Cawangan Perak

ISCU 2025

17TH RISM INTERNATIONAL SURVEYING CONFERENCE FOR UNDERGRADUATES

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WELCOME SPEECH FROM THE CHAIRMAN

RISM 17th International Surveying Conference for Undergraduates (ISCU 2025)

بسم الله الرحمن الرحيم السلام

عليكم ورحمة الله وبركاته

Greetings to all,

It is with great pleasure that I welcome you to the 17th RISM International Surveying Conference for Undergraduates (ISCU 2025), themed *"Embracing Construction Revolution 4.0: Transforming Malaysia's Built Environment."* On behalf of the Royal Institution of Surveyors Malaysia (RISM), I also wish to express our sincere appreciation to Universiti Teknologi MARA (UiTM), Perak Campus, for graciously hosting this significant event.

As we navigate the era of the Fourth Industrial Revolution (IR4.0)—or in our context, Construction Revolution 4.0 (CR4.0)—we are witnessing transformative advancements across the global construction sector. Technologies such as Building Information Modelling (BIM), the Internet of Things (IoT), artificial intelligence (AI), robotics, big data analytics, and cloud computing are redefining the way we build, manage, and interact with our built environment. For Malaysia, embracing CR4.0 is a strategic imperative to achieve our socio-economic and environmental goals.

This conference serves as a vital platform to unite surveying undergraduates from various disciplines, fostering critical dialogue on industry challenges, enhancing professional networking, and preparing a new generation of talent for the rapidly evolving construction landscape. It is also an opportunity for employers to engage with and inspire our future professionals.

I would like to extend my heartfelt thanks to all industry speakers, paper presenters, judges, and participants for their time, contributions, and support in making ISCU 2025 a success. I also commend the organising committee for curating a meaningful and dynamic conference experience.

May the knowledge gained, connections formed, and ideas exchanged during this event inspire all participants to lead and innovate in their future endeavours.

Wishing everyone a productive and memorable conference.

Prof. Ts Sr Dr. Adi Irfan Bin Che Ani'
Chairman, Universities' Partnering Committee
RISM Session 2024/2025
May 2025

WELCOME SPEECH FROM CO-CHAIRMAN

RISM 17th International Surveying Conference for Undergraduates (ISCU 2025)

Bismillahirrahmanirrahim.

السلام عليكم ورحمة الله وبركاته and greetings to all.

It is my great pleasure to welcome everyone to the 17th International Surveyor Conference for Undergraduates (ISCU 2025), proudly hosted by Universiti Teknologi MARA (UiTM) Perak Branch in collaboration with the Royal Institution of Surveyors Malaysia (RISM). This event is a meaningful platform for students in the built environment to share ideas, showcase innovations, and build professional networks. We are honoured by your presence and enthusiastic participation, with 135 accepted papers and 78 poster presentations this year.

UiTM Perak, home to the College of Built Environment, has long been a hub for academic excellence in architecture, planning, and surveying. Our commitment remains strong in nurturing competent graduates who meet industry demands and contribute to nation-building.

While you're here, we invite you to experience the heritage and culture of Perak Tengah from the architectural richness of Rumah Kutai to the historical towns of Pasir Salak, Bota, and Kampung Gajah.

To all presenters and winners, congratulations on your achievements. Let your work today be a catalyst for future success and academic growth. We hope this conference will inspire you to explore new ideas, foster collaboration, and make lasting memories.

My deepest thanks to the Royal Institution of Surveyors Malaysia (RISM) and the organising committee for making this event a success.

We hope your experience here will be rewarding and unforgettable.

Thank you. Selamat datang dan selamat berjaya.

Associates Professor Dr. Nur Hisham Ibrahim, *PMP*
Co-Chairman, Universities' Partnering Committee
RISM Session 2024/2025
May 2025

WELCOME SPEECH FROM THE PROJECT DIRECTOR

RISM 17th International Surveying Conference for Undergraduates 2025

Alhamdulillah, all praise to Allah S.W.T. for His guidance and blessings in making the RISM 17th International Surveying Conference for Undergraduates (ISCU) 2025 a reality.

