



**PUSAT KAJIAN PANTAI DAN OSEANOGRAFI
MAKMAL HIDRAULIK DAN INSTRUMENTASI**

Flood Control Baffle (FCB)

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Flood Control Baffle (FCB)

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1. INTRODUCTION

Urban flooding presents a significant challenge in contemporary city management, often resulting in severe disruptions to infrastructure, economic activity, and public safety. The increasing frequency and intensity of sudden, heavy rainfall events, exacerbated by climate change and rapid urbanization, have heightened the urgency for effective flood mitigation strategies. Traditional flood control methods, such as sandbag barriers and fixed drainage systems, while effective to an extent, often lack the flexibility and rapid deployment necessary for emergency flood response in dense urban environments. As cities continue to expand and impermeable surfaces replace natural drainage areas, the vulnerability of urban floodplains intensifies, necessitating innovative solutions for adaptive flood management.

In response to these evolving challenges, the Flood Control Baffle (FCB) has been developed as a temporary and adaptable flood control mechanism tailored to urban settings. Unlike conventional methods, the FCB is designed to utilize water pressure to enhance its stability, effectively containing and redirecting floodwaters with minimal infrastructure modifications. Its lightweight structure, ease of installation, and efficiency in emergency scenarios position it as a practical alternative to traditional flood barriers. However, while the FCB has shown promise in mitigating flood risks, empirical data on its effectiveness remains critical to validating its reliability under diverse urban flooding conditions.

This study seeks to evaluate the performance of the FCB through controlled experimental testing, focusing on its ability to contain and redirect floodwaters, minimize leakage, and maintain stability under varying hydraulic loads. By assessing its functionality on flat urban terrain, a common flood-prone environment, the research aims to provide insights into its practical applications, limitations, and potential improvements. The findings will contribute to broader discussions on urban resilience, offering city planners and disaster response teams a versatile tool for flood mitigation in rapidly developing urban landscapes.

2. OBJECTIVE

The aim of this study is to observe the effectiveness of the Flood Control Baffle (FCB), particularly its ability to contain and redirect flowing water.

3. PRODUCT DESCRIPTION

3.1 Flood Control Baffle

The Flood Control Baffle (FCB) is a modern flood mitigation tool specifically designed to address the challenges posed by sudden and extreme rainfall events in urban environments. Unlike traditional flood barriers such as sandbags, which require extensive manual labor for deployment and storage, the FCB offers a rapid, effective, and scalable flood control solution. Its self-stabilizing mechanism utilizes the weight and pressure of floodwaters to reinforce its position on the ground, increasing friction and reducing the likelihood of displacement. This design principle enables the FCB to function autonomously, adapting to varying water levels without requiring additional anchoring in standard flooding conditions.

The baffle's structural composition plays a crucial role in ensuring durability and resistance to hydraulic forces. Manufactured using ABS composite reinforcement material, the FCB exhibits high tensile strength (≥ 20 MPa) and bending strength (≥ 40 MPa), making it resilient against mechanical stress and potential deformations caused by turbulent water flow. Additionally, its integrated molding process enhances structural integrity, minimizing weak points that could otherwise compromise performance under extreme conditions. The inclusion of stiffeners with a diameter of no less than 8 cm on both the vertical and ground-facing surfaces further reinforces stability, ensuring the baffle maintains its position even in high-flow scenarios.

Beyond its mechanical properties, the FCB offers versatility in application, catering to a wide range of flood-prone urban settings. Whether deployed to protect critical infrastructure, such as subway entrances, commercial blocks, and residential areas, or used as a diversion tool to channel floodwater away from vulnerable locations, the baffle provides a dynamic and efficient alternative to conventional flood control methods. Its portability, ease of installation, and minimal storage requirements make it highly suited for emergency response operations where time and efficiency are paramount.

Overall, the FCB represents a significant advancement in urban flood mitigation strategies, combining material science, hydraulic engineering, and practical usability into a compact and reliable flood protection system. Its ability to effectively contain and redirect floodwaters with

minimal preparation makes it a valuable addition to disaster management frameworks, ensuring enhanced resilience against sudden and unpredictable flooding events.

3.2 Product specification

The structural integrity and material composition of the Flood Control Baffle (FCB) play a crucial role in its effectiveness as an urban flood mitigation tool. Designed for rapid deployment and durability, the baffle incorporates ABS composite reinforcement material, ensuring high mechanical strength while maintaining flexibility for varied flood conditions. Its integrated molding process enhances structural cohesion, reducing weak points that might compromise performance under heavy water pressure.

