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Selected Melaka Malay traditional houses: comprehensive analysis on building defects, failures and solutions

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ABSTRACT

Building defects affect society at large due to possible danger posed; they also result in direct and indirect cost in repairs, abnormally high maintenance, disputes and possible loss of building use. Defects are generally caused by inadequacies in design, poor workmanship, building usage not in accordance with design and lack of or incorrect maintenance. Normally, dampness and cracks are common manifestations of defects affecting the exterior and the interior space. Dampness can however often lead to cracks, making it difficult to determine root cause and appropriate repair. Not all manifestations may be considered defects and not all defects are serious to the extent that it will affect building stability and occupant safety. Materials are often blamed for defects when the cause lies in the choice of unsuitable materials and/or when their limitations are recognized and taken into account in design and design detailing. The paper however focusing more into the typical defects found within the typical Melaka Malay traditional houses located in the state of Melaka in Malaysia with the highlight stressing into the defects analysis and the potential technical solution suggestions to solve its problem

Key words: building defects, construction failures, building leakage, Malaysia.

1. MR ABDULLAH BIN MANSUR'S HOUSE

1.1 Introduction

The home of the late Mr. Abdullah bin Mansor is located at No.78, Jalan Tun Mamat 2, Kampung Morten Melaka. This house is a type of traditional Malacca Malay house and is about one hundred years old. The house is still in good condition, but there are some changes made to the house accordance with current needs.

For example, the nipah roof that was replaced with zinc roof and addition of a room in the house. Mohammad bin Mohammad Last Halaludin who is married with Kamariah Abdullah, the daughter of the late Mr Abdullah, who was the head of the family in the house at that time.

1.2 Building Failure Cases Analysis I

Based on the investigation that has been carried out, several categories of defects were identified and wood decay is the most prevalent among the defects. Decay is caused by environmental factors, of which building elements exposed to heat and rain and the biological agents such as termite attack [2]. Human weakness in carried out the installation of roof is one of the factors. For example, the installation of asbestos roof finishes and their joints did not follow the correct method. This has led to a leak when it rains. The building has been divided into several key elements to facilitate the study.

A. Floor

a. Refer to Figure 1(a), it was found that the joining of the floor was untidy and this situation has caused the floor to not firmly or tightly fixed in place. The floor boards were able to be detached from the fixed position.

b. As in Figure 1(b), it can be seen that the colour of the wood surface has faded. This defect occurred due to lack of maintenance by the building occupants.

Figure 1(a): Untidy floor joining

Figure 1(b): Faded wood surface colour

B. Floor Girders

a. Refer to Figure 2(a), floor girders or also known as joists, which functioned as floor supports were rotting. This defect was caused by termite infestation.

b. As in Figure 2(b), the floor girders were broken due to the heavy use and tear of the space.

Figure 2(a): Rotted floor girders

Figure 2(b): Broken floor girders

C. Wall

a. Refer to Figure 3(a), the problem of poor installation between floor boards and wall in the porch area has caused a gap between the joining.

b. As in Figure 3(b), the paint surface was bulging due to incorrect use of technique during finishing sweeps.

c. Wallboard which rotted due to exposure to extreme hot weather and tropical rain.

d. The colour of the timber walls have faded and the walls look old due to the exposure to extreme heat and rain and lack of maintenance by the building owner.

Figure 3(a): Gap between floor and wall

Figure 3(b): Bulging paint surface

D. Pillar

a. Refer to Figure 4(a), the pillar at the exterior of the house decayed due to absorption of water during high tide and rain.

b. As in Figure 4(b), the pillar at the passageway that connects the kitchen to the main house rotted due to termite infestation.

Figure 4(a): Rotted pillar

Figure 4(b): Rotted pillar

E. Sill

a. Refer to Figure 5(a), the sill, which is a wooden beam encircling the outer regions of the floor of the house, forming a frame or 'bulkhead' for the floor, rotted due to exposure to hot weather and rain over a long period of time.

b. As in Figure 5(b), the sill on the side of the house rotted as well. This defect was caused by the exposure to extreme heat and rain for a very long duration.

