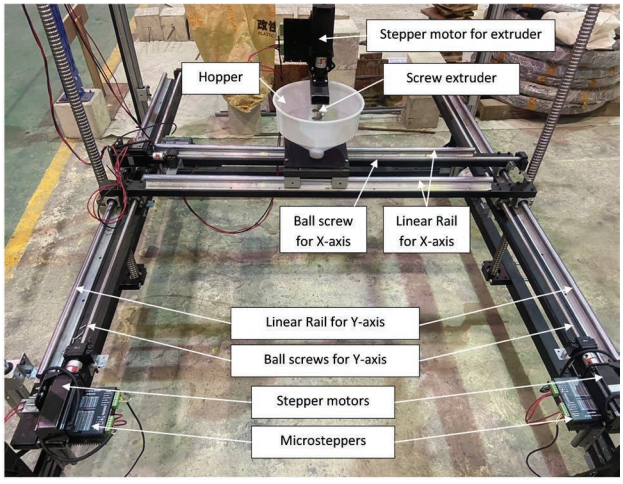
2)Potential industrial partners
   - Construction Firms
   - Research Institutions
   - Precast Concrete Manufacturers
   - Engineering and Architecture Firms
   - Construction Equipment Manufacturers





PRODUCT FEATURES

- Extrude printable concrete without pumps
- Precise printer movement
- Adjustable speed
- Build-up concrete layer-by-layer
- Rapid construction without mould/ formwork



1. SMART AND RESILIENT STRUCTURE

1e. Reliability Engineering & Safety Assessment Research Group (RESA)

RG/RC Name: **Reliability Engineering and Safety Assessment**

NICHE AREA:

- Structural Dynamic
- Pipeline Reliability
- Wave & Hydrodynamic
- Offshore Production Platform
- Risk and Value Management
- Fatigue Analysis
- Soil & Microbial Corrosion
- Meta-Material

SYNOPSIS:

RESA is a specialised research team providing analysis to address the important issue of predicting the safety and assessing the risk of failure of structures and systems from planning to post-design stage. Research interest covers a broad spectrum of Reliability engineering field focusing on the application of scientific know-how to structures and systems for a progressive and systematic risk management and failure control.

LEADER:

PROF. DR. NORHAZILAN MD NOOR

TEAM MEMBER

PROF. DR. NORDIN YAHAYA

ASSOC. PROF. IR. TS. DR. MOHD KHAIR ABU HUSAIN

ASSOC. PROF. IR. TS. DR. NOOR IRZA MOHD ZAKI

DR. MOHAMAD SHAZWAN AHMAD SHAH

DR. AIN NAADIA MAZLAN

DR. LIBRIATI ZARDASTI

TS. DR. NG CHIEW TENG

DR. SAREHATI UMAR

TS. DR. NURUL 'AZIZAH MUKHLAS MUKHLAS

DR. HANIS HAZIRAH ARIFIN

CONTACT:

Address : Faculty of Civil Engineering,
Universiti Teknologi Malaysia
81310 Johor Bahru, Johor Malaysia.
Phone : +6019-368 2493

INTRODUCTION

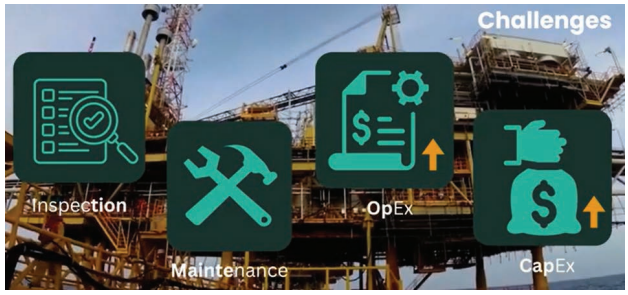
Offshore Pipeline Digital Twin for Monitoring and Assessment

An offshore pipeline digital twin is a virtual replica of a physical pipeline system, designed to enhance monitoring, assessment, and maintenance operations. It integrates real-time data from various sensors, processes it using advanced analytics, and provides valuable insights for informed decision-making.

NEEDS

Malaysia, with its extensive network of pipelines for oil, gas, and water faces several challenges:

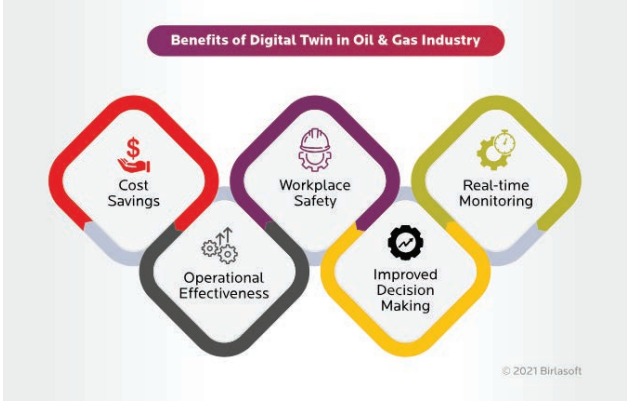
- **Aging Infrastructure:**
  Many pipelines are aging, increasing the risk of leaks, corrosion, and failures.
- **Remote and Challenging Terrain:**
  Some pipelines are located in remote or difficult-to-access areas, making traditional inspection and maintenance difficult.
- **Environmental Impact:**
  Pipeline failures can lead to environmental damage, including oil spills and water contamination.
- **Operational Efficiency:**
  Inefficient monitoring and maintenance can lead to increased downtime and operational costs.



APPLICATION & BENEFIT

Benefits of Pipeline Digital Twins

- **Enhanced Monitoring:**
  Real-time monitoring of pipeline health, pressure, flow rates, and other critical parameters.
- **Predictive Maintenance:**
  Proactive identification of potential issues before they escalate into failures.
- **Optimized Operations:**
  Improved decision-making through data-driven insights.
- **Reduced Downtime:**
  Faster response times to incidents.
- **Improved Safety:**
  Minimized risks of accidents and environmental hazards.
- **Cost Savings:**
  Reduced maintenance costs and operational expenses.



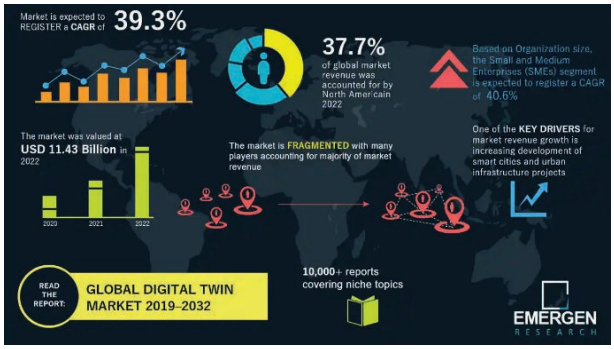
POTENTIAL MARKET

Key market segments include:

1. **Oil and Gas Industry:**
   - Upstream: Exploration and production companies can use digital twins to optimize well performance, monitor pipeline integrity, and improve safety.
   - Midstream: Pipeline operators can leverage digital twins to enhance pipeline monitoring, detect anomalies, and predict maintenance needs.
   - Downstream: Refineries and petrochemical plants can benefit from digital twins to optimize production processes, monitor equipment health, and improve safety.

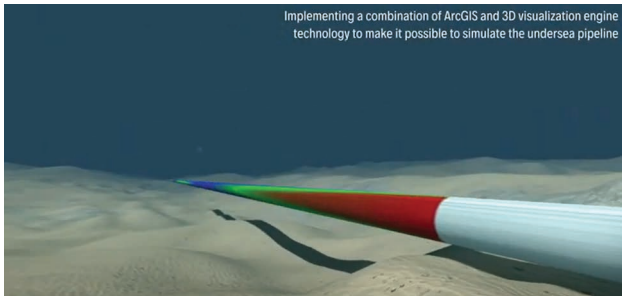
2. **Water and Wastewater Industry:**
   - Water Utilities: Water utilities can utilize digital twins to monitor water distribution networks, detect leaks, and optimize water flow.
   - Wastewater Treatment Plants: Digital twins can help optimize treatment processes, monitor equipment performance, and reduce energy consumption.

3. **Energy Industry:**
   - Power Generation: Power plants can use digital twins to monitor equipment health, optimize operations, and improve maintenance planning.
   - Power Transmission and Distribution: Utility companies can leverage digital twins to monitor power grids, detect faults, and improve reliability.



NOVELTY

Pipeline digital twins are virtual replicas of physical pipeline systems that leverage real-time data to enable comprehensive monitoring, analysis, and predictive maintenance. They are crucial for Malaysia's extensive pipeline network, addressing challenges like aging infrastructure, remote locations, and environmental concerns.

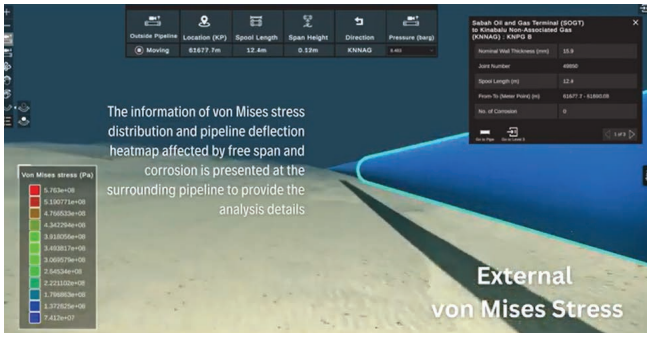


PRODUCT FEATURES

Key features include:

- Real-time monitoring and data acquisition
- Predictive maintenance
- Digital twin modelling
- Corrosion monitoring and management
- Security and cybersecurity
- Remote operations and collaboration

By leveraging these capabilities, offshore pipeline digital twins can improve operational efficiency, reduce downtime, and enhance overall safety and reliability.



UTM
UNIVERSITI TEKNOLOGI MALAYSIA
Faculty of Civil Engineering

2

GEOENGINEERING & GEOHAZARD

2a. Engineering Seismology & Earthquake Engineering Research (eSEER)
   i) Seismic Risk and Monitoring of Structures in Urban Cities
   ii) Integrated Geophysical Investigation and Seismic Fragility Analysis for Enhancing Earth Dam Resilience
   iii) Vibration-based damage detection (VBDD) for structural integrity assessment

2b. Centre of Tropical Geoengineering (GEOTROPIK)

2c. Geotechnical Research Group (GRG)

RG/RC Name: **Engineering Seismology and Earthquake Engineering Research (eSEER)**

TITLE:

Seismic Risk and Monitoring of Structures in Urban Cities.

SYNOPSIS:

Kuala Lumpur, the capital city of Malaysia, is located in a relatively low to moderate seismicity zone compared to other parts of the country. However, it is still susceptible to seismic hazards due to its proximity to active fault systems and the potential for distant earthquakes to have some impact. The local intraplate seismic was initiated from the local fault system in Peninsular Malaysia including Sabah and Sarawak. Several major fault systems in Peninsular Malaysia were mapped by the Department of Mineral and Geoscience including Bok Bak Fault, Bukit Tinggi Fault, Kuala Lumpur Fault and Mersing Fault. Shuib et al. (2017) stated that a series of high magnitude earthquakes including the 2004 Sumatra Earthquake, the 2005 Nias Earthquake and, the 2007 Bengkulu Earthquake had reactivated the local ancient fault system in Peninsular Malaysia. This is supported by the frequent event of weak earthquakes within Peninsular Malaysia from 2007 to 2010 after the huge earthquake strike the Sumatra area. The purpose of this project is to investigate and to certify the structural integrity of the buildings located in Kuala Lumpur. The study involved a series of computer simulation, to analyze and understand the behavior and performance of the buildings with the current dead loads and life loads as well as from any extreme loadings like earthquakes.

LEADER:

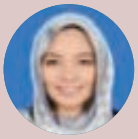
PROF. IR. DR. AZLAN ADNAN

TEAM MEMBER

PM IR. DR. NORHISHAM BAKHARY

PM TS. DR. MARIYANA AIDA AB KADIR

TS. DR. MOHD NUR ASMAWISHAM ALEL



PM TS. DR. SOPHIA C. ALIH

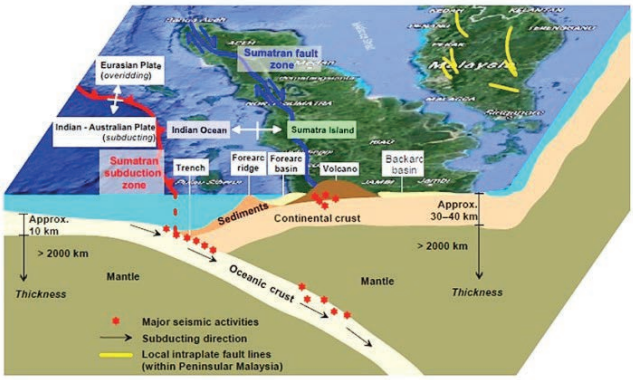
TS. DR. MOHD ZAMRI RAMLI

CONTACT:

Address : eSEER
Faculty of Civil Engineering
Universiti Teknologi Malaysia
Johor Bahru, Johor.
Phone : +6019-755 1665
Website : eseer.utm.my

INTRODUCTION

Consequently, the local intraplate seismic was initiated from the local fault system in Peninsular Malaysia including Sabah and Sarawak. Several major fault systems in Peninsular Malaysia were mapped by the Department of Mineral and Geoscience including Bok Bak Fault, Bukit Tinggi Fault, Kuala Lumpur Fault and Mersing Fault. Shuib et al. (2017) stated that a series of high magnitude earthquakes including the 2004 Sumatra Earthquake, the 2005 Nias Earthquake and, the 2007 Bengkulu Earthquake had reactivated the local ancient fault system in Peninsular Malaysia. This is supported by the frequent event of weak earthquakes within Peninsular Malaysia from 2007 to 2010 after the huge earthquake strike the Sumatra area. For Sabah area, most of the local earthquake was also associated with the active fault movement within the area which mostly concentrated at the Ranau, Lahad Datu, Sandakan and Kunak areas (Tongkul, 2020).



Subduction Zone Fault near Sumatra

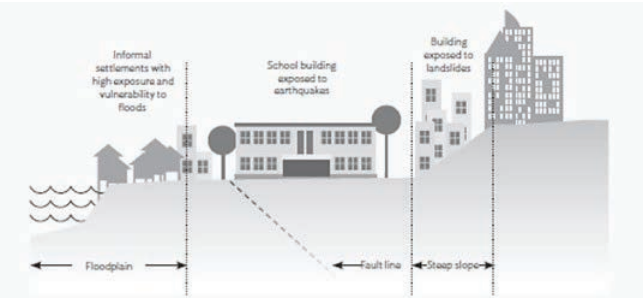
The growing development of Kuala Lumpur

NEEDS

The objectives of this project are as follow:

1. To collect the geological and seismological data from existing database and satellite information.
2. To develop detail microzonation map of Kuala Lumpur.
3. To produce microzonation map involving soil analysis.
4. To conduct rapid visual screening of buildings in Kuala Lumpur.
5. To simulate the earthquake loads for developing demand-capacity and fragility curves.
6. To establish seismic risk map of Kuala Lumpur.
7. To publish guidelines for retrofitting and rehabilitation of existing buildings.
8. Seismic Structural Health Monitoring System.

The structures and and infrastructures of the urban city of Kuala Lumpur.



The possible fault lines underlying a city.

APPLICATION & BENEFIT

After the preparation of the maps of all the risk components, including hazard, exposure, and vulnerability, we need to classify these maps based on their values, and then combine them in order to derive the final earthquake risk map. As we have mentioned before, we have considered two maps for the hazard component: surface PGA and surface rupture width. The surface rupture width map clearly includes two zones inside and outside of the rupture area, having the weights of 1 and 0, respectively. The surface PGA values are also classified into five equal classes of 0.35–0.42, 0.42–0.49, 0.49–0.56, 0.56–0.63, and 0.63–0.7 g. The value ranges are then reclassified into five classes having new values of 1, 2, 3, 4, and 5 proportional to very low, low, medium, high, and very high hazard, respectively. Then, the two classified maps are aggregated in order to prepare a unified hazard map which consists of both ground shaking (PGA) and surface rupture width. Similarly, to that applied to the surface PGA map, the exposure and total vulnerability maps are also reclassified into five classes of 1, 2, 3, 4, and 5, proportional to very low, low, medium, high, and very high exposure/vulnerability. The combination of the above risk components can be conceptually represented using a 3D computation matrix.

