Time Of Concentration In Hydrology Design With Frequency Design

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ABSTRACT

The IDF curves are the major study in rainfall hydrology it gives the assessment of the storm and rainfall. The rainfall data is used for commonly used frequency. The site factors influence the geographical conditions. The rainfall intensity duration-frequency (IDF) curves have been developed and applied. The objective is to relate the difference with the variation of correction factor Cf. As shown in Figs 1 and 2 the table gives an illustration of changing value and intensity approaching zero. When in the system of occurrence of rain there is more than one source of runoff to a given point in a storm then the longest tc is used to estimate the rainfall intensity (I). This tc can be shown in studies in the equation given in the paper for correlation. The concentration time is determined independently in the stream generally in the downstream of flow. The inlet and outlet in sizing is also considered whether an open design or pipe design. In the studies, we are considering the upstream of 5 minutes mainly to run from one end of the pavement to another assuming the inlet and pipe sizing as two different designs for the time of concentration.

KEYWORDS

Correction factor, Curves, Data, Frequency, Intensity, Rainfall, Storm.

INTRODUCTION

Intensity, duration, correction factor, time of concentration, and frequency are correlated for precipitation instants in specific geographical conditions. As per the studies, the given time of concentration will depend upon the storm period of greater intensity than short-period storms. The amount of time it takes for the runoff from the hydrology study near a point in the pavement area to reach its outlet is known as the time of concentration (tc) for a pipe area, whether it is open or closed.[1] The reasoning behind using tc as the duration of the storm to determine peak runoff rate would be covered first.[2] After that, various approaches to estimating tc for a specific drainage area will be examined, and a graph and table will be displayed. For instance, the average intensity of a storm that lasts 50 years and 10mins would be higher as compared to the average intensity of a storm that lasts 50 years and 30 minutes. It is usually assumed that the short-duration rainstorms under consideration will remain at a consistent intensity throughout the storm. Thus, the phrase "constant intensity design storm" comes from this. Think about a storm that lasts shorter than tc. Runoff in this instance will never originate from the whole drainage area. Rain will stop falling and the land closest to the outlet will stop producing runoff by the time the runoff from the drainage area's furthest points reaches the outlet. The storm's intensity will be lower than it would be for a storm of a shorter duration (like tc) with the same return period, but runoff from the overall area of drainage will reach the outlet prior to the storm's end. Therefore, for a given return period, the maximum peak runoff rate would result from a storm of duration tc, during which the peak runoff rate would occur right before the storm ends and the overall area of drainage will drain to the outlet.

METHODOLOGY

Estimating runoff from the tributary catchment[3] in Figure 1.1 that reaches different inlets of the drain is crucial for designing storm water drainage systems. If IDF (Intensity Duration Frequency) curves which have been available, this can be estimated. Based on an analysis of the project area's rainfall data gleaned from the daily rainfall charts, the IDF curve is created. This chapter explains how to construct an IDF curve using the empirical method and analyzes the rainfall data that was collected. Once the required return period's IDF curve has been constructed, it can be used to estimate runoff using a logical method. A brief explanation of probabilistic techniques for creating IDF curves has also been provided.