The following table outlines key technical specifications that define the baffle’s resilience, including tensile strength, bending resistance, and impact durability. Additionally, structural enhancements, such as stiffeners and surface protection layers, contribute to its ability to withstand prolonged exposure to hydraulic forces while maintaining usability. These attributes enable the FCB to function as a stable and effective flood barrier, replacing traditional sandbag systems with a more adaptable and efficient alternative.

Table 1: Technical Specifications of the Flood Control Baffle

Material:	ABS composite reinforcement material
Manufacturing process:	integrated molding
Tensile strength	≥20MPa
Bending strength	≥40MPa;
Simply supported beam without notch impact strength	≥30KJ/m ²
There are two stiffener with a diameter of no less than 8cm on the facade and the ground of the flood control baffle to increase the strength, and the surface is equipped with an anti-abrasion grain protective layer	
The facade of flood control baffle has an integrated oval handle, which is convenient for quick handling	

The Flood Control Baffle (FCB) is engineered to withstand the pressures exerted by urban floodwaters while maintaining its structural integrity and performance. The following specifications highlight key material properties and design features that contribute to its stability, durability, and usability in flood mitigation scenarios.

- ❖ **Material Composition:** Constructed from ABS composite reinforcement material, the FCB offers a balance between strength and lightweight flexibility. This ensures that it can resist hydraulic forces without compromising ease of transport and installation.
- ❖ **Manufacturing Process:** The integrated molding technique enhances the structural cohesion of the baffle, minimizing weak points and improving durability under stress conditions.
- ❖ **Mechanical Strength:**

Tensile Strength (≥ 20 MPa): Provides resistance against stretching forces, ensuring the baffle does not deform under water pressure.

Bending Strength (≥ 40 MPa): Enhances rigidity, preventing structural warping due to continuous exposure to high flow rates.

Impact Strength (≥ 30 KJ/m²): Measured using a simply supported beam without a notch, this parameter ensures resilience against abrupt force exerted by flood currents or debris.

- ❖ **Structural Enhancements:**

Stiffeners: Two integrated stiffeners with a diameter of no less than 8 cm reinforce both the vertical and ground-facing surfaces of the baffle, increasing overall strength.

Surface Protection: The outer layer is designed with anti-abrasion grain protection, reducing wear and tear caused by prolonged exposure to water flow and debris.

Handle Design: An integrated oval handle facilitates quick deployment and removal, ensuring efficiency in emergency situations.

These specifications collectively enable the FCB to function as a highly effective flood control barrier, suitable for urban landscapes where rapid response and adaptability are critical. The emphasis on self-stabilization through water pressure, along with enhanced mechanical resilience, positions the FCB as a superior alternative to traditional sandbags in flood management operations.

4. METHODOLOGY

To evaluate the effectiveness of the Flood Control Baffle (FCB) in urban flood mitigation, a series of controlled experimental tests were conducted in a closed test environment designed to simulate real-world urban flooding conditions. The methodology employed in this study focused on assessing the baffle's ability to contain and redirect floodwaters, its performance under varying discharge rates, and its resilience against overflow conditions. The testing environment was engineered to provide controlled hydraulic conditions, ensuring accurate and repeatable observations.

4.1 Test Environment and Setup

The experimental setup was constructed to replicate typical urban flooding scenarios, particularly in flat terrain environments where water accumulation is common. The Flood Control Baffle was installed on a leveled concrete surface, representing an urban street or low-lying area with minimal gradient. The absence of significant slope ensured that the test results accurately reflected the baffle's effectiveness in containing stagnant water and managing lateral water flow.

To generate controlled water flow, a high-capacity 50 HP water pump, regulated by an electronic inverter, was employed to deliver varying discharge rates systematically. This setup allowed for precise control over the water velocity, depth, and applied hydraulic pressure, ensuring that observations remained consistent across different test phases. The ultrasonic flow meter was utilized to monitor and record the discharge rate, providing accurate, real-time measurements of flow variability and fluid dynamics interacting with the baffle.

4.2 Testing Procedure

The experiment was conducted in five distinct phases, each corresponding to a progressive increase in discharge rate to assess the FCB's performance under increasing hydraulic loads. The test sequence proceeded as follows:

- i. Initial Stagnant Water Condition

Before initiating active flow, the baffle was exposed to a stagnant water condition, simulating a scenario where floodwaters pool in a low-lying urban area. This phase aimed

to evaluate the baffle's ability to form a reliable seal against water leakage and seepage, particularly under prolonged exposure.

ii. Gradual Discharge Increase

Water was introduced into the test environment at an initial discharge rate of 55 liters per second (ℓ/s). Observations focused on the baffle's stability, the degree of lateral water diversion, and any evidence of leakage at the base or edges.