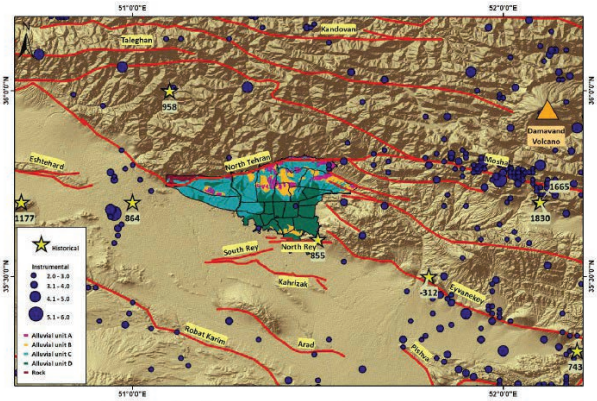


Figure 1. Active faults, historical and instrumental seismicity and alluvial deposits in and around Tehran.

Fault line maps of a city

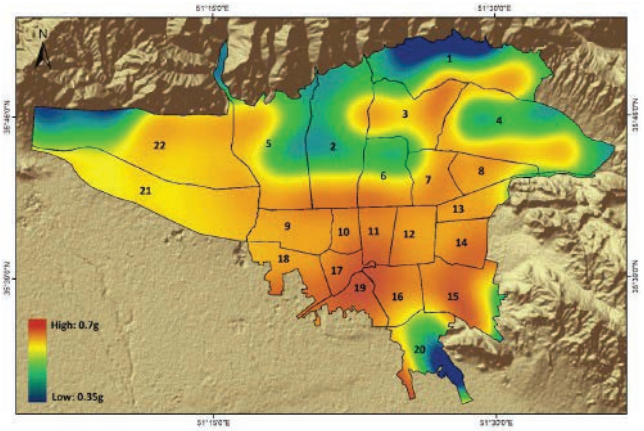


Figure 5. PGA on surface for 475-year return period.

An example of Hazard map of a city (Teheran)

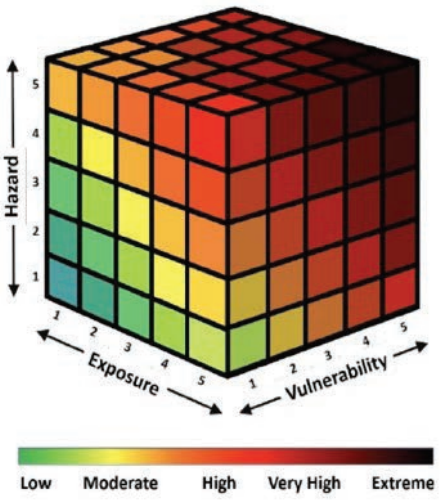
POTENTIAL MARKET

- City centers and districts
- Roads and Bridges infrastructures
- Dam Projects
- Power Plants
- Offshore Platforms

NOVELTY

- Identification of hazard, risk and monitoring system of a city.

	Hazard	Exposure	Vulnerability
1	Very Low	Very sparse	Negligible
2	Low	Sparse	Minor
3	Moderate	Moderate	Moderate
4	High	Dense	Major
5	Very High	Very dense	Catastrophic



PRODUCT FEATURES

The outcome of this study will produce:

a. Seismic microzonation map of Kuala Lumpur City
b. Seismic risk map of Kuala Lumpur City
c. Demand capacity curve for building
d. Demand fragility curve for building
e. Guideline of retrofitting and rehabilitation work for existing building
f. Seismic Structural Health Monitoring System

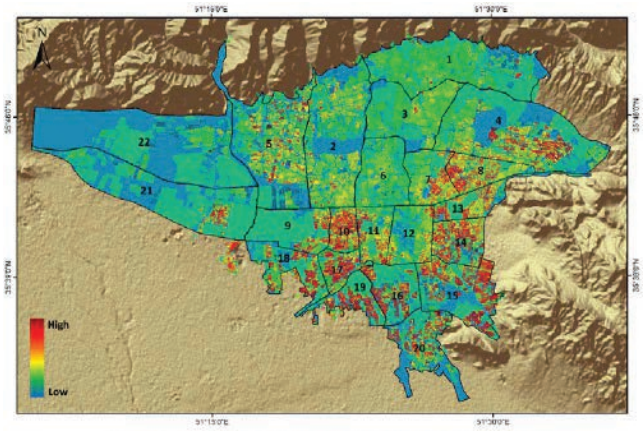


Figure 7. Human exposure (population density) map of Tehran.

Seismic Risk Map

RG/RC Name: Engineering Seismology and Earthquake Engineering Research (eSEER)

TITLE:

Integrated Geophysical Investigation and Seismic Fragility Analysis for Enhancing Earth Dam Resilience.

SYNOPSIS:

Earthquakes are unpredictable and severe geophysical hazards that pose significant risks to human-made structures like water-retaining earth dams. These dams are critical for water management and public welfare, and even minor seismic events can jeopardize their structural integrity, leading to severe consequences for the economy and human safety. Assessing the potential damage through seismic fragility curves is essential for forecasting the impact of earthquakes, particularly during severe events. This project aims to evaluate the seismic fragility of earth dams in Malaysia, a region with growing seismic risks. By utilizing advanced dynamic analysis methods such as the finite element method (FEM) and geophysical methods such as Electrical Resistivity Tomography (ERT) and Multichannel Analysis of Surface Waves (MASW), it is also will explore the vulnerabilities of earth dam structures under seismic loads. Techniques like machine learning will further aid in generating accurate seismic fragility curves. Drawing on methodologies from previous studies in structural engineering and seismic risk analysis, this research seeks to enhance the resilience of earth dams against earthquakes. The findings will contribute to better design and maintenance practices for water-retaining structures in seismically active regions, thereby improving safety and disaster preparedness.

LEADER:

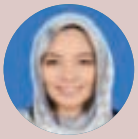
PROF. IR. DR. AZLAN ADNAN

TEAM MEMBER

PM IR. DR. NORHISHAM BAKHARY

PM TS. DR. MARIYANA AIDA AB KADIR

TS. DR. MOHD NUR ASMAWISHAM ALEL



PM TS. DR. SOPHIA C. ALIH

TS. DR. MOHD ZAMRI RAMLI

CONTACT:

Address : eSEER
Faculty of Civil Engineering
Universiti Teknologi Malaysia
Johor Bahru, Johor.
Phone : +6010-900 0250
Website : eseer.utm.my

INTRODUCTION

Earthquakes are among the most unpredictable and destructive geophysical hazards, posing significant threats to human-made structures such as waterretaining earth dams. These dams are crucial not only for water management but also for the welfare of populations and economic stability. Even minor seismic events can compromise their integrity, leading to catastrophic failures with severe repercussions. Predicting potential damage through seismic fragility assessment is therefore vital for mitigating risks and enhancing dam resilience. This research focuses on assessing the seismic fragility of earth dams in Malaysia, a region experiencing increasing seismic activity. By employing advanced dynamic analysis techniques, including the Finite Element Method (FEM) and Multichannel Analysis of Surface Waves (MASW), alongside geophysical methods like Electrical Resistivity Tomography (ERT), the study aims to develop accurate fragility curves tailored to Malaysia's specific geological and structural conditions. The outcomes will inform improved design, maintenance, and emergency response strategies, ensuring the safety and sustainability of critical water infrastructure in seismically active areas.

Earth Dams in Malaysia

NEEDS

The objectives of this project are as follow:

i. To integrate geophysical methods such as Electrical Resistivity Tomography (ERT) and Multichannel Analysis of Surface Waves (MASW) for evaluating the seismic fragility of earth dams in Malaysia.
ii. To conduct dynamic analysis using the Finite Element Method (FEM) and Limit Equilibrium Method (LEM) to assess the seismic vulnerability of earth dams under varying conditions.
iii. To perform a comparative analysis of different methodologies, incorporating innovative approaches to assess the vulnerability of earth dams specific to Malaysia.
iv. To develop dam-specific seismic fragility curves for Malaysia through probabilistic seismic risk modeling, quantifying potential damage under varying seismic intensities.

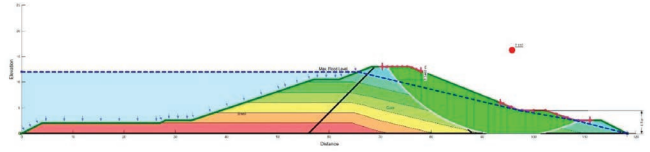


Illustration of slope stability analysis

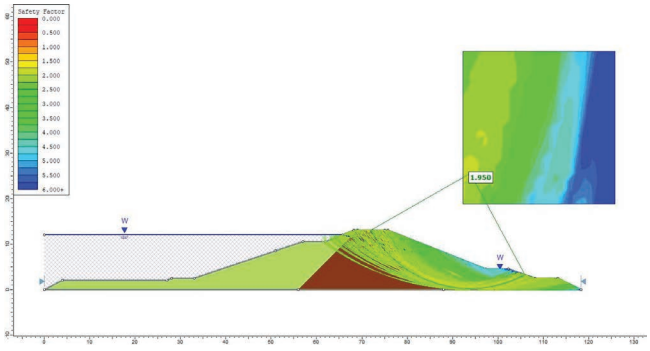
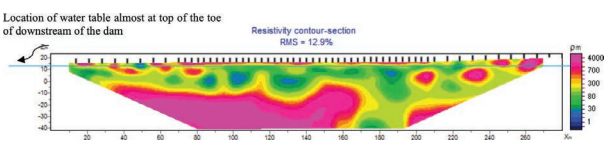


Illustration of slope stability analysis under seismic effect



Downstream slope inferred from the ERT survey and field data.

APPLICATION & BENEFIT

The application of this project lies in enhancing the seismic resilience of earth dams through the development of specialized seismic fragility curves and the use of advanced dynamic analysis techniques. By integrating geophysical methods like Electrical Resistivity Tomography (ERT) and Multichannel Analysis of Surface Waves (MASW), this research offers a practical and efficient approach for assessing seismic hazards in water-retaining structures. The findings from this project, including the creation of seismic fragility curves, will enable dam engineers and decision-makers to evaluate the likelihood of dam failure under varying seismic intensities. These results can guide the design, retrofitting, and emergency planning for dams, ensuring better performance during earthquakes.

The benefits of this project extend beyond seismic risk management for dams in Malaysia. It provides a benchmark for future studies, both in Malaysia and globally, especially in other regions with similar seismic vulnerabilities. By incorporating probabilistic risk assessment and sensitivity analysis, this study not only enhances dam safety but also contributes to more informed decision-making in water management and disaster preparedness. The methods developed in this research can be applied to other critical infrastructures, ensuring the long-term safety and operational stability of water resources in seismic-prone areas.

Geophysical Data Logger

Electrical Resistivity Tomography (ERT)

Multichannel Analysis of Surface Waves (MASW)

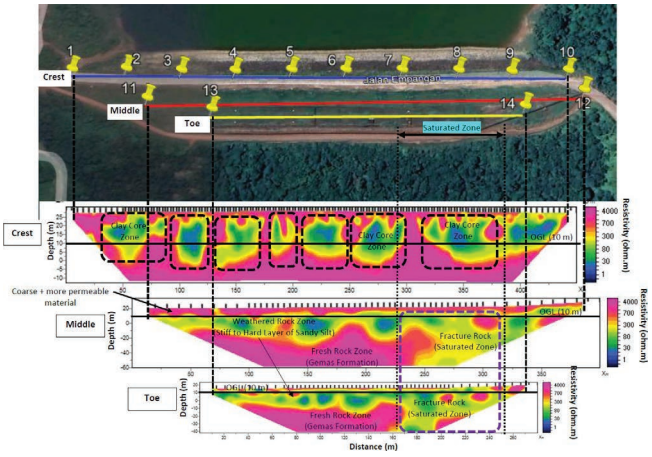
POTENTIAL MARKET

- Ministry of Water, Land and Natural Resources
- Department of Irrigation and Drainage (DID)
- National Disaster Management Agency (NADMA)
- Engineering and Consulting Firms
- Construction and Dam Management Companies
- Insurance and Risk Assessment Firms
- Academic and Research Institutions

Batu Dam (Empangan Batu), Selangor

NOVELTY

- Integrating ERT and MASW techniques with dynamic analysis to develop dam-specific seismic fragility curves.

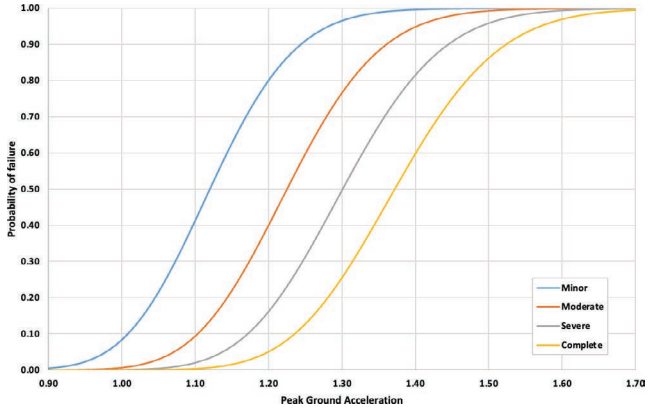


The electrical resistivity tomography (ERT) at project area.

POTENTIAL MARKET

The outcome of this study will produce:

1. **Seismic Fragility Curves:**
   Customized curves for dam-specific seismic vulnerability assessment.
2. **Geophysical Data Integration:**
   ERT and MASW combined for advanced dam seismic evaluation.
3. **Dynamic Response Analysis:**
   FEM-based dam behavior predictions under varying seismic intensities.
4. **Probabilistic Risk Modelling:**
   Monte Carlo simulations to quantify seismic failure probabilities.
5. **Incremental Dynamic Analysis:**
   IDA techniques to assess dam stability during earthquakes.
6. **Seismic Retrofit Recommendations:**
   Guidelines for improving dam safety through design and retrofitting.



Seismic fragility curve for earth dam based on Monte Carlo analysis.

RG/RC Name: Engineering Seismology and Earthquake Engineering Research (eSEER)

TITLE:

Vibration-Based Damage Detection (VBDD) for structural integrity assessment

SYNOPSIS:

Vibration-Based Damage Detection is an advanced, non-destructive technique used for assessing the structural integrity of critical infrastructures like bridges, buildings, and mechanical systems. The approach relies on monitoring changes in a structure's dynamic properties, including natural frequencies, mode shapes, and damping ratios, which are influenced by its material and geometric characteristics. When damage occurs-such as cracks, joint loosening, or material degradation-these properties shift, altering the structure's vibration response. By comparing current vibration data to baseline measurements from a healthy state, engineers can identify, locate, and assess the severity of damage without requiring direct access to the damaged areas.

This method is particularly effective in detecting subtle damage, especially in structures exposed to cyclic loading or harsh environmental conditions. The ability to monitor continuously and in real-time makes vibration-based damage detection a valuable tool for early warning systems, preventing catastrophic failures by allowing for timely maintenance or repair. It is also cost-effective and minimizes downtime since it avoids the need for invasive inspections. Various algorithms and signal-processing techniques, such as frequency-domain analysis, modal analysis, and wavelet transforms, enhance the precision and reliability of this method, making it a crucial component of modern structural health monitoring and asset management programs.

