

Condition Assessment and Non-Destructive Testing on Concrete Structure at Pasar Awam Pagoh

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Abstract: An existing concrete building will deteriorate over time due to a variety of factors, which will have an impact on the concrete's durability and structural safety. Assessing the current concrete quality of existing buildings is essential for ensuring safety. The aim of this study is to visually inspect the building and its surroundings, as well as to determine the concrete quality of the existing structure using the rebound hammer test (RHT) and the Ultrasonic Pulse Velocity Test (UPVT). Therefore, visual inspection was conducted at the beginning for achieves the first objective. Additionally, the rebound hammer test and Ultrasonic Pulse Velocity Test were conducted on ten selected columns and six selected columns for UPVT. As a result, the collected data was referenced with concrete quality. Based on the data collected from RHT test, it found that the highest quality of concrete is column 1 and the lowest concrete quality are column 8 and 9. Additionally, the result of UPVT test, it found that concrete quality was different with RHT which there are several Very poor concretes. From the result, the lowest concrete quality is column 1 and column 2. However, by referring to the Jabatan Kerja Raya (JKR) Condition Assessment Rating, we stated that the overall condition is in rating 3. In conclusion, most of the concrete quality is considered as good layer although defects appeared.

Keywords: Visual Inspection, Rebound Hammer Test, Ultrasonic Pulse Velocity Test, Concrete Quality

1. Introduction

In Malaysia, the construction industry has been recognized as a key producing sector from the start of building in the early 1990s with the creation of massive projects. However, the quality of certain Malaysian building projects is not always up to par. The main issue of the construction sector is always the presence of flaws in the work. As a result of the wide range of functions, system types, and construction materials, various facilities produce a wide range of flaws and quality requirements. An

example of defective work is work that does not meet the contract's explicit or implicit standards, including any drawings or specifications and any inferred agreements regarding its quality, execution and performance or design. In most defective building instances, the main stumbling block is the recovery of the expenses of correcting problems that are detected prior to physical harm occurring [1].

As a rule, a structure should be able to withstand a wide range of weather conditions. Especially regarding the building's structure and the many functions it provides. It needs to be adaptable to the building's amenities. To keep the building secure and of high quality for the foreseeable future, it is necessary to eliminate the elements that led to the problems. In construction, defects refer to flaws and difficulties that are prevalent to many constructions. Structure defect are one of the most critical issues that need to be addressed in the construction of a building [2]. Building defects are a common occurrence, independent of the construction method used or the age of the building. The occurrence of defects is dependent on the reasons that cause them to occur [3].

However, building defects and failures occur for a variety of reasons, and the construction sector must address this problem as a serious concern [4]. For example, honeycombs, hairline cracks at beams, defective design, building materials, structural fractures in walls, rusty reinforcing bars of columns, and etc. In addition, rework was required to address a construction issue that necessitated extra time and effort [5].

Furthermore, non-destructive testing is a means of evaluating material integrity for surface or interior defects or metallurgical condition without affecting the destruction of the material or its fitness for use in any way. Materials and components can be evaluated in a variety of ways, depending on the context in which they are being used. Material damage or defects can be identified and characterized using non-destructive evaluation (NDE) or non-destructive testing (NDT) techniques, which don't require cutting the material apart or otherwise modifying it [6].

Therefore, this study aim is to evaluate the causes of defects in Pasar Awam Pagoh buildings and this chapter contain the objectives which are to identify the causes, types and analyses the data from the results.

1.1 Problem statement

One of the major components of a building that required attention was a building defect. When a structure doesn't work as it should, we look for solutions immediately. The responses usually depend on a variety of criteria, such as their age, the unique nature of the problem, the fact that human error existed or was not present, or a combination of factors.

According to the National Building Agency (1985), problems occur because of poor construction, or as a result of the building not being built according to the plan, or as a result of aspects not included in the design. These primary factors may act alone or in combination, resulting in faults manifested as changes in material composition, construction, size, shape, or weight of materials, or simply in appearances.

