Stormwater Management For Hindamata Flooding

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ABSTRACT

Almost all of the flooding which seriously the disrupt communication and the activity of the Mumbai city, with increasing regularity, are located within the large fill area bounded by the old islands. Not only is the ground levels low but the island of hard basalt rock form natural boundaries to the drainage areas. The low-lying topography, meteorological and hydrological conditions of the Hindamata makes it vulnerable to floods and storm water. Various measures have been conducted for mitigation of flood and inundation damages, but the drainage problem is still one of the major tasks. The flooding inflicted serious damage over the past half-century; these floods have become both more extensive and more severe as experienced in recent storms. Development in the suburbs has taken place very rapidly in recent years. The drainage system is largely of open nallahs based on the original natural drainage channels. The system has not in all places been extended symmetrically to keep pace with development and indeed in many places development has encroached into the drainage channel thus reducing their capacity as the flows they receive has increased. In order to address the problem, different engineering works were utilized to provide flood protection and reduce flood damages. One alternative flood control measure is the provision of underground storage tanks for the purpose of reduction of the peak discharge of flood. Based on the hydrological, topographic and flooding information gathered from government institutions, an underground storage tank facility with a new drain network is proposed as alternative flood control measure in the study area to reduce the flood level and to identify the volume of the proposed storage tank. The conceptual simplified model for underground storage tank simulation model has been used to simulate the operation of the tanks and to evaluate the performance of the proposed structure. Though there are many flooding spots in Mumbai, the Hindamata flooding spot intensively affected. As the major traffic carrying road passes through this an area, it gives serious call to look into this matter. The project deals with finding a proper solution that can be adopted for solving the flooding scenario of Hindamata flooding spot of F/South ward, Mumbai.

I. INTRODUCTION

India is experiencing environmental degradation due to rapid urbanization increase in population and industrialization. The process of urbanization is linked with the economic development, which makes an increasingly higher contribution of the national economy. However, when the growth of urban population takes place at an exceptionally rapid rate, most cities and towns are unable to cope with changing situations due to their internal resources constraints and management limitations. Provision of infrastructure services viz., water; drainage and sanitation. Mumbai is the economical capital of India is one of the most densely populated city of the south-Asian countries. Due to rapid urbanization process, the city is emerging as a mega-city and this trend generates numerous economic and social externalities and social cost such as deterioration of environmental quality, increased pollution and congestion. Water logging, traffic congestion, solid waste disposal, black smoke from vehicular and industrial emissions, air and noise pollution, pollution of water bodies by industrial discharge, all these are the regular problem of the city .

Flooding due to rainfall is severe problem for Mumbai City that is inundated for several hours mainly due to the drainage congestion. Mumbai metropolitan area has experienced water logging for last couple of years. Even a little rain causes a serious problem for certain areas, so that parts of Mumbai are inundated for several days. The water depth in some of the areas may be as much as 1-1.2m, which creates large infrastructure problems for the city and a huge economical loss in production for the city together with large damages of existing property and goods. Rainfall induced flooding, meaning flood in Mumbai City caused by local rainfall occurs in the built-up areas of the city several times a year on a various scale. Inadequate existing drainage channels and their improper operation and management mainly cause these floods. The severe water logging was occurred in June and July in 2005. Some important street intersections were inundated and many of the important business and government offices of the city suffered the most from the flooding.

Flood is in itself abbreviates - Finally Loss Occurred after Opportunities Denied. Flood is influenced by various factors rainfall, river-flow and tidal-surge, topography, measure of flood-control, and alterations due to infrastructural. Some floods grow and discharge gradually, while others can develop in just a few minutes and recede quickly such as flash flood. Flood events are happening for the last many years and centuries. Urban flooding is caused by heavy rainfall overwhelming drainage capacity. It already has large economic and social impacts. These are very likely to

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increase if no changes are made to the management of urban drainage. Urban floods are a great disturbance of daily life in the city. Roads can be blocked; people can't go to work or to schools and economic damages are also high.

II . EASE OF USE

A. *Need of Urban Flood Study*

Urban flooding is significantly different from rural flooding, as urbanization increases flood risk by up to 3 times, peak flows result in flooding very quickly due to faster flow times (in a matter of minutes), large number of people are affected in dense population clusters and severe economic and infrastructure loss to industry and commerce. Urban flooding can be reduced with measures like: maintaining existing drainage channels, providing alternative drainage paths (may be underground), control of solid waste entering the drainage systems, providing porous pavements to allow infiltration of rainwater, etc.

B. *Effects Of Floods In Mumbai*

- Many people were standing on the streets during the rains, thousands lost their houses and properties.
- Large no of businesses were disturbed, banks were closed down.
- Stock markets being closed down for almost two days affected the economy of the nation.
- Mumbai being the financial capital of India contributes huge loss to the country's financial development, during the period of flood.
- Outbreak of epidemics like Leptospirosis (a disease caused when organs like skin, eyes, mouth or nose comes in contact with the flood water that has been affected by animal urines).
- The submergence of the land results in a destruction of buildings and roads which, in turns, is strictly connected with the rebuilding cost.
- As quite frequently the damaged buildings were sites for business running, the revenue loss in production and industry may contribute, to severe economic deterioration.
- Repetitive floods may discourage foreign investments from the private sector and therefore weaken the economy.
- A direct contact with contaminated water may trigger water-borne diseases that can make people ill.
- The cost required for reconstruction of the damaged structures is huge.