LEADER:

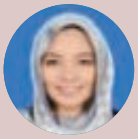
PROF. IR. DR. AZLAN ADNAN

TEAM MEMBER

PM IR. DR. NORHISHAM BAKHARY

PM TS. DR. MARIYANA AIDA AB KADIR

TS. DR. MOHD NUR ASMAWISHAM ALEL



PM TS. DR. SOPHIA C. ALIH

TS. DR. MOHD ZAMRI RAMLI

CONTACT:

Address : eSEER
Faculty of Civil Engineering
Universiti Teknologi Malaysia
Johor Bahru, Johor.
Phone : +6019-755 1665
Website : eseer.utm.my

INTRODUCTION

Traditional structural integrity assessment methods, such as visual inspections, ultrasonic testing, or X-ray imaging, have limitations in detecting hidden or subtle damage, particularly in large or complex structures.

These techniques often require direct access to critical areas, which can be time-consuming, costly, and may involve significant downtime. Additionally, their periodic nature limits the ability to detect damage early. Vibration- based damage detection overcomes these limitations by continuously monitoring changes in a structure's dynamic properties, offering real-time data. It is more reliable in detecting subtle or hard-to-reach damage, ensuring earlier intervention without disrupting operations and reducing the risk of catastrophic failure

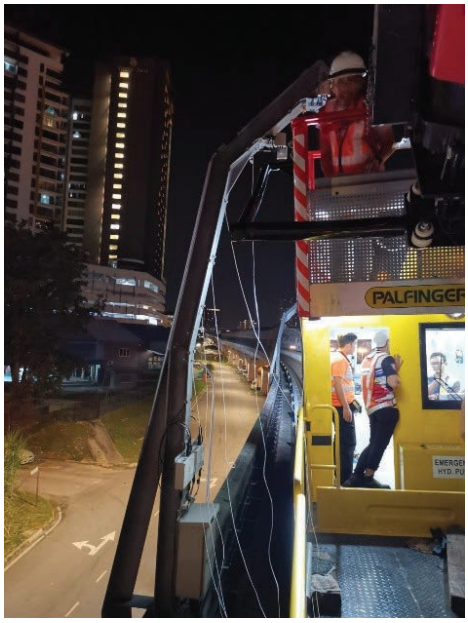
Batu Dam (Empangan Batu), Selangor

Vibration-based damage detection in practice

NEEDS

This method is important to overcome the limitation of traditional structural assessment as below:

- **Limited access in traditional methods:** Traditional inspections often require physical access to critical areas, which can be time-consuming and difficult in complex structures.
- **Early damage detection:** Periodic inspections may miss early-stage damage, increasing the risk of sudden failure. Vibration-based methods enable continuous monitoring for early detection.
- **Cost and downtime:** Traditional techniques often involve expensive equipment and operational shutdowns. Vibration-based systems minimize downtime and reduce inspection costs.



Assessment of train facilities for MRT line 1 using VBDD

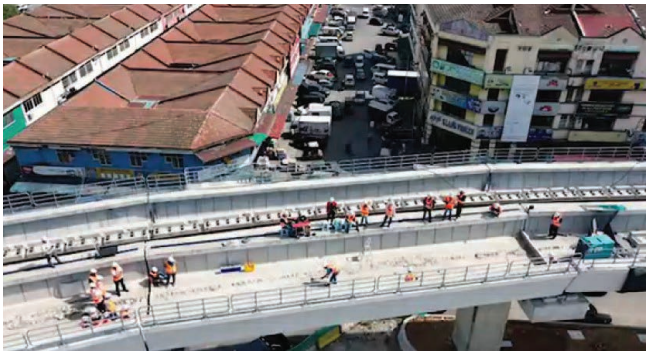
- **Hidden or subtle damage:** Some damage, like internal cracks, can be missed by visual or other conventional methods. Vibration-based detection is more sensitive to these hidden defects.
- **Reliability:** Continuous monitoring ensures higher reliability and timely intervention, reducing the chances of catastrophic failure.

Sensor placement for VBDD

APPLICATION & BENEFIT

Vibration-based damage detection is widely applied in public facilities to ensure the safety and longevity of critical infrastructure. Key applications include:

- **Bridges:** Continuous vibration monitoring detects early-stage cracks, joint deterioration, or structural weakening, preventing catastrophic collapses and ensuring public safety.
- **Buildings:** In high-rise structures, this method monitors vibrations caused by environmental factors like wind or seismic activity, helping to identify potential damage in real-time.
- **Railway Systems:** Monitoring rail tracks and bridges for vibration anomalies helps identify structural defects, ensuring smooth operations and reducing maintenance costs.
- **Dams and Water Infrastructure:** Vibration-based monitoring detects cracks or material fatigue, helping prevent leaks or failures in essential public facilities.



The application of VBDD at LRT3 project.

PRODUCT FEATURES

An example of a product utilizing vibration-based damage detection is Siemens' Siplus CMS1200 Condition Monitoring System. This system continuously monitors the vibration and dynamic properties of machinery and structures, detecting early signs of wear, cracks, or other damage. Key features include:

- Real-time data analysis: It continuously monitors critical infrastructure like turbines, bridges, or industrial machinery to detect any abnormal vibrations.
- Early warning system: It provides alerts for preventive maintenance, reducing the risk of catastrophic failure.
- Remote monitoring: The system allows for automated, remote monitoring, minimizing the need for manual inspections and reducing downtime.

This product showcases the practical application of vibration-based damage detection in industries such as energy, transportation, and civil engineering.

The application of VBDD to assess the integrity of traveller foam for bridge construction.

RG/RC Name: **Centre of Tropical Geoengineering (GEOTROPIK)**

TITLE:
Centre of Tropical Geoengineering (GEOTROPIK)

NICHE AREA:
Tropical Geoengineering

SYNOPSIS:
Inspired by the challenges on complex issues of Geoengineering related to tropical climate, GEOTROPIK was established in 2016. GEOTROPIK is envisioned as a dynamic multidisciplinary field of geoengineering to face problems of practical importance for both industries and government agencies. The main objectives of the establishment of GEOTROPIK are to provide sustainable services to related industries and community in relations with tropical geoengineering, to deliver an intellectual discourse or training in tropical geoengineering field and to become an outstanding consultant centre. Our mission is to establish GEOTROPIK as the world academic service centre in tropical geoengineering field while our vision is to become the leader in tropical geoengineering.

LEADER:

DR. DAYANG ZULAIKA ABANG HASBOLLAH
DIRECTOR
Expertise : Geology, Sedimentology, Carbon Sequestration

TEAM MEMBER

PROF. TS. DR.
EDY TONNIZAM MOHAMAD
Geology, Tropical Rock Engineering, Excavation, Quarrying and Rock Blasting, and Geoenvironment

ASSOC. PROF. SR. DR.
TAJUL ARIFFIN MUSA
Geoinformation, GPS/GNSS network-based positioning and atmospheric study

PROF. IR. DR. AZMAN KASSIM
Slope Engineering, Unsaturated Soil Mechanics, Soil Properties

PROF. IR. TS. DR.
AHMAD SAFUAN A RASHID
Geotechnical and Ground Improvement

PROF. DR. MOHD ROSLI HAININ
Pavement Materials, Design, Construction and Rehabilitation

DR. WAN ANOM WAN ARIS
Geoinformation, GPS/GNSS network-based positioning

TS. DR. BAKHTIAR AFFANDY OTHMAN
Soil Stabilization, Plaxis, Geotechnical Engineering, Liquefaction, Ground Improvement

CONTACT:

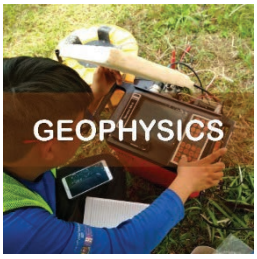
Address	:	Block D03, Level 2, Faculty of Civil Engineering Universiti Teknologi Malaysia 81310 UTM Johor Bahru, Johor.
Email	:	geotropik@utm.my
Phone	:	+607-553 1766 (Office)
	:	011-6349 3588 (Director)
Website	:	www.utm.my/geotropik
Facebook	:	https://www.facebook.com/Geotropik1/

INTRODUCTION

As a service-based research centre, GEOTROPIK provides research, testing, training and consultation services related to geotechnics, tropical soil, rock & subsurface interaction, soil remediation & restoration, groundwater & geoenvironment, geomatics & geospatial information system (GIS), quarrying and mining, sustainability, computational geoengineering and highway pavement. We channelled academic knowledge and engaged with industry experts and government agencies in addressing tropical geoengineering issues for the benefit of the community.

GEOTROPIK has an outstanding research facilities, dedicated technical and administrative staffs and fellows expert in Geotechnics, Geology, Geohazard, Groundwater, Geoenvironment, Geomatics, Geospatial Information System, Geophysics, Instrumentation & Monitoring and Computational Geoengineering, which will promote internal and external networking and coordination, with sharing of resources and knowledge.

• Research • Consulting • Advisory
• Testing • Training • Knowledge Sharing



NEEDS

The needs to establish GEOTROPIK is inspired by the challenges on complex issues of Geoengineering related to tropical climate. GEOTROPIK provides sustainable services to related industries and community in relations with tropical geoengineering.

Improvement of earthworks standard specification

Landslide risk mitigation

Natural disasters

APPLICATION & BENEFIT

One of GEOTROPIK's flagship projects is the exploration of the rock aquifer at UTM, which plays a key role in developing an alternative source of clean water for the university. This initiative will not only benefit the university community but also generate a new revenue stream for the institution.

UTM temui punca air bawah tanah

Omar Ahmad - Mac 31, 2021 @ 6:02pm
bhnews@bh.com.my

Pengarah Pusat Geokejuruteraan Tropika (Geotropik) Universiti Teknologi Malaysia (UTM), Prof Dr Edy Tonnizam Mohamad (kiri) menerangkan projek kepada Naib Canselor UTM, Prof Datuk Dr Ahmad Fauzi Ismail (dua kiri) semasa sesi lawatan beliau ke tapak projek penerokaan telaga air di Hutan Rekreasi UTM. - Foto UTM

JOHOR BAHRU: Universiti Teknologi Malaysia (UTM) berjaya menemui punca air bawah tanah atau 'akuifer' dalam kawasan hutan rekreasi di kawasan universiti itu, di sini.

Pengarah Pusat Geokejuruteraan Tropika (Geotropik) UTM, Prof Dr Edy Tonnizam Mohamad berkata, sumber air itu adalah berkualiti tinggi yang sesuai dijadikan bahan minuman.

POTENTIAL MARKET

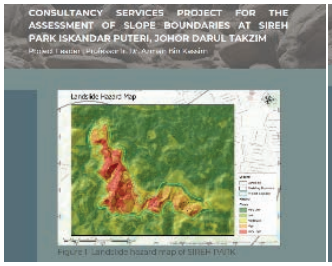
GEOTROPIK has collaborated and provide services to various industrial players, government agencies, academic institutions and professional bodies in addressing complex issues in tropical geoengineering.

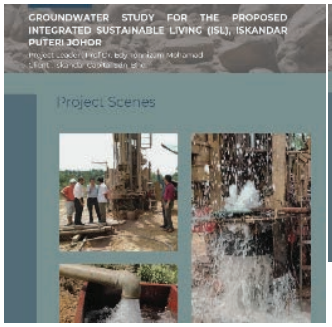
Trans Pacific Textile

NOVELTY

GEOTROPIK serves as the leading reference center for tropical geoengineering.

With a team of experts from diverse academic disciplines specializing in tropical geoengineering, GEOTROPIK is able to deliver customized solutions that effectively address the specific needs of each client.





PRODUCT FEATURES

GEOTROPIK provides innovative engineering solutions through research and consultation services. Apart from that, GEOTROPIK also committed in channelling academic knowledge to the community by organizing various knowledge-sharing events.

2. GEOENGINEERING & GEOHAZARD

2c. Geotechnical Research Group (GRG)

RG/RC Name: **Geotechnical Research Group (GRG)**

NICHE AREA:

- Geoengineering and Geohazard

SUB NICHE:

- Soil and Rock Laboratory and On-Site Testing
- Instrumentation & Monitoring
- Geophysical Survey
- Surveying and Mapping
- Advanced Soil & Rock Mechanics Investigation and Modelling

SYNOPSIS:

About GRG

Geotechnical Research Group (GRG) comprises esteemed academicians who offer expert solutions for intricate challenges in Geotechnical and Geological Engineering, Rock Engineering, Photogrammetry, and Surveying. We provide services as consultants and research partners, where GRG bridges academia and industry, aiding government agencies and entrepreneurs. Additionally, we support practitioners aspiring for advanced degrees.

LEADER:

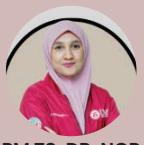
PM IR DR RINI ASNIDA

TEAM MEMBER

PROF. IR. DR. AZMAN

PROF. TS. DR. NAZRI

PROF. PGEOL DR. EDY TONNIZAM



PM TS. DR. NOR ZURAIRAHETTY

PROF IR. DR. AHMAD SAFUAN

SR TS. DR. RADZUAN

TS. DR. MOHD NUR ASMAWISHAM

DR. SITI NORAFIDA

DR. DAYANG ZULAIKA

DR. KHAIRUN NISSA

PGEOL DR. AFIKAH

DR. MUHAMMAD IRFAN

DR. MUHAMMAD FARHAN

DR. AHMAD RAZALI

DR. BAKHTIAR AFFANDY

DR. KASBI BASRI

CONTACT:

Email : grg.civilmy
Website : https://www.utm.my/grg/
Facebook : https://www.facebook.com/grgutm

INTRODUCTION

GRG specializes in geoengineering and geohazard by providing solution in the interest such as developing the rainfall threshold contributing to slope instability in tropical soil. With a mission to drive the solution to the geohazard by implementing the geoengineering cutting edge research and consultation development, GRG plays a crucial role in shaping the future of safer geoengineering national and internationally.

NEEDS

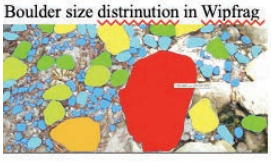
The GRG UTM, help in improving the infrastructure by enhancing safety, reducing costs, advancing sustainable practices, driving innovation, and supporting disaster resilience. It fosters collaboration and helps shape industry standards and policies.

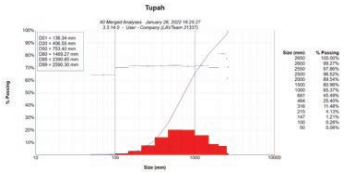
APPLICATION & BENEFIT

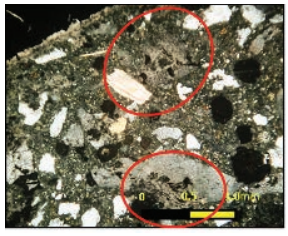
The Geotechnical Research Group offers a wide array of benefits, particularly to the fields of civil engineering, construction, environmental science, and infrastructure development. Here are some of the key benefits:

1. Advancement of Knowledge and Technology

- Innovative Solutions: Our group pushes the boundaries of current geotechnical knowledge, leading to the development of new materials, techniques, and methodologies that can enhance the safety, efficiency, and sustainability of civil engineering projects.
- Risk Mitigation: By identifying potential geotechnical hazards early in the design process, our group helps develop the rainfall threshold level for which may arise from climate change or unforeseen site challenges.
- Understanding Ground Behavior: By studying the behavior of soils and rocks under various conditions, our group helps improve our understanding of foundational issues like settlement, shear strength, and compaction, which are critical for designing stable structures.







2. Improved Infrastructure Design and Safety

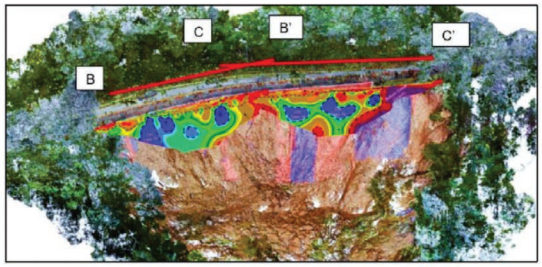
- Robust Site Characterization: GRG enhances the methods used to assess the physical properties of soil and rock at construction sites. This leads to more accurate design decisions for foundations, slopes, embankments, tunnels, and other civil structures, thereby reducing risks related to settlement, liquefaction, or soil instability.
- Seismic Risk Reduction: Research into soil behavior during earthquakes or other dynamic forces can help design structures that are more resilient to seismic activity, potentially saving lives and reducing economic losses in earthquake-prone areas.

