FLOODS CONTROLLING IN URBAN AREAS

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ABSTRACT: Flood control in urban areas is an increasingly urgent priority due to rapid urbanization, climate change, and the inadequacies of existing infrastructure. Urban flooding can cause significant damage to property, disrupt economic activities, and pose serious health risks to residents. This project aims to develop comprehensive strategies for managing and mitigating flood risks in urban settings through an interdisciplinary approach combining advanced technologies, sustainable practices, and community engagement. one key area of focus is the implementation of Sustainable Urban Drainage Systems (SUDS), which include permeable pavements, green roofs, and rain gardens. These systems help manage stormwater at the source, reduce runoff, and enhance groundwater recharge, thereby mitigating flood risks. Another important strategy is the integration of green infrastructure, such as urban wetlands and green corridors, which can absorb excess rainwater and provide co-benefits like improved air quality and biodiversity.

Advanced technologies also play a crucial role in urban flood management. The development of smart city technologies, including IoT sensors and real-time data analytics, allows for the continuous monitoring of water levels and weather conditions, facilitating timely and accurate flood warnings. Early warning systems, coupled with effective emergency response plans, can significantly reduce the impact of floods on urban populations.

This project synthesizes these diverse approaches into a holistic framework aimed at reducing urban flood risks and enhancing resilience. By leveraging innovative technologies, sustainable infrastructure, and active community participation, the project provides a robust blueprint for urban flood management in the face of evolving environmental challenges.

Keywords: Urban flooding, flood control, Sustainable Urban Drainage Systems (SUDS), green infrastructure, Raingardens, urban resilience, climate change adaptation, stormwater management, community engagement.

1. INTRODUCTION

We have seen an increase in the number of flood-related deaths and property damage over the past ten years, and it is anticipated that these factors, along with population growth and climate change, will make flooding more likely in the future. The most dangerous natural disaster are floods, which can be caused by a variety of factors such as river basin water management, land use, drainage system and rainfall pattern [1]. Most Indian cities receive heavy rainfall during monsoons. The highly weather condition with concentrated high more common intensity rainfall are become due to climate change (increased cyclonic activity in Arabian Sea and Bay of Bengal due to warming). Most urban floods in recent times were consequent to episodes of heavy rainfall e.g., Bangalore witnessed > 130 mm rainfall in day one, against mean rainfall of ~4.5 mm/day in this time of the year. Similarly Mumbai recorded ~950 mm of rainfall on July [2].

Causes For Floods: The focus of flood causes has shifted from addressing the after effect of floods developed countries to finding a solution to recurring floods in developing nations.

There was nothing common in the explanations of the causes of floods; some were vague, and the connections to floods were either presumed or unclear. Out of the 24 causes of floods identified by the review, 12 received a score of more than 10%. The most common cause (62%) was heavy rainfall, which was followed by urbanization (40%) and poor waste management (33%) and unplanned growth (24%) and storm usage (24%) and infrastructure failure (22%). Additional factors included inadequate engineering (16%), ineffective law enforcement (16%), development in flood plains (13%), and inadequate drain maintenance (11%). Although only 9% of respondents mentioned climate change, there may be significant effects on urban development as a result [3]. Floods occur in areas where urbanisation greatly increases the amount of impervious area that accumulates over time.

a. Heavy Rainfall.
b. Increased Impervious Surface.
c. Poor Drains.
d. Blockage of Drains.
e. Unplanned Development [4].