Subsequent discharge increments included 125 ℓ/s , 187 ℓ/s , and 234 ℓ/s , with each stage assessing the structural integrity, resistance to water pressure, and effectiveness in maintaining containment as hydraulic forces increased.

iii. Overflow Condition Evaluation

At the maximum discharge rate of 234 ℓ/s , the test simulated an extreme flooding event, wherein water levels exceeded the height of the baffle, leading to controlled overflow. This phase was critical in determining the baffle's stability and resistance to displacement when floodwaters surpassed containment limits.

iv. Analysis of Water Leakage and Structural Performance

Observations included quantifying minor leaks at the base and both ends of the baffle, analyzing whether the leakage remained negligible or could impact the integrity of protected areas over time.

The structural behavior of the baffle was recorded, particularly noting whether additional support mechanisms, such as weighted blocks at both ends, could further enhance stability under severe flooding conditions.

v. Post-Test Assessment and Data Validation

After completing the water flow simulations, the baffle's condition was evaluated, checking for material wear, structural deformation, and ease of reinstallation after deployment.

Data collected from the ultrasonic flow meter and visual observations were validated to ensure consistency and accuracy in performance assessment.

4.3 Analytical Approach

Quantitative and qualitative methods were applied to interpret the results obtained from the test sequences. The primary metrics analyzed included:

- i. Containment Efficiency: Determined by assessing the baffle's ability to retain floodwaters without excessive leakage or displacement.
- ii. Stability Against Hydraulic Load: Evaluated through observations of structural shifting or drift, particularly under high discharge rates and overflow conditions.
- iii. Leakage Assessment: Measured by analyzing seepage levels at the baffle's base and connection points, determining whether leakage remained within acceptable tolerances for flood control applications.
- iv. Overflow Resilience: Assessed based on the baffle's ability to maintain stability when flood levels exceeded the containment height, identifying potential improvements for extreme conditions.

4.4 Significance of Methodology

The methodology adopted in this study provides a systematic and reproducible framework for evaluating urban flood mitigation tools. By conducting controlled experiments across varying discharge rates, the research ensures that the performance capabilities of the Flood Control Baffle can be accurately assessed under diverse flooding scenarios. The findings derived from this methodology contribute to further refinements in flood control strategies, enabling cities to enhance their emergency response mechanisms and infrastructure resilience against extreme rainfall events.