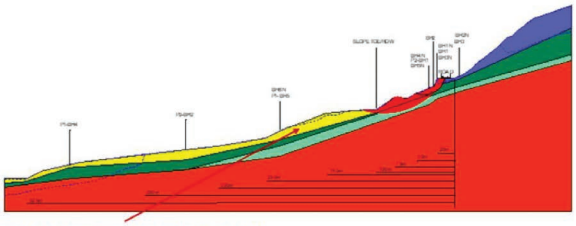
3. Training and Skill Development

- Academic and Professional Growth: Geotechnical research groups provide a platform for students, academics, and professionals to expand their expertise. They often collaborate with industry stakeholders, thus fostering a culture of learning and innovation.
- Collaboration: Research groups create opportunities for collaboration among geotechnical engineers, environmental scientists, policy makers, and local governments, improving the overall quality of civil infrastructure projects.

4. Response to Natural Disasters

- Disaster Preparedness and Recovery: GRG contributes to a better understanding of soil and rock behavior during floods and landslides, providing invaluable insights for disaster response, preparedness, and post-disaster reconstruction efforts.
- Designing Resilient Infrastructure: Studies focused on soil-structure interaction during extreme events help design infrastructure that is more resilient to natural disasters, such as tunnels, bridges and dams that can withstand flooding or buildings designed to handle ground deformation.



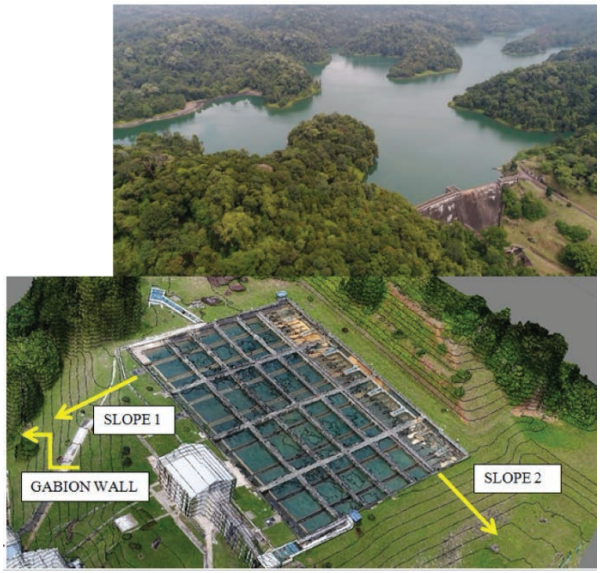


Porewater distributions achieve the critical condition in 2022

APPLICATION & BENEFIT

5. Regulatory Compliance and Standards Development

- Influence on Standards: Geotechnical research contributes to the development of updated engineering standards, codes of practice, and guidelines, ensuring that construction practices are aligned with the latest scientific knowledge and best practices in safety and sustainability.
- Policy Advocacy: Research groups often influence government policies related to land use, construction practices, and environmental protection, contributing to public safety and well-being.



6. Public and Industry Awareness

- Dissemination of Knowledge: Geotechnical research helps in public education and awareness, helping non-experts understand the importance of soil conditions in the safety and longevity of buildings and infrastructure. This can improve public understanding of issues such as sinkholes, landslides, and other geotechnical hazards.

7. Global Relevance

- International Collaboration: Many geotechnical issues are global in nature, requiring international collaboration and the sharing of knowledge to solve problems that transcend national borders.

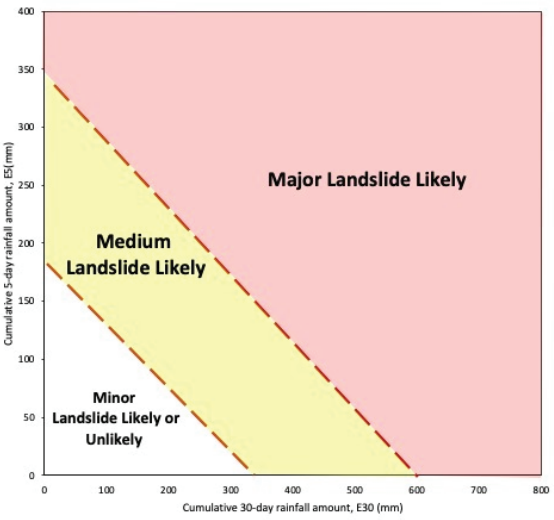
POTENTIAL MARKET

The potential market for GRG innovations is vast, encompassing both local and international construction sectors. With a growing focus on geotechnical, geomechanics and surveying leads a significant demand from the stakeholders of government and private projects worldwide.

NOVELTY

The UTM Geotechnical Research Centre (GRC) brings a fresh perspective to converge the interdisciplinary of Geotechnical and Geological Engineering, Rock Engineering, Photogrammetry, and Surveying fields in one roof.

This will held in the essence, with the **Novelty Geotechnical Research Group** focuses on forward-thinking, sustainable, and technologically advanced solutions that push beyond command boundaries of traditional geotechnical engineering.



PRODUCT FEATURES

The product offerings from GRG UTM are characterized by a blend of advanced laboratory, geotechnical and surveying expertise.

1. Laboratory Expertise

Provide soil and rock testing involves proficiently conducting a range of tests to assess soil/rock properties and behavior. Skilled in soil classification, compaction, permeability, and strength testing, experts analyze samples to provide crucial data for construction, and environmental projects

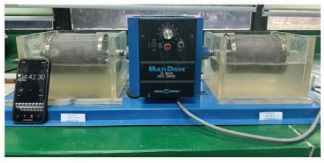
Soil testing:

- Accredited Sieve Analysis
- Accredited Atterberg Limit Test
- Unconfined Compression Strength Test
- Triaxial Testing
- Specific Gravity
- Hydrometer Test (PSA)

PRODUCT FEATURES

In-situ testing :

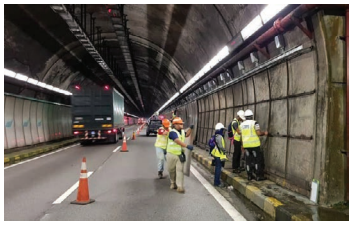
- Seismic Survey
- Resistivity Survey
- Mackintosh Probe
- Rock testing :
- Triaxial test for rock
- Direct shear test for rock
- Rock uniaxial compression test
- Point load test
- Brazilian test
- Slake durability
- Petrographic Analysis on Deteriorate



2. Geotechnical Expertise

We expertise in the geotechnical field, encompassing analyzing soil mechanics, stability, and underground conditions to inform engineering decisions. Skilled in site investigation, slope stability analysis, foundation design, and risk assessment.

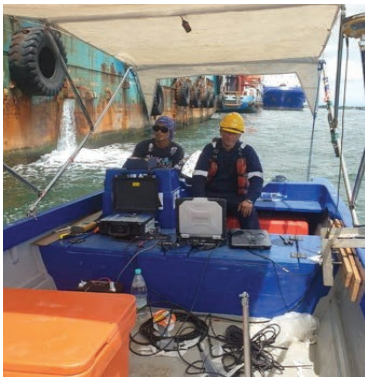
- Feasibility Studies Geological Studies Geohazard Assessment
- Slope Engineering (soil/rock slopes) Geotechnical Modelling
- Rockfall Analysis
- Tunnel Engineering

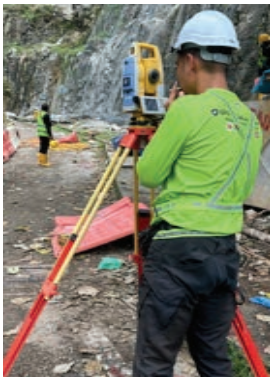


3. Survey Expertise

We provide survey experts involving proficiently capturing, analyzing, and interpreting spatial data to inform various civil engineering projects. They are skilled in using advanced surveying technologies such as precise digital level, robotic total station, GNSS, Terrestrial Laser Scanner, Drones, LIDAR, and GIS software. Surveyors meticulously map land features, boundaries, and infrastructure to support urban planning, construction, environmental conservation, monitoring & instrumentation, forensics investigation, and resource management endeavours with precision and accuracy

- Land Survey Bathymetry Survey
- Drone Application
- Structure Settlement Monitoring GIS
- Terrestrial laser scanning (TLS) Settlement and Deformation Monitoring Surveying





UTM
UNIVERSITI TEKNOLOGI MALAYSIA
Faculty of Civil Engineering

3

WATER RISK

3a. Centre for River & Coastal Engineering (CRCE)
3b. Hydraulics & Hydrology Research Group (HHRG)

3. WATER RISK

3a. Centre for River & Coastal Engineering (CRCE)

RG/RC Name: **Centre For River And Coastal Engineering (CRCE)**

NICHE AREA:

- River & Coastal engineering & modelling
- River, Estuary and coastal ecosystem
- Marine hazard, habitat mapping and mitigations
- Water Resources

SYNOPSIS:

CRCE (Centre for River and Coastal Engineering), established by Universiti Teknologi Malaysia in 1990. We offer multidisciplinary consultancy, training and conducts research in river and coastal engineering. Our specialization is in site investigation, data collection, development of physical and mathematical models, and feasibility studies for hydraulic and coastal engineering projects, contributing significantly to the field's advancement and practical applications.

LEADER:

DR ILYA KHAIRANIS OTHMAN

TEAM MEMBER:

ASSOC. PROF. IR. TS. DR. MOHAMAD HIDAYAT JAMAL

ASSOC. PROF. DR. ZULHILMI ISMAIL

DR. ERWAN HAFIZI KASIMAN

DR. ROZAIMI CHE HASAN

DR. MAZLIN JUMAIN

DR. AMYRHUL ABU BAKAR

DR. MOHAMAD HASIF OSMAN

SR. TS. DR. RADZUAN BIN SA'ARI

DR. SHAMILA AZMAN

DAENG SITI MAIMUNAH ISHAK (RESEARCH OFFICER)

MOHAMAD FAKHARI AIZAT MOHD SAAD (ASSISTANT ENGINEER)

CONTACT:

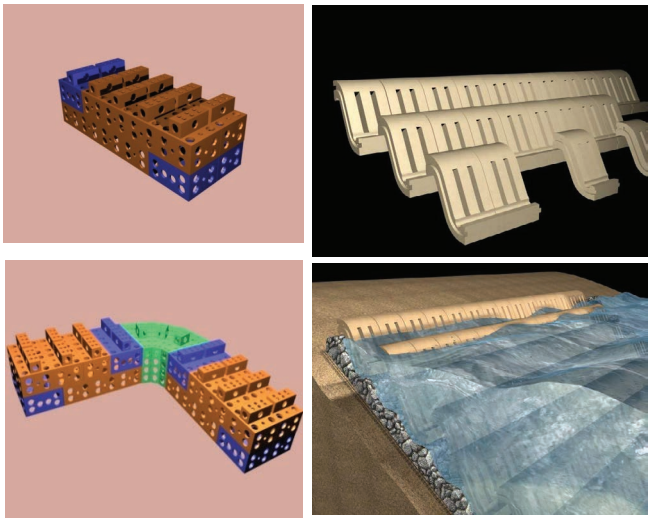
Address	:	Centre for River and Coastal Engineering, Block D01, Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia
Phone	:	Dr Ilya Khairanis Othman (+6019-710 3019)
Emel	:	crce@utm.my
Website	:	https://research.utm.my/crce/
Facebook	:	https://www.facebook.com/crceutm/

INTRODUCTION

Hybrid based Protection in Coastal and Estuary in Response to Future Climate

As climate change increasingly threatens coastal and estuarine environments, innovative and resilient protection strategies are essential. Traditional methods like seawalls have limitations, prompting the rise of hybrid-based protection, which combines natural and engineered solutions. This approach integrates elements like mangroves and wetlands with engineering structures to enhance shoreline stability, mitigate erosion, and reduce storm surge impacts. Hybrid-based protection not only offers immediate benefits but also promotes long-term sustainability by preserving ecosystems. As the impacts of climate change intensify, implementing these strategies becomes crucial for safeguarding our coastal areas.

Digital prototype



Physical prototype

NEEDS

Hybrid-based protection strategies are essential due to several pressing needs:

Adaptation to Climate Change: Rising sea levels, increased storm intensity, and shifting weather patterns necessitate more resilient coastal protection measures.

- Sustainable Development: Combining natural and engineered solutions minimizes environmental impact while providing robust protection, supporting sustainable coastal development.

- Ecosystem Preservation: Natural elements like mangroves and wetlands help preserve biodiversity and ecosystem services, which are crucial for maintaining ecological balance and human well-being.

- Economic Efficiency: Hybrid solutions can be cost-effective in the long term by reducing the need for frequent repairs and providing benefits like flood control, carbon sequestration, and tourism opportunities.

- Community Resilience: Protecting coastal communities from flooding and erosion ensures safety, livelihoods, and overall well-being, enhancing social resilience.

By addressing these needs, hybrid-based protection strategies offer a comprehensive approach to safeguarding coastal and estuarine areas against future climatic challenges.

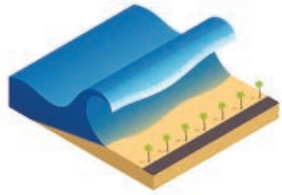
APPLICATION & BENEFIT

Application:

- Coastal Defence:
  Implementing natural elements like mangroves and reefs alongside seawalls and breakwaters.

- Estuarine Protection:
  Using wetlands and restored habitats to manage estuary health and reduce erosion.

- Flood Mitigation:
  Combining green infrastructure with levees and dikes to manage flood risks in coastal areas.



Coastal defense

Estuarine Protection

Flood Mitigation

Benefits:

- Enhanced Resilience:
  Provides a robust defense against climate change impacts, such as storm surges and sea-level rise.

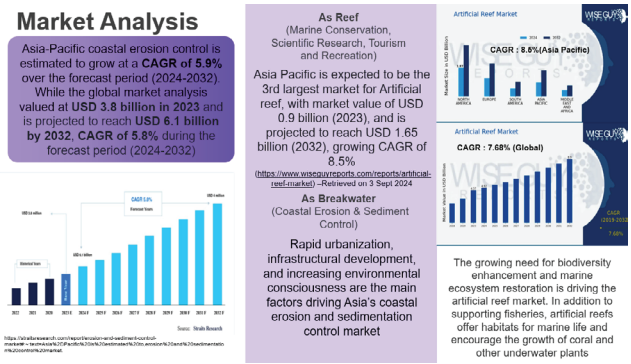
- Environmental Sustainability:
  Preserves and restores ecosystems, promoting biodiversity and ecological health.

- Economic Efficiency:
  Reduces long-term costs by minimizing maintenance needs and offering additional benefits like carbon sequestration and tourism.

POTENTIAL MARKET

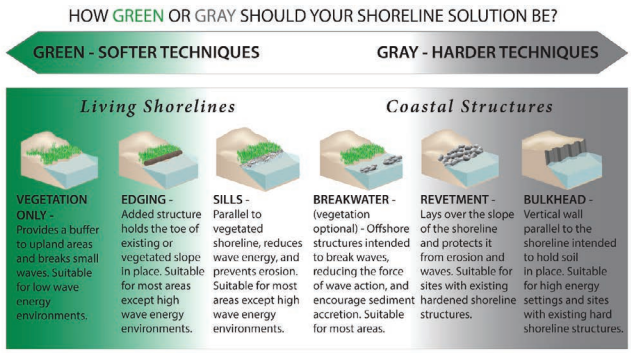
The potential market for hybrid-based coastal protection is vast and growing, driven by the increasing need for resilient and sustainable solutions to address climate change impacts. Key areas include:

- Coastal Cities and Communities: Urban areas vulnerable to sea-level rise and storm surges.
- Tourism Destinations: Coastal regions that rely on beaches and marine ecosystems for tourism.
- Agricultural Regions: Coastal agricultural lands at risk from flooding and erosion.
- Infrastructure Projects: New developments requiring integrated coastal defense systems.
- Environmental Conservation: Areas focused on preserving biodiversity and ecosystem services.