Moreover, the Bukit Damansara incident opened many people's eyes to the importance of appropriate maintenance, not merely to minimize building defects but also to avoid global disasters. According to the Sunday, December 14, 2008, edition of the New Straits Times. In short, the concrete quality assessment toward existing building is significant and necessary especially aged building to control deterioration efficiently and also to prevent failure of structure such as collapse. Moreover, refers to the observations and view of the community in the building Pasar Awam Pagoh, they have said that "building defect which has existed deteriorate over time". Therefore, due to this matter, it gives concern to the occupants of the building. Through testing, the current concrete quality of the structure can be identified. Based on the result obtained, the parameter that result in the deterioration can be investigated. Objectives of this study were as follows.

1.2 Aim

This study is focused on the current concrete quality estimation of an existing structure with over 30 years of history by using non-destructive test. There is a single storey building that is Pasar Ayam pagoh was selected as testing building. Before testing, visual inspection was conducted to investigate building and surrounding condition. After that, Rebound Hammer Test and Ultrasonic Pulse Velocity Test were conducted on the ten selected column and six selected columns in building. Through testing, the parameters such as Rebound Hammer and Ultrasonic Pulse velocity of concrete were obtained and analyzed to estimate the current quality of concrete.

- i. To identify the type of structure defect from visual inspection.
- ii. To determine the concrete quality of existing structure by using Rebound Hammer test and Ultrasonic Pulse Velocity Test.
- iii. To analyze the data obtained from the testing on site.

1. Equipment and Methods

There was appropriate methodology process in direction of achieving the objectives of this study. To achieve this study, several procedures to conduct the study have been selected as shown in the overview of methodology process in Figure 1.

