

**GOVERNMENT POLYTECHNIC
BHUBANESWAR**



**DEPARTMENT OF CIVIL ENGINEERING
LECTURE NOTE**

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CHAPTER-1

INTRODUCTION

The branch of civil engineering which deals with the supply of water for various purposes e.g. domestic, industrial, commercial & public is called **Water Supply Engineering**.

Necessity:-

Water is the most essential commodity for the continuation of life. An adequate & clean water supply is the basic requirement for domestic use for various purposes like—

- (i) Drinking & cooking
- (ii) bathing & washing
- (iii) watering of lawns & gardens
- (iv) air-conditioning system
- (v) street washing
- (vi)

Water is also required for various types of industrial & commercial purposes.

During 1960 Ministry of Health formed National water supply & sanitation committee for reviewing the progress of work of National water supply & sanitation programme & for correct assessment of urban & rural requirements. The report of this committee shows that 60% towns of India cover only 6.5% of total population. Out of this only 48.5% population was supplied with safe water that too 10 to 150 litres capita/day.

In fourth five year plan Rs. 339 crores was arranged for water supply and sewerage. A number of water supply & sewerage schemes were completed. For removing water borne diseases number of schemes were completed. Provision of Rs. 100 crores was done for schemes supplying water to the rural areas of acute scarcity. In India, there was always shortage of funds for its various projects. But in spite of all efforts the expenditure in water supply & sanitation remains within 3% of total plan outlay, which may be considered as good amount. After spending such amounts, in India, its 85% urban population gets safe drinking water. But in rural areas, major work still remains to arrange safe water to its population.

CHAPTER-2

QUANTITY OF WATER

Introduction:-

During planning a water supply scheme, it is the duty of the engineer to carefully examine the various types of water demand of the town & then to find out the suitable water sources from where the demand can be met.

The various types of water demand of a city or town are:-

- (i) Domestic Water Demand
- (ii) Commercial & Industrial Demand
- (iii) Demand for public uses
- (iv) Fire Demand

Domestic Water Demand:- This demand includes the quantity of water required in the houses for drinking, cooking, bathing, washing, gardening, sanitary purposes etc. It mainly depends upon the living conditions of the consumer. As per IS:1172-1963 water required for domestic purposes for average Indian condition per head per day may be taken as 135 lit. In developed countries this may be as high as 350 lit. The total domestic water consumption may amount to 50 to 60% of the total water consumption.

Detail of water requirement for Domestic purposes:-

Sl.No.	Description	Consumption of water per head per day in litres
1.	Drinking	5
2.	Cooking	5
3.	Bathing	55
4.	Washing of clothes	20
5.	Washing of utensils	10
6.	Washing of houses	10
7.	Flushing of Latrines etc.	30
	Total	135

Commercial & Industrial Water Demand:- This includes offices, hotels, hospitals, schools, stores, Shopping centres etc. This demand depends upon the nature of the city, number and types of industries. On an average, 20 to 25% of the total water demand may be allowed for this type of demand in the design.

Demand for public uses :- Public demand includes the quantity of water required for public utility purposes such as watering of public parks, gardening, sprinkling on roads, use in public fountains etc. In many water supply schemes these demands are not believed as

essential and a nominal amount not exceeding 5% of the total demand is kept on arbitrary basis.

Fire Demand: - It is the quantity of water required for fighting a fire outbreak. For high value cities, water requirement for this purpose is particularly essential. The quantity of water required for this purpose can be found out by applying certain empirical formula. These are:-

- (i) National Board of Fire Underwriters Formula: $Q = 4640P^{1/2}(1 - 0.01P^{1/2})$
Where Q = Quantity of water required in lit per minute.
 P = Population of the town in thousands
- (ii) Freeman formula:
 $Q = 1135.5((P/10) + 10)$
- (iii) Kuichling's Formula:
 $Q = 3182P^{1/2}$

Percapita Demand:-

It is the annual average amount of daily water required by one person and includes the domestic, industrial, and public use.

If Q = total quantity of water required by a city per year in litres & P

= Population of the city

Then Per Capita Demand in litre per day = $Q/(P \times 365)$

Variation in Demand:-

It has been seen that the demand does not remain uniform throughout the year, but it varies from season to season, even from hour to hour. So variation in rate of demand may be termed as :

- (i) Seasonal variation.
- (ii) Daily variation.
- (iii) Hourly variation.

Seasonal Variation:- In Summer the water demand is maximum, because people will use more water in bathing, cooling, lawn watering, street sprinkling etc. This demand goes on reducing & in winter it becomes minimum, because less water will be used in bathing & there will be no lawn watering.