NOVELTY

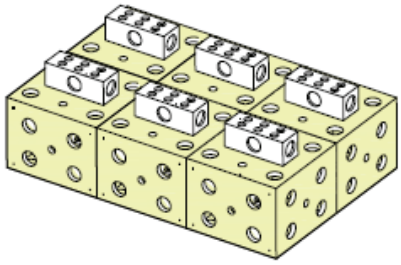
In Malaysia, hybrid-based coastal protection combines natural solutions like mangrove restoration and coral reef rehabilitation with engineered structures such as seawalls and breakwaters. This approach enhances coastal resilience by reducing erosion and storm surge impacts while providing ecological benefits like habitat restoration and biodiversity. Examples include living shorelines in areas like Penang and Port Dickson. Hybrid solutions offer a cost-effective, adaptable, and sustainable way to protect coastlines from climate change impacts.

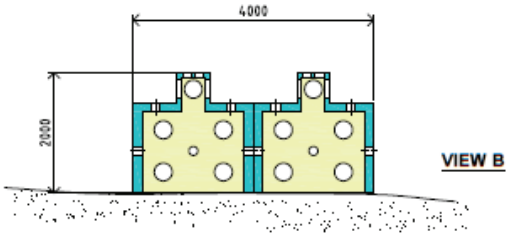


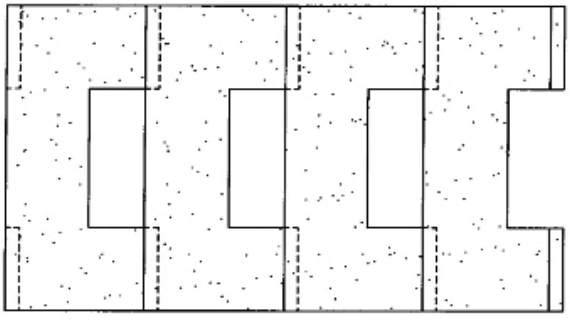
PRODUCT FEATURES

Key features include:

- Porous cubic structure
- Stackable and modular
- Dissipate wave energy & currents
- Dissipate wave energy & currents
- Self-Stabilizing
- Extendable







3. WATER RISK

3b. Hydraulics & Hydrology Research Group (HHRG)

RG/RC Name: **Hydraulics and Hydrology Research Group**

NICHE AREA:

Hydraulics & Hydrology

SUB-NICHE:

- Urban stormwater management
- Urban hydrology
- Water supply
- Water reservoir engineering
- Hydro-environment
- Erosion and sediment control
- Flood risk management
- Watershed modeling
- Flood modeling
- Hydraulic structures
- River and coastal hydraulics
- Coastal structures
- Computational fluid dynamics
- Hydrodynamic modeling
- Climate change assessment and impact
- Water quality
- Non-point source pollution
- Disaster management
- Hydro-related green energy
- Geo-spatial analysis

SYNOPSIS:

Hydraulics and Hydrology Research Group (HHRG) is a research group under the Faculty of Civil Engineering, Universiti Teknologi Malaysia. Our field focuses on water in engineering and science. We aim to promote research in relation to the fundamental, analysis, development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystem. We welcome collaborations, knowledge transfer and community engagement with various stakeholders and research partners.

LEADER:

IR. DR. NOR ELIZA ALIAS

TEAM MEMBER

ASSOC. PROF IR. DR. MOHAMAD HIDAYAT JAMAL

DR. NORALIANI ALIAS

ASSOC. PROF DR. ZULKIFLEE IBRAHIM

ASSOC. PROF DR. ZULHILMI ISMAIL

DR. PONSELVI JEEVARAGAGAM

PROF IR. DR. MARLINDA BINTI ABDUL MALEK

DR. ILYA KHAIRANIS OTHMAN

DR. MOHD RIDZA MOHD HANIFFAH

DR. ERWAN HAFIZI KASIMAN

TS. DR. KOGILA VANI ANNAMMALA

DR. MAZLIN JUMAIN

DR. AMYRHUL ABU BAKAR

DR. MOHD KHAIRUL IDLAN MUHAMMAD

IR. TS. DR. JOSILVA MUNIANDY

DR. MOHAMAD HASIF OSMAN

TS. DR. MUHAMAD ZULHASIF MOKHTAR

IR. TS. DR. NOR AZIDAWATI HARON

DR. NURUL SYAHIRA MOHAMMAD HARMAY

TS. GS. SR. DR. MOHD RADHIE MOHD SALLEH

IR. DR. MOHD AZLAN MOHD YUSOFF

DR. HAZLAMI FIKRI BASRI

INTRODUCTION

Water-related risks are becoming increasingly severe due to a combination of urbanization, climate change, and unsustainable resource management. Rapid urban expansion and population growth intensify water stress, leading to heightened demand and overextraction of water resources, exacerbating scarcity and pollution. While sea level rise heightens risks for coastal cities, aging infrastructure and unsustainable drainage systems contribute to inefficient water distribution and flood management, worsening the impacts of extreme hydrological events.

Our Hydraulics and Hydrology Research Groups addresses and conducts research using current, suitable and explores new technologies, techniques and methods related to solving these challenges.

NEEDS

Our research group is crucial for local governments, agencies, and communities as it provides scientific insights to mitigate water-related risks and extreme weather events. Our research and activities directly benefits communities by enhancing public safety, and promoting climate resilience. Collaborating with various sectors, including academia, industry, and civil society, our research group serves as a critical bridge between science and policy, ensuring that local strategies for water security and disaster risk reduction are based on the latest advancements in hydraulics, hydrology and coastal engineering.

CONTACT:

Group Leader : Dr. Nor Eliza Alias
Email : noreliza@utm.my
Facebook : https://www.facebook.com/hhrgutm

OUR SERVICES

Advancement of knowledge, training and skill development

The Hydraulics and hydrology research group (HHRG) plays a vital role in advancing knowledge by developing innovative methodologies, refining analytical techniques, and generating new insights into water-related risks, extreme weather patterns, and sustainable resource management. We conduct specialized training programs and hands-on activities for local government agencies, professionals, and students with the necessary skills in related to our niche areas. Some of our trainings, knowledge and skill development are as follows:

- ✓ HecHMS & HecRAS Training for DID.
- ✓ Numerical Solution for 1D and 2D Flood Modeling Software Development.
- ✓ Knowledge sharing on the potential application of machine learning, AI, sensors and for localised Early Warning System (collaboration with REKA Inisiatif Sdn. Bhd.).
- ✓ Kursus Pengenalan Asas Sukarelawan UTM Prihatin Bagi Misi Bantuan Kemanusiaan (ASAS 101) co-organized with the National Disaster Association Malaysia (NADIM).

Policy, guideline and standards development

The Hydraulics and hydrology research group (HHRG) plays a critical role in shaping policies, guidelines, and standards by providing scientific evidence and data-driven recommendations for water management, climate resilience, and disaster risk reduction. By collaborating with government agencies, regulatory bodies, and industry stakeholders, we help establish frameworks that ensure sustainable catchment management practices, sustainable drainage systems, effective water-related disaster mitigation, and responsible water usage. Additionally, through continuous research and knowledge advancements, the group contributes to refining existing policies and developing new standards that enhance infrastructure resilience, and community preparedness against extreme weather events. Some of our projects related to policies, guidelines and standards are:

Trainings

- ✓ Flood Risk Standard and Guideline with CREAM CIDB.
- ✓ Climate Change Readiness Index with NAHRIM.
- ✓ Pembentukan Polisi Pembangunan Hijau Johor - Perubahan Iklim (Banjir) with PDT, Johor.
- ✓ Pemurnian Garis Panduan Teknikal Kebangsaan Kajian Kesesuaian Struktur Sabo Di Malaysia, with NAHRIM.

Consultancies and research

The Hydraulics and hydrology research group (HHRG) serves as a key resource for consultancies by providing scientific expertise, data analysis, and evidence-based recommendations for addressing water-related risks, extreme weather events, and sustainable resource management.

Through research-driven insights, it supports designing resilient infrastructure, improving flood mitigation strategies, and optimizing water resource allocation. Additionally, by conducting cutting-edge studies and developing predictive models, the group contributes to the advancement of environmental policies, disaster preparedness plans, and technological innovations that enhance climate resilience and sustainable development. Some of our topics related services and research are as follows.

- ✓ Hydraulics structures design
- ✓ Hydrological analysis
- ✓ Manuals, standart, guidelines or policy development
- ✓ Climate change impact assessment
- ✓ Flood modeling
- ✓ Urban storm water design
- ✓ Flood Risk Assessment
- ✓ Water resources management
- ✓ Evaluation of erosion, ESCP
- ✓ Physical modeling experiments
- ✓ Hydro-dynamic assessment
- ✓ Coastal and river erosion study
- ✓ Finite element modeling
- ✓ Computation Fluid Dynamic Model
- ✓ Non-point source assessment
- ✓ Hydraulic laboratory experiment
- ✓ Water-related GIS analysis
- ✓ And more

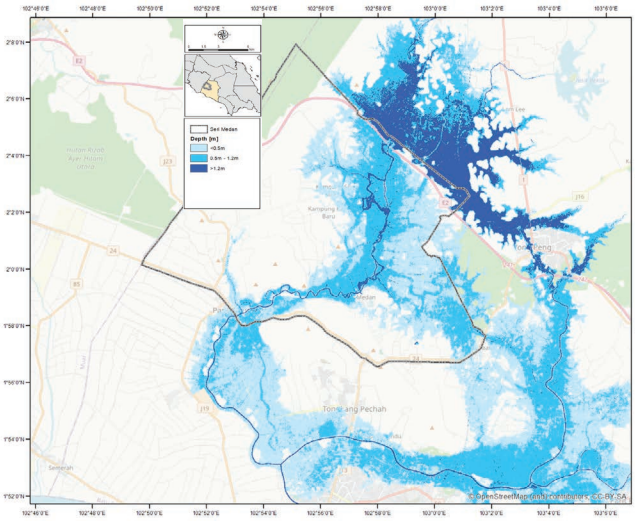
Trainings

Site and physical investigation

Some of our projects related to management and engineering services:

- ✓ Sri Medan, Batu Pahat Flood Mitigation Project.
- ✓ Machap Dam Integrated Catchment Management Plan with DID.
- ✓ Comprehensive Study of the Drainage and Flood Mitigation System in the Tampoi River and Stulang River Basin, Johor Bahru MBJB.
- ✓ Flood modeling for detailed design for flood mitigation Kg Sg Kapal Lama, Pengerang, Kota Tinggi and more with Muda Consult and DID.
- ✓ Kajian Semula Garis Panduan Kawalan Hakisan Pantai, MinConsult and DID.
- ✓ Kajian Semula Sedimentasi Muara Sungai Seluruh Negara with Muda Consult.
- ✓ And more.

Modeling



Public and industry awareness

The Hydraulics and hydrology research group (HHRG) plays a crucial role in raising public and industry awareness by translating scientific findings into actionable insights that help communities and businesses prepare for water-related risks and extreme weather events.

By engaging with the public and local communties through outreach and awareness programs, it ensures that decision-makers, urban planners, the private sector and community understand the implications of climate change and the importance of sustainable water management. Some of our programs are as follows:

- ✓ Climate Change Awareness Program with various schools and collaboration involving HHRG members (SK Sg Telor, SMK Sri Pulai Perdana).
- ✓ Right Tree and Right Place Program Awareness & Tree Planting with CIMB-UTM-MBPG-FRIM.
- ✓ visit from Hasanuddin University Indonesia to Hydraulics and Hydrology Lab.
- ✓ Horizon Hijau: Memupuk Komuniti Melalui Amalan Lestari Dan Pembinaan Ketahanan.
- ✓ Kelestarian Sumber Air Semula Jadi untuk Komuniti melalui Sistem rain Water Harvesting.
- ✓ Save the Planet Program with Invictus International School.

Community services and Awareness Program

Global and local collaboration and engagement

The Hydraulics and hydrology research group (HHRG) fosters global collaboration and networking by partnering with international institutions, research centers, and industry experts to share knowledge, data, and best practices in water risk management and climate resilience. By engaging in joint studies, conferences, and capacity-building programs, we contribute to the global exchange of innovative solutions related to our niche areas. These collaborations strengthen the group's research capabilities, provide access to advanced methodologies, and enhance its role in shaping international policies and strategies for sustainable water resource management. Some of our engagements include:

- ✓ Vietnam March 2024: Debris flow potential research and collaboration with National Research Institute of Earth Science and Disaster Prevention (NIED) Japan and Institute of Geological Science, Vietnam Academy of Science and Technology in Hanoi, Vietnam.
- ✓ Engagement with University of Limerick, University of Galway, University College of Dublin, Trinity College Dublin (Ireland).
- ✓ Engagement with Fisherman Community on Green Energy Solar CSR.
- ✓ Engagement with Village Leader Kg Kayu Ara Pasong on possible local flood CSR.
- ✓ Visit and discussion with Johor Bahru Integrated Operation Control Center (JBIOCC) for potential flood monitoring and early warning system improvement.
- ✓ Engagement and discussion with Indah Water Konsortium.
- ✓ Engagement and discussion with Iskandar Regional Development Authority (IRDA).
- ✓ Visit and engagement with Angkatan Pertahanan Awam Negeri Johor (APM).
- ✓ Engagement with UPPP Johor and BMSB for saltwater intrusion problem.

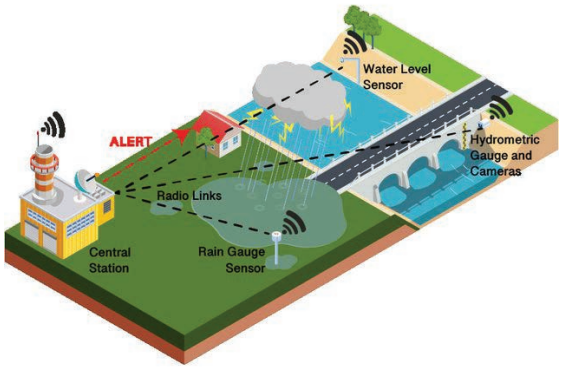
Global collaboration and networking

PROJECT HIGHLIGHTS

1. Advancement in Localized Flood Early Warning System

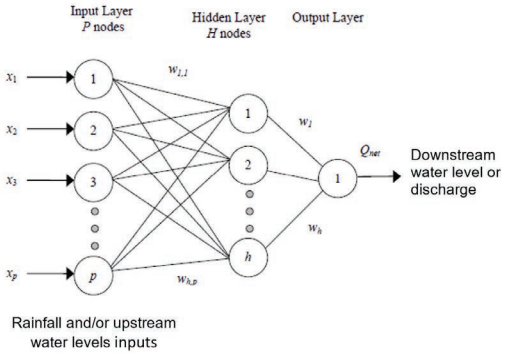
Needs

There is a need to develop Flood early warning specifically tailored for urban catchments. The development must be inexpensive for widespread deployment, as local authorities are typically financially constrained. A localized offers a viable answer to this problem. Several platforms that can be explored can be used to integrate real-time meteorologic data to simulate and forecast flood events. This work aims to utilize open-source software to develop and assess flood early warning system. One of them is HEC-RTS or localized developed GIS-based early warning system utilizing the most basic to intermediate technological type. Machine learning tools can also be used for flood early warning by predicting downstream water levels based on upstream water levels and rainfall data input. The use of machine learning application or AI is also a main focus in our methodology.



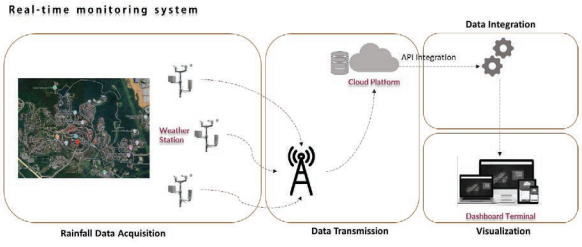
Application & Benefit

The system and process developed through this research will assist and provide a proof of concept on the tools and methods that can be used for flood early warning predictions. A successful system installed in UTM catchment will be a living lab project to be showcased to stakeholders and the industry related to advancement of a localized flood early warning system. Future potential would be to include satellite and radar data as part of the input and flood prediction methodology.