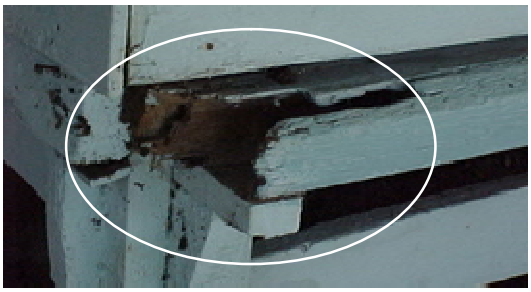

Figure 5(a): Rotted sill

Figure 5(b): Rotted sill

F. Roof Crossbeam

a. Refer to Figure 6(a), the roof crossbeam of the main house was rotted as a result of termite infestation.

b. As in Figure 6(b), water stains were seen on the roof beam as an effect of water absorption from the leaking roof.

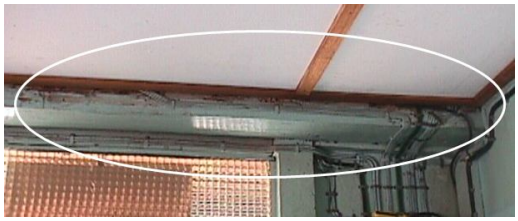

Figure 6(a): Rotted roof crossbeam

Figure 6(b): Water stains on roof beam

G. Roof Rafter

a. Refer to Figure 7(a), the roof rafter in the attic was severely damaged as a result of termite infestation.

b. As in Figure 7(b), the rotted main rafter was caused by termite attack.

Figure 7(a): Damaged roof rafter

Figure 7(a): Rotted main rafter

H. Window

a. Refer to Figure 8, some parts of the window frames were rotted due to termite infestation.

Figure 8: Rotted window frame

H. Baluster

a. As in Figure 9, the baluster was not properly joint to the floor on the house porch causing gap between the connections.

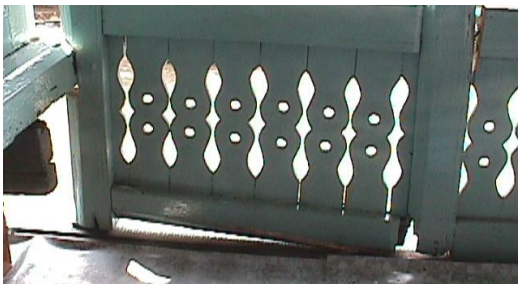

Figure 9: Improperly joint baluster

1.3 Initial Conclusion I (in table format)

Table 1: Summary of the Defect Types and Situation

Element	Defect	Situation
Roof	• Decay rafters by termite attack. • Roof leaks due to connection failure in the roof finishes.	Serious Serious
Ceiling	• Dirty stains due to water absorption from leaking roof.	Not serious
Pillar	• Leaning pole • Decay caused by termites attack. • Decay from exposure to hot weather, rain and high humidity. • Cracks	Not serious Serious Serious Not serious
Cross-beam	• Decay caused by termite attack. • Decay due to heat and rain. • Dirty stains due to absorption of rainwater.	Serious Serious Not serious
Wall	• Decay from exposure to heat and rain over a long period of time. • Bulging paint surface finishing	Serious Not serious
Floor	• Faded colour caused by lack of maintenance.	Not serious
Overall	• Leaking roof • Termite infestation	Serious Serious

1.4 Initial Conclusion I

The investigation which has been carried out has found out that the building is still in good condition. This is because the main structures of the building are still strong and safe for the occupants to use. Defects involve only a small number of elements that are not dangerous to occupants. However, some serious defects must be repaired so that they do not cause any other damages to the elements that are still in good condition.

1.5 Initial Suggestions I

Based on the investigation and discovery, several proposals have been suggested, which are:

1. Installation of roof finishes must be carried out again in accordance with specifications.

2. All damage and decay on columns, walls, crossbeams, roof rafters and wood panelling on the walls need to be replaced with similar materials in accordance with the original specification of the materials or using better materials.
3. Cleaning should be done on the surfaces where dirty stains can be seen either by washing or using a suitable paint finish.
4. Build up better and more systematic draining system in order to avoid stagnant water accumulates at the ground part of the house.
5. Erect the building elements such as columns using appropriate methods.
6. Termite infestation treatment need to be carried out on the whole building.

Last but not least, a good maintenance is advised to be carried out to avoid any failure to the building components. Maintenance programs that are scheduled should be implemented to achieve the optimum results of conservation.