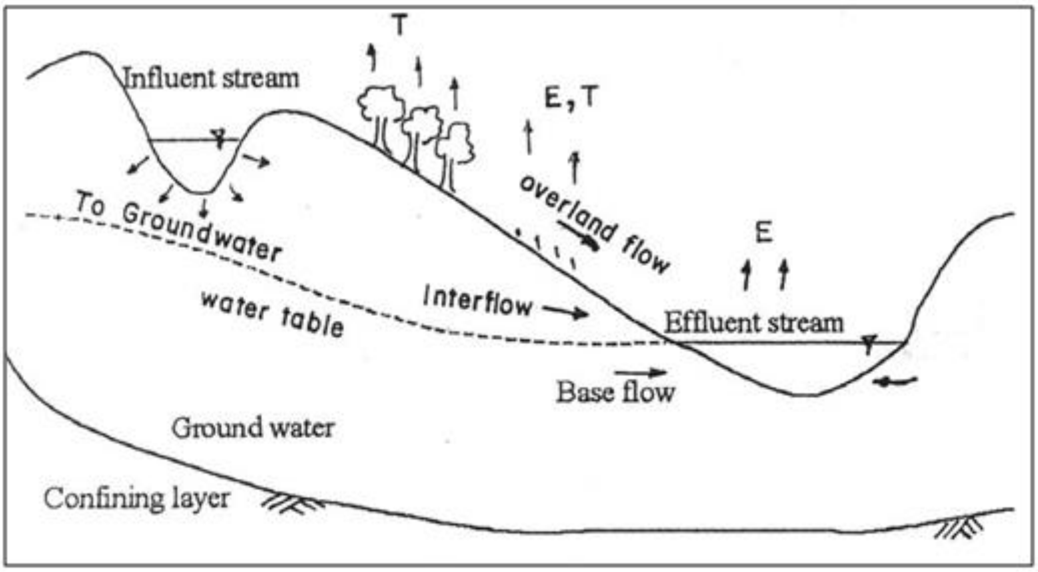

Figure: 1.1 Graph showing the catchment of inlet and outlet stream.

Time of Concentration in Storm Drainage System (tc)

The rainfall intensity that is represented by the letter "i" in the rational formula is the average rainfall intensity that occurs over a particular period of time that is approximately equivalent to the time of concentration in the area of drainage. The intensity of rainfall that will be caused by the design storm can be determined by using the IDF relationship.

The flow travel time from the contributory catchment's hydraulically most remote point to the point under consideration is known as the time of concentration (tc). The time it takes for water to move from the point in the entire contributing catchment that is hydraulically farthest from the design point to the point of concentration is known as the time of

concentration for conduit sizing. Usually, there are two parts to this time:
(1) the time it takes for the flow of the surface to enter the storm drainage system and reach the first inlet, or t0, and (2) the time it takes for surface flow to reach the point of consideration or tf.

$t_c = t_0 + t_f$

The topography, form, and features of the catchment, in addition to the distance between the inlet manhole and the furthest point in the catchment of drainage, all influence the inlet time.[4][5] It usually takes five to thirty minutes in cities. In hilly areas, the inlet time can be as little as 3mins when there are steep slopes. Still, for reasonably accurate inlet time calculation, the following formula is widely utilized.

Time of surface flow (t0) The formula that computes surface flow time using airfield drainage data. While the technique was originally developed to address drainage problems on airfields, it is now frequently applied to surface flow in urban catchments. The surface flow time can be calculated using the following formula:

$$t_0 = \frac{0.994(1.1 - C)L^{0.5}}{S^{0.333}}$$

Where,

C	Rational Method runoff coefficient
t_0	Time of surface flow (in minutes)
L	surface flow length (m)
S	Surface Slope, in percentage (%)
t_f	Time of flow in conduit

$$t_f = \frac{Lconduit}{V}$$

$$V = \frac{1}{n} R^{0.67} S^{0.5}$$

The velocity of flow in m/s has been computed by Manning's equation

S	Longitudinal slope of conduit
n	Manning's roughness coefficient
R	Hydraulic radius of conduit (m)
t_f	Time of travel in conduit, minutes

The coefficient of runoff (C), which depends on the type of surface, is thought to remain constant across storms with varying probabilities of recurrence. Table 1 lists for suggested values of C for many catchment surface kinds.[6][7] The catchment's final development in accordance with the master plan must be in consideration when selecting the values for C.

RESULTS AND DISCUSSION

Determine the link between intensity, duration, and frequency. IDF relationship formulas are empirical and have been formed on the basis of the observation that a storm's intensity decreases with storm duration. Bernard equation is normally adopted equation i = $\frac{a}{t^n}$ i.e. for Indian conditions.

