PROCEEDINGS OF JOHOR INTERNATIONAL INNOVATION INVENTION COMPETITION AND SYMPOSIUM 2024 (JIIICaS 2024)

"Flourish and Nurturing Sustainable Innovation for a Prosperous Nation"

JIIICaS 2024
JOHOR INTERNATIONAL INNOVATION, INVENTION COMPETITION AND SYMPOSIUM

Editorial Board

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Preface

In the name of Allah, the Almighty who gives us the enlightenment, the truth, the knowledge and with regards to Prophet Muhammad (peace be upon him) for guiding us to the straight path. We thank to Allah for giving us guidance and strength to write this e-book.

This e-book compiles the extended abstracts that submitted to Johor International Innovation Invention Competition and Symposium 2024 (JIIICaS2024), where JIIICaS2024 is a virtual platform for all creative minds to share and present their invention and innovation. Each abstract gives a brief background on the innovation or project.

We hope that this e-book will help the readers to get to know the innovation done by the students and get some ideas to develop future innovation products.

Foreword Rector

Assalamualaikum warahmatullahi Wabarakatuh, Salam Sejahtera, Salam Malaysia MADANI and Salam UiTM Dihatiku.

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

It is a great honor to welcome you to the Johor International Innovation, Invention, Competition, and Symposium 2024 (JIIICaS 2024). This event connects various disciplines, focusing on education and engaging educators, students, researchers, and innovators from all walks of life.

Innovation is not just about ideas; it demands perseverance, creativity, and determination to turn those ideas into reality. The remarkable projects showcased today highlight the dedication and spirit of all participants. Initiatives like this not only explore new technologies but also cultivate skills and leadership among our youth. At Universiti Teknologi MARA (UiTM) Johor Branch, we are fully committed to fostering a dynamic culture of innovation, promoting the commercialization of new products, and encouraging meaningful collaborations with industry and society.

As we celebrate this event, I would like to extend my heartfelt gratitude to all sponsors, judges, the College of Computing, Informatics and Mathematics, UiTM Pasir Gudang Campus as the event organizer, as well as to the researchers and participants for their hard work in making this event a success. Let us continue striving for innovation and excellence. May the ideas presented today inspire us and lay the groundwork for future achievements.

Thank you.

Associate Professor Dr. Saunah Zainon
Rector
Universiti Teknologi MARA (UiTM)
Johor Branch

(A-ST115) REINFORCED CONCRETE DAMAGE ASSESSMEMNT VIA METAL MAGNETIC MEMORY

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ABSTRACT

Reinforced concrete structures are an essential part of modern infrastructure, and their safety and lifespan are critical. These structures are affected by load-induced and cyclic stresses over time, which can cause concealed structural damage and threaten their integrity. In general, the beam's integrity is determined by the reinforcement in the concrete. As an outcome, monitoring the behaviour of the reinforcement in the concrete is crucial to ensuring the reinforced concrete beam's integrity. The main purpose of this research is to examine the behaviour of the reinforcement in the beam under cyclic loading utilizing a magnetic metal memory (MMM). 8 reinforced concrete beams measuring 150mm x 200mm x 1750mm were produced and subjected to cyclic loading using three point loads. Throughout the fatigue test, the maximum load and minimum load of 90% and 20% of the beam's ultimate load were applied. The MMM was used to scan the underneath of the beam at the centre in a distance of1150 mm. Visual observation was employed in observing the crack that developed in the beam surface under cyclic loading. The MMM approach was discovered to be useful in the detection of RC beam damage. It has the potential greatly improve RC beam safety. Early and accurate damage assessment identifies and mitigates structural faults, lowering the danger of unexpected failure and assuring occupant and public safety.

Keywords: metal magnetic memory, three-point loading, cyclic loading, reinforced concrete beam, steel

1.0 INTRODUCTION

Reinforced concrete (RC) structures are commonly used in construction, such as bridges and carriageways for high-speed railways and dams, they are exposed to cyclic loads over their service life. This type of loading impacts the performance and integrity of the structures, as performance diminishes (Md Nor et al., 2014). As the weight acts continually, the consequences extend beyond the concrete to the steel bars imbedded in it. Noorsuhada (2016) presented an overview of the impacts of cyclic loading on reinforced concrete buildings. It was discovered that the loading leads to the production of cracks in the concrete till failure and necessitates monitoring of the structures during operation to ensure the integrity of the structure.