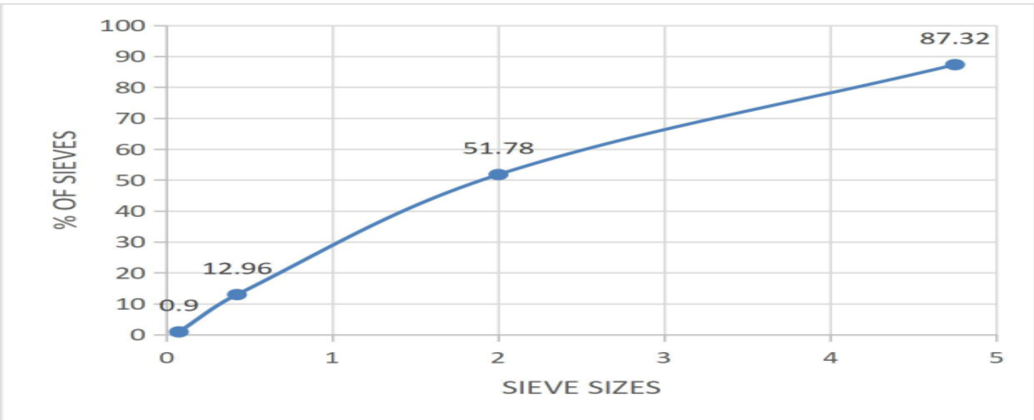
2. LITERATURE REVIEWS

The flow accumulation, and ponding of precipitation and/or snowmelt in regions close to buildings causes overland flooding. Overloaded storm water systems cause water to flow uncontrollably across the surface and into homes through openings above grade. Additionally, water is seeping into the basement from the backfill area that is right next to the foundation wall's exterior. [5]

This study proposed a new, novel paver block option to retain rainwater for evaporative cooling as well as reduce the urban runoff during precipitation events. A 6cm-thick block from this study can retain about 9.5L/m2 rainwater, beyond that amount WR blocks will behave as standard impervious pavements. Pavements made of a suite of interlocking WR paver blocks can be used as a strategy to mitigate the urban flooding to some degree. For the conditions in this study, a water-filled 6cm thick WR paver block depleted in about 1-2days [6]. After observing 69 rainfall events from an aged intensive green roof in Manchester, UK discovered that the average runoff retention of the extensive roof was 67.5%. Kolb kept an eye on both the extensive and intensive roofs evaporation and runoff coefficients. It is discovered that an intensive green roof evaporates more but releases less runoff than an extensive green roof [7]. This study uses a street block as validation object and demonstrates its effectiveness of peak runoff reduction. Therefore, the crucial point of this model is to predict the flood control operations of the hypothetical rainwater valves during typhoon and storm periods [8].

3. TESTS ON SOIL SAMPLE

a. Grain Size Analysis:



Graph: 3.1 Sieve Analysis

RESULT:

The tested soil sample is well graded gravel soil.

b. To determine the shear strength of the soil sample:

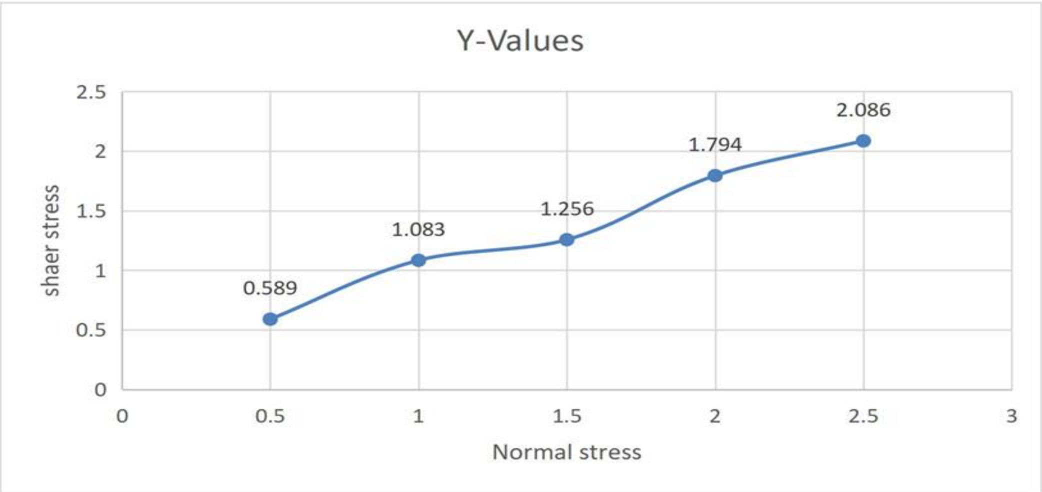
Cross sectional area: 36sqcm

Correction factor: 0.312

Cohesion(C) = 0

The internal friction angle (Φ) = 32 degree

Graph: 3.2 Direct Shear Stress



c. To perform the California bearing ration test on soil sample:

PENETRATION In mm	PROVING RING READING	LOAD (kgf)
0.5	13	50.31
1.0	27	104.49
1.5	41	158.67
2.0	58	224.46
2.5	74	286.38
4.0	114	441.18
5.0	134	518.58

RESULT:

The CBR percentage of specimen for 2.5mm penetration with respect standard CBR value is 26.57.

The CBR percentage of specimen for 5mm penetration with respect standard CBR value is 24.84.