2. MR BUJANG SIAM'S HOUSE

2.1 Introduction

Refer to Figure 10(a) and 10(b), this house is located at No. 861, Perigi Hang Tuah, Km. 6, Kampung Duyong, Melaka. It was built in 1961 at a cost of RM 5,000. The house has twelve columns and can be categorized as a building which has two houses detached to it with a long roof on top. The house comprises of a front porch or veranda, an annex, the main house, the middle house, two bedrooms and a kitchen. The difference of this house with other traditional Malay house is that it does not have a *"selang"*, which is a passageway that connects the kitchen to the main house. The middle house has taken over the function of the *"selang"*, where the women guests were welcomed.

Figure 10(a): House of Bujang Siam

Figure 10(b): House of Bujang Siam

2.2 Building Failure Cases Analysis II

Based on the investigation that has been carried out, several categories of defects were identified. Wood decay is the most prevalent among the defects and damages. Wood decay is highly caused by the presence of biological agents such as pest, which is termites that has attacked several elements of the building, such as the floor, the girders of the floor, the pillars, and the walls. Analysis of this building has been divided into several main elements to facilitate study.

A. Floor

a. Refer to Figure 11(a), the floor apron has cracked as a result of heavy usage by the occupants.

b. As in Figure 11(b), it can be seen that the floors were rotting which was caused by termite infestation.

Figure 11(a): Cracked floor apron

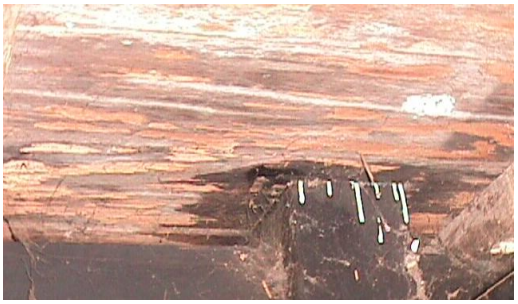

Figure 11(b): Rotted floor

B. Floor Girders

a. Refer to Figure 12(a), the floor girders were rotted due to termite infestation.

b. As in Figure 12(b), it can be seen that the girders and floor boards have been destroyed due to termite attack.

Figure 12(a): Rotted floor girders

Figure 12(b): Destroyed girders and floor boards

C. Wall

a. Refer to Figure 13(a), the wallboard has ruptured as a result of heavy usage by the building occupants.

b. The ledge or lath has decayed due to termite infestation.

c. As in Figure 13(b), it can be seen that mould and fungus grew on brick wall due to exposure to moisture.

d. Brick wall became mossy as a result of water absorption from the kitchen.

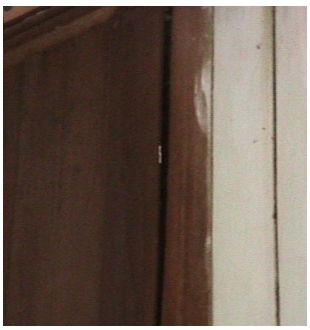

Figure 13(a): Ruptured wall

Figure 13(b): Mossy brick wall

D. Pillar

a. Refer to Figure 14(a) and 14(b), it was found that both the deteriorated pillars were due to termite infestation, causing holes on the surface of the wooden pillar.

Figure 14(a): Decayed pillar

Figure 14(b): Decayed pillar

E. Window

a. Refer to Figure 15(a), the paint surface on the timber window frame was bulging.

b. As in Figure 15(b), it can be seen that the timber ram in the roofing ventilation space was broken.

Figure 15(a): Bulging paint

Figure 15(b): Broken timber

F. Roof

a. Refer to Figure 16(a), the whole finishes of the roof which was made of zinc was rusted as a result of weathering factor.

b. As in Figure 16(b), the colour of the paint on the surface of the "*tebar layar*", which means "sailed ready" for roofing ventilation, has faded due to exposure to weathering factor.

c. Refer to Figure 16(c), dirty stains are found on the roof rafters due to infiltration of rain water at the porch area.

d. As in Figure 16(d), it can be seen that the wood surface on the ridge of the house was peeling due to splash of rain.