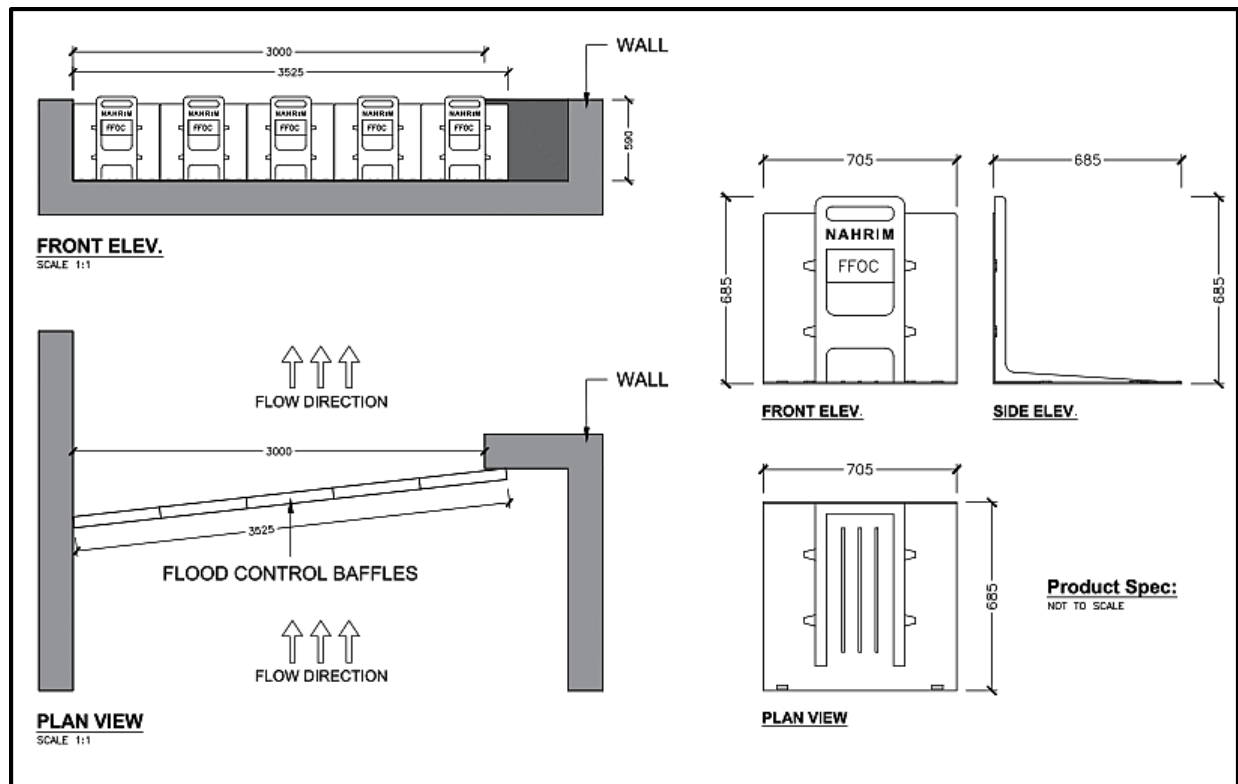


Figure 1: Test Layout and Flood Control Baffle specification



Figure 2: Installation of the Flood Control Baffle to contain and divert water



Figure 3: Ultrasonic Flow Meter and 50 HP water pump.



Figure 4: Condition with stagnant water



Figure 5: Condition at a discharge rate of 55 ℓ/s .



Figure 6: Condition at a discharge rate of 125 ℓ/s .



Figure 7: Condition at a discharge rate of 187 ℓ/s .



Figure 8: Condition at a discharge rate of 234 ℓ/s .

5. TEST FINDINGS

5.1 Effectiveness in Containing Floodwater

Flood containment plays a vital role in urban flood mitigation, ensuring that water is either redirected away from critical infrastructure or contained within designated areas to minimize damage. The Flood Control Baffle (FCB) was developed to provide a temporary, self-stabilizing flood barrier capable of performing under conditions of sudden and intense rainfall. The controlled experimental tests conducted in this study examined the baffle's containment efficiency, stability under hydraulic forces, and resilience under overflow conditions, offering valuable insights into its practical flood management applications.

5.1.1 Flood Containment Performance

Observational data from the controlled testing environment validated the FCB's ability to act as a reliable flood barrier, successfully preventing floodwaters from breaching protected zones. The containment tests, conducted on a flat urban surface, allowed researchers to evaluate its functionality in conditions where floodwaters tend to accumulate and stagnate rather than drain away. This scenario mirrors real-world urban flooding conditions, particularly in low-gradient environments, such as commercial zones, residential entryways, and warehouse perimeters, where the threat of flood intrusion is most severe. The results demonstrated that the baffle effectively retained water, minimizing flood intrusion and ensuring critical infrastructure protection. Unlike traditional sandbag barriers, which require labor-intensive deployment and occupy excessive storage space, the FCB offers a space-efficient and rapidly deployable alternative, making it an ideal choice for emergency flood response in densely populated urban environments.

5.1.2 Effectiveness in Water Diversion

In addition to flood containment, the FCB displayed strong capabilities in redirecting water flow, ensuring that high-risk areas remained secure during flood events. The ability to alter the trajectory of floodwaters is essential for protecting subway entrances, underground shopping malls, and parking facilities, where water accumulation can cause severe damage to infrastructure and property. Experimental results showed that the FCB effectively redirected floodwaters, preventing excessive accumulation in areas

requiring protection. Its adaptability for both containment and diversion applications positions it as a versatile flood management tool, allowing emergency response teams to modify flood control strategies in real time based on evolving conditions.

5.1.3 Urban Flooding Applications and Emergency Preparedness

Rapid deployment and adaptability are key factors in effective urban flood management, particularly in disaster scenarios where cities must respond swiftly to mitigate damage. The FCB's ability to function efficiently in flat terrain environments highlights its suitability for urban flood control operations, ensuring minimal preparation requirements while maintaining effective containment and diversion. The successful performance of the FCB in controlled test environments suggests that it can be integrated into urban emergency preparedness frameworks, providing cities with a cost-effective and scalable flood control solution. The experimental results reinforce its viability as a preferred tool for flood management, offering urban planners and disaster response teams a reliable means to protect infrastructure and properties from flood damage.

