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Identification of Structural and Non-Structural Defects of Load-Bearing Wall Systems in Low Rise Buildings

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ABSTRACT

Malaysia is one of the developed countries that has grown rapidly in various sectors including the construction sector. However, there are some defects in non-structural and structural load-bearing walls. One of the components that needs attention is structural and non-structural defects of load-bearing wall systems in low-rise buildings. The study aims to provide insights into the identification of common structural and non-structural defects of load-bearing walls, investigate the main causes that lead to structural and non-structural defects, and provide suggestions concerning the methods and strategies for rectifying both structural and non-structural flaws in load-bearing walls. According to the study, construction material, maintenance of building condition, overloading, water damage, design flaws, foundation settlement vibration, and seismic activity. The types of structural and non-structural defects at load-bearing walls are major cracks, honeycomb, dampness, foundation issues, peeling paint, spalling, termites, and efflorescence. The method and strategy for rectifying both structural and non-structural flaws in load-bearing walls are crack repairs foundation repair material replacement load redistribution. In conclusion, this study contributes to the existing body of knowledge by providing a thorough evaluation of structural and non-structural flaws in the load-bearing wall systems of low-rise structures.

1. Introduction

The state of structural integrity and resilience for low-rise buildings in Malaysia's growing construction sector is critical in maintaining the safety of such structures over time and securing habitable units in them [1-5]. As the country is undergoing rapid urbanization and increased infrastructure developments, the degree of attention on construction defects is increasing. Load-bearing wall systems are an important element in many underlying low-rise structures' stability and usefulness that this proposal will attempt to discuss the complex issue of structural and non-structural flaws within them [6-10]. Furthermore, the construction faults increase maintenance cost,

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reduce building lifetime, and create immense damage to the environment and are therefore harmful for the proposed consideration [11,12]. In a similar way, the impact of shortcomings within domestic properties with respect to the ability to avoid or reduce issues occurrence, economic and consumer satisfaction elements [13-15]. Such elements could complicate low-rise structure evaluation of structural and non-structural imperfections. In addition, Mydin [16] warn that defective management of building defects has serious implications for owners as well as users' security. Such a shortage could hamper the success of this recommended appraisal [17]. The deterioration of the architectural features, as well as the need for speedy building condition assessments, are also highlighted by Sulieman *et al.,* [18]. If these flaws are not corrected promptly and effectively, the whole planned appraisal might fail. The current body of evidence indicates that a host of factors influence both the structural defects and the non-structural deficiencies within a wall system in low rise buildings. The lack of originals and replacements in the Malaysian domestic market negatively affects maintenance practice, resulting in insufficient maintenance. Such an aspect may lead to poor upkeep and replacement of load-bearing wall systems in turn can undermine their structural stability and functionality. This research is aiming to identify common structural and non-structural defects of load-bearing walls. It is also to investigate the main causes that lead to structural and non-structural defects of load-bearing walls. In addition, to provide suggestions concerning the method and strategy for rectifying both.

2. Literature review

2.1 Definition of Load Bearing Wall

According to Sotelo and Pino [19], the structural load bearing wall is one of the important architectural capabilities which transfer vertical hundreds and forces to other supporting elements of the building along with its own weight and externally introduced hundreds. The construction's vital component manufactured from metallic, concrete or masonry ensures the overall strength of the shape. The loads bobbing up from wind, gravity, seismic, and so on arise on this structure. These hundreds act upon them deliberately to distribute these wall hundreds evenly within the shape with the intention to resist this distribution of the load across the shape.

2.2 Definition of Structural Defect of Load-Bearing Wall

A structural fault in load-bearing walls is a mistake or mistake within the layout or construction of partitions that preserve the burden of the complete structure or a big part of it. To distribute the masses from a shape's numerous elements, along with its flooring and roofs, to the base, load-bearing walls are crucial. Any flaw in those partitions would possibly jeopardise the constructing's normal balance and protection. For example, major cracks [18].

2.3 Definition of Non-Structural Defect of Load-Bearing Wall

A common non-structural defect in load-bearing partitions refers to problems or imperfections that, even as not immediately compromising the structural integrity of the walls, may additionally still affect the advent, functionality, or durability of the building. These flaws commonly do not endanger the shape's well-known stability; instead, they should do with look, functionality, or renovation. For example, cosmetic crack, paint or finishing defect, dampness, water stains and efflorescence [20].

2.4 Common Structural and Non-Structural Defects of Load-Bearing Walls

In Malaysia, load-bearing walls, which are essential in ensuring the general stability of buildings, suffer from a variety of common defects, that affect structural safety and durability. Most of these defects are structural and may relate to bad workmanship during construction or low-quality construction materials. Examples of such defectives are insufficient reinforcement, weak mortar joints resulting from faulty mixing of concrete, and weak load-bearing capacity caused by poor bricklaying or blockwork [21]. Such defects reduce the effectiveness of walls to carry the vertical loads safely and without the risk of collapse from earthquakes, overloading, etc. Non-structural defects do not imminently endanger the stability of the building; however, they are of great concern. Probably the most common is cracking which may be the result of thermal expansion, settlement, or processes that relate to moisture variation - extremely common for tropical countries like Malaysia, where changes in humidity are quite sharp [22]. Further, the waterproofing or damp-proofing provisions, inadequately designed or constructed, facilitate easy ingress of moisture and cause efflorescence, eventually leading to mould growth and material decay [23].