Figure 16(a): Rusted zinc roof

Figure 16(b): Faded paint surface

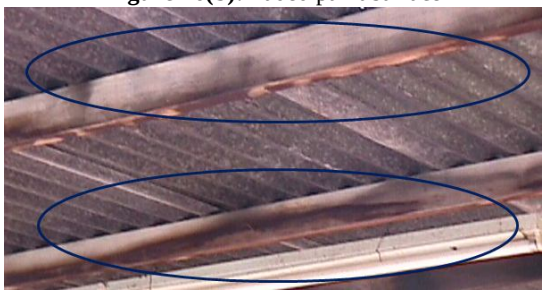

Figure 16(c): Dirty stains on rafters

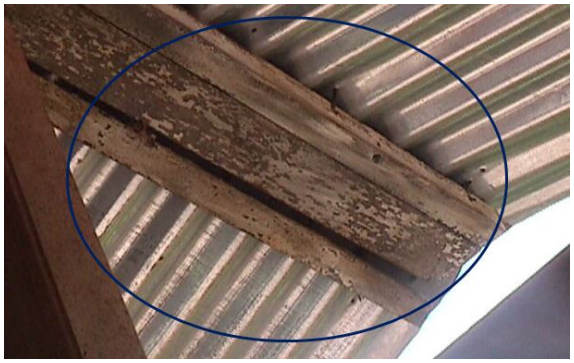

Figure 16(d): Peeling wood surface

2.3 Initial Conclusion II (in table format)

Table 2: Summary of the Defect Types and Situation

Element	Defect	Situation
Roof	• Faded wood colour on roof rafter. • Rusted zinc finishes.	Not serious Not serious
Pillar	• Decay caused by termite attack. • Cracks	Serious Not serious
Wall	• Decay caused by termite attack. • Dirtiness from exposure to surrounding weather. • Broken caused by heavy usage.	Serious Not serious Not serious
Floor	• Decay caused by termite attack.	Serious
Overall	• Termite infestation • Hot and humid tropical climate weathering action all year round.	Serious Not serious

2.4 Initial Conclusion II

The investigation which has been carried out has found out that the building is still in good condition. This is because the main structure of the building is still strong and safe for the occupants to use. Serious defects involve only a small number of elements that are not dangerous to occupants, while other defects do not consider as serious.

2.5 Initial Suggestions II

Based on the investigation and discovery, several proposals have been suggested, which are:

1. All damage and decay on pillars and walls need to be replaced with similar materials in accordance with the original specification of the materials or using better materials.
2. Cleaning should be done on the surfaces where dirty stains can be seen either by washing the surface elements and using a suitable paint finish over the whole building.
3. Termite infestation treatment needs to be carried out on the whole building.

Last but not least, a good maintenance is advised to be carried out to avoid any failure to the building components. Maintenance programs that are scheduled should be implemented to achieve the optimum results of conservation on the whole.

3. TUAN HAJI HUSSIN BIN LAJIS'S HOUSE

3.1 Introduction

Haji Hussin bin Lajis, who is the third owner of this researched house is already 65 years old. Although the homeowner is already quite old, he is still active in social activities and charity activities which are held especially in Kampung Morten. He started settled down in Kampung Morten when he was still young during his childhood with his family.

Refer to Figure 17, the house was built in 1960 and occupied by him after completion of its construction in the same year. Although this house is categorized as the Melaka Malay traditional house with 16 stilts, the owner still wanted to have slight difference from the others and also to realize his dream of having distinctive elements in his house.

About 15 years ago, he has made some modifications on his home. He said a house is just like a human being, it needs reformation and also needs to be aesthetically appealing, to avoid the building to be old-fashioned and outdated.

Figure 17: House of Mr Haji Hussin Bin Lajis

3.2 Building Failure Cases Analysis III

Based on the investigation that has been carried out, several categories of defects were identified. Defects are usually caused by environmental factors such as hot weather and rain, as well as the presence of biological agents such as termites and fungus on the walls and pillars. Wear and tear factor also contributed to the defects of the elements such as the activities carried out by the building occupants. Wear and tear is damage that naturally and inevitably occurs as a result of normal wear or aging. Human weakness is one of the factors that cause defects in the roofing part where the installation of asbestos roof finishes did not follow the specification which led to roof leaks when it rains [6]. Analysis of the building has been divided into several key elements to facilitate the research.

A. Floor

a. Refer to Figure 18(a), the floor boards were broken and decayed due to infiltration of rainwater from the leaking roof.

b. As in Figure 18(b), water stains were found on the floor boards in the attic as a result of a leaking roof.