Additionally, observations from overflow scenarios indicate that reinforcing the FCB's stability with additional support mechanisms at both ends would optimize its resilience in extreme flooding conditions. A minor enhancement using weighted blocks or temporary barriers would improve its ability to maintain position and prevent lateral displacement, ensuring continued effectiveness even when floodwaters exceed standard containment limits. Through systematic testing and analysis, the findings demonstrate that the Flood Control Baffle provides a robust, adaptable, and efficient solution for urban flood mitigation. Its containment performance, stability under hydraulic forces, and capability for rapid deployment position it as a critical tool for modern flood management, ensuring cities can effectively respond to sudden flood events while protecting critical infrastructure and public safety.

5.2 Minimal Water Leakage

Effective flood barriers must not only contain water but also minimize leakage, ensuring that floodwaters do not infiltrate protected areas. The Flood Control Baffle (FCB) was specifically designed to provide a reliable seal against floodwater intrusion, reducing the risk of seepage and

unintended water flow. A key component of its performance evaluation is the degree of water leakage at the baffle's base and lateral edges, as excessive seepage can compromise the integrity of flood containment measures.

5.2.1 Sealing and Leakage Prevention Mechanisms

The design of the FCB incorporates material enhancements and structural stability features that contribute to its effectiveness in preventing water leakage. Constructed from ABS composite reinforcement material, the FCB offers high resistance to prolonged water exposure, ensuring that its structural integrity remains intact despite continuous contact with floodwaters. Additionally, the integrated stiffeners on both the vertical and ground-facing surfaces play a crucial role in reinforcing the flood barrier's seal, reducing the likelihood of seepage beneath or around the baffle.

A fundamental feature of the FCB is its self-stabilizing mechanism, which enhances sealing efficiency through water pressure. The weight of accumulated floodwaters presses the baffle firmly against the ground, increasing friction between its base and the surface, thereby forming a secure barrier against potential seepage points. This pressure-driven sealing effect is particularly effective for temporary flood control applications, where rapid deployment and minimal preparatory work are essential.

5.2.2 Experimental Observations and Leakage Analysis

Controlled tests were conducted across a range of discharge rates to assess water leakage under varying hydraulic conditions. Observations revealed that leakage remained minimal, with only negligible seepage detected at the base and lateral edges. Key findings from the leakage assessment include:

- i. **Base Seepage:** Minimal leakage was observed at the interface between the baffle and the ground, confirming its ability to form a reliable seal in urban flood conditions.
- ii. **Edge Leakage:** Small amounts of surface water infiltration were recorded at the lateral connection points, but these remained within acceptable tolerances for temporary flood barriers.

- iii. Long-Term Stability: Water retention tests demonstrated that seepage did not accumulate over time, reinforcing the FCB's effectiveness in containing floodwater for extended durations.

Importantly, the experimental results confirmed that any minor leakage detected during testing did not compromise the integrity of the barrier, ensuring consistent flood containment even under high-pressure flow conditions.

5.2.3 Implications for Urban Flood Management

The ability of a flood barrier to effectively seal against water infiltration is critical for urban flood resilience strategies. The FCB's minimal leakage performance suggests that it is a viable alternative to traditional sandbag barriers, which often suffer from water penetration issues and structural inconsistencies. Furthermore, the ease of deployment and stable sealing mechanism make the FCB an ideal solution for rapid flood response operations. In emergency situations, where time-sensitive flood control measures are necessary, its low-leakage performance ensures efficient containment without requiring extensive reinforcement. The FCB's ability to maintain its seal under varying hydraulic loads further highlights its practical applicability in urban environments, particularly in densely populated areas where traditional flood barriers may not be feasible.

Observations from the study also highlight potential optimizations that could further enhance its sealing performance, particularly in high-flow scenarios. For instance, reinforcing the edges with additional sealing strips or weighted supports could further reduce lateral seepage, making it even more effective for prolonged flood containment applications.

The FCB's ability to perform consistently under diverse flood conditions, coupled with its structural resilience and minimal water leakage, positions it as a highly efficient flood mitigation tool. Its adaptive design, self-sealing stability, and effective containment capabilities provide a comprehensive flood management solution, allowing urban planners and emergency response teams to implement effective flood prevention strategies with minimal infrastructure modifications.

5.3 Performance Under Overflow Conditions

One of the key challenges in urban flood management is the ability of flood barriers to remain effective when water levels exceed their containment height, leading to overflow. In extreme flood events, barriers must not only contain water but also maintain stability despite hydraulic forces pushing against them. The Flood Control Baffle (FCB) was specifically designed to utilize the weight and pressure of floodwater to reinforce its ground stability, ensuring minimal displacement during overflow conditions.