The following describes the curve fitting technique used to determine the equation's constants: The equation i = $\frac{a}{t^n}$ on logarithmic scale turns into the following form i.e, straight line equation, Where,

$$logi = \log a - nlogt$$

t	rainfall duration (min)
i	intensity of rainfall (mm/hr)
a and n	constant

Hence, the trend line could be roughly represented by a straight line of best fit by plotting i & t on log-log graph paper. This line's slope will yield the value "n," and the value of "a" will result from its intercept on the Y-axis.
The graph displays the various idf c at tc values, and the model is described for the various c values in the equation and simulated for the following values that illustrate the duration's nature. Additionally, Table 1 presents the outcome of catchment design and restructuring at the point of no disturbance, when the intensity of the IDF curves minimizes.[8] The results are displayed in Table 1 below, where the time tc is represented and the corresponding change in the intensity duration graph for the storm of 100 years is noted

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	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Correction Factor, Cf	1	1	1	1	1	1	1	1
5-min	0	6.37	0	7.3	8.03	9.13	9.99	10.85
10-min	0	5.06	0	5.9	6.53	7.48	8.22	8.96
15-min	0	4.24	0	5	5.56	6.4	7.06	7.71
20-min	0	3.66	0	4.36	4.88	5.63	6.23	6.82
25-min	0	3.23	0	3.89	4.36	5.06	5.6	6.14
30-min	0	2.9	0	3.52	3.96	4.6	5.11	5.61
35-min	0	2.64	0	3.22	3.64	4.24	4.71	5.18
40-min	0	2.43	0	2.98	3.37	3.94	4.38	4.82
45-min	0	2.25	0	2.77	3.14	3.68	4.1	4.52
50-min	0	2.1	0	2.6	2.95	3.46	3.86	4.26
55-min	0	1.96	0	2.44	2.78	3.27	3.65	4.03
60-min	0	1.85	0	2.31	2.64	3.1	3.47	3.83
65-min	0	1.75	0	2.19	2.51	2.96	3.31	3.65
70-min	0	1.66	0	2.09	2.39	2.83	3.16	3.5
75-min	0	1.58	0	2	2.29	2.71	3.03	3.35
80-min	0	1.51	0	1.91	2.2	2.6	2.91	3.22
85-min	0	1.45	0	1.84	2.11	2.5	2.81	3.11
90-min	0	1.39	0	1.77	2.03	2.41	2.71	3
95-min	0	1.33	0	1.7	1.96	2.33	2.62	2.9
100-min	0	1.28	0	1.65	1.9	2.26	2.53	2.81
105-min	0	1.24	0	1.59	1.84	2.19	2.46	2.73
110-min	0	1.2	0	1.54	1.78	2.12	2.38	2.65
115-min	0	1.16	0	1.49	1.73	2.06	2.32	2.57
120-min	0	1.12	0	1.45	1.68	2	2.26	2.51