4. RAINFALL DATA: In Telangana state the current annual rainfall of 1387.8 mm (53% excess) is the highest recorded rainfall in last 19 years. The second highest is 1322.4mm in the year 2020-21 and the third highest is 1180.5 mm in 2021-22 [9].The above rainfall data table clearly showing that the rainfall is more in July month compared to the month and also somewhat more in the month of September but not much as in July. Around 121% deviation in rainfall volume compared to normal and 53% deviation compared to the previous year. Rainfall pattern changing invariably due to climate change due to pollution [10].

S.No	Month	Month Normal	Normal As on Date	Actual Rainfall (As on Date)		Current Year % of Dev. Over Normal	% of Dev over Previous Year
				Prev. year (2021-22)	Current Year (2022-23)		
1	June	129.3	129.3	194.3	150.6	16	-22
2	July	244.4	244.4	353.4	539.9	121	53
3	August	219.6	219.6	185.6	186.2	-15	0
4	September	127.9	127.9	276.2	222.1	74	-20
South West Monsoon		**721.2**	**721.2**	**1009.5**	**1098.8**	**52**	**9**
1	October	95.5	95.6	60.1	117.9	23	96
2	November	23.9	23.9	31.7	0.9	-96	-97
3	December	5.5	5.5	1.1	7.0	27	536
Northeast Monsoon		**124.9**	**124.9**	**92.9**	**125.8**	**1**	**35**
1	January	6.8	6.8	35.8	0.7	-90	-98
2	February	4.6	4.6	0.1	0.1	-98	0
Winter Season		**11.5**	**11.5**	**35.9**	**0.8**	**-93**	**-98**
1	March	8.2	8.2	1.6	42.0	412	2525
2	April	12.1	12.2	5.1	53.0	334	939
3	May	28.3	28.3	35.5	68.4	142	93
Summer Season		**48.7**	**48.7**	**42.2**	**163.4**	**236**	**287**
Annual Rainfall		**906.3**	**906.3**	**1180.5**	**1388.8**	**53**	**18**

4. METHOD TO CONTROL FLOODS

Flood Control By Introducing Raingardens:

The effects of urban runoff on the environment and human activities can be severe. It can affect the recreational, cultural, aesthetic, and ecological values of water bodies. In addition, untreated water can negatively affect the shallow groundwater quality [11].Rain gardens are engineered gardens designed to fastening the vegetation natural ability to infiltrate the storm water into the ground and sometime it is called bio retention structures. Treatment occurs through the process of sedimentation, filtration, and absorption and up taken by the prepared rain gardens[12]. This natural manmade vegetative covers which helps to reducing the heavy storm leads to flooding and containments loads on water ways [13]. **Components Of Raingarden**:

Rain gardens help remove pollutants and slow down storm water flows, recharge freshwater bodies and look attractive. Rain gardens work by ponding storm water in the planted area, which is then filtered through the soil mix and by plant roots. These absorb and filter contaminants before storm water flows into surrounding ground, pipes, drains and streams, and eventually to the sea. Each component is required to ensure that a rain garden operates effectively [14].

Location Selection: Rain gardens are suitable for most locations including individual sites, public roads and new subdivisions. They are particularly suitable for residential zones and retrofit situations in public streets [15]. They are best avoided where available head is low (< 300), groundwater is high; a high sediment load is expected, on steep grades, in areas with lots of underground utility services and in areas of heavy industry[16]. Generally, rain gardens need to be connected to a storm water pipeline in the street to avoid water logging. Where the underlying soil is very permeable (i.e. an initial infiltration rate of at least 50 mm/hr, but ideally higher), rain gardens may discharge directly to ground through the base of the rain garden.

5.DESIGN OF RAINGARDENS

Water quality volume

Catchment area (A) = 5000 m2
Composite first flush coefficient (C_{ff} = 44% (WWDG)
First flush dept = 25mm
Water quality area A_{wq} = A.C_{ff}
=5000 X 44/100
=2200m^2

Minimum live storage

Volume of first flush (V_{ff}) = 0.02 5 X 2200
= 55 m^3
Minimum live storage (LS) = 40% of V_{ff}
= (40/100) X 55
=22 m3

Filtration area of live garden

Volume of first flush (V_{ff}) = 88 m^3
Planting soil depth (d_{rg}) = 0.6 m
Coefficient of permeability (k) = 0.0545 cm/sec
Average height of water (half maximum depth) h = 0.15 m
Time to pass V_{ff} through soil bed (T_{rg}) = 1.0 day