Potential Market

The proof of concept and system platform can be marketed to flood disaster management local authorities, government and private sectors.



Novelty

This project highlights simple but effective tools, system and methodology for flood early warning system.

2. Assessment of Non-Point Source Pollution Hotspots in Machap Dam Watershed

Needs

The Machap Dam catchment in Kluang, Johor, is a critical water resource for agriculture and domestic use, but it faces declining water quality due to non-point source pollution. Economic expansion in the Simpang Renggam area, including landfills, poultry farms, and plantations, has contributed to this issue. In March 2019, elevated ammonia levels, likely from illegal dumping and landfill leachate, caused the temporary shutdown of a water treatment plant. To address these challenges, identifying key pollution sources and implementing targeted Best Management Practices (BMPs) is essential for improving water quality and protecting water security.

Application & Benefit

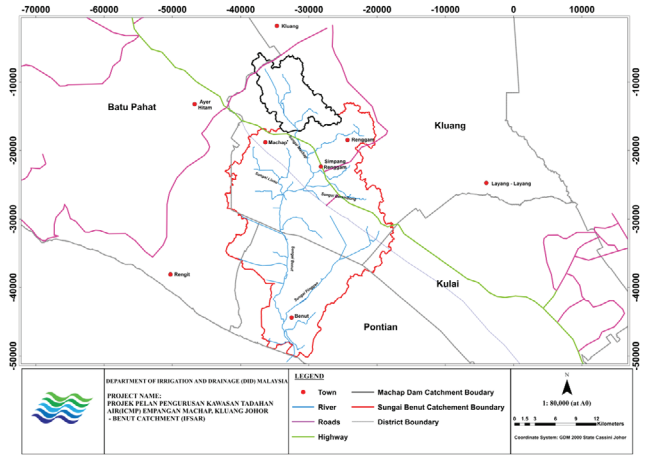
The assessment of non-point source (NPS) pollution hotspots in the Machap Dam watershed is critical for improving water quality and ensuring sustainable water resource management. By identifying specific areas within the watershed that contribute the most to pollution—such as agricultural runoff, urban stormwater, and industrial activities—targeted mitigation strategies, including Best Management Practices (BMPs), can be applied more effectively. This approach will not only enhance water security for agricultural and domestic use but also reduce treatment costs, protect aquatic ecosystems, and support the long-term economic development of the region by ensuring a reliable and clean water supply.

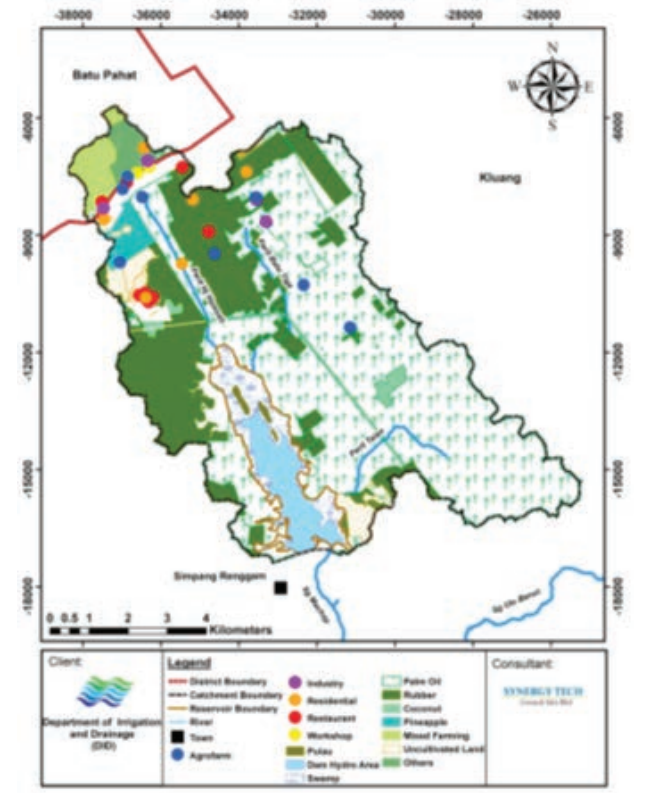
Potential Market

The primary market for the assessment of non-point source pollution hotspots in the Machap Dam watershed includes government agencies such as the Department of Irrigation and Drainage (DID) Malaysia, Additionally, the findings can benefit local authorities, water treatment facilities, and environmental consulting firms that work closely with DID on pollution mitigation and water quality improvement projects.

Novelty

The novelty of this project lies in its data-driven, targeted approach to identifying non-point source (NPS) pollution hotspots within the Machap Dam watershed. By utilizing advanced spatial analysis and modern environmental monitoring techniques, the project introduces a more efficient and cost-effective strategy for pollution mitigation.

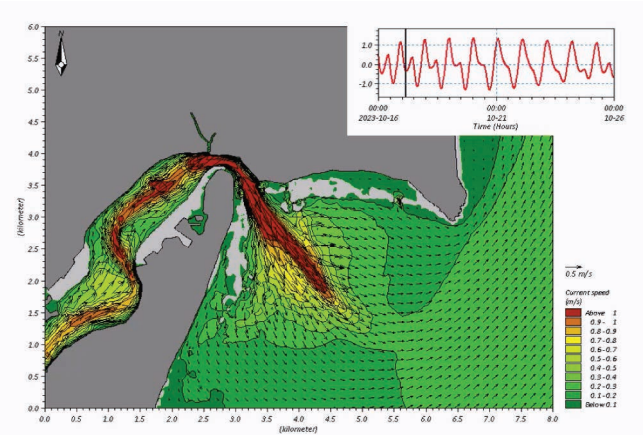


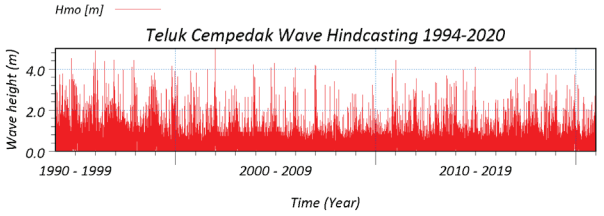


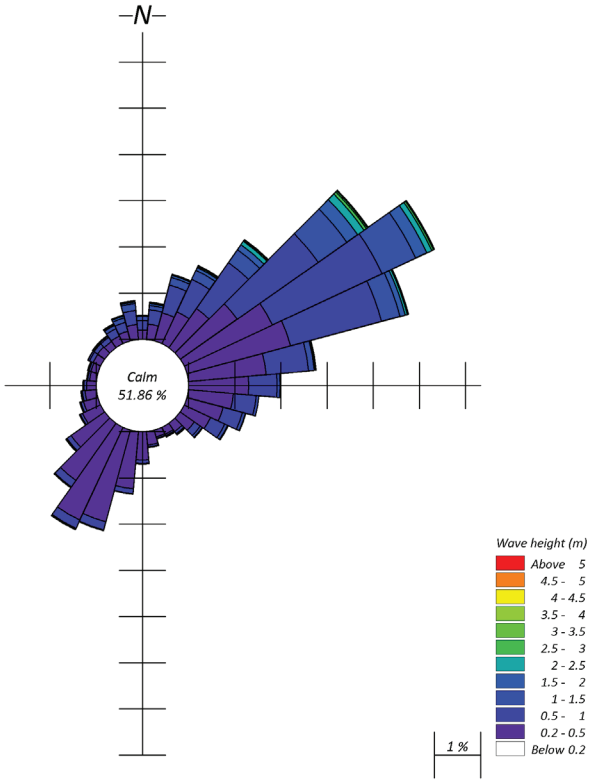
3. Coastal Hydraulic Study

The coastal system maintains a balance that accounts for shoreline stability and beach replenishment. Offshore shoals and coral reefs attenuate incoming wave reducing their impact on shoreline. Beach dunes provide a barrier catering for periodic erosion and accretion along the shoreline preventing seawater inundation of coastal areas. Together with others coastal features and habitats, these characteristics need to be preserved or even enhanced to maintain their positive effect on the coastal area. A coastal hydraulic study is required to determine the impact due to any development, reclamations work and changes around the coastline. Planning and projects such as Integrated shoreline management plan (ISMP), river mouth study, Coastal erosion study, coastal structures (jetties, ports etc.) and marine outfall required Environments and coastal hydraulics study to investigate the impact to the environment and any mitigation options to minimise the impact.

Coastal study will analyse the bathymetry of the area and model the wave propagation, tides and currents hydrodynamics, sea level rise, sediment transport, sediment plume, erosion and accretion patterns during normal and monsoon seasons.







UTM
UNIVERSITI TEKNOLOGI MALAYSIA
Faculty of
Civil Engineering

4

TRANSPORTATION ADVANCEMENT

4a. Pavement & Transportation Research Group (PTRG)

4.TRANSPORTATION ADVANCEMENT

4a. Pavement & Transportation Research Group (PTRG)

RG/RC Name: **Pavement and Transportation Research Group**

ABOUT:

The Pavement and Transportation Research Group (PTRG) at UTM is a leading research hub dedicated to advancing knowledge in pavement engineering and transportation systems. Focused on sustainable and innovative solutions, the group specializes in areas like pavement materials, highway design, and traffic management. By integrating cutting-edge research with industry needs, PTRG aims to enhance infrastructure durability and performance, contributing to safer, more efficient transportation networks.

NICHE AREA:

- Pavement Forensic Study
- Smart Pavement Materials
- Sustainability and green Technology
- Road Maintenance and Rehabilitation
- Traffic & Transport Planning
- Traffic Management and Analysis

LEADER:

ASSOC. PROF. TS. DR. HARYATI YAACOB

TEAM MEMBER

PROF TS. DR. MOHD ROSLI BIN HIANIN

DR. SITI ASMAH BINTI HASSAN

DR. NORHIDAYAH BINTI ABDUL HASSAN

DR. AZMAN BIN MOHAMED

DR. NORDIANA BINTI MASHROS

DR. MOHD KHAIRUL AFZAN BIN MOHD LAZI

DR. MOHD ZUL HANIF BIN MAHMUD

DR. MUHAMMAD NAQIUDDIN BIN MOHD WARID

DR. SITI NUR NAQIBAH BINTI KAMARUDIN

DR. MOHD KHAIRUL IDHAM BIN MOHD SATAR

CONTACT:

Address	:	Block D02, Transportation Laboratory, Faculty of Civil Engineering, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia.
Email	:	ptrg.utm@gmail.com
Phone	:	(+6) 013-741 5050
Website	:	https://people.utm.my/hnorhidayah/research-group/
Facebook	:	Pavement & Transportation Research Group - PTRG
YouTube	:	Pavement and Transportation Research Group

PRODUCT FEATURES & APPLICATION

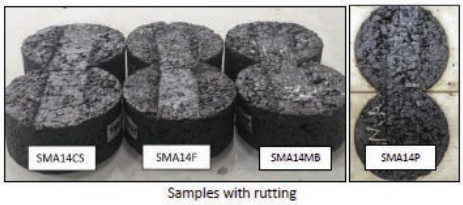
- The invention introduces the usage of glass fiber reinforced product (GRP) waste into asphalt mixture.
- Presence of the fiber waste enhances the durability of asphalt mixture.
- Fiber waste in road applications offers a sustainable alternative.
- Fiber waste is an alternative for cellulose fiber (commercial product) used in industry.

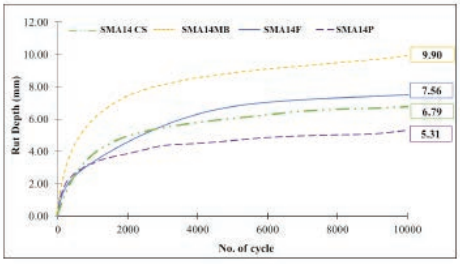
NEEDS

- Manufacturing of GRP produces between 10% to 15% of waste.
- The waste ends up in landfills, causing environmental challenges due to space occupation.
- 370 metric tons waste per year into land fill approximately USD706,000 (cost of waste).
- Cost for waste disposal approximately RM55,000 per year.

BENEFITS:

- Improve the durability of asphalt mixture in term of rutting, cracking and moisture resistance.
- Minimize fiber waste in landfills.
- Dry mixing modification is simple and easy to implement at asphalt plant.





NOVELTY

Usage of GRP-NOV ASPHALT 24 (powder & strand wastes) with specify sizes and quantity in improving the durability of asphalt mixture.

Los Angeles drum

UTM Machine

Deformed Cantabro sample

UTM
UNIVERSITI TEKNOLOGI MALAYSIA
Faculty of Civil Engineering

5

SUSTAINABILITY

5a. Centre for Environmental Sustainability & Water Security (IPASA)
5b. Water & Wastewater Treatment (WWT)
5c. Impact & Restoration Water Bodies (IRWB)
5d. Industrialize System (IS)
5e. UTM GreenPrompt

RG/RC Name: **Centre for Environmental Sustainability and Water Security (IPASA)**

NICHE AREA
Water Risks and Climate Resilience

SUB-NICHE AREAS
- Environmental Sustainability
- Water Management
- Water Pollution Control

SYNOPSIS:
Founded in 1994, the Centre for Environmental Sustainability and Water Security (IPASA) at Universiti Teknologi Malaysia (UTM) unites experts in climate resilience and water risk management. The centre focuses on critical areas such as climate variability, water pollution control, water quality management, risk assessment, and integrated water resources management (IWRM).

IPASA's mission is to mitigate water risks while enhancing community and ecosystem resilience to the impacts of climate change. With a soon-to-be-accredited laboratory for water and wastewater analysis, IPASA employs advanced tools in hydrological, climatological, and water quality modelling to provide comprehensive assessments and innovative solutions for water security challenges.

IPASA's impactful work includes high-profile projects such as the development of the Climate Change Adaptation Framework for the Water Sector in collaboration with the Ministry of Environment and Water (KASA). Additionally, the centre has established National Water Balance Systems for various river basins, supplying essential data for sustainable water resource planning.

Through its contributions to scientific publications, policy recommendations, technical reports, and training programs, IPASA advances practical, science-based strategies for climate adaptation. These efforts are integral to Malaysia's long-term resilience to water-related climate risks, solidifying IPASA's role as a leader in sustainable water management.

LEADER:

PROF. TS. DR. ZAINURA ZAINON NOOR
DIRECTOR

TEAM MEMBER
RESEARCH FELLOW AND ASSOCIATE

TS. DR. NUR SYAMIMI ZAIDI

PROF. DR. ZULKIFLI YUSOP

PROF. IR. TS. DR. SHREESHIVADASAN CHELLIAPAN

PROF. DR. KASTURI DEVI A/P KANNIAH

PROF. IR. TS. DR. MOHD FADHIL MD DIN

ASSOC. PROF. DR. CHOONG WENG WAI

IR. DR. NOR ELIZA ALIAS

TS. DR. YONG EE LING

AP. CHM. DR. MOHD FIRDAUS ABDUL WAHAB

SUPPORTING STAFF

TS. SITI FADILLA MD NOOR

SITI HANNA ELIAS

CHM. MOHD FAIZ FOZE

CONTACT:

Address : Centre for Environmental Sustainability and Water Security (IPASA)
Block C07, Level 2,
Universiti Teknologi Malaysia (UTM)
Johor Bahru, Johor
Website : https://research.utm.my/ipasa/
Facebook : https://www.facebook.com/utm.ipasa
Email : ipasa@utm.my

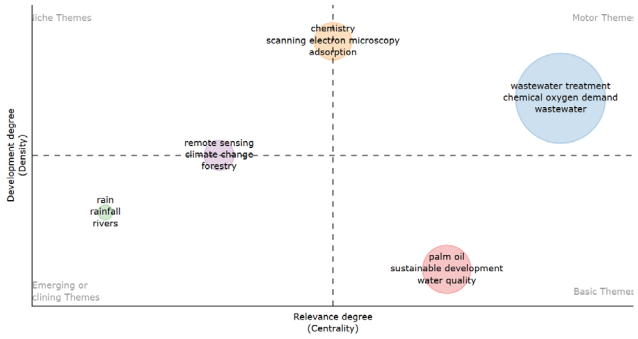
INTRODUCTION

The Centre for Environmental Sustainability and Water Security (IPASA), Universiti Teknologi Malaysia (UTM), is dedicated to advancing sustainable water management and environmental resilience. Its niche focus on "Water Risks and Climate Resilience" reflects the centre's expertise in addressing urgent global challenges. This niche area emphasizes understanding and mitigating water-related risks due to climate change, such as droughts and floods, to ensure water security. Through holistic, adaptive strategies, IPASA aims to protect ecosystems and planetary health, ultimately fostering resilience and sustainability in both local and global contexts.