The metal magnetic memory (MMM) approach has been widely used for stress concentration diagnosis because to its advantages of time savings, low cost, and ease of operation as compared to traditional magnetic flux leakage methods. To date, no theoretical model has been reported to describe the link between stress concentration and SMFL signals in MMM method. Wang et al. (2010) suggested a linear model for analysing SMFL signals in the stress-concentration zone.

The MMM approach may detect these effects using a magnetogram, which shows the dependency of magnetic field intensity on probe distance from the start of the experiment. A specific cart with probes is moved above the surface of the measured region (for example, in a pipe or beam axis), and the device's wheel measures the driven distance. The signal from each channel, along with the distance, is captured in digital form in the device's memory and shown graphically, either directly as Hp or as a gradient dHp/dx. The captured data is presented as a graph (also known as a magnetogram). The inspection can reveal zones with greater stress concentration (SCZ), indicating an increased possibility of changes or faults in the material structure. The concentration of stress is proportional to the magnitude of the magnetic field intensity gradient at a given point. This NDT approach has a significant advantage in measuring speed and sensitivity (Pospisil et al., 2021).

2.0 OBJECTIVE

The objective of this study is to determine the maximum loading capacity (P_{ult}) of the reinforced concrete beam under static loading. It is also to determine the behaviour of steel bar in concrete using Metal Magnetic Memory when subjected to 90% P_{ult} cyclic loading.

3.0 METHODOLOGY

A reinforced concrete beam of 150 mm x 200 mm x 1750 mm was constructed for this study. The fatigue test was carried out at a maximum load of 90% of the beam's load capacity. Throughout the fatigue test, a 1 Hz sine wave was used. The MMM was secured to the beam's lowest section. The scanning line was 1450 millimetres long.

Table 1: Load protocol for the fatigue test

	P_{ult} (kN)	P_{max} (kN)	P_{min} (kN)
SB16	66	59	13
SB12	43	39	9

The static test was undertaken to determine the maximum load that the beam can withstand without severe deflection or failure. This test was performed on two samples: one with a 12mm tension bar and one with a 16mm tension bar. The load technique was used to assess the damage to the reinforced concrete beam. The ultimate load for 12mm and 16mm sample are 43kN and 66kN respectively. The cyclic load test was conducted with maximum load of 90% of the ultimate load while the minimum load was set at 20% of the ultimate load as stated in Table 1. Figure 1 shows the setup of the sample for fatigue test. The fatigue test for each sample was performed for 100 cycles for the first 10 tests, followed by 1000 cycles for the next tests. The test will finish when the sample breaks or the crack width reaches 5 mm.

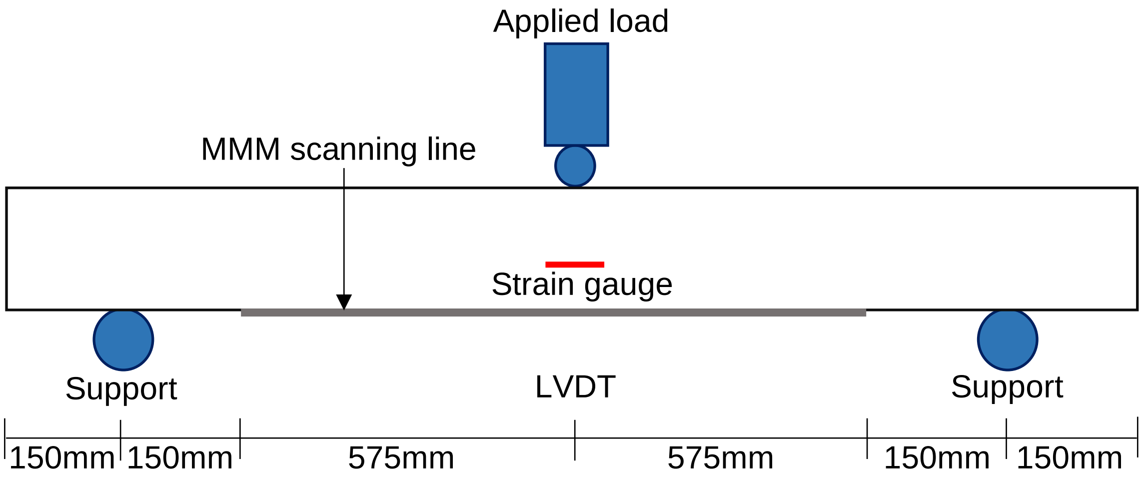
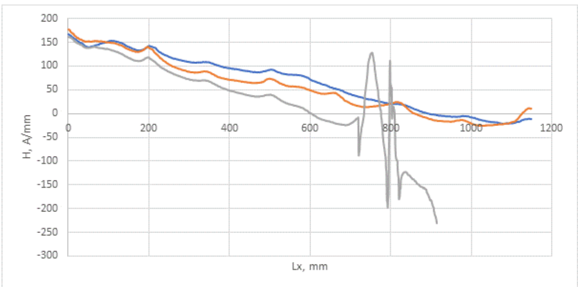