5.3.1 Stability Against Hydraulic Forces

During experimental testing, the FCB was subjected to progressively increasing discharge rates, culminating in a maximum flow rate of 234 ℓ/s , simulating severe flooding scenarios. The results indicated that while overflow occurred, the baffle remained stable, effectively resisting drifting and lateral movement. The self-stabilizing mechanism, which relies on the downward pressure of water to enhance ground friction, proved effective in maintaining the baffle's position even when floodwaters surpassed its designed containment height.

One of the critical observations was the distribution of overflow impact. When water levels exceeded the baffle height, the floodwater spread evenly over the barrier, rather than forcing a concentrated surge that could displace the structure. This controlled overflow dispersion prevented unpredictable water surges, which often contribute to barrier failure in traditional flood control systems.

5.3.2 Observations on Structural Behavior

Despite its overall stability, some lateral shifting was observed, particularly in areas where water pressure was asymmetrical due to environmental variables such as uneven terrain or directional flow shifts. Under standard overflow conditions, the baffle remained firmly positioned, but in cases where continuous water movement created lateral force, the ends of the baffle showed slight movement. This suggests that additional end-support mechanisms may further optimize stability, particularly in long-term overflow scenarios.

To counteract this minor shifting effect, weighted blocks or temporary anchoring systems could be introduced at both ends of the baffle, preventing any sideward displacement caused by prolonged exposure to overflow forces. Such enhancements would further strengthen the baffle's ability to function as a reliable flood management tool, even in extreme urban flooding events.

5.3.3 Practical Implications for Urban Flood Control

Overflow resilience is a critical parameter in flood mitigation planning, particularly for temporary flood barriers deployed in emergency situations. Many traditional containment solutions, such as sandbags, suffer from structural failure when overwhelmed, leading to rapid water intrusion and reduced effectiveness. The FCB's ability to maintain stability during overflow suggests that it can serve as a more dependable alternative, particularly in high-risk urban zones where flood levels are unpredictable. For city planners and emergency response teams, the ability to deploy a stable, overflow-resistant barrier provides enhanced flexibility in flood mitigation operations. The FCB's effectiveness under overflow conditions makes it a valuable tool for protecting infrastructure, such as subway entrances, underground parking areas, commercial centers, and residential zones, reducing the likelihood of flood-induced damage.

Additionally, the findings suggest that while the FCB is inherently stable, minor modifications to anchoring at the ends could further improve its reliability in extreme flood events. The integration of small structural reinforcements, such as temporary side barriers or weighted stabilizers, may provide additional security, ensuring that the baffle remains optimally positioned even when exposed to sustained overflow conditions. The experimental results confirm that the FCB is a highly effective containment and redirection tool, capable of withstanding overflow without significant displacement. Its self-stabilizing design, controlled overflow dispersion, and adaptability to urban terrain make it a practical flood control solution for cities seeking rapid and efficient response measures.

5.4 Suitability for Flat Terrain

Urban flooding is frequently exacerbated by flat terrain, where water tends to accumulate rather than drain efficiently. In such environments, flood control measures must be capable of

containing and redirecting stagnant water, particularly in areas where drainage infrastructure is limited or overwhelmed. The Flood Control Baffle (FCB) was specifically designed to function effectively in low-gradient urban environments, ensuring that floodwaters do not spread uncontrollably into critical infrastructure and residential zones.

5.4.1 Performance in Flat Urban Conditions

Experimental testing was conducted on a nearly flat surface, representative of typical urban landscapes, including paved streets, commercial areas, and industrial zones, where flood accumulation is a frequent concern. Observations confirmed that the FCB effectively contained stagnant water, preventing excessive lateral movement and infiltration into protected areas.

Unlike traditional flood barriers, such as sandbags or fixed concrete floodwalls, which require significant preparation and structural reinforcement, the FCB demonstrated adaptability to various urban terrains without the need for anchoring or fixed installation. Its self-stabilizing design, which relies on the pressure of floodwaters to increase ground friction, ensured that the baffle remained securely positioned even in areas with minimal terrain variation. The ability of the FCB to function efficiently in flat flood-prone environments means that it can be deployed in a wide range of urban settings, including commercial blocks, transportation hubs, and low-lying residential areas, where standing water can lead to property damage and infrastructure disruption.