It is with great honour and gratitude that I welcome all participants, guests, academicians, and industry professionals to this prestigious event, proudly organized under the Royal Institution of Surveyors Malaysia (RISM). This 17th edition of ISCU stands as a proud testament to our collective dedication toward academic excellence, professional collaboration, and youth empowerment in the field of surveying.

I extend my heartfelt appreciation to RISM for its unwavering support, to the hardworking ISCU 2025 Organising Committee, and to all 16 partnering universities across Malaysia for their commitment and contributions. Your efforts have shaped this conference into a dynamic platform for knowledge exchange, innovation, and professional growth.

To the academicians and practitioners present, your insights are invaluable in bridging the gap between academic theory and real-world practice. To our undergraduate participants, your passion, curiosity, and commitment are the very foundation of our future. May this conference not only deepen your academic journey but also ignite a spirit of leadership, integrity, and sustainable thinking.

Let this gathering serve as more than an academic milestone. May it foster lifelong networks, inspire transformative ideas, and chart new directions in our shared professional journey.

Wishing everyone a rewarding and inspiring conference experience.

Sr Dr. Nurul Fadzila Zahari
Project Director
RISM 17th ISCU 2025

IDENTIFICATION THE PRESENCE OF AIR CAVITIES USING GPR IN DIFFERENT COMPACTNESS OF SOIL RELATED TO SINKHOLE

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ABSTRACT

Ground Penetrating Radar (GPR) is a widely used method which is non-destructive for underground or subsurface detection. It is used in various field and proved to be reliable and effective. This study focuses on detecting the presence of air cavities using GPR and analyzing the radargram output based on the compactness of soil and different frequencies. The compactness is used to illustrate the presence of cavities underground artificially. The research examines how variations in compactness of soil affect the radargram response in showing the presence of cavities using different frequencies. Experimental results demonstrate that lower permittivity materials enhance signal penetration but reduce reflection contrast, whereas higher permittivity materials result in stronger reflections, improving cavity detection. The findings highlight the importance of frequency selection and material properties in optimizing GPR surveys for subsurface anomaly detection and by having an artificially created cavities, the results can be study to see the changes.

Keywords: GPR, cavities, compactness, frequency.

I. INTRODUCTION

With the rapid urban development and growing infrastructure, the limited space the ground can provide is limited causing the increased use of the underground areas such as transportation, utilities and more. As underground infrastructure grows, accurately mapping utility locations is crucial to maintaining up-to-date data and preventing issues.

In recent years, the Ground Penetrating Radar (GPR) has gained a lot of attention due to its ability to image both metallic and non-metallic targets, which is an important aspect in multiple applications such as archaeological survey (Garcia-Fernandez et al., 2024) landmines (Yarovoy et al., 2007), agriculture (Perez-Gracia, 2023), monitoring moisture content (Cao et al., 2022), or cavities underground to name a few. It shows just how much potential the GPR has and its usability for many purposes.

With increasing underground utilities in urban areas, space has become densely packed with pipes for water, energy, and communication (Broere, 2016). This study aims to identify underground air cavities and analyze soil compactness using B-scan and C-scan methods, which provide clear subsurface visualization and the best results for this research.

II. PROBLEM STATEMENT

The advancement of Ground Penetrating Radar (GPR) has made it an essential tool for underground surveys in construction, archaeology, agriculture, utilities, and environmental studies. By sending electromagnetic waves into the ground, GPR helps detect abnormalities, cavities, and underground structures, preventing potential hazards.

For example, issues like sinkholes or soil collapse caused by dense utility networks and air cavities can be identified early with GPR, allowing for preventive maintenance and soil reinforcement (Alsharahi et al., 2019). Soil compactness is also crucial, especially under roads and buildings, as it ensures structural stability. Factors like material mixture, layer thickness, and weather conditions affect compaction, which influences air voids and dielectric properties (Van Geem, 2023).