C. *Study Area*

Mumbai (Dadar Hindamata) is very congested city Therefore, flooding is a natural part of the life of its inhabitants. Thus water logging in Mumbai is not a new problem but the frequency of this problem is increasing day by day. Flooding due to rainfall is also a severe problem for Hindamata (Dadar) that is inundated for several days mainly due to the drainage congestion (Dadar Hindamata, 2005). Mumbai (Hindamata) metropolitan area has experienced water logging for last couple of years.

Catchment Boundaries:

North boundary	-	MMGS Road
East boundary	-	G. D. Ambekar Road
West boundary	-	Dr. B. A. Road
South boundary	-	P Guruji road & Dr. Walimbe road

Fig 1: Study Area

Catchment area of Hindamata flooding is 1.017 km^2

There is several reasons for this flooding problem :

- Topography
- Inadequacy of drainage capacity
- Large drain network length
- Disappearance of old catchment bodies

III . METHODOLOGY

A. *Study Of Current Situation*

Many of highly populated cities in the developing countries that are located on the coast, eg. Mumbai are highly susceptible to urban flooding one of the main reason cited for this is rapid urbanization which causes changes in landscape owing to construction of urban infrastructure and changes in runoff conveyance network.

➢ *Topographical Survey*

Urbanization significantly changes the characteristics of a catchment as natural areas are transformed to impervious surfaces such as roads, roofs and parking lots. The increased fraction of impervious surfaces leads to changes to the storm water runoff characteristics, whilst a variety of anthropogenic activities common to urban areas generate a range of pollutants such as nutrients, solids and organic matter.

Hindamata is low laying saucer shaped area.From MMGS road to Hindamata the drains are flowing under gravity due to downward slope. From hindamata to P. Guruji road the drains are flowing backwards which causes accumulation of storm water over the roads which causes major serious traffic.

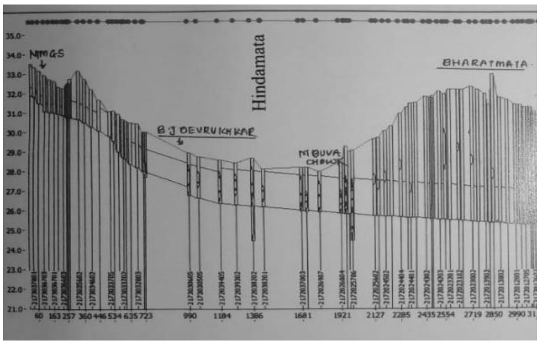

Fig 2: L section of catchment boundary

➢ *Hydrological Survey*

The occurrence of the extreme rain event on 26th July 2005 subsequently elicited the inadequacy of having only two rainfall-recording weather observatories (at Colaba and Santacruz) set up by IMD. Data obtained from IMD and BMC(in mm/day), by studying this data we plotted an average rainfall intensity graph.

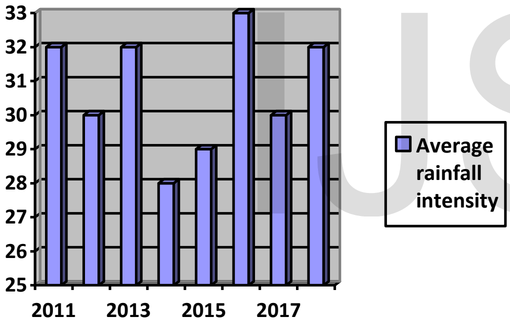

Fig 3: Average rainfall intensity graph

Considering average rainfall intensity 30mm/hr.

➢ *Drainage Survey*

Following figure shows drain detail at Hindamata chowk

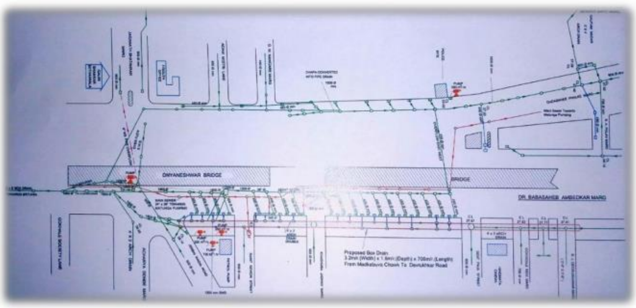

Fig 4: Drain detail at Hindamata chowk

B. Analysis Of Current Situation

According to our analysis we came to know that the accumulation of surplus water on the road surface is because of its saucer shape topography. As graph shown in below, the depth of accumulated water varies from year to year (1995 to 2010).

By analyzing current situation, we observed that the drain network up to Hindmata is flowing under gravity. A submersible pump installed at Hindamata Chowk of capacity 300 m^3/hr to flow water through drain at higher velocity. There is continuous rise in slope from Hindmata to Parmar Guruji marg , due to this slope water flows in reverse direction i.e. towards Hindmata which decreases net discharge flowing through existing drain network .

