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Disaster Management of Floods and it's Retaining Techniques

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Abstract: *Millions of people are impacted by floods, a frequent and destructive natural disaster whose severity is increasing as a result of climate change. The project, "Disaster Management of Floods and Its Retaining Techniques," focuses on flood control in the Mula-Mutha River basin in Pune's flood-prone Sangamwadi and Sinhagad Road areas. The study evaluates the causes, effects, and mitigation techniques of flooding brought on by encroachments, urbanization, heavy rainfall, dam releases, and poor drainage*

Keywords: disaster management, flood control wall, retaining techniques, stormwater management.

I. INTRODUCTION

Using creative and sustainable methods to lessen the effects of flooding, this project focuses on flood disaster management in Sinhagad Road and Sangamwadi. This project will evaluate existing flood risks and management strategies in order to investigate workable solutions like better drainage systems, flood forecasting, community readiness, and the use of technology for enhanced monitoring and response. The goal is to create a strong framework that lessens the long-term effects of floods on the environment and community while also aiding in their management.

One important waterway that passes through Pune, Maharashtra, is the Mula-Mutha River. The Mula and Mutha rivers, which rise in the Western Ghats, converge to form it. Whereas the Mutha River rises from the hills close to the town of Mulshi, the Mula River begins close to the village of Morgaon. These rivers merge near the city of Pune and then flow through the urban and surrounding areas. The Mula-Mutha River, which supplies water for drinking, industrial, and agricultural uses, is essential to the local ecology. However, the river has experienced serious pollution problems over the years as a result of fast urbanization, including the discharge of solid waste, industrial waste, and untreated sewage, which has degraded the river's water quality.

With a focus on the Mula-Mutha River basin and particular case studies on Sinhagad Road and Sangamwadi, this project seeks to create an integrated and sustainable approach to flood disaster management. It investigates the reasons behind flooding, evaluates the risks that exist today, and suggests creative ways to lessen the effects, like better drainage systems, flood forecasting, soil stabilization, and the building of flood walls. The study aims to develop a strong framework that lessens the long-term effects of floods on the environment and nearby communities, making Pune safer and more resilient by utilizing technology, community readiness, and contemporary engineering solutions.

II. PROBLEM STATEMENT

Flooding remains one of the most devastating natural disasters globally, with urban areas like Pune experiencing severe impacts due to rapid urbanization, inadequate drainage systems, and climate variability. The Mula-Mutha River basin, particularly regions such as Sinhagad Road and Sangamwadi, is highly susceptible to flooding during heavy rainfall and dam water releases. These flood events result in significant property damage, displacement of communities, and disruption of urban infrastructure. Traditional flood management strategies have proven insufficient in mitigating flood risks effectively, necessitating the development of innovative retaining techniques and sustainable urban planning solutions. This research aims to analyze the flood dynamics in flood-prone zones of Pune, evaluate existing flood

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management techniques, and propose advanced retaining mechanisms to enhance flood resilience. By integrating hydrological analysis with sustainable engineering solutions, the study seeks to establish a robust framework for flood disaster management that reduces vulnerability and promotes community resilience in urban flood-prone areas.

III. OBJECTIVE & ANALYSIS

The objectives of this research is to study the event followed by heavy rain in the locality of pune comprising the flow path of over flow water from khadakwasla dam river mula-mutha and the nearly areas along the river. To study in brief severely frequently affected areas due flood in pune due to the over flow of dam release and high flowing discharge in the mula-mutha river.To study major causes and preventive measures of flood related problemsin few critical flood prone areas.To compute techniques and method to reduce flooding related issue.

Design of flood wall: -We will be designing a concrete flood wall to protect the water overflowing into the sangamwadi area. The concrete flood wall design is a vertical flood wall which we will implement to build along the banks of the Mula-Mutha river.

For this design we need to calculate the height, length and thickness of the flood wall, which will be calculated with the corresponding water flood forces, water levels and the soil conditions in the area. From the water levels of the Mula-Mutha river along with the flood water velocities and the river flow pattern, we first of all required the design flood level and design flood velocity. For these design levels we required a cumulative data regarding the rainfall intensity, rain fall duration, climate, river depth, width of river and other hydrological data, which in turn is a tough task to collect all these data.