2.6 Main Causes that Lead to Structural and Non-Structural Defects of Load-Bearing Walls

Defects in load-bearing wall elements such as structural or non-structural ones can show, each in their way, affecting the safety, durability, and functionality of buildings. The defects most likely arise from failures related to design, construction, or materials [24]. Inadequate structural design mostly relates to the estimation of a load or poor detailing of reinforcement, resulting in weakened load-bearing walls, hence experiencing cracking or failure under stress. Poor construction practices include improper curing of concrete, inadequate compaction of masonry units, or poor supervision during the construction process, which can cause uneven settlement, misalignment of the walls, or weak bonding strength between the materials to achieve overall structural integrity. Non-structural defects may be less immediately critical; however, they are still a management issue that contributes toward the degradation of load-bearing walls over some time. Climatic factors play a great part here, wherein moisture becomes the principal performer. Poor waterproofing or damp-proofing permits the ingress of water into the construction, hence ensuing efflorescence, moulds, and deterioration of mortar, plasters, or other materials. Secondly, poor ventilation enhances these problems and can foster condensation and mould issues in a humid climate. Further, the thermal expansion and contraction due to temperature variation can cause cracking, especially for walls where mismatching coefficients of expansion material usages are used without proper consideration.

3. Methodology

3.1 Case study

This case study investigates a few architectural projects based in Penang, Malaysia. These are projects such as Durian Baby and Friends on Lebuh Acheh, Kedai Jeruk Tempayan on Jalan Chowrasta, Kong Fatt Trading on Lebuh Carnarvon, Yi Ping Fang Art Studio on Jln Arumugam Pillai in Bukit Mertajam, and the Fun Tea Garden on Jalan Dr Lim Chwee Leong in George Town. Each of the case studies was focused on the design process, functionality, environmental considerations, and the effect of these structures on their users and the neighborhood. The information shall be gathered through a comprehensive viewport, observation, and interviews with relevant professionals so that an in-depth understanding of the architectural features and their problems/defects may be carried out.

3.2 On-Site Assessment

On-site evaluation and assessment refer to a process whereby a property or a physical location is evaluated from within its area. Assessment through site visit shall be through observation of the conditions, inspection, and collection of relevant information about its condition and functionality with its peculiar characteristics or inherent attributes.

3.2.1 Rebound hammer test

The structure's strength can be evaluated once the relationship between the compressive strength and rebound number has been established. As strength increases, the frequency of bounces typically increases as well. Several factors, including cement type, aggregate type, surface moisture content, concrete age and curing, concrete surface carbonation, etc., can affect bounce frequency.

Table 1
Average rebound hammer

Average rebound number	Quality of concrete
>40	Very good hard layer
30 - 40	Good layer
20 - 30	Fair
< 20	Poor
0	Delaminated

3.2.2 Dampness test

A concrete encounter, also known as a moisture meter, is essentially a device created to measure the level of moisture content within walls, particularly those built with either concrete or masonry. This device becomes quite vital in telling how dripping or damp a wall really is, since this always affects the structural integrity and durability of any building. It can detect and displaying the moisture levels just by pressing the moisture meter against the wall surface, thereby detecting any possible issues with water intrusion. The regular use of a moisture meter will allow for early detection of moisture problems, which aids timely interventions to prevent further damage and maintain the health of the structure.

3.3 Interview Session

The guided interview session is geared towards suggestions regarding the method and strategy that will mitigate these structural and non-structural defects in load-bearing walls. It shall bring out good practices for their identification and diagnosis of issues such as cracks, moisture damage, and settlement. This shall form part of a discussion entailing the analysis of several techniques of repairs: from reinforcement materials and underpinning methods to sealants and protective coating applications. In this session, much emphasis will be placed on the integrity and safety of the structure, cost-effectiveness, and durability of the proposed solutions. It also aims to ensure preventive measures and maintenance strategies for mitigating future problems in the load-carrying walls to guarantee long-term stability.

Table 2
Demography of respondent

Demographic	Mr. A	Mr. B	Mr. C
Position in industry	Building Surveyor	Civil Engineer	Architect
Experience in industry (years)	2	11	3

4. Results and Discussion

4.1 Type of Defects

This section shows the defects at the case study.

4.1.1 Major cracks

A can be seen in Figure 1(a), major cracks in building walls are among the major structural defects attributed to weather-related factors, especially extreme temperature fluctuations and high humidity. The major reason for these cracks is normally due to the thermal expansion and contraction going on with various building materials that expand when the temperature is extremely high and contract in cold conditions. This repeated movement over time weakens the structural strength and causes major cracks in the walls. High humidity thus exacerbates this by increasing the level of moisture within the materials to go through more expansion and contraction cycles. It is this kind of stress, combined with other possible factors like bad construction practices or degradation of the materials, that eventually leads to the visible hazardous cracks described by Verstrynge *et al.,* [25]. These issues are addressed by in-depth knowledge of local climate conditions and construction techniques for handling thermal movement and moisture control.

4.1.2 Peeling paint

As shown Figure 1 (b), peeling paint is common and is influenced by a few environmental factors related to moisture, temperature changes, and failure to prepare the surface properly before painting. Then, depending on the high level of humidity or direct water exposure of the walls, some amount of moisture drawn into the layer of paint and substrate can occur, which reduces the bonding force between paint and wall surface. These temperature changes make the wall and paint expand and contract at different rates, causing stress that further compromises this bond. Also, if the wall surface has not been properly cleaned, primed, or dried before painting, the paint, in the first instance, adheres poorly. With time, these stresses and weaknesses appear in the form of cracking, peeling, and detaching of paint from the surface, thereby spoiling the aesthetic appeal and rendering the wall prone to damage by the environment. Therefore, due care must be taken for proper surface preparation and the right materials specified for bearing the specific environmental conditions [26].