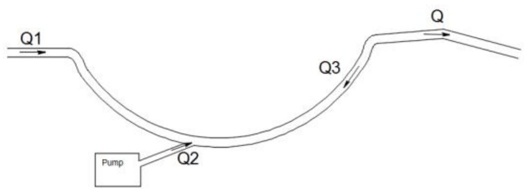

Fig 5: Drain network at Hindamata Chowk

Let ,

Q1 be the discharge through the existing drain network under gravity.

Q2 be the discharge due to submersible pump installed at Hindamata Chowk.

Q3 be the discharge through the existing drain network due to upward slope.

Q be the net discharge flowing through existing drain.

$$Q = (Q1 + Q2) - Q3$$

Forward Discharge (Q1+Q2) = 3.15 m^3/sec
Backward discharge (Q3) = 2.77 m^3/sec
Therefore, capacity of existing drain
Net Discharge (Q) = 0.38 m^3/sec = **1350 m^3/hr**
Net velocity = 0.15 m/sec

Approximate calculation of volume of water logging:
According to available data,
Catchment area :1.017km^2
Average rainfall intensity : 30mm/hr.
Therefore,
Total volume of water on the catchment=$1.017\times10^6\times30\times10^{-3}$
= 30510m^3/hr
Assuming 2.5mm/hr Infiltration (GREEN-AMPT parameter)
Runoff water =30510 - 2542=27968 m^3/hr
Total surplus water = 27968-1350 = **26618** m^3/hr

D. Proposing Solutions For Flooding

Fig 6: Proposed drain Network

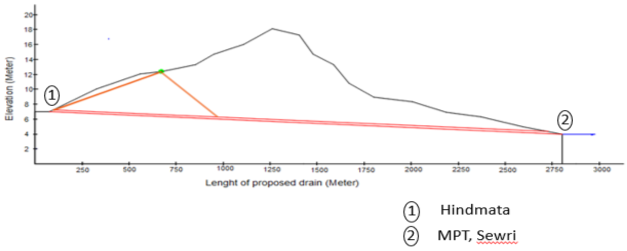

Fig 7: L section of Proposed drain path

1. Design of main drain network :

Diameter of pipe : 1.8 m

Length of drain : 2.8 km

Head difference available for proposed drain is approximately 3m.

Velocity by **Manning's Equation**

$V = (1/n) *(D/4)^{2/3} *(S)^{½}$

Discharge = Q = 3.26 m^3/sec = **11726** m^3/hr.

Total surplus water remaining after proposed drain

= 26618– 11726

= **14892** m^3/hr.

2. Underground Storage Tanks :

Underground storage tanks are provided below public grounds or parks of sufficient depth. Storage tanks collect and store Storm water runoff during a storm event, then release it at controlled rates to the downstream drainage system, thereby attenuating peak discharge rates from the site.

Design of proposed storage tank:

Here we are going to design storage tank below the public garden so that it cannot affect the present scenario under any roads in the city from the current situation in our study area few grounds are available some of them are listed below with their area :

1. Naigaon parade ground:

Area : 6260 m^2
Assuming 3 m depth for our proposed storage tank.
Volume =18780 m^3

2. Sadakant Dhavan ground :

Area : 4180 m^2
Assuming 3 m depth for our proposed storage tank
Volume =12540 m^3

Total storage tank capacity= (Volume of 1)+(Volume of 2)
= 18780 + 12540
= 31320 m^3

For maintaining flow in both tanks a submersible pump of 6 m^3 /sec. (pumps are provided for both the tank)

IV . *CONCLUSION & FUTURE SCOPE*

By studying and analyzing the current situation we are proposing following solutions:

1) A main drain of diameter (1.8m) from Hindmata chowk to Seweri outfall which is about 2.8km.
2) The storage tanks which can store the surplus water for some duration of time during heavy rainfall. A submersible pump of 6 m^3/sec is to be provided to transfer surplus water into proposed storage tanks.
Locations of proposed tanks:

1) Naigaon Parade Ground : (Lat: 190030.0N
Long: 725045.5E)
2) Sadakant Dhawan Ground (Lat: 190025.6N
Long: 725040.2E)
3) A sub drain of diameter (1.2m) from Hindmata chowk to storage tanks to transfer surplus water.

If rainfall intensity of 30mm/hr for 4hrs	Volume of surplus water at Hindamata Chowk (m^3)
Before proposing solution	1,11,872
After proposing solution	28,248

Table 1: Effect of proposed structure

By providing this type of solutions we can reduce the surplus water up to **75%** which really help for smoothening the traffic flow and reducing the property loss and the main aim to avoid loss of precious human life.

FUTURE SCOPE

By proposing outfall at Sewri, we can discharge storm water effectively.
Similarly, we can design same drainage network for "King's Circle" which is also major flooding spot in Mumbai nowadays.
This analysis can be proved very useful for Municipal coporation of Greater Mumbai (MCGM).

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