But as the water resource department Pune has estimated flood peak level for the water from the khadakwasla dam through its path. They have estimated and plotted two lines of flood flow, one is blue line and another one is the red line. Blue line represents the level of the flood likely to occur "once in 25 years ". Red line is the level of the flood likely to occur "Once in 100 years ". Area inside the blue line is a prohibitive zone and no construction is allowed in this zone, The zone between blue and red line is restrictive zone with construction under certain conditions is allowed spillway discharge from the dam. Though we say 'marked' these lines are nowhere to be seen on the ground. All this site on the maps inside the locked cupboards of the WRD. By estimating the rainfall patterns, rainfall intensity, rainfall duration and frequency, there calculations have to be drawn. As IMD deal with the all these data, the WRD could access the data for their estimation. Thoroughly studying the river morphology and accounting for the changes in river channel geometry and roughness variations is also crucial before drawing the conclusion for flood peak values and plotting the flood frequency curve. Probability Density function (PDF

Gumbel's distribution:

Gumbel's distribution is a popular statistical method used to estimate flood frequency curves. Gumbel's distribution, also known as the Extreme Value Type I (EV1) distribution, is a statistical model used to analyse extreme events, such as floods.

From this statistical method two functions are estimated namely:

- Probability Density function (PDF)
- Cumulative distribution function (CDF)

After computing these parameters, the PDF, CDF, the return period is calculated. The return period corresponding to the estimated flood peak using the inverse of the distribution function (CDF).

Flood Frequency Curve: Flood frequency curve is plotted using flood peaks and corresponding return period. Flood frequency curve shows the relation between flood peak & return period.

The flood frequency curve is a plot of the flood peak discharge or level against the return period.

Return period (T):

This also known as the recurrence interval, is the estimated average time between occurrences of a flood event of a given magnitude.

The design flood peak is estimated from the flood frequency curve. We need to compute the design flood peak corresponding to the chosen return period from the flood frequency curve. So, we proceed further with the return period of 100 years with the high flood level of 545.962 with the annual maximum flood peak data for the Mula- Mutha river and its analysis through the flood frequency distribution, WRD has given levels for 25 years and 100 years occurrence. After plotting the flood frequency curve using the analyse flood peak data, we get the relationship between the flood peak and the return period.

By using these values, we have considered the flood peak value of 546m as the high flood level for a return period of 100 years. Further in this process of designing a retaining flood wall to overcome this flood peak values we need to determine the design values, for the to design of our flood wall. So as observed and determined flood peak levels is 546 for a return period of 100 years our design flood level will be 546m. We estimate that the flood wall is to be constructed to retain a high flood level of 546 m.

Next design consideration we needed is the design flood velocity. We need to know for which high flood velocity the flood all is to be design. So, the average flood velocity observed of Mula-Mutha river near our area of interest i.e. Sangamwadi are to be observed between 3.5to 4.5m/s. And the highest flood velocity observed during last year peak flood was 4.5m/s This velocity is the velocity at which the Mula-Mutha river water is going to flow and try to hit the proposed flood wall. So, to design our flood wall the highest flood velocity should be considered to keep our design at safer side. Thus, we consider 4.5m/s as our design flood velocity. Therefore, the design flood level and design flood velocity for a 100-year return period 546m & 4.5m/s respectively.

However, values computed are not perfectly as the channel roughness and vegetation across a river varies so the average roughness has to be considered. The bridge of sangamwadi and its abutment and pillars construction also get vary as year passes by slightly the upstream & downstream boundary conditions over the time.

Calculations of flood control wall:

Design flood level = 546 m

Ground Elevation = 542 m

Design flood velocity = 4.5 m/s

Height of flood wall = DFL+ free board

Height of flood wall = 546+1 =547

Flood wall to be constructed = 547-ground elevation

= 547-542

H = 5 m

Material strength

Type of flood wall - PCC flood wall

Lc = 24KN/m^3 -M20 grade

Calculation of flood forces:

Hydro-static force

FH =1/2 ρwgh^2 X width of flood wall

Let us take w = 1

Height of flood wall = 4m

FH = 1/2 X ρwgh^2 X 1

= 1/2 X 1000 X 9.81 X 4^2 X 1

= 78.46 KNm

Which act at H/3 from base i.e. 4/3 = 1.33m

Hydro-dynamic force

FD = 1/2 ρ Cd A V^2

Assume drag coff = 1.5

A = 4 X1 = 4 m^2

V = 4.5 m/sec

FD = 1/2 X 1000 X 1.5 X 4 X 4.5^2

= 60.75 KN/m

Which act at H/2 = 4/2 =2 m
Total flood forces = FH + FD
= 78.46 +60.75
= 139.21 KN