Dimensions of rain garden in residential streets

Parameter	Value
Typical residential block area	1 ha
Living zone	L1
Road reserve width	20 m
Width available for rain garden (including a 2 m wide buildout)	5 m
Rain gardens total surface area	117 m^2
Total length of rain gardens	23 m
Loss of car parks	4
Rain garden footprint as a percentage of impervious area	2.6%

6. CONSTRUCTION OF RAINGARDEN

A. Locate the services and excavate: Excavate the new rain garden to the depth 1 to 1.5m. Excavate the rain garden with toothed bucked to avoid closing of the voids of soil interface. Take care to avoid the compacting the existing ground by not driving across or using heavy machinery in the area, its decreases drainage capacity. The soil below the rain garden should be loosened of a at least 300 mm.

B. Install under drainage: Install the under drain system (if required) and connect to the piped storm water system. The under drain should generally in between 100 and 150mm in diameter and have a maximum slope of approximately 0.5% (5mm drop over 1 m length). A zero grade over short lengths is acceptable. Under drain pipe beneath the rain garden should be SN16 UPVC and solid or drilled in accordance with sd377/3. The piped section outside the rain garden should not be drilled. Where trees are installed in a rain garden then the under drain should not be drilled and an alternate solid pipe drainage system should be used.

C. Install under drainage: Install the under drain system (if required) and connect to the piped storm water system. The under drain should generally in between 100 and 150mm in diameter and have a maximum slope of approximately 0.5% (5mm drop over 1 m length). A zero grade over short lengths is acceptable. Under drain pipe beneath the rain garden should be SN16 UPVC and solid or drilled in accordance with sd377/3.

D. Construct overflow drainage: Construct overflow drainage and connect to storm water reticulation. If needed overflow pipes should be fitted with grates or screens to prevent clogging of pipes with litter or debris.To create storage capacity in rain gardens, overflow drainage must be carefully constructed so level of the overflow matches those specified in the construction plans.

E. Back Fill Under Drainage System: In the process of preparing of the bed for the under drainage the gravel should not be placed from height it will damage the under drainage system. Place gravel from a low level and spread manually. The surface of the gravel drainage layer media shall be constructed with constant zero grades.

F. Install transition (sand) layer: If specified, install the sand layer as detailed on plans. Typically, a minimum of 100 mm depth to prevent movement of the soil mix into the under drain. Use clean sand free of debris, fine sediments and clay. Level with a rake but do not compact.

G. Install rain garden media mix: Backfill with rain garden media mix. Rain garden media mix is critical to the performance of the rain garden. Rain gardens ideally require a 600 mm thick layer of rain garden media mix for the plants and for water quality treatment.

H. Complete to finished level: Wet rain garden media and carefully excavate or fill to get desired finished level. The level of the rain garden is always being below the level of road or foot path for easy flowing of water in to the rain garden. Generally the level of rain garden kept 300 mm below the surface of the road or foot level

7. CONCLUSION

Now a days we are seeing that occurring of floods is urban areas is very common due to change in rainfall pattern falling with higher intensity with in shorter duration(because of climate change due to pollution) and also another reasons is the whole ground surface is covering with impervious layer in the developing process and all lakes are filling and constructing the buildings over it results there is no place to go for water and also drainage system capacity is not sufficient to drain off the rainfall runoff due to this floods are occurring.

Metropolitan cities have combined sewer drainage system, due to heavy rainfall runoff the drainage system at that time not able to transfer the whole rainfall, manholes are opening due to high pressure caused rainwater flowing through the sewers and flowing over the roads and water coming to the houses causing in comfortable to residence, floods are taking the life so many members also greatly impact on economy of country, around 4.3 billion loss of economy in India due to the floods, we can stop the floods by introducing the rain gardens in the metropolitan cities not completely but it we will stop up to some limit. The principle involved in this is runoff of particular location is diverted in respective rain garden near to it, the water which is coming from the impervious layer (road or pavement or concrete flooring) don’t have any choice to percolate in to the ground, so whole water accumulating at one place and causing floods, it’s better to transfer water into the ground from respective location it reduces the reduction in floods and improvement in the ground water table , so there is no chance to get water scarcity in present and future (like situation Bangalore is facing). By introducing of rain gardens at specific location (at parking places or foot paths not covering the full area) reduce the floods and increase the ground water table. By introducing of rain garden in urban areas also try to cool down the surrounding areas it is also helps in reducing the global warming by consuming the carbon dioxide (which is emitted from the vehicles) and giving the fresh oxygen to the surrounding areas.

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