4.1.3 Old concrete wall texture

A can be found in Figure 1 (c), concrete surfaces become rough, uneven, and worn due to several environmental forces and regular use. Environmental exposure is a major cause of deterioration of the concrete, meaning weathering by winds, rains, and changes in temperatures. The winds wear down the surface, with rainfall adding water that infiltrates into it, while at low temperatures it freezes, causing internal damage. Temperature change expands or contracts the concrete, which can be the cause of cracking and roughness on the surface. Other factors, such as physical usage like foot or vehicular traffic further hasten the trend. All these effects result in an aesthetically unpleasing concrete that appears rough and worn out [27]. More importantly, it has underlying risks to its structural integrity in the long run. Proper maintenance and protective measures must therefore be taken seriously to reduce these effects on concrete surfaces and increase their lifespan.

4.1.4 Efflorescence

As illustrated in Figure 1 (d), Efflorescence is a crystalline deposit of salt, often, on the surface of masonry and is undesirable both aesthetically and functionally. It could be a result of poor workmanship in building or bringing a building to completion. Poor preparation of the surface, improper laying on plaster or paint, and poor finishing are common causes that bring about uneven wall surfaces and can easily lead to efflorescence. When these salts are dissolved by moisture and come to the surface, they form white, powdery stains that can mark their appearance on the wall [28]. From a functional perspective, efflorescence can serve as an indication of deeper moisture problems that, someday, may compromise the building materials. Proper construction methods from appropriate surface preparation to high-quality finishing materials go a long way to preventing this problem on its own.

4.1.5 Holes

Figure 1(e) shows the cracks, these holes in walls are mostly explained by moisture damage or by differences in the moisture content of these construction materials. Water intrusion can lead to the formation of such holes in several ways. Water can enter the wall structure through leaking plumbing or roofing, inadequate waterproof coatings, and an absence of, or deficiency in, damp-proof courses [29]. In the case of prolonged wetness, this is very well developed, leading to the degradation of the material and the formation of holes. Water enters the wall, weakening the structure of the wall, whereby plaster or drywall falls apart to form holes and cavities. Proper waterproofing, maintenance, and timely repairs can prevent or help one avoid the occurrence of such moisture-caused damage.

4.1.6 Mould

As can be seen in Figure 1(f), High-level humidity or condensation is usually the primary reason for mould growth on walls. Excessively humid air is likely to condense into water on cooler surfaces like walls when there is a fair temperature difference between indoors and outdoors. This condensation can foster mould growth. Moreover, further aggravation can result from other sources of water intrusion into the dwelling, including those caused by plumbing leaks, a broken roof, or seal failure around windows [30]. These sources become constant providers of water, which then enhances the progressive development of mould. Proper ventilation, maintenance of plumbing systems, and inspection and repair of possible points of entry for any kind of water intrusion are preventive measures against mould growth.

4.1.7 Honeycombing

As visible in Figure 1 (g), honeycomb defects are characterized by the existence of voids or gaps that resemble the structure of a honeycomb and therefore compromise the integrity and strength of concrete. These defects usually result from several key problems during the construction process [6]. The first is flawed compaction, where inadequate pressure is applied to the mix, hence not being capable of completely filling the forms. Another critical factor is insufficient vibration while pouring, which aids in removal of air pockets and ensures uniformity of mixture without which voids will be formed. Very significant also are the environmental conditions: these may reach very high temperatures that shall increase the rate at which not only the evaporation of water needed for proper curing takes place but also humidity variations, both, which will result in honeycombing. These defects decrease the structure capacity of concrete, its durability, and life; they also call for due attention during construction practices and environmental conditions to avoid creating them.

4.1.8 Vandalism

As illustrated in Figure 1 (h), This style of damage is reflective of a widespread graffiti culture wherein individuals deface public or private property with unauthorized markings or designs. This culture often crops up due to various socio-economic factors, like an unhappy urban environment, social alienation, and a desire for expression of self. The best way to deal with the situation is to understand the impulses and societal context that continue to perpetuate such behaviour. It is also, many a time, an intricate product of the interplay between these socio-economic factors, urban milieus, social alienation, and the urge for self-expression [31]. This multidimensionality of graffiti explains why it cannot simply be conceived of or looked at as an act of vandalism but is rather a carrier of deeper social issues and the urge for individual identity and visibility within a community. It will be imperative to understand and address these root causes, which contribute to strategies for mitigating graffiti use without necessarily pushing back on the positions and needs of those engaging in the graffiti.

4.1.9 Dampness

As can be found in Figure 1 (i), leakages from broken roofs and burst pipes, as well as faulty seals of window frames allowing water into the walls, are the main reasons for water infiltration into the building. Poor ventilation reinforces this process by preventing the moist air from being released to the outside atmosphere, where it will evaporate, thus leading to perpetual dampness [32]. These conditions certainly contribute greatly to mould proliferation, structural damage, and deterioration of indoor air quality. An effective solution will have to involve not only the sealing of leak sources but also enhancing ventilation to let moisture that can infiltrate into the building evaporate efficiently and outgas it to keep it dry and healthy indoors.

