# Case Study of Storm Water Drainage System of Vadodara City

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*Abstract*— This paper presents novel design of storm water drainage system for Kamla Nagar Area of Vadodara city. The present design is based on rainfall data. Past 20 years rainfall data has been taken for study. The system has been designed considering in total of 84% of impervious area. Different methods have been used for runoff estimation. Here, rational method has been used for estimation of storm water runoff. The outfalls of system are directed to Kamla Nagar pond.

***Key words:*** Runoff, Storm water, Drainage

## I. INTRODUCTION

Storm water is define as a water which comes on a earth in form of circular water drops or due to melting of ice (in extremely cold areas)that enters the storm water system. Storm water that does not soak into the ground becomes surface runoff, which either flows into surface waterways or is channelled into storm sewers. Storm water is of concern for two main issues: one related to the volume and timing of runoff water (flood control and water supplies) and the other related to potential contaminants that the water is carrying, i.e. water pollution.

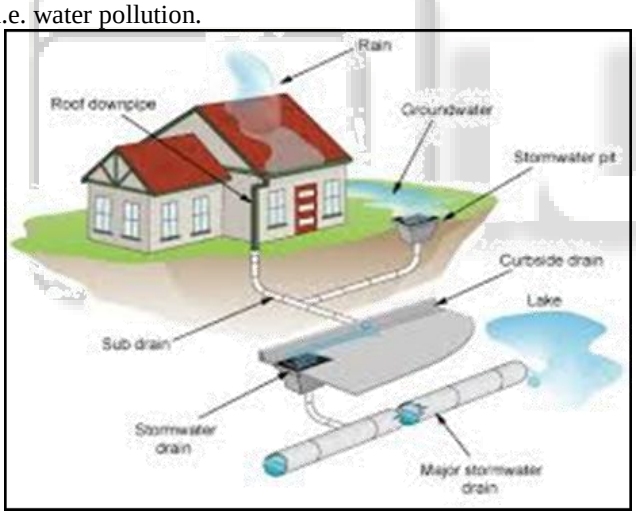


Fig. 1: Typical Storm water Drainage System

Storm water drainage design is basically based on runoff quantity estimation. Various methods are available for runoff quantity estimation.

1) Rational Method
2) Peak Discharge Method
3) Tabular Method (TR-55)
4) Unit Hydrograph Method

In this research, Rational Method is used for drainage design. It is also suggested in CPHEEO Manual published by Central Government.

## II. STUDY AREA

The topography of Kamla Nagar area is generally flat and gently sloppy from Northeast to Southwest. These area is flooded during rainy season. This area having pond known by "Kamla Nagar pond". The water during heavy flood creates problem in these area, so there is need of proper discharge of storm water is required. For solve problem project of construction of Ruparel kaans take place. The Ruparel kaans starts from junction of Ajwa chowkdi to Kamla Nagar pond. The Ruparel kaans from Ajwa chowkdi to Kamla Nagar pond is of 700m. It is closed channel kaans and discharge of storm water is take place at Kamla Nagar pond.

Fig. 2: Map of Kamla Nagar Area (Vadodara city)

## III. DESIGN CRITERIA

The main factor for design of storm water drainage system is storm runoff. Storm runoff is that portion of precipitation which drains over the ground surface.

- Coefficient of roughness is taken as 0.11 for rectangular section while deigning internal storm water drains.
- The rainfall intensity of 3.5cm per hour as per rainfall data and relative calculations.
- The gradient of bed ranges between 1 in 1000 to 1 in 3000.
- For non-silting & non-scouring conditions the velocity of flow is kept between 0.6 m/sec. to 1.8 m/sec.
- The factor of imperviousness as 0.845. The calculation for the same is also given.