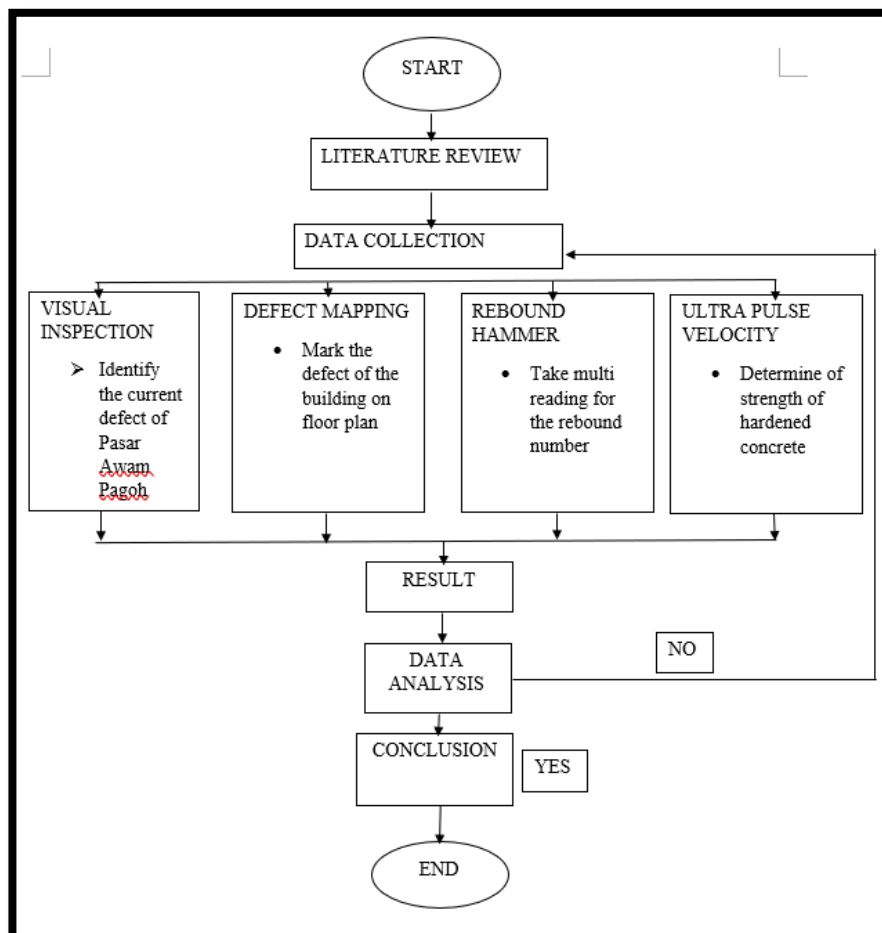


Figure 1: Flow Chart of Entire Project

2.1 Equipment

While conducting this study, there were equipment to be used in determine concrete quality:

a. Rebound Hammer



Figure 2: Rebound Hammer

b. Ultrasonic Pulse Velocity



Figure 3: Ultrasonic Pulse Velocity

2.2 Methods

As for selection of building, Pasar Awam Pagoh was chosen. It is strategically located at Jalan 32, Pagoh, 84600 Pagoh, Johor. A visit at the selected building has been done to find out building defect such as crack, spalling, rebar Corrosion and mould growth through Visual Inspection. To identify the type of structure defect from first objective. Visual inspection has been implemented, which to assess the condition and performance of the building to ensure the building is safe to occupy for another 10 years. Therefore, the report will conclude the level of building safety.

Pasar awam Pagoh consist of non halal section and halal section as shown in Figure 4. The normal operating hours of the building was from 6.00 am to 12.00 pm. However, during this Covid-19 pandemic, the operating hours of the building was still same as before.

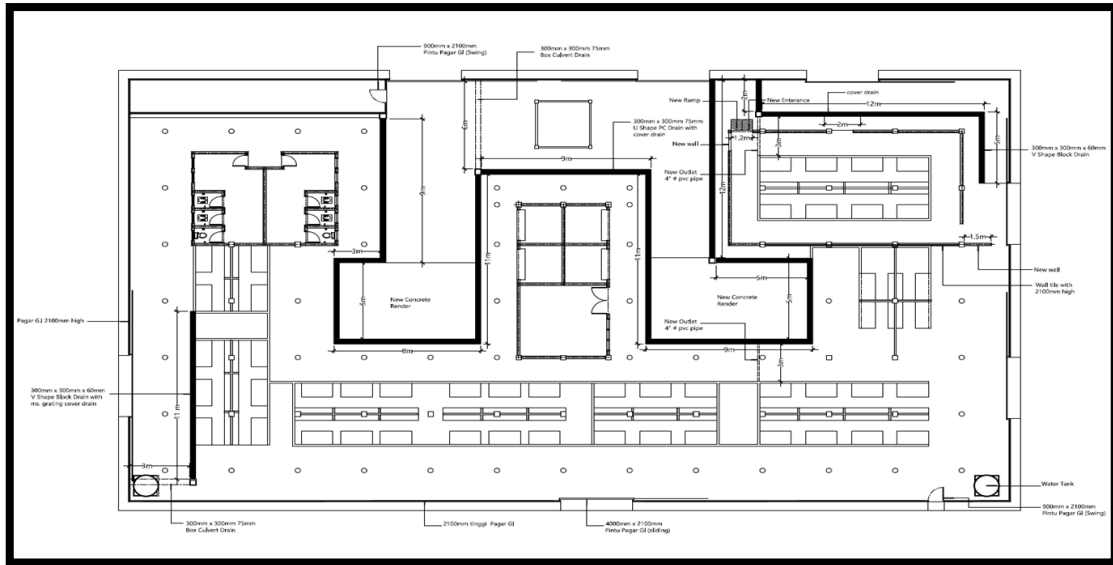


Figure 4: Layout Pasar Awam Pagoh

Besides, Figure 4 shown that the wet market has covered an area about 1363 square meter not including parking space. of Pasar Awam Pagoh. According to Figure 5 shown that position of building defect has been marked and label with color where red marked as floor crack and yellow as column cracked through Visual Inspection.

