

AN INVESTIGATION OF A FLOOD BARRIER TO REDUCE PROPERTY DAMAGE VIA FABRICATION AND 3D MODELLING

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Abstract: Malaysia's southwest monsoon season from May to September results in increased rainfall and recurring urban floods. This study proposes and fabricates a conceptual flood barrier for domestic use aimed at reducing property damage by temporarily blocking still water at building entry points. After evaluating existing flood protection solution, a conceptual design was proposed incorporating a solid panel supported by L-brackets and sealed with a rubber gasket. A scaled prototype, measuring 10 cm in height and 30 cm in width, was developed using polypropylene panels, 3D-printed PLA L-brackets, and rubber gaskets for sealing. Experimental tests showed the barrier effectively withstood still water up to 10 cm with minimal leakage. Suggested improvements include modularity, full collapsibility, and integration of a pump for residual water management. The results highlight the feasibility of a low-cost, rapidly deployable barrier suitable for residential flood protection.

Keywords: *Flood barrier, 3D modeling, mechanical design, urban flooding, property protection*

INTRODUCTION

Flooding is a major environmental issue in Malaysia, particularly during the southwest monsoon season. From May to September, intense rainfall increases the risk of flash floods in urban areas, resulting in significant property damage. Flood-prone regions such as Klang Valley have experienced severe flooding events, such as the 2021 incident that displaced over 125,000 residents. To address these challenges, this project investigates a small-scale flood barrier designed to protect property entrances during low-level flooding.

While traditional sandbags are cost-effective, they require significant effort to deploy and are bulky to store. Advanced barriers do offer better sealing and easier setup but come at higher costs. Comparisons highlight a trade-off between cost, deployability, and structural integrity. The Malaysian government's Flood Mitigation Plan emphasizes the need for practical solutions at the household level, aligning with this study's objectives.

MATERIALS AND METHODS

The methodology consists of four main phases: conceptual design, CAD modeling, and design and fabrication.

Conceptual Design and Evaluation Three preliminary flood barrier designs were proposed. Each concept was assessed based on affordability, ease of setup, structural integrity, portability, and manufacturability. A scoring matrix was used to select the optimal solution, where Design 2 featuring a removable panel supported by collapsible L-brackets was chosen for further development.

CAD Modeling SolidWorks was used to design all structural components, including the panel, L-brackets, and support system. Files were exported in STL format for 3D printing. Multiple iterations were tested virtually to optimize fit, load support, and assembly convenience.

Design and Fabrication The final prototype consisted of the following components:

- **Panel:** Polypropylene sheet weighted with metal plates
- **L-Brackets:** 3D printed from PLA using SolidWorks-generated STL files
- **Gasket:** Rubber foam bonded to the panel for sealing involved taping metal plates to the panel, gluing rubber foam for water resistance, and securing the barrier using L-brackets inside a test container.

RESULTS AND DISCUSSION

Design & Fabrication The 3D design of the flood barrier and final prototype as below.

