RAINFALL ANALYSIS FOR STORM MANAGEMENT OF UNJHA, GUJARAT.

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***ABSTRACT*:** Rational Method is worked out for count of spillover age in the investigation territory, Unjha Town, Gujarat which is much of the time overwhelmed by rain in bring down geographical region. where as the mean yearly precipitation in Gujrat state is 1107 mm where as the Study territory has mean yearly ainfall of 519 mm. The pinnacle hourly power of one hour got from 34 years precipitation information (gave by SWDC, Gandhinagar) is 33.02527 mm/hour. Mahesana civil enterprise and Engineers utilizes force of 50 mm/hour with a repeat interim of 2 years. Indeed, even India metrological office has proposed 18.4 mm/hour force for the investigation area. The present investigation prescribes precipitation force of 33.02527 mm/hour with a repeat interim of two years utilizing information of 34 years. The investigation is helpful for processing outline spillover or release. The ascertained tempest can be utilized as a part of tempest arrange planning. In the present examination bring down flooding zones and its medicinal allots has been find. The suggested precipitation force is of 18.4 mm/hour which can be considered for the outline and it will be adequate to empty tempest out of city amid substantial precipitation.

***Keywords*:** Rational method, Maximum hourly precipitation, Storm water, Rainfall, Rainfall Analysis.

INTRODUCTION

A storm drain, storm sewer (US), surface water deplete/sewer (UK), storm water deplete (Australia and New Zealand), or just a deplete or deplete framework is intended to deplete overabundance rain and ground water from impenetrable surfaces, for example, cleared lanes, auto parks, parking garages, trails, walkways, and rooftops. Storm channels shift in plan from little private dry wells to huge civil frameworks. They are nourished by road canals on most motorways, turnpikes and other occupied streets, and in addition towns in territories which encounter overwhelming precipitation, flooding and seaside towns which encounter general tempests. Many tempest seepage frameworks are intended to deplete the tempest water, untreated, into waterways or streams.

Objective: To decide the mean yearly precipitation, to do precipitation examination and to discover configuration release for waste system utilizing Rational Method.

MATERIAL AND METHODS

Study Area: Unjha is a town of Mahesana district which is situated at 23.8077794°North latitude, 72.3952941° East longitude and 111 meters elevation above the sea level and having about 54,620 inhabitants. In unjha monsoon season is from June to September. Average annual rainfall in unjha varies from 81 mm to 315 mm.