4.1.10 Vegetation Encroachment

Figure 1(j) shows the cracks that occurred at the wall. Encroachment of vegetation refers to the growing of plants or weeds on or around surfaces of walls. Often enough, this is abetted by factors such as sunlight exposure and amounts of humidity that create a conducive environment for the growth of plants [33]. Eventually, this growth leads the roots to enter the cracks of the walls and develop physical damage, thus impairing their structural integrity. It may also serve to retain some moisture against the wall, just perfect for further decay and thereby weaken the structure. Addressing vegetation encroachment, therefore lays in the form of regular maintenance, wherein after scraping off the plants and repairing the cracks an inclusion of managing the environmental factors that led to the growth in the first place is made. This will ensure surface protection against the building from external factors is retained for as long as needed.

4.1.11 Fungus

As can be seen in Figure 1(k), Fungus growth on walls is greatly influenced by a set of factors that combine to provide a friendly environment for the proliferation of fungi. High levels of moisture are chief among these and are usually due to pipe, roof, or window leakage that allows intruding water to stay within the walls [32]. Such wet environments are ideal for fungi to grow and breed since fungus germinates and grows only in a moist environment. Once established, the fungi will further perpetuate the problem of moisture by retaining both water and nutrients, hence creating an environment that will create serious damage, such as decaying organic materials or degrading wall surfaces. This can be achieved by stopping the ingress of moisture at its source and curing it through improved ventilation, although fungicidal treatments will likely be required to prevent re-growth and protect the building structure.

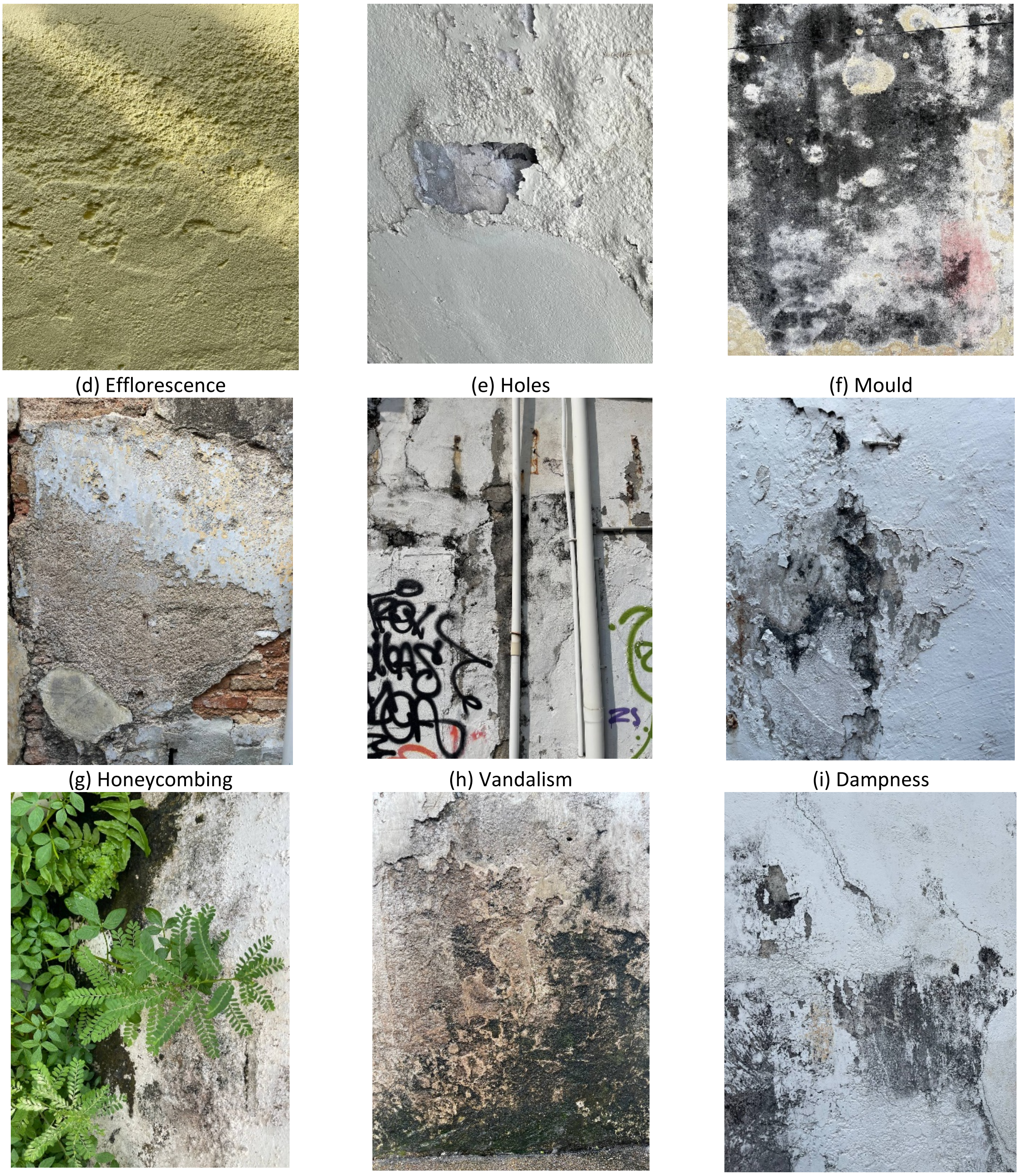
4.1.12 Crack

Figure 1(l) shows the cracks that occurred at the wall. Cracks in walls are mostly the result of natural aging and wear over time. Various factors act together to bring about this kind of worn state of a building. Environmental exposure to sun, wind, and moisture makes most of the materials weak. Other factors include structural stress during the settlement or movement of buildings, while others could be from regular use and vibrations that cause the formation of cracks in them [34]. These cracks may start small but later begin to widen, making the wall vulnerable to infiltrations of water into the wall and thus causing deterioration. This may be the source of other problems related to structures in buildings. It is, therefore, the only way to ensure the durability and safety of the buildings by inspecting them regularly for cracks and repairing them at the most opportune time, fixing the problem before it leads to higher structural problems.