### *A. Rational Method for estimation of Stormwater Runoff*

The storm water quantity is determined by the rational formula.

$$Q = \frac{C.i.A}{360} \qquad (1.1)$$

Where,
Q = quantity of storm water
C = coefficient of runoff
i = intensity of rainfall
A = drainage area in hectares
Thus, for estimation of runoff, the basic data required are as follows:

- Runoff coefficient
- Rainfall intensity
- Time of concentration tc
- Probable future condition of area to be drain

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### *B. Coefficient of Runoff*

In the Rational method, the value of runoff coefficient 'C' is required. The runoff coefficient is a fraction which is multiplied with the quantity of total rainfall, to determine the quantity of total rainfall, to determine the quantity of rain water which will reach the sewers.

| Sr. No. | Type of Surface Area | Value of Runoff Coefficient |
|---|---|---|
| 1 | Forest and wooden area | 0.01 to 0.20 |
| 2 | Open ground, unpaved, | 0.10 to 0.30 |
| 3 | street and railroad yard | 0.10 to 0.25 |
| 4 | Parks, lawns, meadows and gardens | 0.15 to 0.30 |
| 5 | Gravel roads and walks | 0.15 to 0.60 |
| 6 | Asphalt pavements in good conditions | 0.85 to 0.90 |

Table 1: Runoff co- efficient

$$\text{Runoff coefficient 'C'(overall)} = \frac{A1.C1+A2.C2+\cdots\ldots+An\ Cn}{A1+A2+\cdots\ldots+An} = \frac{\sum A.C}{\sum A}$$

Where,
$A_1$, $A_2$ … = are the different types of area
$C_1$, $C_2$ ...= their runoff coefficient

## IV. TYPICAL CALCULATIONS OF SWDS

Typical design calculation for SWD from Node 1 to 2 for 1st part Ch: 115.146 km to existing kotar at Ch: 112.087 km.
Quantity of storm water (Qactual):
Where,
$Q_a$ = Actual discharge in cum/sec.
A = Catchment area in hector.
C = Impervious factor for the catchment
i = Intensity of storm in cm/hr
Impervious factor,

$$C = \frac{K1a1+K2a2+K3a3}{A} \qquad (1.2)$$

Where,
A = Total Catchment area
$K_1a_1$ = Equivalent Road Area
$K_2a_2$ = Equivalent Road Area
$K_3a_3$ = Equivalent Open Area

Here, $K_1$, $K_2$, $K_3$ are impervious factor of area $a_1$, $a_2$, $a_3$ respectively.

Following segmentationof developed / non developed area has been arrived at on the basis of layout plan Vadodara.
Imperviousness factor ($k_1$) for Roof Surface = 0.95
(Asphalted + Open) - ($k_2$) for Road surface = 0.60
($k_3$) for Open surface = 0.60

### *A. Velocity of Flow:*

Area of drain = bxd
Wetted Periphery of drain (P) = b + 2 x d
Hydraulic mean depth (R) = A/P

$$\text{Chezy's Constant (C)} = \frac{87}{1+M/1.81\sqrt{R}}$$

Where,
m = roughness coefficient
= 0.11 for R.C.C
Slope of the drain is taken as 1:3000
S = 1/3000

Velocity of flow = $C\sqrt{R}\times S$
Qprovided = A × V

## V. RESULTS

Kamla Nagar area is residential area so percentage of imperviousness is taken as84%. So coefficient of runoff taken as 0.84 in this study.

Depth of kaans is taken as 2m and width is taken as 4m; in which depth of P.C.C 0.15m, height of wall is1.50m and slab of 0.350m.

From calculation provided discharge ($Q_p$) is higher than actual discharge ($Q_a$). So, the drain section is provided is ok.

Section is closed conduit of total length 700m .at each 15 m precast grating with theromcol is provided for cleaning purpose into kaans and grating of 600x 600mm provided at each 7.5m distance for entering surface runoff.

Fig. 3: Cross Section of SWD Kaans

## VI. CONCLUSION AND RECOMMENDATION

After performing the design, it can be concluded that the Q actual is coming less than the Q provided. So, the design for SWD is safe.

It can be seen that as rainfall intensity and pattern is changing, the need is arise to modify the existing drainage system by providing SWD.

Hence, one may adopt this design for SWD for the effective management of storm water.

Also, one can use this study of SWD design for other regions also.

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