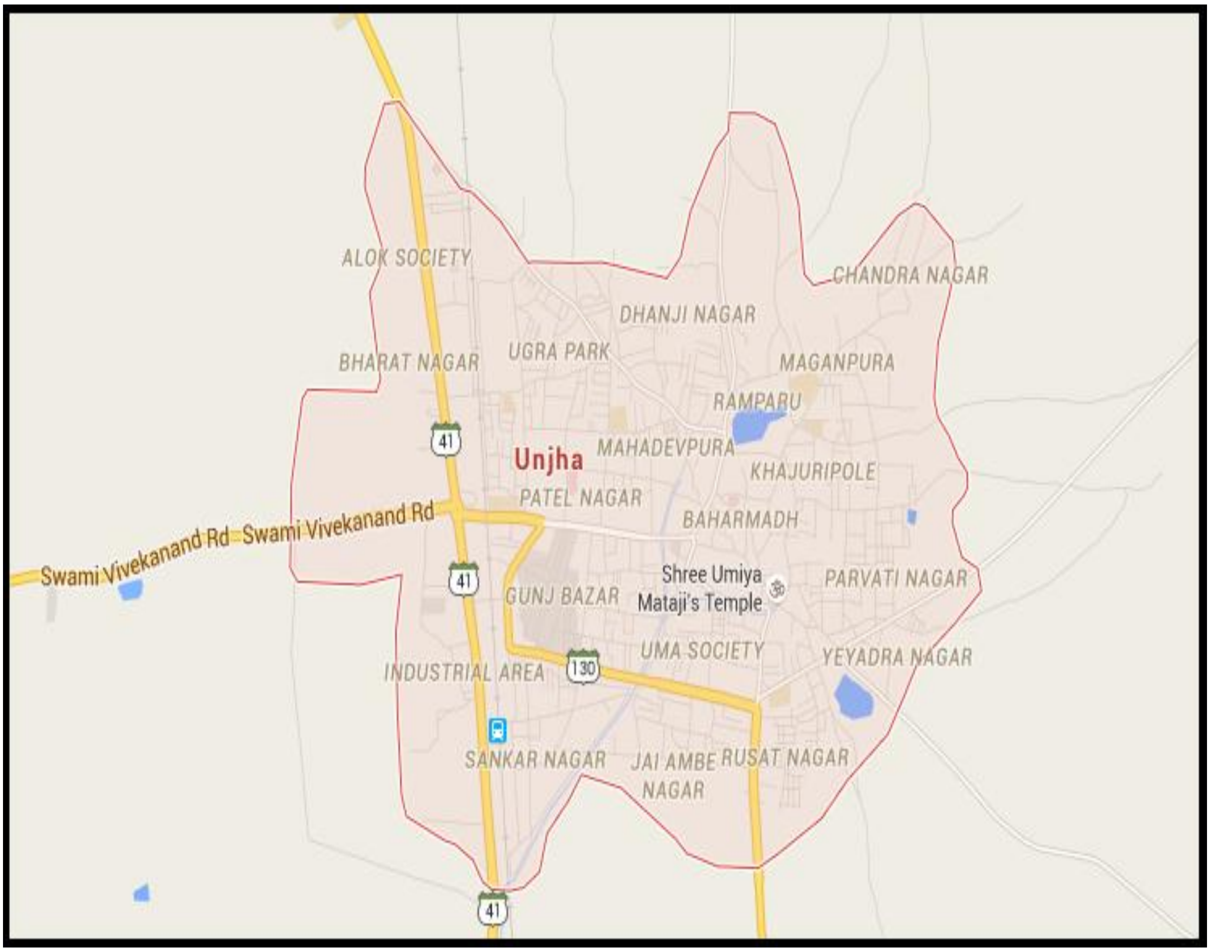

Fig.1. shows the location of unjha

Data Collection:

For the present examination yearly precipitation information and yearly 24-hour greatest precipitation information from year 1975 to 2014 has been gathered from State Water Data Center, Gandhinagar. The information examination has been for the 34 year information.

Estimation of 1-hour Rainfall from 24-hour Maximum Rainfall Data:

India Meteorological Department (IMD) empirical reduction formula is used to find short duration rainfall values from annual maximum values. The empirical formula used is

$$P_t = P_{24} \left(\frac{t}{24} \right)^{1/3}$$

where,

P_t is the required rainfall depth in mm at t hour duration.

P_{24} is the yearly 24 hour maximum rainfall in mm.

t is the duration for which the rainfall depth is required in hour.

Table 1: Maximum (Peak Rainfall)

		1-Hour Max. Rainfall	
YEAR	ANNUAL RAIFALL (mm)	YEARLY 24-Hr MAX. RAINFALL	1-Hr MAX. RAINFALL $P_t = P_{24}(\frac{t}{24})^{\frac{1}{3}}$
1981	619	175	60.669
1982	213	51	17.68068
1983	341	112	38.82816
1984	540	155	53.7354
1985	190	52	18.02736
1986	113	24	8.32032
1987	36	25	8.667
1988	562	162	56.16216
1989	374	82	28.42776
1990	494	128	44.37504
1991	320	69	23.92092
1992	386	113	39.17484
1993	394	113	39.17484
1994	754	213	73.84284
1995	329	69	23.92092
1996	295	63	21.84084
1997	713	312	108.16416
1998	715	199	68.98932
1999	318	136	47.14848
2000	289	38	13.17384
2001	467	78	27.04104
2002	364	49	16.98732
2003	556	59	20.45412
2004	541	105	36.4014
2005	983	148	51.30864
2006	1309	192	66.56256
2007	716	157	54.42876
2008	349	54	18.72072
2009	345	56	19.41408
2010	619	83	28.77444
2011	610	75	26.001
2012	318	53	18.37404
2013	1206	75	26.001
2014	1263	123	42.64164
Sum	17641.00	3598	1247.35464
Mean Pm		105.8235294	36.68690118
Standard Deviation (S)		63.27404111	21.93584457

Probability Distribution or Frequency Analysis:

There are many regularly utilized hypothetical circulation capacities, for example, Generalized Extreme Value Distribution (GEV), Gumbel, Pearson sort 3 disseminations and so on. In the present examination, Gumbel recurrence investigation is utilized as a part of the investigation of precipitation information. It is extremely helpful and straightforward technique as it utilizes greatest esteems or pinnacle precipitation. The goal of recurrence investigation is to relate the greatness of occasions to their recurrence of event through likelihood dispersion. With the assistance of this examination a chart is plotted between 1-hour most extreme precipitation (mm) and the Gumbel's recurrence factor (K). 1-hour most extreme precipitation profundity for various return time of 2, 5, 10, 20, 50 and 100 year is computed by give condition as beneath,

$$Pt = Pm + Ks \qquad (1)$$

Where,
Pt is the frequency precipitation (in mm) for each duration with a specified return period T
Pm is the average of the maximum precipitation corresponding to specific duration

$$P_m = \frac{1}{n}\sum_{i=1}^{n} P_i \qquad (2)$$

Where P_i is the individual extreme value of rainfall and n is the No. of years.

K is the Gumbel Frequency Factor which is a function of return period.

$$K = \left\{ -\ln\left(-\ln \frac{T}{T-1} \right) - Yn \right\} / Sy \qquad (3)$$

S is the standard deviation of 1-hour maximum precipitation

$$\boldsymbol{s} = \left(\frac{\boldsymbol{1}}{\boldsymbol{n-1}} \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} (\mathbf{Pi} - \mathbf{Pavg})^2 \right)^{\frac{1}{2}} \qquad (4)$$

Table 2: 1-hour Maximum Rainfall Depth at different return period

	1-Hour Max. Rainfall Depth At Different Return Period					
T	2	5	10	20	50	100
1/T	0.5	0.2	0.1	0.05	0.02	0.01
1-(1/T)	0.5	0.8	0.9	0.95	0.98	0.99
K=[-ln{-ln(1-1/T)}-0.539593]/1.142478432	-0.151495276	0.840582154	1.497423735	2.127481951	2.943027682	3.554164444
Return period	2 Years	5 Years	10 Years	20 Years	50 Years	100 Years
Pt is the expected 1-hour T-year rainfall depth (Pt=Pm+K*s)	33.36372435	55.12578065	69.5341555	83.35501457	101.244699	114.6505

A sample calculation of frequency analysis is shown in table 2. Similar calculations were performed for data upto 34 years. 1-hour maximum Rainfall is arranged in descending order and was assigned rank according to their magnitude. Return Period was calculated using $T=\frac{N+1}{m}$. After finding the return period chances and failure of occurrence were computed for the analysis. k is a function of return period . $P_t=P_m+k*s$ gives 1 hour maximum rainfall depth for different return periods.

Correlation of 1-hour maximum rainfall intensity (P_{t}) and K value is plotted in the figure given below:

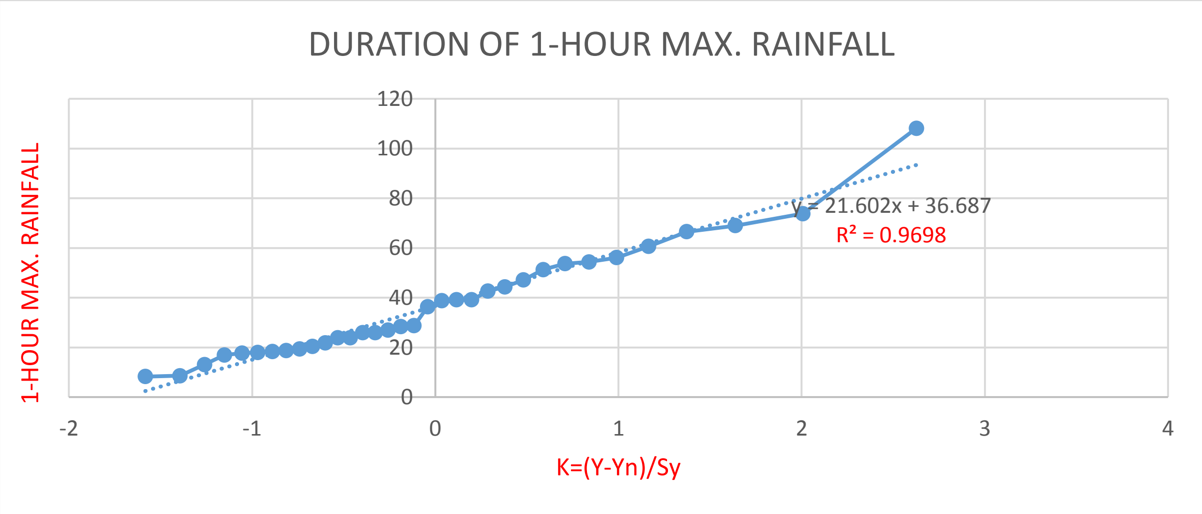

Fig.2. Duration of 1-hour Maximum Rainfall

Table 3: Minute Rainfall Depth (mm)

