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Assessment of Wooden School Furniture Defects when Exposed to Flood Simulation

Yanti Abdul Kadir, Hashim W.Samsi*, Siti Zaliha Ali, Khairul Azmi Jabar, Noor Azrieda Abd Rashid, Khairul Masseat, Maryam Mohd Radzi
**Corresponding Author*

Forest Research Institute Malaysia, 52107 Kepong, Selangor, Malaysia

yanti@frim.gov.my; : hashimws@frim.gov.my, sitizailihaali@frim.gov.my, khairulazmi@frim.gov.my, azrieda@frim.gov.my, khairulm@frim.gov.my, maryama7xradzi@gmail.com
Tel: +60362797741

Abstract
Flood is one natural disaster that can occur yearly in Malaysia, usually from November to January. Unexpected floods due to climate change, unexpected heavy rainfall, and lack of drainage systems can have a tremendous effect. The affected has many impacts, such as damage to property like household and institutional furniture. Based on the institution/school information, the furniture submerged during the flooding was 90% damaged. The objectives of this study are to determine the durability of the school furniture and to evaluate the defects when the products are exposed to flood (simulation).

Keywords: Wooden, furniture, defect, flood

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1.0 Introduction

In Malaysia due to Malaysia's position in tropical areas, the frequency of rain can cause a lot of rain and sometimes exceed the norm. Thus, Malaysians face yearly floods (Ab Hamid et al., 2022). The flood also caused property damage, especially furniture submerged or washed away by the flood. The latest flood happened at the end of 2021 and was one of the worst, submerging various buildings, including schools, and causing damage to school furniture such as desks and chairs (Halid et al., 2021). The school's chairs and desks are made of wood, which can absorb water if immersed for a long time. Damages that can be seen include the jointing parts of the chair and table.

2.0 Literature Review

Since floods are not an issue that can be solved easily, this situation needs to be faced by improving the school's wooden furniture. Thus, when immersed in water, the behavior is done by testing the school chair and table in real water. The study simulates a flood-like situation where the furniture samples are immersed in the lake for a certain period. The furniture samples were observed in terms of the differences and changes that may occur between the controlled and improved furniture samples before and after the immersion. The parts of the wooden furniture sample were likely to have an effect after measuring the immersion. It is to know the different

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changes that may happen. The result of the study can be used to improve wooden furniture. This study aims to observe the wooden furniture immersed in the water. Thus, the objectives of this study are to determine the behavior of wooden furniture when stimulated to long immersion into water and to analyze the changes that occurred in the properties and characteristics of wooden furniture before and after water immersion.

3.0 Methodology

Wooden furniture samples of chairs and tables for primary and secondary students were obtained from the manufacturer following the Malaysia Ministry of Education (KPM) product specifications. There are two versions of the furniture, which are controlled (existing product without any improvement) and improved furniture. The part is being improved by adding a coating in every part of the furniture's surface using an acrylic coating (AC). Sealer with silicone and sealant for parts that have gaps and defects by using glue and a nail gun for mortise and tenon jointing.

Furniture samples are measured and labeled (coding). The labeling (coding) of the samples are KRB: Kerusi Rendah tambahbaik (Improved primary chair), KMC: Kerusi Menengah control (Controlled secondary chair), MRB: Meja Rendah tambahbaik (Improved primary table), MMC: Meja Menengah control (Controlled secondary table). Thickness size for parts likely to suffer damage and expansion is measured and marked. The measured parts include the gap using a thickness gauge, the part likely to absorb water, and the thickness of the tabletop for the table and the seat for the chair using a Vernier caliper. The entire sample is checked to identify any defect that occurs before immersion. Sealant and filler spray was used to close the gap and defect. Before immersion, the Moisture content (MC) reading is taken on the part likely to absorb water. The weight of the furniture sample before immersion is weighed. All measurement, weight, and damage data are recorded. All the steps are repeated for samples after 3 days of immersion.

All the measurement and data needed before immersion was recorded. Then, the furniture samples were loaded in the lorry to send to the FRIM lake. Furniture samples are also tied using ropes and marked. The furniture sample is placed slowly into the lake. The rope's end is tied to the wooden stake and marked to avoid being lost or drifting away. The sample was left to immerse for 3 days.

After 3 days, the samples were removed from the lake by pulling the rope into the side. Ensure the furniture is not in contact with the ground to avoid damaging the surface of the wood. The furniture samples were returned to the composite workshop to clean and remove dirt that stuck to them like mud using clean water. Left the furniture sample air-dry under the shade without direct sunlight or rain overnight. Then, the procedure for measuring and weighing is repeated to know the data and result after 3 days of immersion. All the data were gathered and recorded to make an observation. The methods are repeated for the next samples and immersion.