(a) Major cracks

(b) Peeling Paint

(c) Old Concrete Wall Texture



(d) Efflorescence (e) Holes (f) Mould
(g) Honeycombing (h) Vandalism (i) Dampness
(j) Vegetation Encroachment (k) Fungus (l) Cracks

Fig. 1. Types of defects

4.2 Method of Rectifications

This section refers for method of rectifies for every defect at case study:

4.2.1 Structural repair

As can be seen in Figure 2(a), Major wall cracks may require strong structural repairs for stability and durability. Epoxide or polyurethane injection is done to seal bigger cracks [35]. This is effective since the injected materials seal tightly and bond well with the damaged surfaces, thus offering durable repairs. In other cases, metal reinforcement is needed, mostly in serious structural problems, before the crack is sealed off. This is simply done by running metal bars or a mesh across the crack to give more strength to the structure of the wall for it to stay together in one piece and not give way. Once this foundation of reinforcement is built, then the injection material of choice will be used to fill the crack, adding more strength, and avoiding such happening again. It, therefore, offers a solution not only for the superficially apparent damages but also strengthens the structure against future stresses, and environmental elements, and ensures long-term building stability.

4.2.2 Quality paint

High-performance, weather-resistant paints are very important to aesthetic appeal and durable protection of painted surfaces. Paint formulations of this kind are fabricated from ingredients that can withstand moisture and changes in temperature and ultraviolet exposure from the sun [36]. The application of at least two coats will give more durability and lifespan to the painted surface. One coat provides an even cover over the surface and builds a foundation, and another one enhances the hold of paint on the surface. This double application at one go not only enhances the strength of adhesion of paint to the substrate to prevent peeling and cracking but also enhances the visual beauty with an even and glossy finish. Furthermore, proper surface preparation for painting requires cleaning and priming where necessary for a paint system to develop the required adhesion and performance. Those types of practices can gain aesthetic satisfaction and long-term protection against painted surfaces from environmental elements.

4.2.3 Repair and resurface

When concrete surfaces become pitted, spalled, or uneven-looking, this concrete resurface solves it with great adhesion to any existing concrete for renewed uniformity and durability [37]. First, prepare a clean surface that is free of debris. Mix the concrete resurface overall rough or pitted areas, as instructed in the mixing and application directions of the packaging. Apply the resurface using a trowel, spreading it evenly and at the right thickness to fill in the gaps and even up the surface. Allow the resurface to be partially set; this follows the instructions of the product applying and levelling it. Finish with a smooth finishing layer over the resurface for a sleek and even finish in surface texture. This not only restores the façade of concrete but also enhances any loss of structural integrity to make sure it looks great and stands strong for years.

4.2.4 Sealant application

As can be seen in Figure 2(b), a penetrative sealer should be applied to avoid the infiltration of water and to safeguard the surfaces of the wall. It is a sealant that can penetrate deep into the very effectiveness of the porous surface of the wall material, ensuring long-lasting waterproof characteristics [38]. Clean and dry the surface of the wall before applying the sealant. Apply a penetrating sealant by use of a brush, roller, or sprayer on the surface area of the wall, making sure that the whole surface area has been sufficiently covered. Allow the sealer to soak in and dry according to the manufacturer's instructions. Applied, the sealant creates a repellence barrier that repels water and minimizes the damage from water, mould growth, and efflorescence the white, powdery residue originating from salt deposits. Such a periodic maintenance program relating to the reapplication can result in continued effectiveness over time to retain the integrity and appearance of the wall surface.

4.2.5 Filling and repair

Clean any holes in the wall very well so that no loose material, be it dust or dirt, remains within them, as this is a preparation needed to have the patching of these areas glued well to their surface. After cleaning the holes, fill them up with an appropriate patching material. Take some cement-based filler to fill them, and with that, the repair will have good strength and hold well on the surface of the wall. Apply this patching material using the pallet knife or trowel; push it firmly into the holes and out flat to lie even with the surrounding surfaces. Allow the filler to dry completely according to the manufacturer's instructions before lightly sanding the patched areas. This rectification method not only reinstates the integrity of the wall but also ensures a neat, professional look at the repair that will completely blend in with the existing surface [39].

4.2.6 Cleaning

As can be seen in Figure 2(c), effective cleaning of mould-affected areas requires one to prepare a solution of one part bleach to ten parts waters in the bucket. After soaking, proceed to apply the bleach solution liberally onto the surface affected by the mould and let it sit for a few minutes to enable the killing of the mould completely. Scrub the surfaces affected rigorously to ensure that any visible mould residue is removed. After scrubbing, the surface should be rinsed thoroughly with clean water to remove the bleach solution and any remaining mould particles. In this step, care should be taken to ensure that the cleaned surface is well-dried to avoid any residual moisture, which may provide substrates to nourish further mould growth. In a situation where the level of mould infestation is a huge, then professional remediation services can be sought for thorough and safe removal of the mould [20].

4.2.7 Surface cleaning

In honeycombed areas of concrete, first, all loose rubble and dust from the surface should be removed. The surface to be repaired is then to be cleaned using a stiff broom or compressed air to ensure that it is free from dust and particles. This step is done to enhance good anchorage of the repairing materials onto the concrete through mechanical bonding. By doing so, ensure a clean and debris-free surface where the repair materials will have good bonding to enhance the strength and durability of the set concrete [18].