Additionally, GPR antenna frequency determines penetration depth and resolution. Lower frequencies penetrate deeper with lower resolution, while higher frequencies provide clearer images but with limited depth (Daniels, 2004). Choosing the right frequency based on survey needs ensures the best results.

III. EXPECTED OUTCOME

The expected outcome of this study is the radargram shown in Figure 1.0 where there are three types of compactness.

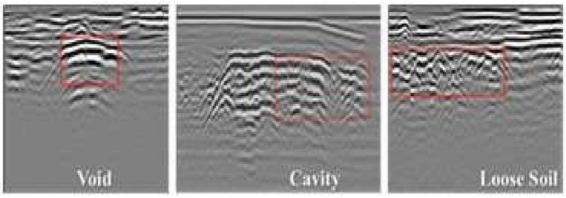

Figure 1.0 Expected Outcome of the study (He et al., 2024)

The expected outcome for this study is to see the difference in radargram image between fully compacted soil, semi-compact soil and absence of soil around the utility underground just like the outcome above which acquired from the previous research in China.

IV. PARAMETER

The GPR operates by sending electromagnetic waves into the ground and detects reflections from underground changes, like material differences or hidden objects (Dong & Ansari, 2011). The time and strength of the reflected signal help locate these anomalies. Signal loss depends on the material's dielectric properties—higher dielectrics weaken the signal more, while lower dielectrics allow it to travel further (Alsharahi et al., 2016). Figure 1.0 shows the principle of GPR in different materials.

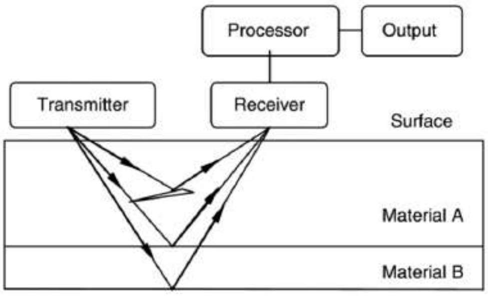

Figure 1.0 GPR working principle (Dong & Ansari, 2011)

V. AIR CAVITY

Human activities such as ground extraction and poor drainage are what causes the soil structure to weaken and create an underground cavity. These cavities form slowly, but acidic water speeds up the process by dissolving soluble rock, making certain areas more prone to collapse (Theron & Engelbrecht, 2018). Research also shows that water and air-filled cavities expand over time as they move through underground voids (Dobrilović et al., 2024).

In Japan, studies found that cavities often cause sinkholes and ground cave-ins. As cavities grow, the instability of their ceilings can lead to surface collapses (Kuwano, 2021). Underground cavities generally form in two ways: naturally, through erosion in calcareous ground, or due to aging infrastructure in urban areas. Sewer pipes older than 30 years are linked to an increase in road cave-ins. However, identifying the exact cause isn't always straightforward, as about one-third of urban road cave-ins occur for unknown reasons.

VI. TYPES OF COMPACTNESS

Soil compaction is used in many fields such as highway embankments, earth dams, engineering structures and many more. The loose soil needed to be compacted to increase their unit weights because compaction increases the strength of the soil subsequently, increases the bearing capacity of foundations built over them. Additionally, compaction improves the stability of embankment slopes and reduces undesired settlement of structures (Das & Sobhan, 2013).

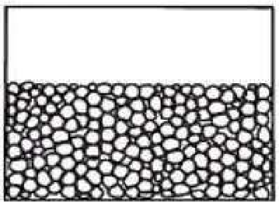

Figure 2.0 Diagram of Compact Soil (Jamal, 2017)

Figure 2.0 shows the diagram of compact soil which is tightly packed with minimal void spaces, achieved through rolling or tamping to increase density and stability(Das & Sobhan, 2013). It has high density, low permeability, and strong load-bearing capacity. The tight arrangement increases dry density, while reduced voids prevent water infiltration, making it useful for landfill liners and roadbeds. Its strength also makes it ideal for construction support (Holtz et al., 2013).