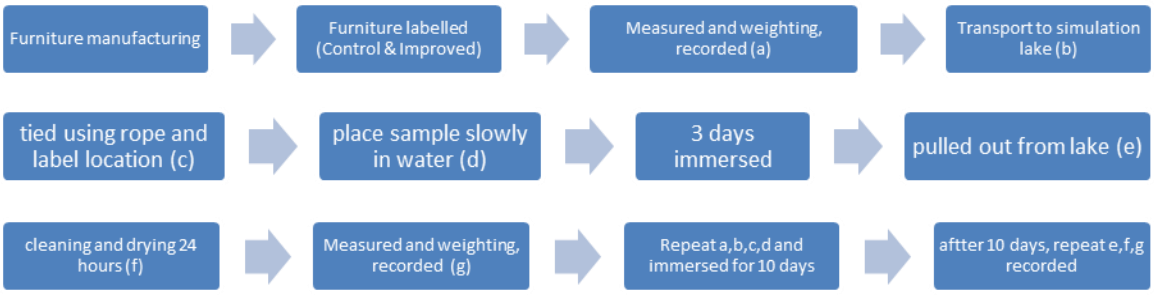

Fig. 1: In-house method of furniture immersed

3.0 Finding and discussion

Tables 1 and 2 show increasing and decreasing values for all the samples KRB2, KMC, MRB2, and MMC, before and after the immersion. For the weight of the chairs sample, there is a 22.53% increase in weight after 3 days for improved sample KRB2, which is higher than the controlled sample, 13.25%. As for the thickness average for the seat sample, KMC has a higher value with a 4.51% increase than the KRB2 sample for 1.84%. The percentage for average thickness for gaps, parts expected to swell, and the moisture content for MRB2 is lower than KMC, proving that the improved sample is better than the controlled sample.

Table 1: School chair sample result

Sample	Reading	Weight (Kg)	Thickness average (mm)			Average Moisture content (%)
			Seat	Gaps	Parts expect to swell	
KRB2	Before	5.86	15.80	0.35	26.90	15.01
	After day 3	7.18	16.09	0.32	27.63	31.69

	%	22.53%	1.84%	6.67%	2.69%	1.11
KMC	Before	7.55	18.31	0.17	27.22	13.26
	After day 3	8.55	19.135	0.15	28.12	31.07
	%	13.25%	4.51%	10.00%	3.32%	1.34

Table 2: School table sample result

Sample	Reading	Weight (Kg)	Thickness average (mm)			Moisture content average (%)
			Tabletop	Gaps	Parts expect to swell	
MRB2	Before	12.28	19.44	0.30	36.68	13.54
	After day 3	14.23	20.00	0.20	37.25	30.26
	%	15.88%	2.88%	33.33%	1.55%	1.23
MMC	Before	13.71	19.725	0.24	37.58	12.94
	After day 3	15.65	20.045	0.18	38.25	30.97
	%	14.15%	1.62%	3.68%	1.80%	1.39

Based on Tables 1 and 2, an increasing and decreasing value can be observed for all the samples KRB2, KMC, MRB2, and MMC before and after the immersion. For the weight of the chairs sample, there is a 22.53% increase in weight after 3 days for improved sample KRB2, which is higher than the controlled sample, 13.25%. As for the thickness average for the seat sample, KMC has a higher value with a 4.51% increase than the KRB2 sample for 1.84%. The percentage for average thickness for gaps, parts expected to swell, and the moisture content for MRB2 is lower than KMC, proving that the improved sample is better than the controlled sample.

For the weight of table samples, there is a 15.88% increase in weight after 3 days for improved sample MRB2, which is higher than the control sample, 14.15%. Likewise, as for the thickness average for the tabletop sample, MRB2 also has a higher value with a 2.88% increase than the MMC sample for 1.62%. The percentage for average thickness for gaps, parts expected to swell, and the moisture content for MRB2 is lower than MMC, proving that the improved sample is better than the controlled sample.

Results for mortise and tenon joints for samples KRB2 and KMC are still in good condition without any defect. However, the sealant at the back of the seat was peeled off. Some defects also occur on the seat's surface without damaging the chair's properties and function. Mortise and tenon joints for sample MRB2 and MMC are still in good condition without any defect. However, the sealants were peeled off. Some defects occurred on the surface without damaging the properties and function of the table.

After the immersion, the sample KRB2 defects occur, such as in figures 2 and 3. The gap occurred between the seat and the full rails and leg as the sealant was peeled off. End check also occurs at the seat, while surface check is at the side rail.

Figure 2: Surface scratch

Figure 3: Gap

After immersed defects occurred on the KMC sample, such as in Figure 4, blister-like defects occurred at the stretcher surface. This may happen because of the coating defects when absorbing the water. As the seat is warping, the degree of warping increases, as Figure 4. The warping also resulted in an end check to occur on the seat.

Figure 4: Gap

Figure 5: Warping

5.0 Conclusions

From the observation based on the results, the improved furniture may tend to resist absorbing water. Closing all the gaps or defects that allow the water to sip inside the wood helps avoid defect damage. In addition, correctly cutting the right size and correctly assembling all the furniture parts play an important role as they can decrease the number of defects occurring.

However, due to some technical issues that involve the manufacturer, the sample still needs to be fully prepared as the improved furniture sample. The result of a human-made mistake while handling the process of taking in and out the furniture from the lake causes damage to the surface of the wood.

Therefore, some improvements can be made to avoid the damage by using tools such as cranes to put in and remove the furniture. The manufacture of the furniture also must be done correctly. This can be proven based on the result above, as most parts already have defects and are not sealed properly, resulting in bigger defects such as warping.

Thus, this study can continue with the proper technique and tools to get the best result and achieve the target of producing furniture that is water resistant. The furniture can also be used for a long time as the properties increase even when immersed in water.

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