4.2.8 Security measures

Security cameras are to be installed at some strategic points directly opposite a property on the upper floor to increase vigilance, which would hamper vandalism incidents. All vulnerable spots, entry points, and views from the cameras should be covering these areas. Lighting conditions should also be optimally bright, particularly in dimly lit areas. Bright light is considered one of the potent deterrents to unwanted activities. Consider the inclusion of motion-activated lights that turn on immediately upon the detection of movement. The sudden illumination works as an excellent deterrent for vandals by reducing the possibilities of acts of vandalism tremendously [17].

4.2.9 Damp proofing

Damp-proof membranes and coatings applied to walls prevent dampness in buildings. According to Nikmat and Sabihah [20], damp-proof membranes are largely used in both new buildings and refurbishment processes for preventing the ingress of moisture and its consequences, such as mould growth, degradation of building materials, and structural damage." These membranes are normally applied at construction time to prevent water infiltration into a building element. On the other hand, damp-proof coatings act as retrofitting to virgin walls and significantly reduce dampness by creating a repellent for water/moisture. All these damp-proofing solutions, when properly applied and adhering to the manufacturer's specifications, assure enduring protection and, therefore, enhance the life span of the building structure.

4.2.10 Removal

The vegetation growing on or near walls is best removed by falling and total uprooting or cutting down and out using garden shears or a weed trimmer. Care should be taken to see that the vegetation is removed from its base so that there is no further growth potential. After cutting, prudent disposal methods should be applied to avoid spreading into new areas. In cases where vegetation presents tenacity or covers an area, consider the use of herbicides in a very targeted manner. Follow the instructions on the herbicide label to the letter and obey environmental laws. Apply herbicides carefully and in a targeted way so that they affect only the plantings you wish to kill, and so that they avoid affecting off-target plants or surfaces. This step-wise approach ensures thorough vegetation removal and the minimum environmental impact while hindering future growth [19]

4.2.11 Moisture control

There are two major methods to control moisture indoors: improving ventilation and using a dehumidifier. Improved ventilation keeps the air moving in a building and will, therefore, more quickly lower humidity by removing moist air and exchanging this with relatively drier air. Simple practices such as opening windows when the weather allows, running exhaust fans in kitchens and bathrooms, and keeping air vents clear are beneficial for promoting indoor circulation of air and reducing humidity inside building [18]. Moreover, the dehumidifiers could deal with the excessive humidity in those places and ensure ideal moisture levels are attained, therefore eliminating problems like the growth of moulds and structural problems brought about by excess humidity inside.

4.2.12 Repair

In cases where the crisis is too weak regarding the structure of the building, epoxy injection is advocated as the best treatment for effective repair. It reopens the crack back to its original condition with the use of high-strength epoxy resin, which adheres well with concrete to achieve strong attachment. Not only does this assist in stabilizing the structure, but it also prevents recurrence or further expansion of the crack. Under pressure, the epoxy resin is injected into the crack so that all the void space is filled and tightly attached to the surrounding concrete [21]. At this point, curing the epoxy thereafter fully reinstates the structural integrity of the concrete, thereby leaving the area perfect and strong. In such a manner, it becomes particularly effective for addressing structural cracks when long-term stability and safety are paramount to a building

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(a) Structural repair (b) sealant application (c) cleaning

Fig. 2. Method of rectifications

4.3 Overall Building Rating For 5 Case Study

Based on the Figure 3, ratings for five buildings may be based on their overall scores. Jeruk Tempayan scores highest with 5.2, meaning it attains the highest rating among the five case studies. Next in rank is Kong Fatt Trading with a total score of 4.4. Following this is Yi Ping Fang, attaining a total score of 3.7. The worst-rated building among the case studies is the Fun Tea Garden, with a total score of 3:18; this ranking, therefore, gives a view of their condition and performance according to the criteria measured in the evaluation process.