Table 1. Intensity Duration for Storm of 100 year

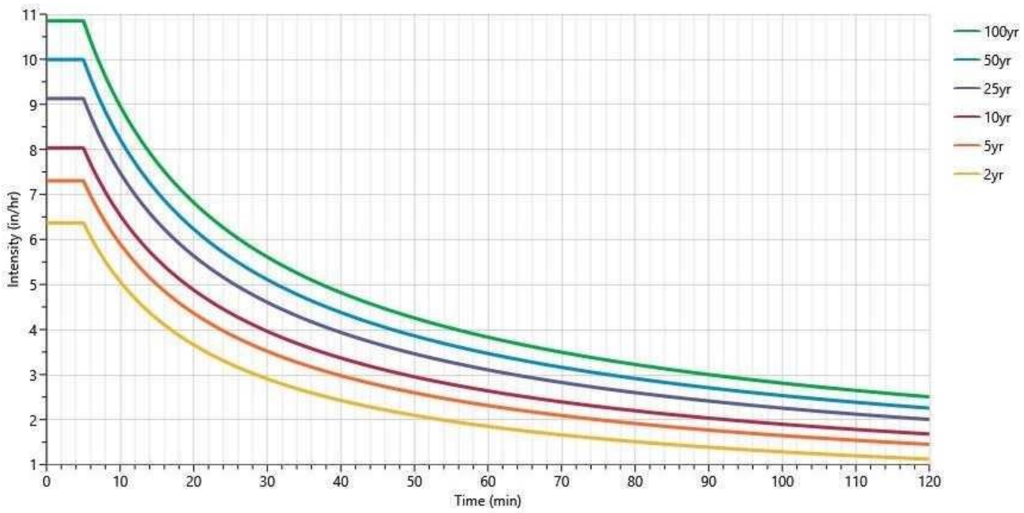

Figure: 1.2 Graph showing the co-efficient c for all values. (constant)

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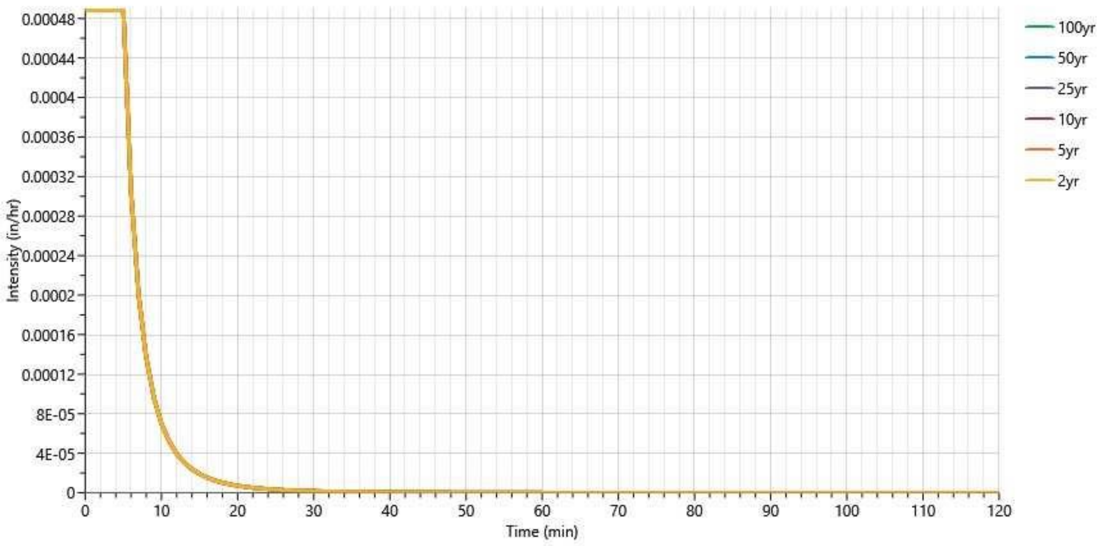

Figure: 1.3 Graph showing the co-efficient c for all values (varying)

CONCLUSION

In India, a large country, the projected percentage change in intensity of rainfall, however, might not be included in the design until after a thorough analysis of at least the previous 30 years' worth of data. First, in order to account for the climate change impact on rainfall and the resulting variation in design discharge, the duration, intensity, and frequency curves for a given catchment or locality planning to design new or retrofit old stormwater drains must be updated on a regular basis. Inlet structures are located at both the upstream and intermediate points along the gutter line. The site's geometry, the inlet opening capacity, and the amount of tributary drainage determine the inlet spacing. The most cost-effective and hydraulically efficient system is often produced through a process of trial and error when it comes to inlet placement. The above drains' design performance can be further increased to a greater return period, such as once every ten years, by putting the rainwater harvesting structures the manual recommends in place at the household level, along storm water drains and conduits, and in commercial and high-importance areas with frequent flooding.

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