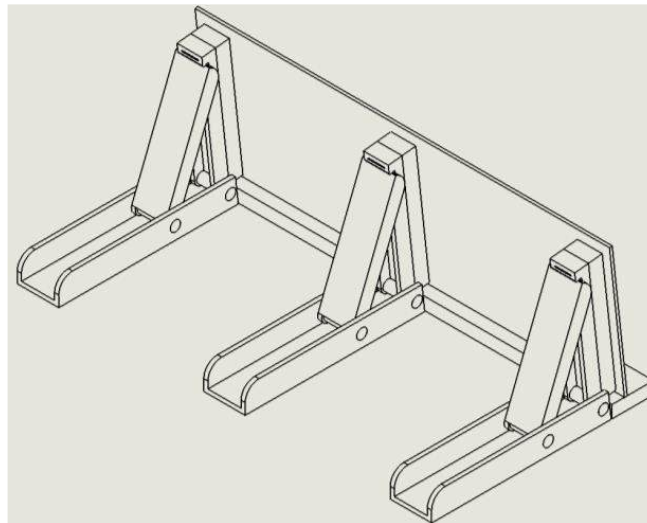


Figure 1. Isometric view of flood barrier

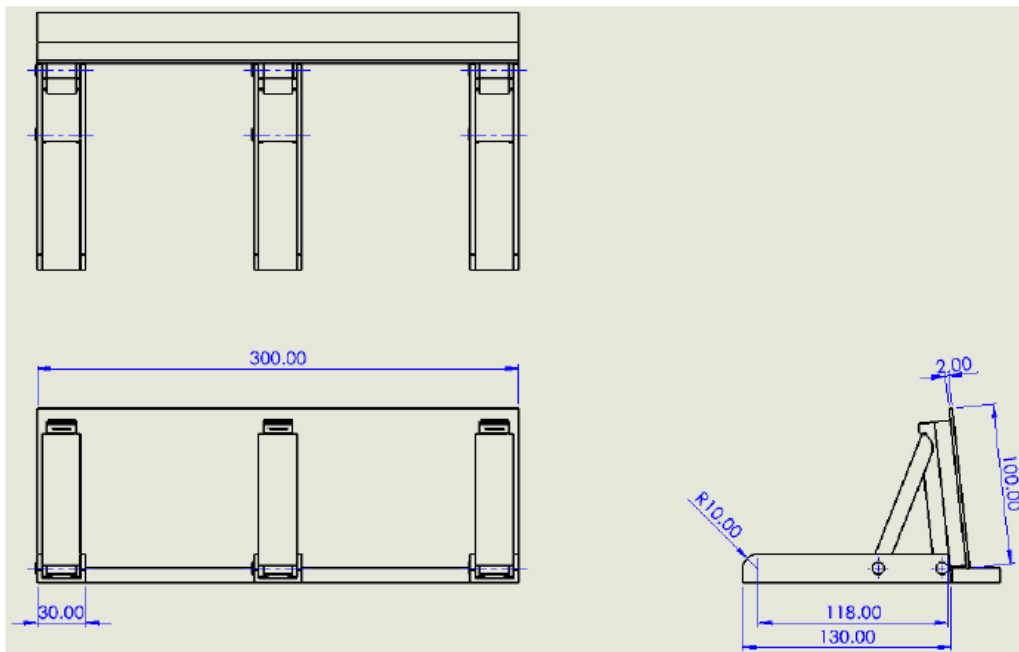


Figure 2. Third angle projection of flood barrier



Figure 3. Prototype of the flood barrier

Leakage Rate Analysis To quantify the effectiveness of the flood barrier, a leakage rate analysis was conducted. The test involved placing the barrier in a controlled container environment with a 10 cm still water level on one side. Water that passed through was collected and measured at hourly intervals over a 6-hour duration.

The total volume of leaked water after 6 hours was approximately 150 mL, resulting in an average leakage rate of 25 mL/hour. After implementing the gasket and increasing panel weight, the leakage volume dropped to 30 mL over 6 hours, or 5 mL/hour. This represents an 80% reduction in leakage, validating the effectiveness of the design modifications as shown in Figure 4.

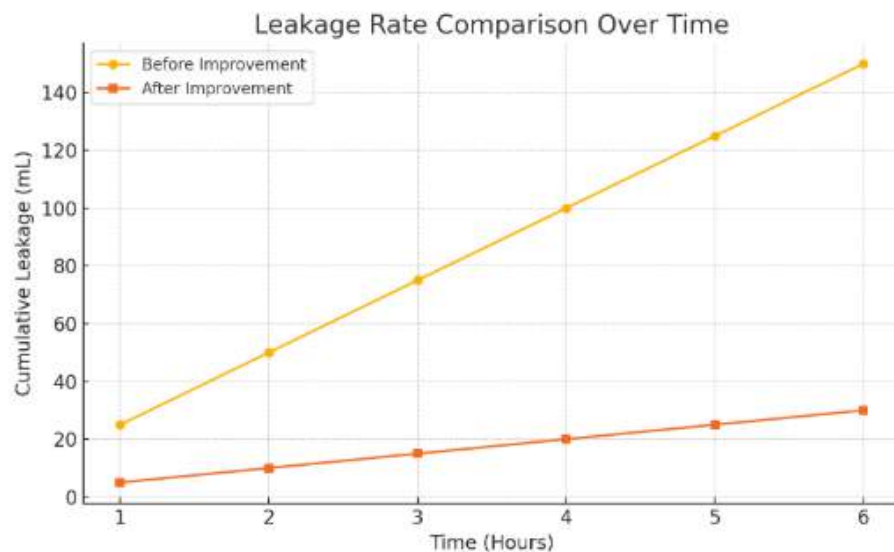


Figure 4. Graph of leakage rate comparison over time

These results demonstrate that even under static water pressure, proper sealing and stability play a critical role in barrier performance. Further reductions in leakage could be achieved through improved surface contact or additional sealing methods.

CONCLUSIONS

The fabricated flood barrier developed in this study has successfully demonstrated its potential to reduce property damage during low-level flooding by effectively delaying the ingress of floodwater. Through experimental testing, the integration of a rubber gasket and added panel weight proved to be essential in minimizing leakage, with an observed 80% reduction in water seepage. This highlights the critical role of sealing and structural stability in domestic-scale flood mitigation systems. Future work should continue to explore improvements in material durability, real-world deployment scenarios, include pressure testing and structural simulations and user-centered design to ensure broader adoption and long-term effectiveness.

REFERENCES

- Haziq Sarhan, R., Minhaz Farid, A., Mazlin, M., and Chen Kim, L. (2023). Reviewing Challenges of Flood Risk Management in Malaysia. *Water*, 15(13), 2390. <https://doi.org/10.3390/w15132390>
- Khairi Supar, Sheikh Ismail, S. M. N., Azmi, M. A., Jafri, A. I., Mohamad Azim Mohammad Azmi, & Hilton Ahmad. (2024). The Development of Semi-Auto Flood Door Barrier. *Multidisciplinary Applied Research and Innovation*, 5(2), 24-30. <https://publisher.uthm.edu.my/periodicals/index.php/mari>
- Muñoz-Caballero, J., Vergara, D., Fernández-Arias, P. and Antón-Sancho, A. (2022). Design of a Smart Barrier to Internal Flooding. *Inventions*, 7(4), 88. <https://doi.org/10.3390/inventions7040088>
- Shukman, D. (2022, January 2). *Malaysia floods hit seven states forcing thousands to evacuate*. CNN. <https://edition.cnn.com/2022/01/02/asia/malaysia-floods-evacuation-intl-hnk/index.html>
- Tan, W. Y., Teo, F. Y., Chong, C. X. Y., Tan, C. Y., and Lim, C. H. (2024). A Review on Lightweight Mobile Flood Wall Barrier: Way Forward for Malaysia. *IEM Journal*, 84(2). <https://doi.org/10.54552/v84i2.210>