	Minute Rainfall Depths				
Minute	5	10	15	30	120
Factor*	0.29	0.45	0.57	0.79	1.25
Return Period Year	mm	mm	mm	mm	mm
2	9.675480062	15.01367596	19.01732288	26.35734224	41.70465544
5	15.98647639	24.80660129	31.42169497	43.54936671	68.90722581
10	20.1649051	31.29036998	39.63446864	54.93198285	86.91769438
20	24.17295423	37.50975656	47.5123583	65.85046151	104.1937682
50	29.36096271	45.56011455	57.70947843	79.98331221	126.5558738
100	33.248645	51.592725	65.350785	90.573895	143.313125
Factors are taken from Journal Of Indian Water Work Association, Vol.-Octo-Dec-2007 (page 289)					

Table 3 shows the information of minute rainfall (5,10,15,30,120) for the different return periods i.e 2,5,10,20,50,100.

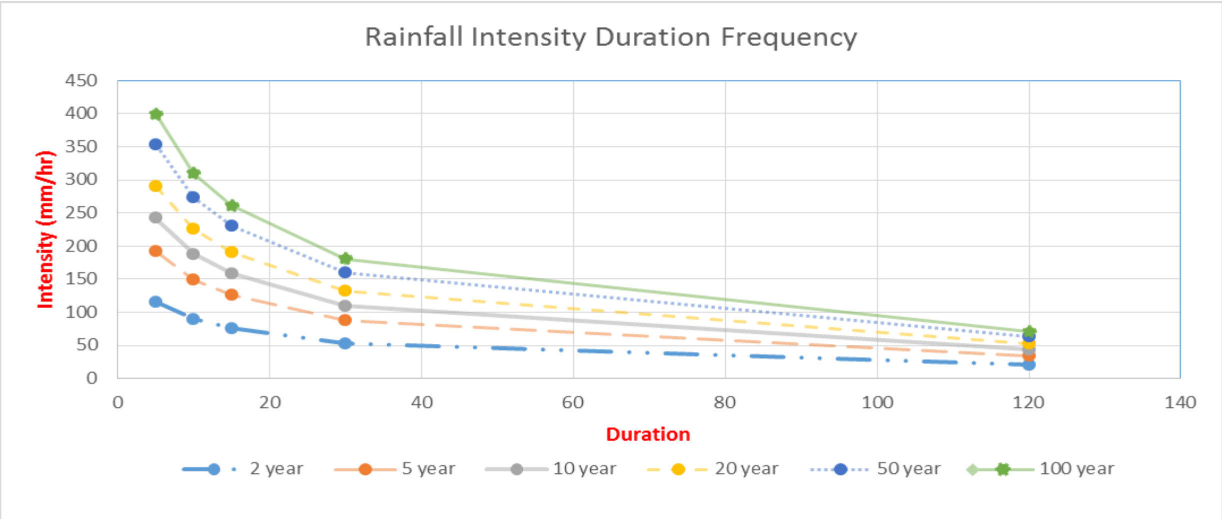

Fig. 3: Rainfall Intensity Duration Frequency Curves

Intensity duration curve is in the form of logarithmic type, it is plotted on logarithmic scale in the fig.3.

The relationship between "t" and "i" may be expressed by a generalized mathematical formula. The commonly used one is shown as under,

$$i = a/t^n \quad (5)$$

Where, i = Intensity of rainfall in mm/hr

t = Duration of storm in minutes

a = Constant

n = Constant

To find the values of "a" and "n" take a log at both side of above equation.

$$log_e\, i = log_e\, a \ - \text{n}\, log_e\, t \quad (6)$$

Then take a logarithmic values of table 4 as bellow,

Table 4 : Logarithmic Values of Rainfall Intensity Duration Frequency Depths-mm/hr

Return Period	2	5	10	20	50	100
0.698970004	2.064853768	2.282933997	2.383777428	2.462510976	2.546951538	2.600955
1	1.954638289	2.172718517	2.273561949	2.352295496	2.436736058	2.49074
1.176091259	1.881209371	2.0992896	2.200133031	2.278866579	2.363307141	2.417311
1.477121255	1.721931611	1.94001184	2.040855271	2.119588819	2.204029381	2.258033
2.079181246	1.319154542	1.53723477	1.638078202	1.716811749	1.801252311	1.855256

Then the graph between the logarithmic values of intensity and duration for different years 2, 5,10,20,50 and 100 was plotted. Then the equation of every slopes and from the equation of 2 years data find the values of “a” and” because Frequency of flooding in Commercial and high priced areas once in 2 years was find out.