5.4.2 Containment and Diversion in Low-Slope Areas

One of the primary challenges of flood mitigation in flat terrain is water stagnation, which often results in prolonged flooding when natural drainage systems become overwhelmed. The FCB's containment capability, demonstrated through controlled testing, suggests that it can effectively prevent floodwater from encroaching upon vulnerable areas, reducing the risk of long-term water accumulation and structural deterioration. Additionally, the FCB performed well in water diversion applications, ensuring that excess floodwater could be redirected toward designated drainage points without infiltrating areas requiring protection. This feature is particularly beneficial in urban environments, where

emergency flood response strategies often require flexible barriers that can be repositioned to guide water flow in real time.

5.4.3 Implications for Urban Flood Mitigation Strategies

The suitability of the FCB for flat urban terrain provides valuable insights for city planners, emergency response teams, and infrastructure specialists seeking efficient flood control solutions. Many urban regions suffer from inadequate drainage capacity, leading to persistent flood conditions that negatively impact transportation networks, commercial activity, and public safety. Given the versatile deployment capability of the FCB, it presents an alternative to cost-intensive flood mitigation systems, offering a rapid response solution that requires minimal preparation and installation effort. Its ability to function effectively on flat surfaces without extensive anchoring makes it an ideal tool for emergency flood containment, particularly in urban zones where permanent flood barriers may not be feasible. The findings suggest that further refinement of deployment strategies, such as optimizing the positioning of multiple interconnected baffles, could enhance containment efficiency in large-scale urban flooding scenarios. The adaptability of the FCB ensures that flood mitigation efforts remain dynamic and responsive, meeting the evolving demands of climate change-driven extreme rainfall events.

The experimental results confirm that the FCB is a highly effective flood management tool for urban environments with flat terrain, ensuring that floodwaters are contained and redirected efficiently. Its stability, ease of deployment, and versatility position it as a critical asset in contemporary flood mitigation planning, particularly in densely developed urban centers where rapid flood response measures are essential.

5.5 Applicability for Diversion and Stagnant Water Containment

Flood mitigation strategies must address not only active water diversion but also the containment of stagnant water, which can lead to prolonged flooding and infrastructure damage. The Flood Control Baffle (FCB) was designed to function in both scenarios, offering a versatile flood management solution capable of redirecting water flow while simultaneously containing standing floodwaters. Its ability to adapt to changing urban flood conditions makes it a highly effective tool for emergency flood response.

5.5.1 Effectiveness in Flood Diversion

In urban flooding events, directing floodwaters away from critical infrastructure is essential for minimizing damage to residential, commercial, and transportation hubs. The FCB was tested in controlled discharge conditions, demonstrating its ability to successfully redirect water flow, preventing entry into protected areas such as building entrances, underground facilities, and commercial spaces. Observations from experimental testing confirmed that the FCB altered the trajectory of floodwaters efficiently, ensuring that high-risk zones remained protected. Unlike static flood barriers, which primarily serve as containment structures, the FCB actively influences water movement, enabling real-time flood management adjustments based on environmental needs. This dynamic flood control capability enhances its practical application in urban emergency response scenarios, where rapid adjustments to flood barriers are often required.

The ability to guide floodwaters toward designated drainage points reduces the risk of water accumulation in areas with inadequate drainage infrastructure, ensuring that flood mitigation efforts are not merely reactive but proactively managed. This adaptability positions the FCB as a critical tool in modern urban flood planning, offering city planners an efficient way to control water flow during sudden flood events.

5.5.2 Containment of Stagnant Floodwaters

Urban flooding frequently results in standing water accumulation, particularly in low-lying areas where natural drainage is insufficient. Stagnant water poses multiple hazards, including structural degradation, transportation disruptions, and potential health risks due to waterborne contaminants. The FCB's containment capabilities were evaluated under controlled stagnant water conditions, demonstrating its ability to secure designated flood zones and prevent water from spreading beyond the intended boundaries. Observations indicated that the FCB formed a reliable flood containment barrier, ensuring that stagnant water remained confined within defined perimeters. This characteristic is particularly valuable for urban flood response strategies, where long-term water retention must be managed to prevent excessive flood spread.

In urban planning, the ability to strategically contain floodwaters allows emergency responders to implement targeted drainage solutions, reducing the risk of water infiltration into vulnerable structures. The FCB's capability to contain standing water complements its diversion functions, ensuring a comprehensive flood control strategy that addresses multiple flood scenarios simultaneously.