Figure 1: The setup of fatigue test for SB16 and SB12

4.0 RESULTS

The signal Figure 2 depicts the results of metal magnetic memory (MMM) testing on SB16, whereas Figure 3 depicts the results for SB12. At various distances, the Hp-2 value is higher. This is due to the presence of ties for both connection and reinforcement. The link spacing results in a consistent peak distance. SB16 sample fail and break after only 120 cycles. SB12 sample attain 5mm crack widths after 6135 fatigue test cycles.



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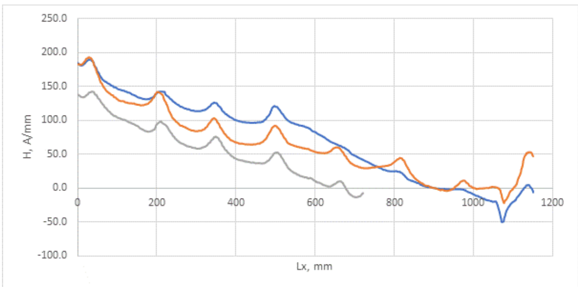

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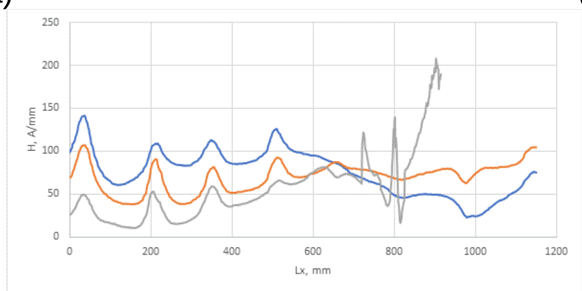


(c)

Figure 2: The MMM result for SB16 at (a) scanning line 1, (b) scanning line 2 and (c) scanning line 3