NEEDS

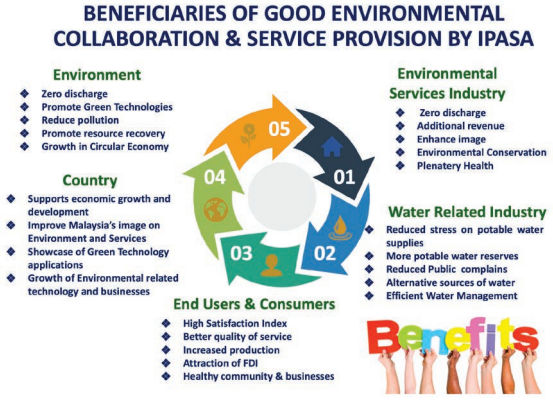
IPASA plays a critical role in advancing sustainable solutions to pressing environmental challenges. Given Malaysia's vulnerability to climate change, extreme weather, and pollution, there is an urgent need for specialized research and innovation in water security, environmental management, and climate resilience.

IPASA serves as a vital platform for developing science-based strategies to safeguard water resources, enhance ecosystem resilience, and support sustainable urban and rural development. It also plays a pivotal role in guiding policy, engaging communities, and fostering collaborations that ensure environmental health and water security for future generations.



APPLICATION & BENEFIT

- **Assessment of Water-Related Risks:** Evaluate the impacts of climate change on water scarcity, contamination, and ecosystem disruption.
- **Climate Resilience Strategies:** Develop infrastructure, conservation techniques, and ecosystem-based adaptation (nature-based solutions) to protect water systems.
- **Climate Mitigation:** Integrate strategies such as carbon sequestration, sustainable land-use practices, and energy-efficient water management to reduce emissions linked to water use.



APPLICATION & BENEFIT

- **Sustainable Water Management:** Promote practices that ensure water availability and quality under changing climatic conditions.
- **Policy and Community Action:** Influence policies and local actions to strengthen responses to water risks in a changing climate.
- **Planetary Health:** Safeguard water ecosystems to support biodiversity, human health, and global ecological stability.
- **Water-Climate-Health Nexus:** Enhance the integration of water management policies with the health of people and the planet.

POTENTIAL MARKET

- Government Agencies
- Water Utilities and Authorities
- Industries with Environmental Impact
- Urban Planning and Development Firms
- Environmental Consultancies
- Educational and Research Institutions
- Non-Governmental Organizations (NGOs)
- Local and International Universities
- International Development Agencies
- Local Communities, including School Students

NOVELTY

IPASA distinguishes itself through its integrated approach to water security and climate resilience. By combining monitoring, predictive modelling, and community-focused initiatives, the centre delivers innovative solutions for pressing challenges. IPASA pioneers advanced pollution control technologies and fosters climate-resilient strategies to safeguard water resources and ecosystems amid extreme weather events. Its focus on planetary health connects human well-being with ecosystem sustainability, and interdisciplinary collaborations drive science-based policy recommendations. This unique combination of expertise, technology, and stakeholder engagement establishes IPASA as a leader in sustainable environmental solutions.

SERVICE FEATURES

- **Integrated Water and Environmental Solutions:** A comprehensive framework combining water security, environmental management, and climate resilience for complex challenges.
- **Climate-Resilient Water Security:** Solutions to anticipate and adapt to extreme weather events like floods and droughts.
- **Community-Centred Sustainability Programs:** Participatory approaches integrating traditional knowledge to ensure environmental and social goals.
- **Innovative Pollution Mitigation Solutions:** Advanced technologies targeting industrial, agricultural, and urban pollution.
- **Interdisciplinary Collaboration:** Cross-sector partnerships uniting academia, industry, government, and communities for holistic solutions.
- **Policy Advisory and Strategic Partnerships:** Evidence-based recommendations to support sustainability goals and align with national and regional frameworks.
- **Sustainable Development Solutions:** Integration of water-sensitive designs and green infrastructure for urban and rural resilience.

5. SUSTAINABILITY

5b. Water and Wastewater Treatment (WWT)

RG/RC Name: **Water and Wastewater Treatment**

TITLE

Nature-based materials for water and wastewater treatment

SYNOPSIS:

Water security presents significant challenges in our society, influenced by interconnected factors such as water scarcity, extreme climate events, and declining water quality from pollution and biodiversity loss. Emerging interest in the use of natural materials, including agricultural and aquaculture by-products, has prompted in-depth studies on their characteristics and effectiveness in enhancing treatment processes like coagulation, adsorption, and filtration. These investigations aim to optimize their application for improved water quality and resource recovery, while also achieving cost reductions and promoting sustainable practices in water and wastewater management.

LEADER:

PROF. TS. DR. ZAINURA ZAINON NOOR
DIRECTOR

TEAM MEMBER
RESEARCH FELLOW AND ASSOCIATE

TS. DR. NUR SYAMIMI ZAIDI
(nursyamimi@utm.my)

PROF. DR. KHALIDA MUDA
(khalida@utm.my)

DR. MOHAMAD S. J. DARWISH
(sjmohamad@utm.my)

DR. LIEW WAI LOAN
(wlliew@utm.my)

DR. HAZLAMI FIKRI BASRI
(hazlami@utm.my)

CONTACT:

Address : Universiti Teknologi Malaysia,
81310 UTM Johor Bahru, Johor

INTRODUCTION

Nature-based materials are substances derived from natural sources such as agricultural residues, biochar, aquaculture residue, natural zeolite and natural fibers. These materials are used for the removal of contaminants (organic pollutants, heavy metals, and contaminants of emerging concern), nutrient recovery (nitrogen and phosphorus), and water recovery through various methods, including adsorption, coagulation, filtration, and granular sludge. Harnessing environmentally friendly nature-based materials enables more effective and sustainable water and wastewater treatment approaches that align with the Sustainable Development Goals (SDG).

NEEDS

Identifying Issues:

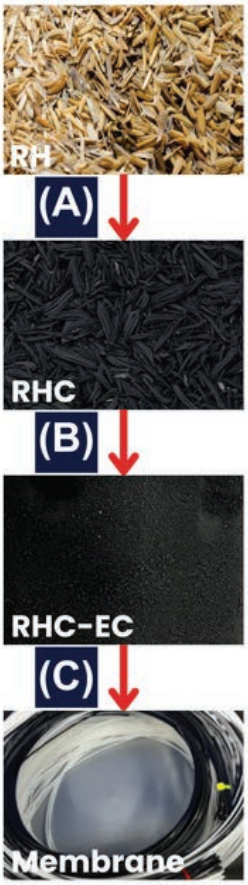
- Water pollution and quality deterioration
- Contaminants of emerging concerns
- Water scarcity
- Climate change adaptation
- Economic constraints

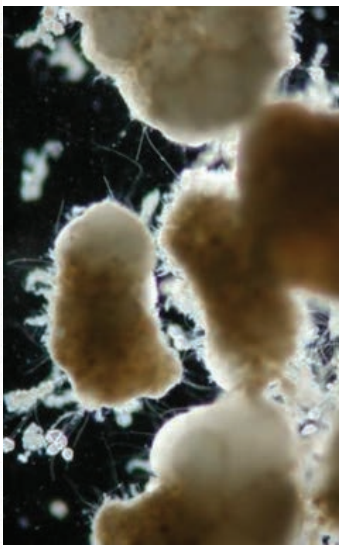
Global and local needs:

- Technological advancements and innovation
- Harnessing resource recovery
- Community engagement

APPLICATION & BENEFIT

Using locally available nature-based waste materials for pollutant removal from wastewater provides dual benefits: efficient waste management and enhanced water quality. On top of that, the valorization of carbonaceous waste into graphene materials transforms these by-products into valuable resources.





POTENTIAL MARKET

- Water treatment plants
- Sewage treatment plants
- Industrial effluent treatment facilities
- Research and Development Institutions
- Consumer products

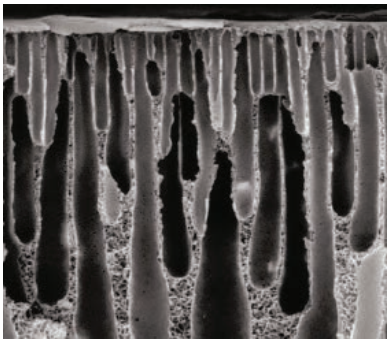
NOVELTY

- Innovative material upcycling and development
- Adaptation to emerging contaminants

SERVICE FEATURES

The product offerings from Water and Wastewater Treatment RG combine emerging technology with sustainable methods, emphasizing the use of nature-based materials in treatment processes. Key features include:

1. Natural zeolite as an adsorbent for nutrient recovery from wastewater
2. Rice husk derived photothermal membrane distillation for reclamation of industrial effluent
3. Enhanced biogranulation system for wastewater treatment
4. Removal of heavy metal contamination in water and soil via biomineralization using microbial induced carbonate precipitation (MICP)
5. Removal of Organic and Nutrient Content in Wastewater by Active Plant-based Natural Coagulant
6. Novel biodegradable fibre as biofilter media for pollutant removal
7. Removal of heavy metals during struvite crystallization in wastewater
8. The use of eco-enzyme during the initial development of biogranules in wastewater treatment



RG/RC Name: **Impact and Restoration of Water Bodies**

TITLE

Advancing Water Quality Solutions: Innovations in Monitoring, Pollutant Detection, and Microplastic Research

SYNOPSIS:

Our research group leads advancements in water quality monitoring and the detection of aquatic pollutants, addressing critical challenges in water resource management and protection. We specialize in developing innovative solutions using advanced technologies such as remote sensing, biosensors, and AI-driven analytics to enhance the accuracy and efficiency of water quality assessments.

As part of our work, we investigate microplastics as pollutant, studying their sources, pathways, and ecological impacts, while applying state-of-the-art techniques for their detection and analysis.

Our mission is to bridge the gap between research and practical application, delivering actionable solutions for industries aiming to improve environmental practices, policymakers developing effective water management strategies, and organizations committed to sustainable development. By partnering with us, stakeholders gain access to cutting-edge knowledge, tailored tools, and a dedicated team equipped to address complex water quality challenges and safeguard aquatic ecosystems.

LEADER:

DR SHAMILA AZMAN

TEAM MEMBER

PM DR MOHD ISMID MOHD SAID

DR SALMIATI

DR MUZAFFAR ZAINAL ABIDEEN

DR MOHAMED ZUHAILI MOHAMED NAJIB

DR MOHD RADHIE MOHD SALLEH (ASSOCIATE GROUP MEMBER)

CONTACT:

Contact Person : Dr Shamila Azman
Email : shamila@utm.my
Tel : +6012-7113292

INTRODUCTION

Water quality faces increasing threats from pollution, with microplastics being a significant global concern.

Our research group focuses on:

- Advancing understanding of water quality challenges.
- Developing innovative solutions to address these issues.

Key areas of investigation:

- Sources, pathways, and impacts of pollution.
- Use of cutting-edge technologies, for water quality monitoring including:
  - Remote sensing.
  - Biosensors.
  - AI-driven analytics.

Goals:

- Enhance water quality monitoring and management.
- Bridge research and practical application.
- Provide tools and insights for industries, policymakers, and environmental organizations.

Outcome: Protect aquatic ecosystems and ensure sustainable water resources.

NEEDS

- **Reliable Water Quality Monitoring Tools:** Addressing the growing demand for accurate, cost-effective, and user-friendly technologies to monitor water quality.
- **Actionable Insights for Decision-Making:** Providing data-driven solutions to enable industries, policymakers, and environmental organizations to make informed decisions.
- **Mitigation of Environmental Risks:** Helping customers reduce the impact of pollutants on ecosystems and comply with environmental regulations.
- **Enhanced Sustainability Practices:** Supporting industries in meeting sustainability goals and improving their environmental footprint.

- **Customizable Solutions:**
  Delivering tailored monitoring systems and analytical tools that cater to specific customer needs across different sectors.
- **Market Leadership in Innovation:**
  Offering cutting-edge technologies, such as AI-driven analytics and biosensors, to set clients apart in competitive markets.
- **Regulatory Compliance Support:**
  Assisting clients in meeting local and global environmental standards and certifications.
- **Long-Term Cost Savings:**
  Providing solutions that optimize resource use and reduce operational costs over time.

APPLICATION & BENEFIT

APPLICATIONS

- **Industrial Water Management:**
  Real-time monitoring of water quality to optimize industrial processes and reduce pollutant discharge.
- **Environmental Conservation:**
  Tracking pollutants to protect aquatic ecosystems and biodiversity.
- **Policy Development:**
  Providing data and insights to help policymakers create effective environmental regulations and water management strategies.
- **Sustainable Agriculture:**
  Monitoring irrigation water quality to enhance crop yield and minimize contamination risks.
- **Urban Water Systems:**
  Ensuring the safety and sustainability of drinking water and wastewater treatment systems.
- **Water Quality Monitoring in Fish Farms:**
  Ensures optimal water conditions for fish health and growth.
- **Pollutant Detection:**
  Identifies harmful substances such as microplastics, heavy metals, and chemical residues in aquaculture systems.
- **Disease Prevention:**
  Tracks water parameters (e.g., oxygen levels, pH, temperature) to prevent diseases in aquatic species.

APPLICATION & BENEFIT

- **Feed Efficiency:**
  Monitors nutrient levels in water to optimize feed usage and reduce waste.
- **Sustainable Farming Practices:**
  Supports environmentally friendly practices by minimizing pollutant discharge into surrounding ecosystems.
- **Research and Academia:**
  Advancing scientific understanding of water pollutants and their long-term ecological impacts.

BENEFITS

- **Cleaner and Safer Water:**
  Ensures water quality for drinking, agriculture, industrial use, and aquaculture.
- **Informed Decision-Making:**
  Provides actionable insights for resource management and sustainability.
- **Regulatory Compliance:**
  Helps industries and aquaculture operations meet environmental and safety standards.
- **Cost Efficiency:**
  Reduces operational costs and prevents losses through optimized monitoring and management.
- **Sustainability Leadership:**
  Supports environmentally friendly practices and long-term ecosystem health.
- **Enhanced Productivity:**
  Improves yield and quality in aquaculture while minimizing waste and pollutants.
- **Technological Edge:**
  Leverages cutting-edge tools like AI, biosensors, and remote sensing for precision analysis.
- **Market Advantage:**
  Builds trust and competitiveness with sustainable, high-quality products.

POTENTIAL MARKET

- **Industrial Sector:**
  - Factories and manufacturing plants requiring water quality monitoring for compliance and efficiency.
  - Industries seeking solutions to manage and reduce pollutant discharge.
- **Agriculture:**
  - Farmers and agricultural businesses using irrigation systems to ensure optimal water quality for crops.
  - Sustainable farming initiatives focused on reducing water contamination.
- **Aquaculture:**
  - Fish farms and seafood production facilities aiming to enhance yield and ensure water quality.
  - Businesses needing pollutant detection systems to protect aquatic species and comply with safety standards.
- **Municipal Water Management:**
  - Urban water authorities monitoring drinking water, wastewater, and stormwater systems.
  - Cities and municipalities looking to optimize water resource management.
- **Environmental Organizations:**
  - NGOs and conservation groups monitoring water ecosystems and addressing pollution challenges.
  - Research institutions studying the impacts of pollutants like microplastics on ecosystems.
- **Government and Policy Makers:**
  - Agencies developing and enforcing water quality regulations and sustainability strategies.
  - Public sector initiatives focused on protecting water resources.
- **Technology and Innovation Markets:**
  - Developers of AI-driven tools, biosensors, and remote sensing technologies for water quality analysis.
  - Startups and tech companies integrating advanced water monitoring solutions.