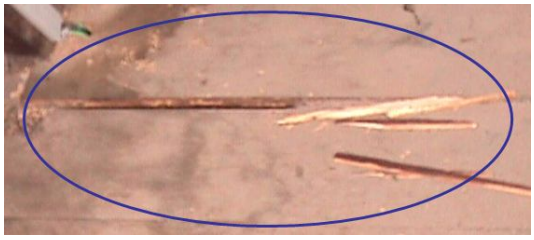

Figure 18(a): Broken floor boards

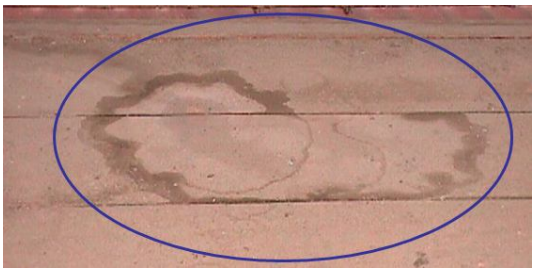

Figure 18(b): Water stains on floor boards

B. Wall

a. Refer to Figure 19(a), the wood panelling on the walls were dirty due to water absorption when the roof leaks.

b. As in Figure 19(b), the walls crumbled and the colour of the paint finishes faded as a result of exposure to rain and hot tropical weather all the time.

c. Refer to Figure 19(c), the wood panels were rotting which were caused by termite infestation.

d. As in Figure 19(d), the wood panels have broken due to nailing work on the walls by the users of the building.

e. Refer to Figure 19(e), stains of dirt and moisture were seen on the wall due to absorption of water from the bathroom.

f. As in Figure 19(f), the sill wood were rotted caused by the exposure to weathering factor.

Figure 19(a): Dirty wood panelling

Figure 19(b): Crumbled walls and faded paint

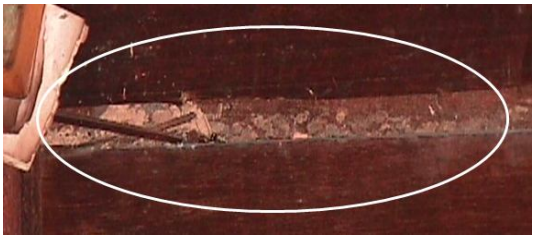

Figure 19(c): Rotted wood panels

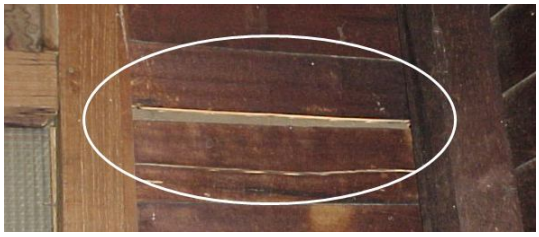

Figure 19(d): Broken wood panels

Figure 19(e): Stains on wall

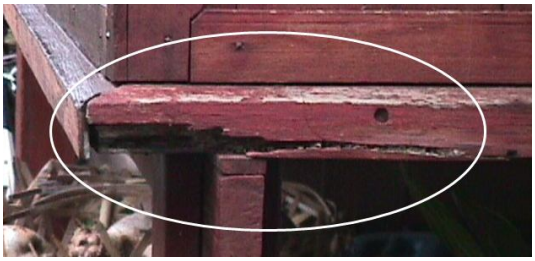

Figure 19(f): Rotted sill wood

C. Pillar

a. Refer to Figure 20(a), the pillar were rotting due to termite infestation.

b. As in Figure 20(b), the rotted pillars were caused by constant exposure to weathering factor.

Figure 20(a): Rotted pillar

Figure 20(b): Rotted pillar

D. Window

a. Refer to Figure 21(a), the colour of the paint finishes were fading due to the absorption of rainwater.

b. As in Figure 21(b), the window frame was decayed as a result of termite infestation on the surface of the wood.

Figure 21(a): Faded paint

Figure 21(b): Decayed frame

E. Roof

a. Refer to Figure 22(a), the connection of the cross rafter with the main rafter was destroyed due to termite infestation.

b. As in Figure 22(b), the main rafter that was rotted due to termite infestation in the middle part of the house.

c. Refer to Figure 22(c), the rain gutter was leaking.

d. As in Figure 22(d), the joining of the roof finishes which did not follow the exact specification has led to roof leaks when it rains.

