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Effect of Increase the Value of Coefficient of Runoff in Storm Water Network Design

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***Abstract* - This paper presents the effect of increase the value of coefficient of runoff in storm water network design. The design of storm water network rational method is used. The increase the value of coefficient of runoff is effect the velocity of water in the pipe of storm water drain. It also affects the design of slope of the drainpipe in storm water network. It effect the depth of excavation for the laying the pipe network. The main affect the increase the value of coefficient of runoff is depend on the imperviousness of the drainage basin. Increased values of the velocity more affect the pipe network. It increases the diameter of the pipe. The result show the average slope of the pipe network, the average velocity of the pipe and the average depth required for the excavation of soil for laying the pipe network.**

***Key Words* - coefficient of runoff, rational method, velocity of water**

I. INTRODUCTION

The purpose of providing storm water drains is to carry over the rainfall runoff (flood water) from the terraces, paved court-yards, footpaths, roads etc. of the developed area; so the occurrence of flooding reduced to the acceptable frequencies. Therefore, the storm water drains are designed according to the extent and type of tributary area to be drained. When a rain falls on a certain area, a part of it is intercepted by the soil, a part of it is evaporated and the remaining part of rain water flows over land towards the valleys, nallas, streams, khadis, rivers etc. as storm water runoff. Since the storm water runoff has to be removed through drains or pipes, we must evaluate the maximum or peak rate of runoff, which can be produced from a certain catchment or drainage area by the given rain, at any moment. However, when the area under design is being developed, built-up as well as paved ones, the rain falling on such impervious surfaces of roofs of buildings, terraces, pavements, courtyards, footpaths, streets, roads etc. is required to be collected and drained away through proposed storm water drains. Estimation of the storm water runoff, reaching the storm water drains is dependent on the intensity and the duration of rainfall (i.e. precipitation), the characteristics of the catchment / drainage basin and the time required for such flow to reach the drain. The storm water flow for this purpose may be determined by using rational method or empirical formulae or other suitable methods like hydrograph method, rainfall-runoff correlation studies etc. The empirical formulae that are available for estimating the storm water runoff can be used only when the comparable conditions to those for which the equations were derived initially can be assured. Here rational method is used for the design the storm water network. The GUDA TP 18 & TP 19 is used for the study area for the design of storm water network.

II. RATIONAL METHOD

The entire rainfall over the drainage area does not reach to the storm water drainage system. The characteristics of the drainage area such as imperviousness, topography including depressions and water pockets, shape of the drainage basin and duration of the rainfall determines the total runoff to be considered in the drainage system. A fraction known as “coefficient of runoff” also needs to be determined for each drainage basin. The runoff reaching the drains is given by the following equation of rational method,

$$Q = 10 \times c \times i \times A$$

For estimation of storm water runoff, the basic data required are as follows:

- The runoff coefficient i.e. the proportion of rainfall, which will run over the ground surface and will reach to the drains.
- Rainfall intensity – duration data for the drainage basin under consideration.
- Probable time required for storm water to flow over the ground surface and reach to the first inlet of drain known as time of entry (t_e).
- Time of concentration (t_c) i.e. the shortest time required for the storm water runoff to reach a certain point, comprising the time of entry (t_e) and time of flow (t_f) in the drain up to that point.
- Probable future condition of the area to be drained i.e. percentage of impervious surface that may be expected when the area will be developed to the fullest extent.

A. Coefficient of Runoff

The part of runoff that flows in the network depends on the imperviousness of the drainage basin, shape of drainage basin, duration of storm water flow. This factor that governs the amount of flow reaching the drains is known as “coefficient of runoff”. If the entire basin area is impervious, as in the case of surface covered by roofs and pavements, the runoff coefficient will be unity. The more is the paved area in rainfall-affected zone, the more will be the runoff co-efficient and vice versa. Again, for unpaved areas the co-efficient of runoff would be less, as these areas would be more prone to absorb water and further help in ground water recharge and economical size of the conduits.

Since it is difficult to get the accurate value of the runoff co-efficient due to uncertainty of the development, the better way to determine the co-efficient is to consider the site conditions that would exist at design period. The percentage of imperviousness of the drainage basin area can be obtained from the records of a particular district or zone. However, in absence of such data, the following may serve as a guide, as per CPHEEO "Manual on Sewerage and Sewage Treatment" (2nd edition), New Delhi. These are reproduced in **Table 1**

Table 1: Imperviousness Factors of Drainage Area

No.	Type of Area	Percentage of imperviousness
1	Commercial and industrial area	70 to 90
2	Residential area	
	(a) High density	60 to 75
	(b) Low density	35 to 60
3	Parks and other undeveloped area	10 to 20

III. DESIGN OF STORM WATER DRAIN PIPES

The estimated design flows depend, to a large extent, on the assumption, the accuracy of which is variable. In spite of this, care is required to select an accurate friction-flow formula as to avoid compounding errors. However, the design practice is to use the Manning's formula for storm water drains (pipes).

$$V = 1/N \times R^{2/3} \times \sqrt{s}$$

Above formula is used to find velocity of water in design drain. In the formula the velocity is depend on the gradient of the pipe. So the change in the gradient the change in the velocity of water in the design drain pipe.

IV. RESULT

In the design of storm water network in the rational method the different value of the coefficient of runoff is put. The change of the slope of the design pipe, velocity of the water using the Manning's formula and the depth of the excavation for laying the pipe is analyzed. We study the storm water network of TP 18 & TP 19 of GUDA (Gandhinagar urban development authority). The different value of the coefficient of runoff is put and the design is made the entire network. If increase the value of the coefficient of runoff the average slope the all storm network is increase. If the slope is increase the velocity of the water increase. So the increase of the velocity is more then it may affect the pipe network. We analyzed that the increase the slope in study area the increase the velocity. Increase the gradient it may also affect the average depth of excavation. The depth of excavation is increased due to increase the gradient. The different value of the coefficient of runoff the change of the velocity of water, slope of the pipe and depth of excavation is shown in below table.

Table -2

Runoff coefficient (c)	Average Slope (1 in gradient)	Average Velocity (m/s)	Average Depth of excavation (m)
6	0.00149	0.910	2.24
6.5	0.00185	0.996	2.34
7	0.00197	1.031	2.42
7.5	0.00208	1.072	2.49
8	0.00212	1.097	2.62
8.5	0.00221	1.147	2.73
9	0.00241	1.215	2.91

In table we can see that increase the value of coefficient of runoff slope of the pipe is increase. Velocity of water and the depth of excavation for laying the pipe is also increase. Due to increase velocity erosion of pipe is increase. Depth of excavation increases so the size of the manhole is increase. So the overall cost of storm water network is increases. It is not economical.

V. CONCLUSIONS

Above result show that increases the coefficient of runoff is not useful for storm water network for the dispose the rain water in the river or other outlet. Coefficient of runoff increases due to urbanization of area. So the increase of the urbanization is reduced to prevent storm water network and other purposes to prevent natural resources and residential area, industries etc. due to excess flooding effects. Increase the natural resources, trees etc. for the prevent the excess runoff of water.

VI. REFERENCES

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