NOVELTY

- **Integrated Approach:**
  Combines advanced water quality monitoring with targeted pollutant detection to provide comprehensive solutions.
- **Cutting-Edge Technology:**
  Utilizes innovative tools like AI-driven analytics, biosensors, and remote sensing for unparalleled precision and efficiency in water analysis.
- **Customizable Solutions:**
  Develops tailored systems to meet the unique needs of diverse industries, from aquaculture and agriculture to urban water management.
- **Focus on Microplastics:**
  Addresses the emerging and critical challenge of microplastic pollution.
- **Bridging Research and Application:**
  Translates advanced scientific research into practical tools and actionable insights for real-world implementation.
- **Sustainability-Driven:**
  Aligns with global sustainability goals by promoting environmentally friendly practices and preserving aquatic ecosystems.
- **Market Differentiation:**
  Offers clients a technological edge and innovative solutions that go beyond traditional water quality monitoring methods.

PRODUCT FEATURES

- Real-time Water Quality Monitoring
- Pollutant Detection
- Microplastic Analysis
- Data Integration: Combines sensor data with historical trends for better decision-making.
- Remote Monitoring: Wireless systems and IoT integration for continuous data collection.
- Smart Water Management
- Sustainable Solutions


Bahan asas menggunakan *Macrocomposite©*


Gambaran rekabentuk

RG/RC Name: **Industrialize System (IS)**

TITLE:

Advanced Industrialized Building Solutions for Low-Carbon, Digital, and Resilient Infrastructure.

SYNOPSIS:

The Advanced Industrialized Building Solutions initiative aims to transform the construction sector through sustainable, digitally-driven, and resilient methodologies. By integrating Building Information Modelling (BIM), AI, IoT, and smart materials, this program addresses the industry's urgent needs for cost-effective, eco-friendly, and future-proof solutions. Through close collaborations with industry partners and government bodies, the initiative helps architects, engineers, and construction firms seamlessly adopt advanced practices that reduce carbon footprints, automate processes, and enhance infrastructure resilience.

LEADER:

ASSOC. PROF. DR. AHMAD RAZIN ZAINAL ABIDIN
SIMULATION-BASED DESIGN
FEM & NUMERICAL MODELLING

TEAM MEMBER

1. 
PROF. DR. AHMAD BAHARUDDIN ABD RAHMAN
• Steel & Precast Concrete
• Structural Stability

2. 
ASSOC. PROF. DR. JAMALUDIN MOHAMAD YATIM
• Advanced Composites and Biocomposites

3. 
ASSOC. PROF. DR. IZNI SYAHRIZAL IBRAHIM
• Precast Concrete Structures
• Forensic Engineering

4. 
ASSOC. PROF. DR. ROSLLI NOOR MOHAMED
• Precast Concrete Structures

5. 
TS. BAHARIN MESIR
• Building Information Modelling

6. 
TS. DR. FARIDAHANIM AHMAD
• System Analysis and Architecture

7. 
DR. HALINAWATI HIROL
• Hydraulic and Hydrologic Modelling
• Software Engineering

CONTACT:

RG Group Leader : Assoc. Prof. Dr. Ahmad Razin Zainal Abidin
Email : arazin@utm.my

INTRODUCTION

The construction industry is undergoing a profound transformation driven by urbanization, climate adaptation, and technological innovation. The increasing demand for affordable housing and effective construction practices has necessitated a shift towards sustainable and energy-efficient methods, while the adoption of Building Information Modeling (BIM), IoT, and AI offers streamlined workflows and enhanced resilience. These advancements align the sector with modern demands, prioritizing low-carbon, adaptable, and disaster-resilient infrastructure.

This initiative leverages BIM Labs, computer laboratories, and expertise in computer science and IoT to integrate cutting-edge tools such as AI-driven predictive analytics and IoT-based monitoring systems. By fostering collaborations with industry leaders like CIDB and JKR, and implementing innovative solutions like digital twins and modular construction, the program redefines traditional practices. It positions the Industrialized System (IS) Research Group as a leader in sustainable, digital, and efficient infrastructure development.

NEEDS

1. **Environmental Urgency:**
   - Pressure to reduce carbon emissions and adopt sustainable practices.
   - Demand for green building standards and energy-efficient methods integrated into BIM and IoT platforms.

2. **Technological Gaps:**
   - Limited adoption of tools like BIM, AI, IoT, and digital twins in construction.
   - Need for skilled professionals proficient in data analytics and construction automation.

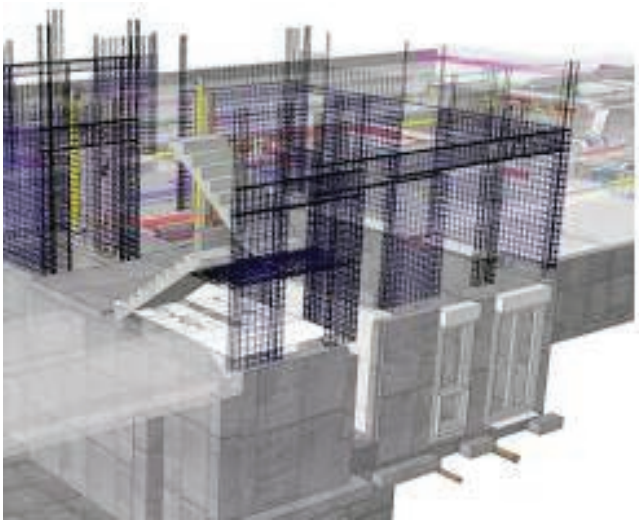
NEEDS

3. Infrastructure Resilience:

- Risks from climate events necessitate disaster-resilient structures.
- Integration of AI-driven simulations and predictive maintenance tools.

4. Productivity & Cost Efficiency:

- Traditional methods face delays, cost overruns, and labor shortages.
- Adoption of modular construction and automated techniques enhances resource optimization.



APPLICATION & BENEFIT

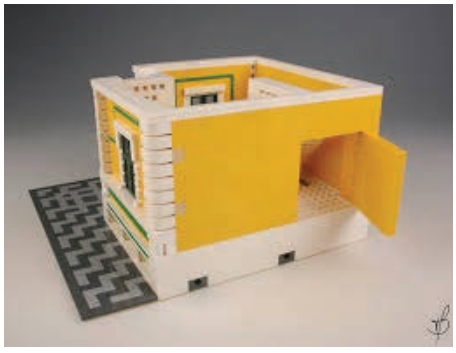
1. Affordable Housing & Effective Construction Practices: Address housing demand with cost-effective, modular solutions.
2. Sustainability: Reduced carbon footprints via eco-friendly materials.
3. Digital Transformation: Streamlined management with BIM, IoT, and custom software.
4. Resilience: Disaster-resistant, climate-adaptive structures.
5. Skill Development: UG & PG-level BIM upskilling programs with tools like REVIT, TEKLA, NAVISWORK, CIVIL 3D, and IBS.

POTENTIAL MARKET

Urban affordable housing and smart city infrastructure are key areas of focus, supported by government initiatives like **SMART City**, and private sector projects such as high-rise developments and industrial facilities. The program fosters collaboration with key stakeholders, including **CIDB, JKR,** and academic institutions, to ensure impactful and innovative outcomes.

NOVELTY

- **Tech Integration:** Advanced **BIM (3D to 7D)**, AI, IoT, and drone technologies for monitoring and defect analysis.
- **Smart Materials:** Eco-friendly innovations like self-healing concrete.
- **Real-Time Insights:** IoT-based monitoring for predictive maintenance.
- **Modular Construction:** Off-site fabrication and rapid assembly for efficiency.



PRODUCT FEATURES

- **BIM Proficiency:** High-level BIM tools supporting **digital twins** and sustainability.
- **IoT Systems:** Real-time monitoring with smart sensors.
- **AI Analytics:** Predictive decision-making for maintenance and operations.
- **Drones & 3D Printing:** Faster workflows and reduced waste.
- **Eco-Friendly Designs:** Low-carbon impact tailored for green certifications.
- **Smart City Readiness:** IoT-integrated infrastructure for urban development.

RG/RC Name: **UTM GreenPROMPT**

TITLE

Artificial Intelligence for Digital Project Management in Construction

SYNOPSIS:

The construction industry, a vital component of the global economy, has long been characterized by complex processes and the need for informed decision-making. The construction industry is reshaping itself along the whole construction lifecycles, including the planning, construction, Operation, and Maintenance (O&M). For the purpose of launching the real digital strategies in CEM, Artificial Intelligence (AI) acts as the backbone to change the way a construction project performs. Appropriate management over the lifetime of a project is a necessity for all sorts of construction projects, aiming to guide the project to success under the control of time, cost, scope, quality, and collaboration.

Amidst the rapid advancements in Artificial Intelligence (AI) technology, the construction industry is experiencing a remarkable transformation in its project management practices. AI is reshaping the landscape of construction project management by enhancing efficiency, improving accuracy, and providing valuable insights.

As AI technologies continue to evolve, their integration into construction management processes will likely become more sophisticated, driving further advancements in the field.

LEADER:

ASSOCIATE PROFESSOR DR ROZANA ZAKARIA

TEAM MEMBER

IR. TS. DR. THONG JIA WEN

IR. KAMALIAH MOHD SAHA

DR. SUZILA MOHD

DR. SHAIFUL AMRI MANSUR

MR. ABDUL RAHIM ABDUL HAMID

CONTACT:

Email : rozana@utm.my
Tel : +6013-7791810

INTRODUCTION

The construction industry has undergone a significant transformation in recent years, with the integration of digital technologies playing a crucial role in revolutionizing project management practices. One such technology that has garnered increasing attention is AI, which has the potential to streamline various aspects of construction project management. AI has rapidly transformed various fields, and the construction industry is no exception. The Construction engineering and Management (CEM) the Architecture, Engineering, and Construction (AEC) industry supply chain has its unique problems and complications, which covers a set of construction-related activities and processes along with human factors and interactions between technology, knowledges and skills. In the context of Industry Revolution 4.0 (IR 4.0), whereby in Malaysia called Construction 4.0, CEM is going through constant innovations towards digitalization and intelligence. In order to realize a considerable boost in automation, productivity, and reliability.

NEEDS

The construction industry is inherently complex due to the nature of the industry itself. Complex project management is a specialized profession that requires a specific set of competencies and a deep understanding of the project and its.

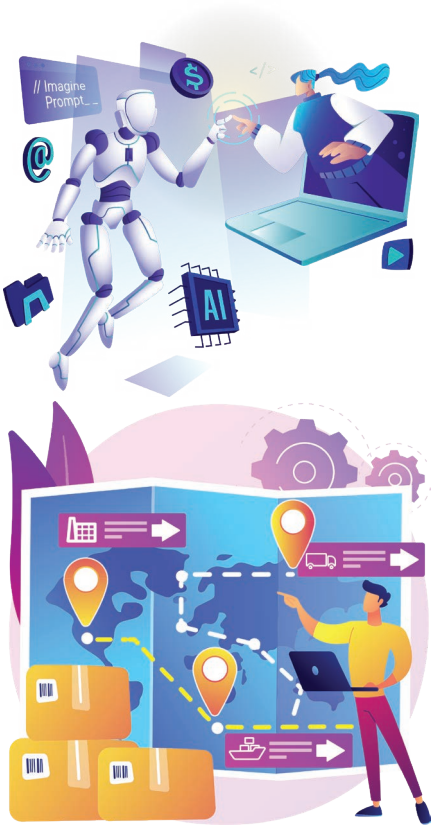
To successfully execute a project in a complex context, project managers must not only address the demands of the increasingly complex environment but also develop the right strategies and be willing to adapt advanced technologies.

The integration of AI technologies, such as the Internet of Things, Augmented and Virtual Reality, 5D-BIM, Autonomous Equipment, and Predictive Analytics, has the potential to revolutionize digital construction project management.

APPLICATION & BENEFIT

AI is influencing this domain:

1. **Project Planning & Scheduling**
   (Predictive Analytics, Optimised Scheduling)
2. **Design Simulation**
   (Generative Design, Virtual Reality, Augmented Reality)
3. **Construction Site Monitoring**
   (Drone and Computer Vision, image analysis)
4. **Risk Management**
   (Risk Assessment, Anomaly Detection)
5. **Cost Management**
   (Cost Estimation, Expense Tracking)
6. **Contract Management**
   (Smart Contract, Document Analysis)
7. **Supply Chain Optimisation**
   (Inventory Management, Logistic Management)
8. **Workforce Management**
   (Labour Productivity, Safety Monitoring)
9. **Data integration Analysis**
   (Centralised Data Management, Advanced Analytics)
10. **Customer and Stakeholder Communications**
    (Chatbot and Virtual Assistants, Feedback Analysis)



POTENTIAL MARKET

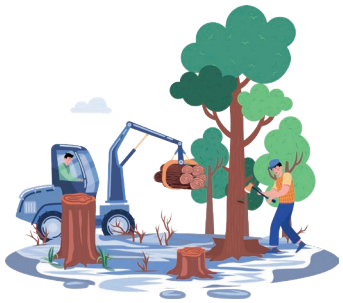
Drivers of Market Growth

- Demand for Efficiency: The construction industry is increasingly focusing on improving efficiency and reducing costs. AI solutions that offer predictive analytics, optimized scheduling, and automated processes are in high demand.
- Technological Advancements: Advances in machine learning, computer vision, and data analytics are making AI solutions more effective and accessible. This technological progress is fuelling adoption in the construction sector.
- Complex Projects: The rising complexity of construction projects, coupled with the need for effective project management, is driving the demand for AI solutions that can handle intricate planning, monitoring, and coordination.
- Labour Shortages: The construction industry faces a shortage of skilled labour. AI can help bridge this gap by automating routine tasks, enhancing productivity, and optimizing workforce management.

NOVELTY

Artificial Intelligence (AI) brings several novel and transformative elements to digital construction project management, enhancing various aspects of the construction lifecycle from planning to execution:

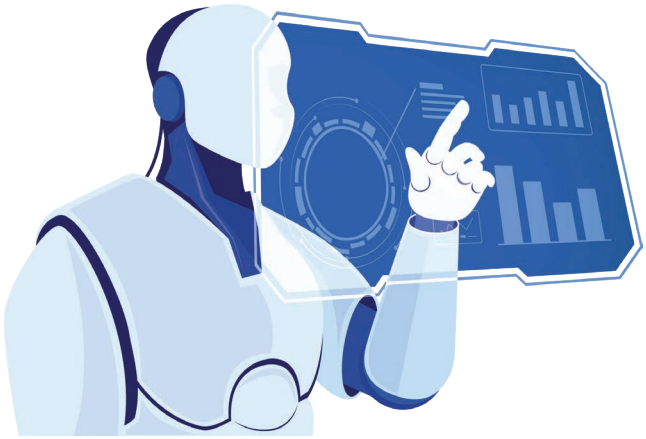
- Advanced Predictive Analysis
- Generative Design
- Real-time Site Monitoring & Analysis
- Intelligent Risk Management
- Smart Contract and Automation
- Enhanced Collaboration and Communication
- Optimised Resource Management
- Enhanced Data Integration and Visualisation
- Sustainability and Environmental Impact
- Continuous Learning and Improvement



PRODUCT FEATURES

AI-driven software/ Dashboard/ Tools:

- To automate and enhance planning and scheduling tasks.
- To streamline processes and solution, fostering continuous improvement.
- To optimize resource allocation, productivity and construction safety.
- To make adaptive learning for more informed decisions, quality control, cost management.
- To evaluate risks factors and updates risk assessment.



Halaman ini sengaja dibiarkan kosong