Figure 22(a): Destroyed rafter connections

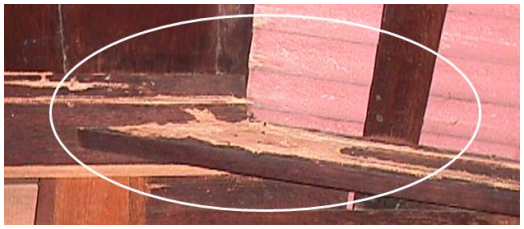

Figure 22(b): Rotted main rafter

Figure 22(c): Leaking rain gutter

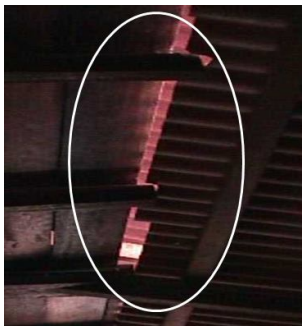

Figure 22(d): Leaking roof

3.3 Initial Conclusion III (in table format)

Table 3: Summary of the Defect Types and Situation

Element	Defect	Situation
Roof	• Decay rafters by termite attack. • Roof leaks due to connection failure in the roof finishes. • Rainwater splashes without "*tebar layar*" at the kitchen area. • Leaking rain gutter.	Serious Serious Serious Serious
Floor	• Dirty stains and decay caused by leaking roof.	Serious
Pillar	• Decay caused by termite attack. • Decay from exposure to hot weather, rain and high humidity.	Serious Not serious
Cross-beam	• Decay caused by termite attack. • Faded wood colour and looked dilapidated.	Serious Not serious
Wall	• Faded wood colour caused by hot weather and raining. • Dirty and mossy. • Broken and decayed caused by rainwater infiltration. • Broken wall due to heavy usage.	Serious Not serious Serious Not serious
Overall	• Leaking roof • Termite infestation • Hot and humid tropical climate weathering action all year round.	Serious Serious Not serious

3.4 Initial Conclusion III

The investigation which has been carried out has found out that the building is still in good condition. This is because the main structure of the building is still strong and safe for the occupants to use. Defects involve only a small number of elements that are not dangerous to occupants. However, some serious defects must be repaired in order for it to not cause any other damages to the elements that are still in good condition.

3.5 Initial Suggestions III

Based on the investigation and discovery, several proposals have been suggested, which are:

1. Installation of roof finishes must be carried out again in accordance with specifications.
2. All damage and decay on columns, walls, crossbeams, roof rafters, wood panelling on the walls and rain gutter need to be replaced with similar materials according to the original specification or using better materials.
3. Paint the entire building with appropriate finishes which are able to withstand the surrounding weather.
4. Addition of installation of spreading shades in the kitchen area to avoid the splashing of rain water when it rains.
5. Limit the use of rubber mats in certain spaces so that any problems on the floor can be easily checked often, while avoiding moisture being trapped under the rubber mat.
6. Carry out termite attack treatment on the whole building.

4. MR HAJI JOHAN BIN SABTU'S HOUSE

4.1 Introduction

Refer to Figure 23, he built this house in 1964 and the house is an addition to the back of the house that he built in 1960. Haji Johan has built this house with his own effort for one year by using similar types of wood. He worked from morning until night to build the front part of his house. All carvings that were found in the house had been carved by Mr Haji Johan and he usually takes only one day to complete one small detailing carving. In the beginning, the front part of the house was built as a shop that was rented by a Chinese boss.

Figure 23: House of Mr Haji Johan

4.2 Building Failure Cases Analysis IV

Based on the investigation that has been carried out, several categories of defects were identified. The surface element which was dirty and dusty is the majority defects seen on the walls, beams, doors, windows and stairs. Analysis of this building has been divided into several main elements to facilitate study.

A. Floor

a. Refer to Figure 24(a), the cement render surfaces were ruptured and detached from the fixed positions which were caused by wear and tear factor.

b. As in Figure 24(b), the floor apron has cracked because of the factor of heavy usage by the users.

c. Refer to Figure 24(c), the faded colour of wooden floor was due to the leaking roof element.

d. As in Figure 24(d), it can be seen that the cement render surfaces were ruptured and potholed as a result of wear and tear factor by the building occupants.