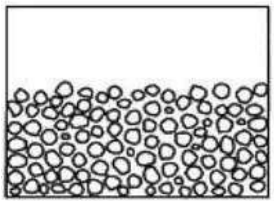

Figure 3.0 Diagram of Semi-Compact Soil (Jamal, 2017)

Figure 3.0 shows semi-compact soil which is a middle state between loose and compact soil, with moderate density and some void spaces. It forms naturally or through light compaction. This soil has moderate permeability, allowing some water infiltration, making it useful for agriculture. However, its load-bearing capacity is lower than generally form in two ways: naturally, through erosion in calcareous ground, or due to aging infrastructure in urban areas. Sewer pipes older than 30 years are linked to an increase in road cave-ins. However, identifying the exact cause isn't always straightforward, as about one-third of urban road cave-ins occur for unknown reasons.

VII. TYPES OF COMPACTNESS

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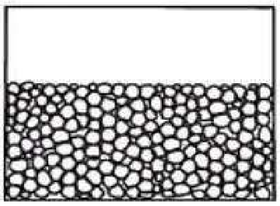


Figure 4.0 Diagram of Compact Soil (Jamal, 2017)

Figure 4.0 shows the diagram of compact soil, which is tightly packed with minimal void spaces, achieved through rolling or tamping to increase density and stability(Das & Sobhan, 2013). It has high density, low permeability, and strong load-bearing capacity. The tight arrangement increases dry density, while reduced voids prevent water infiltration, making it useful for landfill liners and roadbeds. Its strength also makes it ideal for construction support (Holtz et al., 2013).

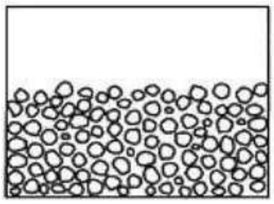


Figure 5.0 Diagram of Semi-Compact Soil (Jamal, 2017)

Figure 5.0 shows semi-compact soil which is a middle state between loose and compact soil, with moderate density and some void spaces. It forms naturally or through light compaction. This soil has moderate permeability, allowing some water infiltration, making it useful for agriculture. However, its load-bearing capacity is lower than compact soil due to the remaining voids (Craig, 2004)

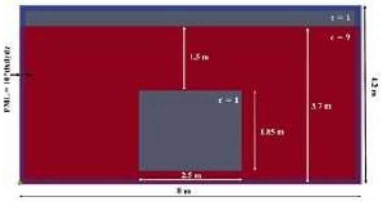


Figure 6.0 Diagram of Void Soil (Persico et al., 2023)

Figure 6.0 shows voids in soil or cavities which are empty spaces between soil particles that can be filled with air or water. A key factor in soil mechanics is the void ratio, which measures the proportion of voids to solid material. Soil voids affect porosity, deformability, and drainage. Porosity refers to the gaps between particles, impacting water flow, compressibility, and air retention. Deformability means highly porous soil compresses and deforms more easily under pressure. Drainage and aeration depend on use voids benefit plant growth in agriculture but can weaken structures in construction (Terzaghi et al., 1996).

VIII. SOFTWARE USED

The software used in this study are ReflexW and Reflex2D which are both specialized software used for processing the GPR data. It was developed by a company named Sandmeier Scientific Software with a goal to provide efficient data visualization, data processing and data interpretation for underground imaging. Reflex2D is a basic software for the users that needed to use it to process two-dimensional data, particularly in underground survey such as geographical, archeology and utility while ReflexW provides tools suitable for processing and visualizing two-dimensional and three-dimensional data. Such features available in the software are filtering, migration and signal gain.

IX. METHOD USED

This study uses B-scan and C-scan methods for data collection, each with a unique way of presenting information. B-scan creates a 2D cross-sectional view by combining multiple A-scans along a survey line, forming a continuous vertical slice. It helps detect and map underground utilities by showing their depth and location (Jol, 2008). It is also useful for identifying underground threats like cavities, sinkholes, or areas prone to land depression (Zhang et al., 2023).