Uplift Pressure = ρgh
= 1000 X 9.81 X 4
= 39.24 KN/m^2

Overturning Moment Due to Flood Forces Acting Laterally on Flood Wall
Mo = F X Distance
= FN X 1.33 + FD X 2
= 78.56 X 1.33 + 60.75 X 2
= 225.85 KN/m

Wall Geometry and Width Calculation
A trapezoidal section of flood wall is effective for PCC flood wall
Top width
Min. Practical width = 0.3 - 0.5 m
Let us first take width as 0.3 m
Base width
_____ To calculate
H = 5m

Area of C/S of trapezoidal = A + B / 2 X H
W = Area X Density of material
= A + B / 2 X 24

Stability calculation for finding base width
Overturning stability Fos > 1.5
Mov of resistance of flood wall = Mr = w X B/2
Factor of safety = Mr/ Mo > 1.5
Mr > 1.5 X Mo
Mr > 1.5 X 225.85
W X B/2 > 1.5 X 225.85
But w = A + B / 2 X H2
= 0.3 + B / 2 X 5 X24
0.3 + B /2 X 5 X 24 X B/2 > 225.85 X 1.5
(0.3+B) X 30 B > 338.775
(0.3+B) X B > 338.775/30
0.3B + B^2 >11.29
B^2 + 0.3B - 11.29 = 0
B = - b √b^2 - 4 ac/ 2a
= - 0.3 √0.3^2 - 4 X 11.29/ 2
= 3.06 m

Sliding Stability for sliding Fos= 1.5
Fr = μ w _______

Sliding resistance by flood wall

Fos = Fr/F > 1.5

μ = 0.6 coefficient of friction of wall

μ w = FX 1.5

0.6 X w > 1.5 X 139.21

0.6 X w > 208.815

w > 348.025

W = 0.3 + B X 5 X 24/2 > 348.025

0.3 + B > 348.04 25/60

0.3 + B > 5.48

B > 5.8 - 0.3

B > 5.5

Beating pre mute check

Q beating = W/B < 180 KN/m^2 _______ beating capacity of soil for Sangamwadi

Using B = 5.5

A+B/2/B X 4 < 150

0.3 + 5.5 / 2 X 5 X24 =348

A = 348/5.5 = 63.17 < 150 KN/m

Hence its safe

Uplift Check

Fu = puB

= 39.24 X 5.5 = 215.82 KN/m

pu = 348 - 215.82

= 132.18 KN/m

Hence its stable

Width of trapezoidal flood wall

Top width = 0.3 m

Bare width = 5.5 m, which satisfaction overturning, sliding & uplift verification using bare width 8.3 m

Mr = w X B/2 = 348 X 5.5/2

Fos = 957/225.85

= 4.2 > 1.5

Hence safe

Sliding

Fr = μ w

= 0.6 X 384 = 230.4

Fos = Fr/f = 230.4/139.21 = 1.65 > 1.5

Hence its safe

The Final Design Dimensions of Flood Wall

Top width (A) = 0.3 m

Bare width (B) = 5.5 m

Height (H) = 5 m

Material = 1920 PCC (24KN/m^3) Density

IV. CONCLUSION

With a special emphasis on the Sangamwadi and Sinhagad Road areas of Pune, we have investigated the main causes of flooding in these areas. It was discovered through thorough site investigations, hydrological data analysis, and literature reviews that the flooding issue is largely caused by elements such as excessive rainfall, dam water releases, poor drainage, fast urbanization, and riverbank encroachments. We suggested and created efficient flood management plans to lessen these risks, with a primary emphasis on soil stabilization and building a flood retaining wall alongside the Mula-Mutha river close to Sangamwadi. A five-meter-tall flood wall was suggested as a solution to handle a 100-year flood event with suitable safety margins following thorough computation and design considerations. Our research emphasizes the significance of integrated flood management, which blends non-structural strategies like community awareness, early warning systems, river rejuvenation, and sustainable drainage planning with structural solutions like flood walls. Adopting such all-encompassing strategies can greatly lower the risk of flooding, safeguard infrastructure, and increase urban communities' ability to withstand future floods. In order to make Pune safer and more flood-resilient, urban planners, engineers, and disaster management authorities can use the project's conclusions and suggested methods as a useful guide.

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