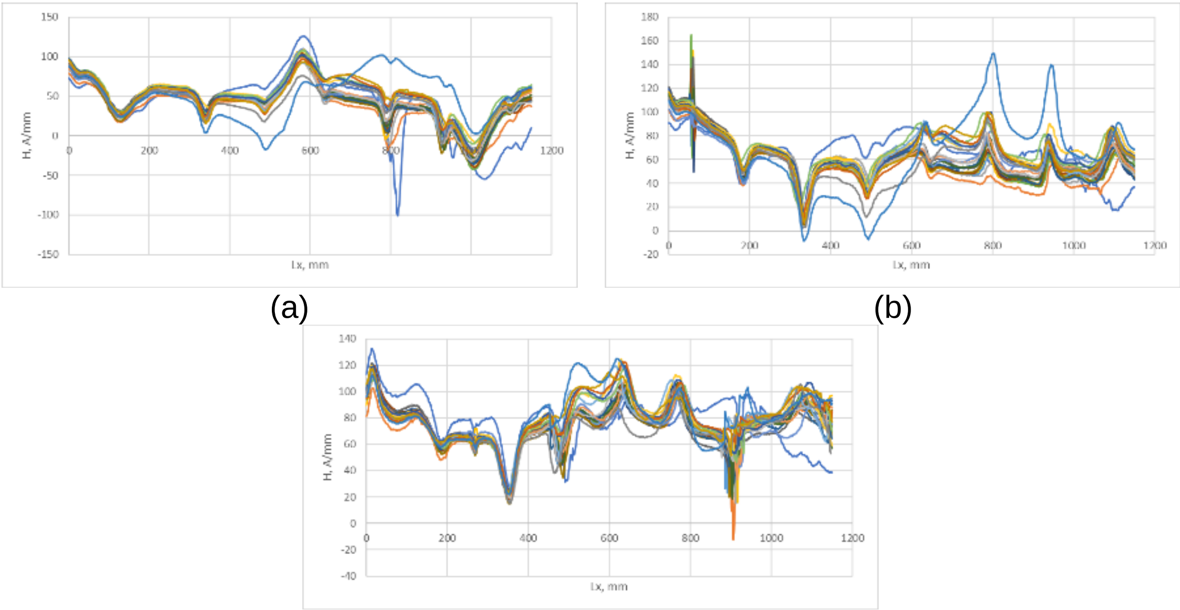
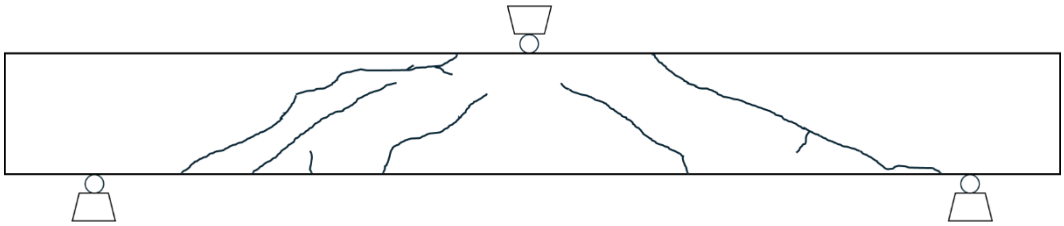
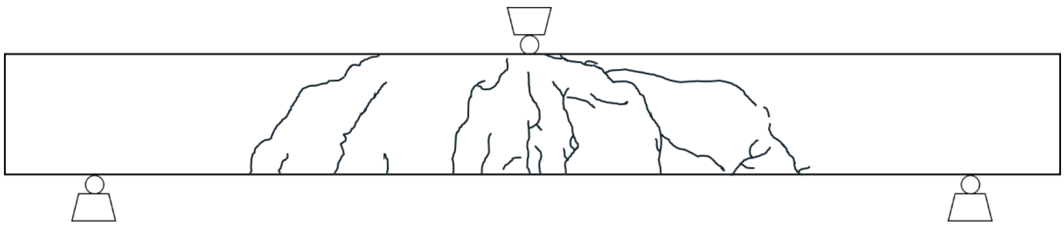


Figure 3: The MMM result for SB12 at (a) scanning line 1, (b) scanning line 2 and (c) scanning line 3



(a)



(b)

Figure 4: Crack pattern of the sample (a) SB16 and (b) SB12

The metallic magnetic storage sensor device can produce two types of magnetic flux leakage signals: component signals, represented by H(p), and normal composite gradient signals, represented by dH(y)/x. The component signal is created by deforming the Hp-1 and Hp-2 signals. Most of the signals had high magnetic gradient values, indicating a zone of large stress concentration. The magnetic flux leakage signals take on a convex shape with each cycle, showing that cyclic voltage deformation causes substantial fluctuations in signal shape. Figures 2 and 3 indicate that the crack growth zones at the scan line are used to characterize the magnetic signal parameters. When a load is applied to the bar, a high signal is detected via HP-1 and HP-2. This shows that the reinforcement in the beam has changed significantly. Figure 4 shows the final crack pattern for SB16 and SB12. From the crack pattern, the failure mode of the samples is shear failure for SB16 and flexural failure for SB12.

5.0 CONCLUSION

In conclusion, the Metal Magnetic Memory approach uses magnetic flux signals to identify faults in reinforced concrete beams. The MMM signal, calculated from the Hp-1 and Hp-2 signal values, reveals considerable stress concentration zones in the centre of the scanned surfaces. As a result, the MMM approach can detect the behaviour of steel bars by increasing flux leakage signals that indicate the zone of stress concentration in reinforced concrete beams.

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