Figure 24(a): Ruptured cement render surface

Figure 24(b): Cracked floor apron

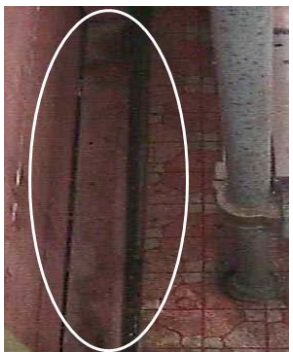

Figure 24(c): Faded floor

Figure 24(d): Potholed surface

B. Wall

a. Refer to Figure 25(a), dirt was found on the wall surfaces as a result of having thick dust that has not been cleaned.

b. As in Figure 25(b), it can be seen that the peeling paint finishes were caused by the exposure to hot surrounding weather and rainy environment.

c. Refer to Figure 25(c), the wall surface on the vault was cracked, due to the vibration of the road nearby.

d. As in Figure 25(d), the dirty stains can be seen on the wall surface as a result of exposure to weathering factor.

e. Refer to Figure 25(e), the faded colour of the timber was due to the exposure to extreme heat and tropical rain.

Figure 25(a): Dirty wall

Figure 25(b): Peeling paint

Figure 25(c): Cracked wall surface

Figure 25(d): Dirty wall surface

Figure 25(e): Faded timber colour

C. Pillar

a. Refer to Figure 26(a), the cracked pillar was due to the vibration from the road nearby.

b. As in Figure 26(b), the surface of the pillar is dirty because of the constant exposure to the surrounding weather and lack of maintenance by the building occupants.

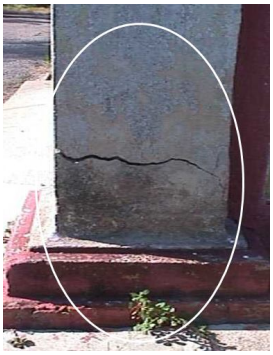

Figure 26(a): Cracked pillar

Figure 26(b): Dirty pillar surfaces

D. Crossbeam

a. Refer to Figure 27(a), dirt was seen on the surface of the roof beam because of roof leaks.

b. As in Figure 27(b), the colour of the wooden roof beam has faded as a result of water absorption during the rain.

Figure 27(a): Dirty roof beam

Figure 27(b): Faded colour of wooden roof beam

E. Window

a. Refer to Figure 28, the surface of the window was dirty and dusty as it has not been cleaned by the users for ages.

Figure 28: Dirty window surface

F. Door

a. Refer to Figure 29, dirt on the surface of the door was due to the thick dust that has not been cleaned off

Figure 29: Dirty door surface

G. Roof

a. Refer to Figure 30(a), absorption of water into the concrete roof was due to the leaking water tank.

b. As in Figure 30(b), dirt was accumulated on the surface of the roof finishes as it was often exposed to the tropical weather.

Figure 30(a): Water stains on concrete roof

Figure 30(b): Dirty roof finishes

H. Ceiling

a. Refer to Figure 31(a), stains were found on the ceiling as a result of roof leaks.

b. As in Figure 31(b), stains and mosses were seen on the ceilings which were caused by a leaking roof.

Figure 31(a): Water stains on ceiling

Figure 31(b): Mosses on ceiling

I. Furniture

a. Refer to Figure 32, individual pieces of glass on the prefabricated bookshelf has broken as a result of heavy usage.

Figure 32: Broken glass cabinet door

J. Staircase

a. Refer to Figure 33, paint finishes on the handrail of the staircase have peeled off because of the frequent exposure to the hot and humid tropical weather.

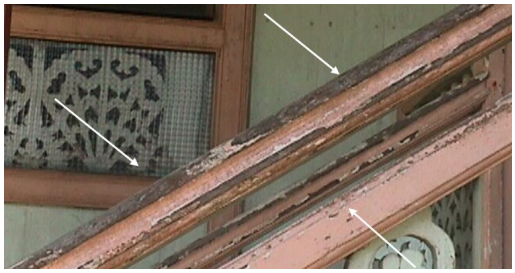

Figure 33: Peeling paint finishes

4.3 Initial Conclusion IV (in table format)

Table 4: Summary of the Defect Types and Situation

Element	Defect	Situation
Roof	• Faded wood colour on roof beam. • Dirty stains on beam and ceiling. • Rotted asbestos finishes.	Not serious Not serious Serious
Pillar	• Cracks	Not serious
Wall	• Dirty stains and dusty. • Faded wood colour • Cracks • Mossy • Peeling paint	Not serious Not serious Not serious Not serious Not serious
Floor	• Cracks caused by heavy usage. • Dirty stains	Not serious Not serious
Overall	• Leaking roof • Hot and humid tropical climate weathering action all year round. • Dirty stains and dusty.	Serious Serious Serious

4.4 Initial Conclusion IV

The investigation which has been carried out has found out that the building is still in good condition. This is because the main structures of the building are still strong and safe for the occupants to use. Serious damage only involves roof finishes that must be repaired immediately in order for it to not cause any damages to the other building elements.