C-scan combines multiple B-scans to create a 3D or plan-view representation, making it ideal for utility mapping. It is also used in fields like archaeology (Conyers, 2016) and for detecting underground changes such as leaks and cavities, which could pose hidden dangers over time (Zhou & Lai, 2023).

X. DATA COLLECTION

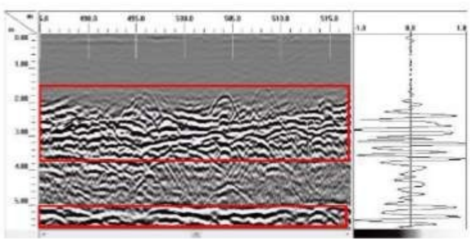
The data collected follows the aim, objectives and problems statement stated. Firstly, a rectangular hole is dig and a pipe will be planted and buried with soil according to the depth and compactness of the soil. Then, the area will be surveyed using GPR to get the radargram output. The step is repeated for the compact soil, semi-compact soil and void soil using different frequency.

For the compact soil, the plan is after digging the soil following the preferred depth, the pipe will be planted on the soil beside the hole where the soil is compacted and not disturbed. While for the semi-compact soil, the soil will just be sprinkled or pushed just enough to fill it without compacting it and overlay plywood over it to illustrate the loose soil and small cavity in the soil. Lastly, for the void soil, the plan is to overlay plywood over the hole to illustrate the void space underground. All of this is to see the difference in radargram output for every type of compactness to see the difference and identify the soil structure for each type of compactness.

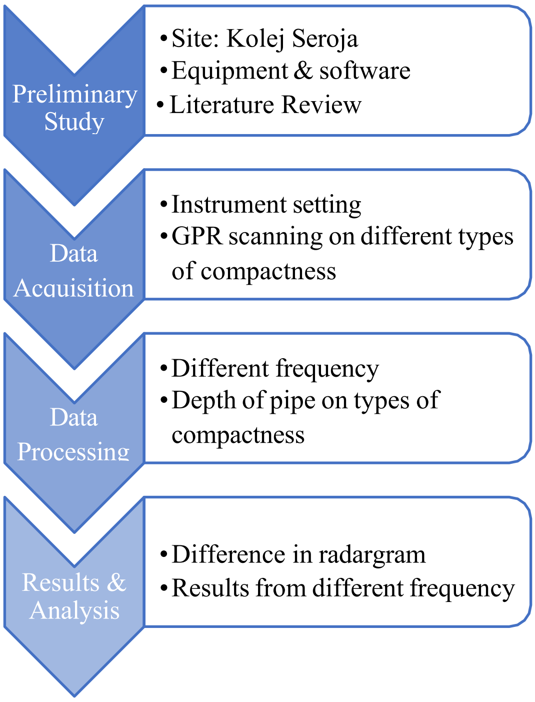
The main data collected during this phase is the real depth, depth from GPR, radargram output on each type of compactness and different frequency on different types of compactness. The method used to collect the data is B-scan and C-scan which can produce the output in the form of two-dimensional and three-dimensional. This truly helps in identifying the depth and location of the pipe underground. It also helps in identifying the location or area of the cavities existing underground.

XI. DATA PROCESSING

The data collected needs to be processed using the Reflex2D and ReflexW software to enhance the image for easier interpretation. It is a common software used to visualize the GPR data into two-dimensional or three-dimensional view. This software provides efficient data visualization, data processing and data interpretation for underground imaging. Before the hyperbola can truly be pinpointed, the radargram data need to go through the filtration and enhancement such as move start time, dynamic correction, background removal, bandpass butterworth, gain and curve fitting. After the enhancement process, the data will be imported in GPR format (.rd3) into the software. Figure 3.2 shows the example of radargram output.



XII. FLOWCHART METHODOLOGY



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