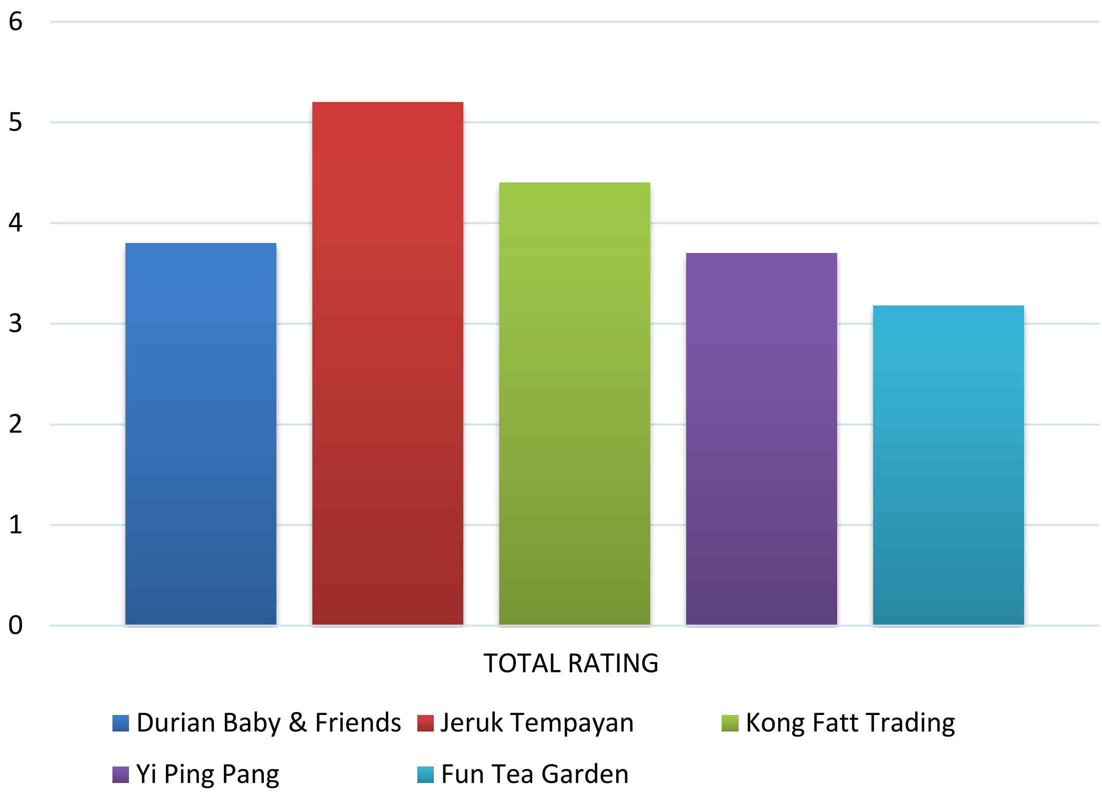

Fig. 3. Building rating

4.4 Overall Result Test Rebound Hammer

Based on Figure 4, Durian Baby & Friends and Kong Fatt Trading both have very consistent quality concrete throughout their tested points on the wall, with an average rebound number of 30.55 to 35.11. This probably is because the buildings use well-mixed and rightly cured concrete; hence, they enjoy a high rating for structural integrity. In contrast, Jeruk Tempayan, Ying Ping Yang, and Fun Tea Garden show poor quality concrete for their respective wall sections. Where mean rebound values were 10 to 14.22, both showed exceptionally low averages, indicating the presence of unsatisfactory concrete quality and in the end bringing down the structural strength and durability of the building. The wall points of Ying Ping Yang indicated fair-quality concrete, with a rebound number of 28.44 to 28.77. That means improvement may be needed, but not as serious as the other two.

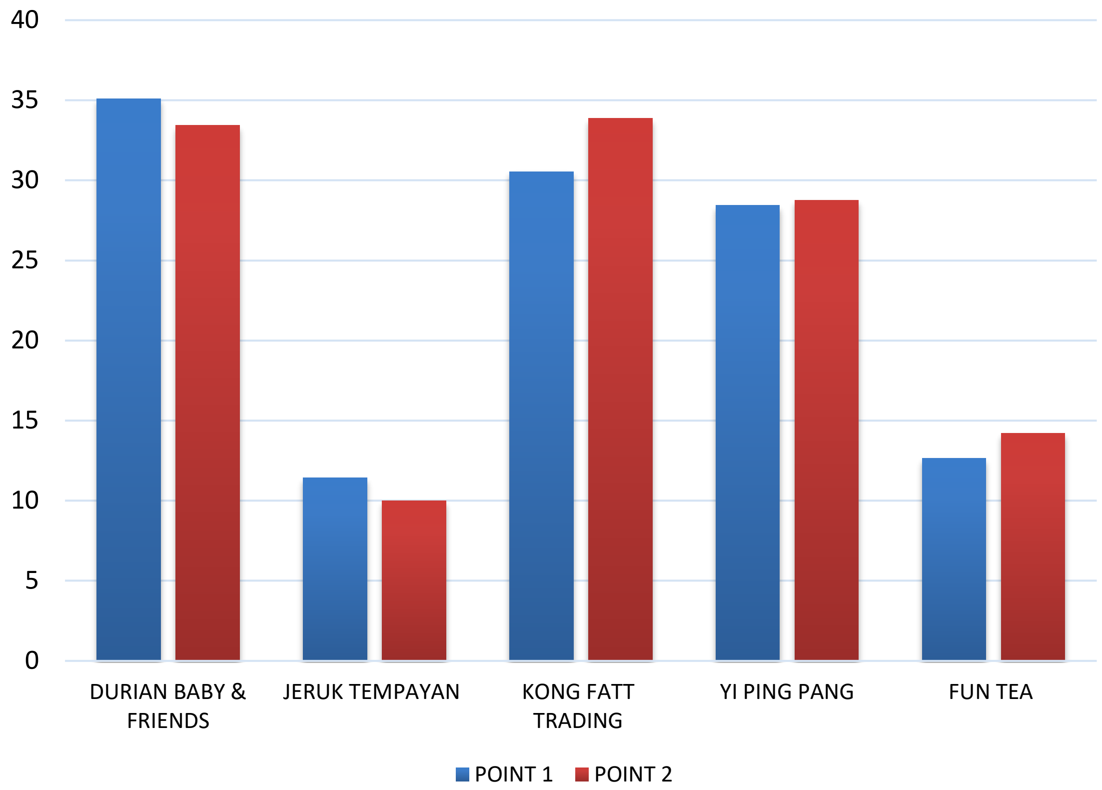

Fig. 4. Overall result of rebound hammer

4.5 Concrete Encounter (Moisture Meter)

Based on Figure 5, Jeruk Tempayan measured 3.0%, 3.1%, and 3.6% at points 1, 2, and 3, respectively. The results from Kong Fatt Trading showed 3.4%, 3.1%, and 3.5% at their respective points 1, 2, and 3. At Ying Ping Yang, the respective readings were 2.8%, 2.9%, and 3.1%. Finally, Fun Tea Garden recorded the lowest levels at 1.9%, 2.2%, and 1.2% measured during points 1, 2, and 3, respectively. The Moisture Content levels were relatively flat across all structures tested, thus indicating a low-to-moderate degree of moisture availability within the considered walls. It is thus deduced that although it may be high in some spots and requires attention, at most other places, it is within acceptable limits. Continuous monitoring and maintenance will indeed keep the moisture controlled and lead to no further damage concerning the structure's integrity over time.