4.5 Initial Suggestions IV

Based on the investigation and discovery, several proposals have been suggested, which are:

1. Cleaning should be done on the surfaces where dirty stains can be seen either by washing the surface elements and using a suitable paint finish over the whole building.
2. Termite infestation treatment needs to be carried out on the whole building.
3. Conduct further research on the effects of vibration from the main street which is too close to the researched building.

Last but not least, a good maintenance is advised to be carried out to avoid any failure to the building components. Maintenance programs that are scheduled should be implemented to achieve the optimum results of conservation on the whole.

5. PRELIMINARY CONCLUSION

From the result of the visual finding, it can be concluded that the external factor affecting standard or historical traditional buildings especially those located in the case study location; Melaka are due to climatic change, air pollution, and lack of maintenances (see Fig. 34 below). Climatic condition is the act of atmospheric event such as rainfall, temperature, air pressure and humidity [1]. Due to the tropical climatic condition, Malaysia has heavy rainfall and warm sunshine all year round. Therefore the external part of the building tends to weather rapidly [5].

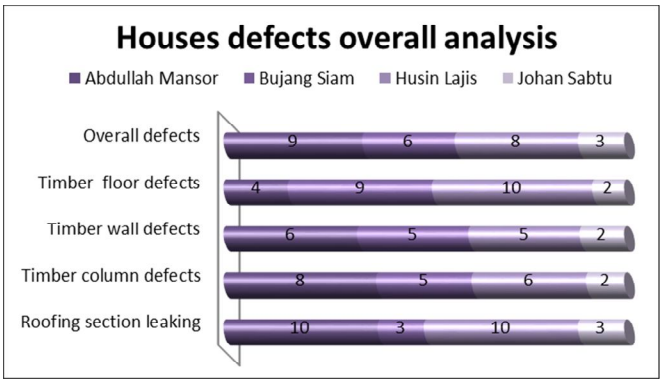

Figure 34: The above chart shows the overall analysis of the house defects based on the type of defects and level of seriousness.

The process of weathering by tropical sun, wind and monsoon rain is defined as the breakdown and alteration of material by mechanical and chemical processes such as even the humid subtle temperature changes triggered building defects naturally [4]. From observation, smoke pollution from vehicle and human activity, causes the soiling of facade by deposition of black carbonaceous particle. Most buildings located facing or positioned near the main road have black carbonaceous particle. Lastly, lack of maintenances by the owner is another important factor impacting the deterioration of the traditional or heritage buildings in Malaysia. The owner must play important role in preventing defects from reoccurring. Poor maintenances knowledge among the house owner in dealing with the defect and building failures also contributed to the deterioration factor [3].

Finally, Table 5 below shows the initial summary of the selected Melaka traditional houses data and defects overall percentage. To sum up, it can be concluded that to get effective remedial material, understanding of the deterioration factor and the material characteristic is a must. Therefore, each defect has its own character and the produce of the right remedial material can eliminate the defect to occur. It is hope this paper at least be able to make awareness to prevent building failures reoccur and give guides for better design and maintenance task.

Table 5: Selected Melaka traditional houses data and defects initial summary.

No.	House name	History	Location	Materials	Overall Defect Damages %
1	Abdullah Mansur House	Claimed 100 years old	Kg Morten, within Melaka City Centre	Timber (80%), Brick with cement plaster (20%), asbestos free roofing	90% Mostly timber related defects
2	Bujang Siam House	12 pillars, *Berbandung* 2 with long roof, built 1961 (RM5,000)	Kg Duyong, 4km east of Melaka City Centre	Timber (90%), Brick with cement plaster (10%), zinc roofing	60% Mostly timber related defects
3	Husin Lajis House	16 pillars, Built 1960, originally 1950	Kg Morten, near Melaka City Centre	Timber (80%), Brick with cement plaster (20%), asbestos free roofing	80% Mostly timber related defects
4	Johan Sabtu House	Built 1964 (back part-built 1960), timber type-*seraya* tree	Kg. Sebatu, 8 km south of Melaka City Centre	Timber (85%), Brick with cement plaster (15%), zinc roofing	30% Mostly timber related defects

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