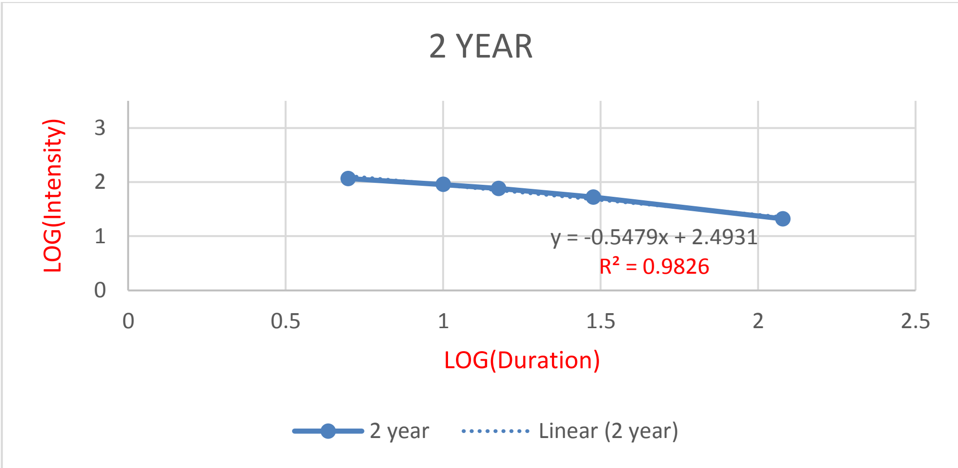

Figure 4 : Rainfall Intensity vs Duration Curve

From above graph the equation of slop is as bellow,

y = -0.5479x + 2.4931
Here, n = 0.5479

$log_e\ a = 2.4931\ so,$

$a = 311.24$

According to value of a and n intensity (i) will be determined as bellow,

I = a/t^n (mm/hr) (7)
I = 311.24/60^0.5479
I = 33.0252 mm/hr

Table 5 shows the values of Runoff Co-efficient which is determined according to different land.

Table 5 : Runoff Co-efficient

		RUNOFF COEFICINT		
Type of land	Area(square kilometer)	Standard Runoff Coeficint	Taken runoff coefficient	C*A
Cultivated Land	1.87820225	0.08-0.41	0.35	0.657370788
Low Dense Vegetated Land	1.50046325	0.1-0.25	0.20	0.30009265
Fallaow Land	0.34184275	0.1-0.3	0.20	0.06836855
Buitup Area	1.01337875	0.3-0.9	0.80	0.810703
Mixed Vegetated Land	1.9008445	0.05-0.35	0.25	0.475211125
Open Land	0.8891225	0.12-0.62	0.40	0.355649
Total	7.523854			2.667395113
			weighted runoff coefficient	0.354525103

The determination of storm water runoff at each segment with passage of duration of rainfall is calculated using ration formula,

Q = 0.278cia (8)

Where, Q = runoff in m^3/sec
c = Impervious Factor
i = Intensity of rainfall in mm/hr
A = Actual area of Unjha Town in square kilometer

Table 6 : Runoff

i=a/t^n (mm/hr)	33.0252
Area (square kilometer)	7.698026
Q = 0.278ciA (m3/s)	25.05628138

RESULTS AND CONCLUSION

Investigation of precipitation and overflow measurement is done to assess the system productivity of seepage arrange utilizing balanced technique. Assurance of precipitation Intensity is required to outline proficient tempest seepage arrange. Without brief term precipitation and with day by day information, Empirical equation can be effortlessly used to register the brief span precipitation from every day precipitation information to help in the plan of tempest water waste system. Assessed precipitation force has been ascertained as 33.02527 mm/hour with a repeat interim of 2 years from the nitty gritty investigation of precipitation information of 34 years. Precipitation Intensity is evaluated after recurrence investigation of the precipitation information. The figured overflow is 25.056 m3/s, which can be utilized as an outflow release for organize planning.

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