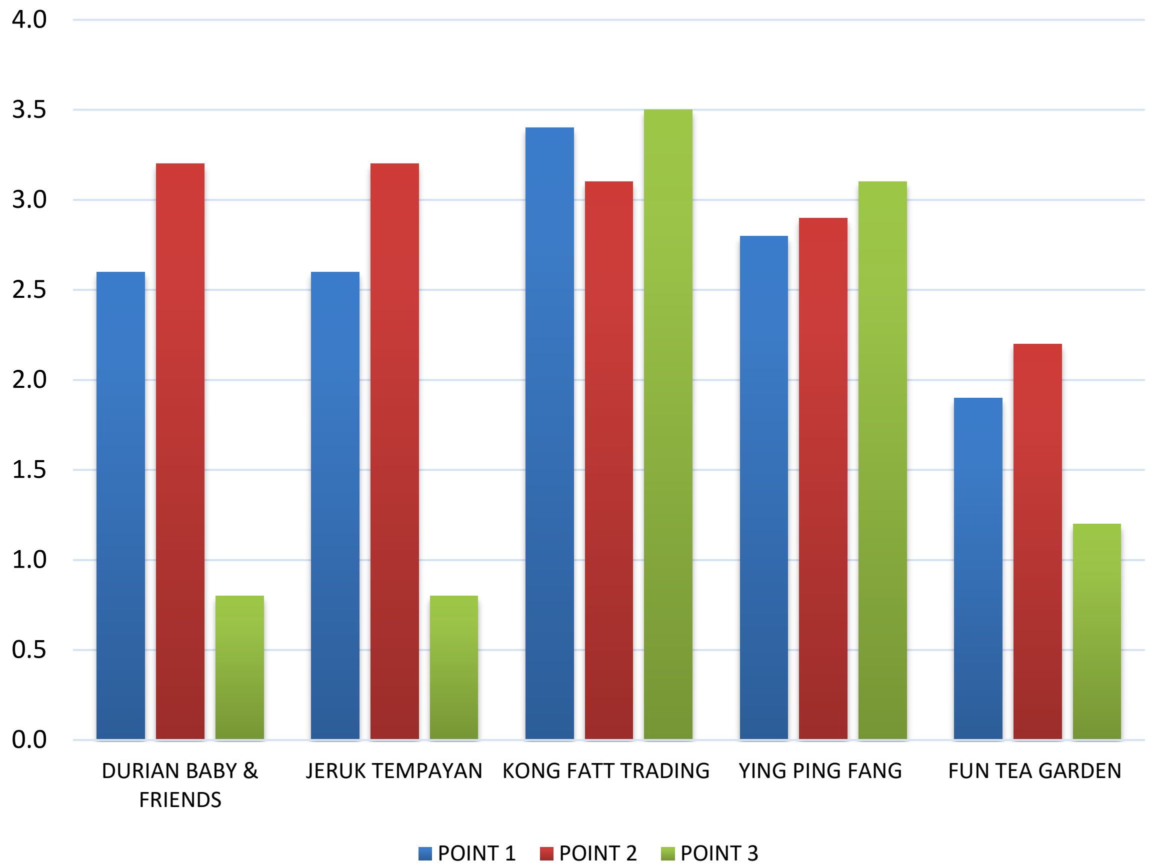

Fig. 5. Overall result of moisture test

5. Conclusions

To conclude, the purpose of the research challenge "Appraisal of Structural and Non-Structural Defects of Load-Bearing Wall Systems in Low-Rise Buildings" is to deal with essential troubles concerning the design of low-upward push homes. The observe goals to identify common structural and non-structural defects of load-bearing walls, to investigate the main causes that lead to structural and non-structural defects and to provide suggestions concerning the method and strategy for rectifying both. The findings of these studies have noteworthy results for several stakeholders and the wider production and architectural domain names. Firstly, architects, engineers, and developers who oversee making plans, development, and renovation of low-rise building will locate superb cost within the study’s findings. They may enhance the sturdiness, safety, and integrity of buildings by making well-informed judgments by spotting the standard structural and non-structural flaws in load-bearing walls. Professionals can be better geared up to become aware of viable weaknesses in present buildings and undertake preventive measures at some point of creation if they are aware about the primary sources of those faults. In general, constructing rules and requirements can be updated and informed with the aid of regulatory bodies and legislators the usage of the expertise collected from this observation, thus encouraging decrease-rise systems which might be safer and extra strong. The social ramifications of more secure buildings are especially considerable as they improve occupants' widespread existence with the aid of selling their health and well-being. The observation can enhance the curriculum in architecture, engineering, and creation-related fields, making future professionals extra ready to handle the possibilities and troubles in low-rise construction development. As such, academic institutions will discover the studies precious. In essence, this look at is crucial and has packages out of doors of academia. It has succeeded in identifying flaws, searching into their origins, and suggesting repair plans for load-bearing walls in low-upward thrust structures, which lays the foundation for more secure, greater environmentally pleasant, and financially advantageous building methods. By doing this, it has a useful effect on all the stakeholders in low-upward push creation tasks, which subsequently enables them to create constructed environments which might be more secure, greater sturdy, and long-lasting for both gift and destiny generations.

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