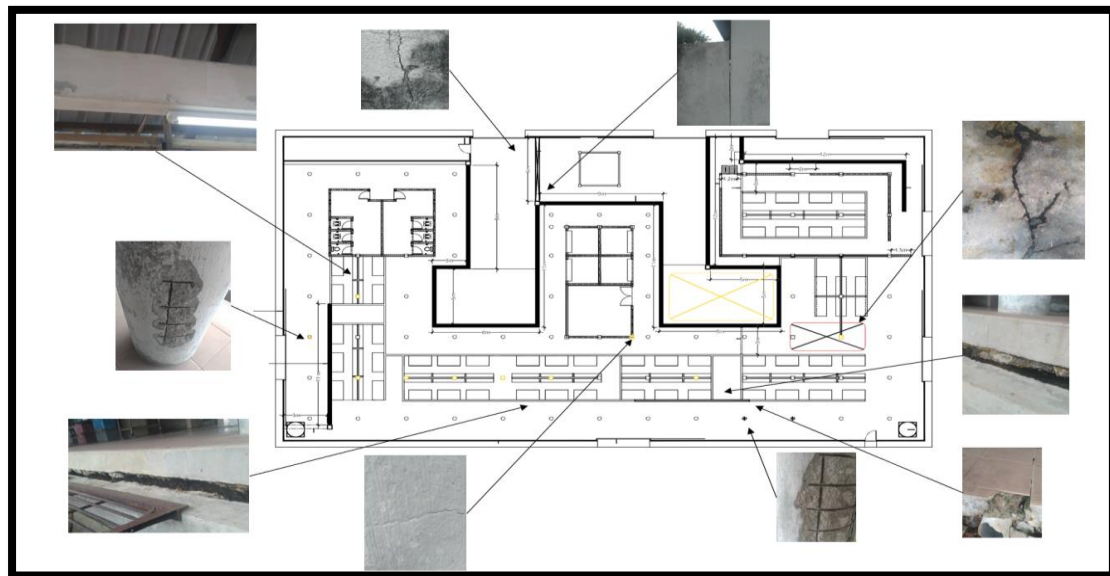


Figure 5: Defect mapping of Pasar Awam Pagoh

However, Rebound Hammer Test and Ultrasonic Pulse Velocity Test were conducted on the ten selected column and six selected columns in building. Through testing, the parameters such as Rebound Hammer and Ultrasonic Pulse velocity of concrete were obtained and analyzed to estimate the current quality of concrete.

For calculation of UltraSonic Pulse Velocity was calculated by using following formula as shown in Figure 6 for UPV testing equation is based on ASTM C597 and Rebound Hammer test was calculated as shown in Figure 7 for average of rebound number has taken for each column of Pasar awam Pagoh.

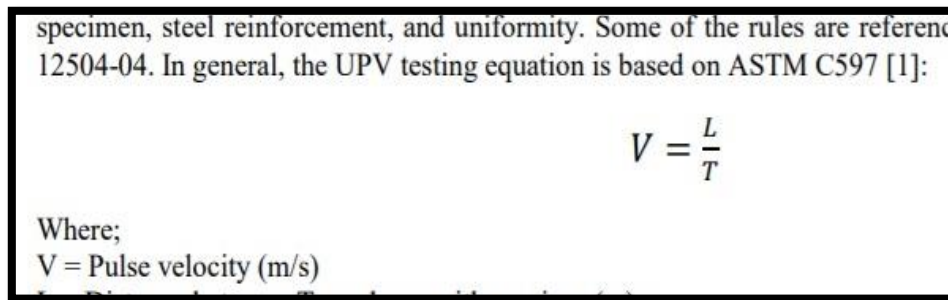


Figure 6: UPV testing equation is based on ASTM C597

$$\frac{\text{Rebound Number}}{\text{Average of Rebound Number}}$$

Figure 7: Average of rebound number

2. Results and Discussion

A rebound hammer was tested on Pasar Awam Pagoh on a defect that potentially has strong concrete quality. Below is the table that we had summarized for the data:

Table 1: Rebound Hammer Result for ten columns

Test Location Structure	Mean, R	Angle (0 °)	Corrected, R
Column 1	50.33	0	50.33
Column 2	44.11	0	44.11
Column 3	44.89	0	43.50
Column 4	40.33	0	40.33
Column 5	38.67	0	38.67
Column 6	39.78	0	39.78
Column 7	39.78	0	39.78
Column 8	38.22	0	38.22
Column 9	38.22	0	38.22
Column 10	39.90	0	39.90
	Average		41.284

From the Table 1 shows that most of the defects that exist on the column are cracks and most of the quality concrete of Pasar Awam Pagoh was a good layer according to Quality of concrete according to rebound number (P.K Gupta., 2015). Therefore, it can conclude that the average of rebound number is 41.284 which, the very good hard layer.

Table 2: Ultrasonic Pulse Velocity result of six column

Location (Structure)	Distance (m)	Velocity (m/s)
Column 1	0.290	1446.38 (Very Poor)
Column 2	0.290	3586.89 (Good)
Column 3	0.290	3493.98 (Medium)
Column 4	0.290	1448.55 (Very Poor)
Column 5	0.290	3090.04 (Medium)
Column 6	0.290	3184.36 (Medium)

The Table 2 shown the overall result of the Ultrasonic Pulse Velocity of Pasar Awam Pagoh. The Velocity shows the distance of pulse between transducer in meter per second. From the result, most are medium and concrete Quality except Column number 4. This result was compared with a table of concrete Quality in structures in terms of the ultrasonic pulse velocity. This testing can be categorized as minor defects because testing results need various aspects not just by Velocity but maybe the strength of the concrete itself. However, very poor result of the defect is because the defect is serious and must be observed for maintenance. Overall

3. Conclusion

In this study, there are totally three objectives. The first objective is to investigate building condition and building's surrounding condition. To fulfill these objectives, a visual inspection was conducted. Through the visual inspection, the general information such as function of building had been collected. Moreover, the building condition has been observed. It found that some foundations of building are damage is slightly critical, necessitating the implementation of routine maintenance work. The wall cracking and separation between wall had been occurred on this building. Furthermore, the visual inspection also used to observe and investigated of the condition testing on column of the building. It discovered the testing experiencing some defect, column cracking.

The second objective is to determine concrete quality of the existing building. To fulfill this objective, the RHT and UPVT were conducted on ten column and selected six columns. Based on the result obtained, it discovered highest concrete quality of all tested column are 50.33 (obtained from RHT) and 3586.89 m/s (obtained from UPVT) respectively. Moreover, lowest concrete quality obtained are 38.22 (obtained from RHT) and 1446.38 m/s (obtained from UPVT) respectively. Based on the result of the Rebound Hammer Test and Ultrasonic Pulse Velocity value. It found that the average of rebound number is 41.284 which, the very good hard layer (based on Rebound Number) and most of UPV was medium concrete quality.

The third objective is to analyze the data obtained from the testing on site. Based on the result obtained, it discovered that both tests carried out according to procedure of Rebound Hammer Test and Ultrasonic Pulse velocity Test. Based on the result obtained there are difference in result of concrete quality. Both tests discovered different result may be due tool being used correctly or there is an error with the equipment being used.

However, this study concluded that the major defect on Pasar Awam Pagoh is Crack. This might be happening due to is due the existing standard are not followed the requirement, and it's also because the building is very old. This is because most of the cracks are lack concrete cover.

Thus, based on the inspection that has been done, we conclude that Pasar Awam Pagoh can still be used. However, by referring to the Jabatan Kerja Raya (JKR) Condition Assessment Rating, we stated that the overall condition is in rating 3. The detected damage is slightly critical by visual inspection, which necessitates the implementation of routine maintenance work. Due to that, Muar Municipal Council should be aware, and they were suggested to take a safety precaution and do a major repair towards the building. This is essential to ensure the safety of occupants.

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