5.5.3 Practical Implications for Flood Management

The dual functionality of the FCB—facilitating flood diversion while ensuring stagnant water containment—makes it a critical component of urban flood resilience strategies. City planners and disaster response teams require adaptable flood control tools capable of responding to both active and prolonged flood events. The ability of the FCB to redirect water flows while sealing off flood-prone zones positions it as an advanced alternative to traditional containment methods, offering greater flexibility in flood response operations. Additionally, integration with existing urban flood response infrastructure, such as stormwater drainage systems and temporary flood barriers, could further enhance the effectiveness of the FCB in large-scale urban flood mitigation efforts. By strategically deploying multiple interconnected baffles, cities could establish temporary flood control networks, ensuring real-time flood diversion and containment without requiring permanent infrastructure modifications.

The FCB's ability to function effectively in both diversion and stagnant water containment scenarios confirms its viability as an advanced flood mitigation solution, enhancing urban resilience against sudden and prolonged flooding events. Its self-stabilizing design, high containment efficiency, and rapid deployment capability ensure that cities can respond effectively to extreme weather conditions, protecting critical infrastructure and vulnerable areas from flood damage.

6. Conclusion

The findings from this study confirm that the Flood Control Baffle (FCB) is a highly effective, adaptable, and practical solution for urban flood management. Designed to contain and redirect floodwaters efficiently, the FCB demonstrates remarkable stability, even under overflow conditions, ensuring that critical infrastructure and residential areas remain protected. Its self-

stabilizing mechanism, which utilizes hydraulic pressure to enhance ground friction, enables rapid deployment and reliable performance in diverse flood scenarios, making it a valuable asset in emergency response operations. The results from controlled experimental testing highlight the FCB's ability to minimize water leakage, maintaining integrity as a flood containment barrier while ensuring that seepage remains negligible. Its suitability for flat terrain applications further reinforces its versatility in urban environments, allowing for effective flood control without requiring extensive anchoring or structural modifications. Moreover, its dual functionality in diversion and stagnant water containment offers urban planners and disaster response teams a scalable flood mitigation tool, capable of addressing immediate flood threats and long-term water retention challenges. While the FCB has proven its effectiveness in standard and extreme flood conditions, experimental observations suggest that minor reinforcements, such as weighted supports at both ends, could further optimize stability in prolonged overflow scenarios. Implementing these enhancements would increase resilience, ensuring consistent flood protection even when water levels exceed containment limits. Given its rapid deployment capability, ease of handling, and minimal storage requirements, the FCB presents a viable alternative to conventional flood control systems, such as sandbags, which require significant labor and logistical support. As cities grapple with increasingly unpredictable weather patterns and intensifying flood risks, integrating innovative, flexible flood control solutions like the FCB into urban resilience strategies will be critical for enhancing disaster preparedness and infrastructure protection. By leveraging the insights gained from controlled field testing, future applications of the FCB could explore expanded deployment strategies, ensuring widespread accessibility and improved performance under extreme urban flooding conditions. Through continued refinement and integration into flood mitigation frameworks, the Flood Control Baffle has the potential to become a cornerstone of modern urban flood defense, safeguarding critical assets, infrastructure, and communities from the devastating impacts of flooding.

7. Recommendation

To enhance the effectiveness of the Flood Control Baffle (FCB) in urban flood mitigation, several refinements could be implemented based on the findings from experimental testing. One key recommendation is the reinforcement of stability mechanisms, particularly at both ends of the baffle, to prevent lateral shifting during overflow conditions. While the FCB demonstrated strong

resistance against displacement, minor structural reinforcements such as weighted supports or temporary anchoring methods could further improve its resilience in extreme flooding scenarios. Additionally, integrating interlocking connection systems between multiple baffles could enhance scalability, allowing for broader coverage in large-scale urban flood events. These adjustments would ensure greater reliability, particularly in flood-prone areas where prolonged water pressure may impact barrier performance.

Furthermore, optimizing the sealing performance of the FCB can minimize edge seepage, ensuring complete flood containment. Observations from controlled tests indicate that while leakage remained negligible, enhanced sealing features, such as rubberized base layers or additional compression seals, could further reduce water infiltration risks. These improvements would be particularly valuable in long-term containment scenarios, where minimal seepage is crucial for protecting critical infrastructure and vulnerable urban spaces. Beyond technical enhancements, strategic deployment planning is essential to maximize efficiency. Cities should integrate the FCB into preemptive flood mitigation frameworks, ensuring that emergency response teams have quick access to deploy barriers ahead of expected flooding events. By refining both structural and deployment strategies, the FCB can play a pivotal role in strengthening urban resilience, offering a cost-effective, adaptive flood management solution for modern city landscapes.