Daily Variation :- The rate of demand may vary from day to day also. This is due to habits of the consumer, climatic conditions, holidays etc. On hot and dry day water requirements will be more as compared to a rainy day.

Hourly Variation :- The rate of demand during 24 hours does not remain uniform & it varies according to hours of the day. On Sundays & other holidays the peak hours may be

about 8 A.M. due to last awakening whereas it may be 6 A.M. on the other working days. Certain industries may be working in day & night shifts & consuming more water.

Factors affecting Per Capita Demand:-

The various factors which affect the per capita demand are:-

1. **Climatic condition :-** Water requirements during summer are more than winter. During summer more water is used for bathing, drinking & also more water is consumed in running coolers etc. Hence water consumption is much more in summer than that in winter.
2. **Size of city :-** Generally the demand of water per head will be more in big cities than that in small cities. In big cities lot of water is required for maintaining clean & healthy environments while in small towns it is not required.
3. **Habits of people :-** High class community uses more water due to their better standard of living & higher economic status. Middle class people use water at average rate and for poor people, a single water tap may be sufficient for several families.
4. **Industries:-** More water will be required in highly industrialised city.
5. **Cost of water :-** More costly is the water, less will be rate of demand. Hence the cost at which water is supplied to the consumer may also affect the rate of demand.
6. **Quality of water:-** A water work system having a protected & good quality of water supply would always be more popular with consumers. Hence more quantity of water will be consumed if the quality is good.
7. **Pressure in the distribution system :-** These would be of great importance in the case of localities having a number of two or three storied buildings. Adequate pressure would mean an uninterrupted and constant supply of water.
8. **System of supply :-** The system of supply may be continuous or intermittent. In continuous system water is supplied all the 24 hours while in case of intermittent system, water is supplied for certain fixed hours of the day only, result in some reduction in the consumption. This may be due to decrease in losses & other wasteful use.

Methods of forecasting population:-

The following are the methods used for forecasting population:

- (i) **Arithmetical Increase Method :-** In this method, the increase in population is assumed to be constant and an average increase of the last 4 to 5 decades is calculated and added in the present population to determine population of the next future decade. The population can be found out at the end of “n” year or “n” decades.

$$P_n = P + n \cdot i$$
(where P = Present population, i = Yearly or per decade increase in population).

- (ii) **Geometrical Increase Method :-** In this method the average %age of growth of last few decades is determined. The population forecasting is done on the basis that %age increase per decade will be the same. Thus population at the end of “n” years or decades is given by :

$$P_n = P(1 + (i/100))^n$$

Where i = %age rate of increase per decade

- (iii) **Incremental Increase Method :-** This method is improvement over the above two methods. The average increase in the population is determined by the arithmetical method and to this is added the average of the net incremental increase once for each future decade. Thus population at the end of “n” years or decades is given by :

$$P_n = P + n(I_a + I_c)$$

Where I_a = Average Arithmetical Increase & I_c

= Average incremental Increase

- (iv) **Decreasing Rate Method :-** In this method the average decrease in the %age increase is worked out and is then subtracted from the latest %age increase for each successive decade.

Problem:-

The following data have been noted from the census department.

Year	Population
1940	8,000
1950	12,000
1960	17,000
1970	22,500

Calculate the probable population in the year 1980, 1990 & 2000.

Answer by using Arithmetical Increase method:

Year	Population	Increase in population
1940	8,000	-----
1950	12,000	4000
1960	17,000	5000
1970	22,500	5500
	Total	14,500
	Average	4,833

Solution

Year	Population
1980	$22,500 + 1 * 4833 = 27,333$
1990	$27333 + 1 * 4833 = 32,166$
2000	$32166 + 1 * 4833 = 36,999$

AnswerbyusingGeometricalIncreaseMethod:

Year	Population	Increasein population	Percentageincrease in population
1940	8,000	-----	-----
1950	12,000	4000	$(4000/8000)*100=50.0\%$
1960	17,000	5000	$(5000/12000)*100=41.7\%$
1970	22,500	5500	$(5500/17000)*100=32.4\%$
Total		14,500	124.1
Averageperdecade		4,833	41.37

Thepopulationattheendofvariousdecadewillbeasfollows:

Year	Expectedpopulation
1980	$22,500+(41.37/100)*22,500=31,808$
1990	$31,808+(41.37/100)*31,808=44,967$
2000	$44,967+(41.37/100)*44,967=63570$

AnswerbyusingIncrementalIncreaseMethod:

Year	Population	Increase in Population	Incremental Increase
1940	8,000	-----	-----
1950	12,000	4000	-----
1960	17,000	5000	+1000
1970	22,500	5500	+500
Total		14,500	+1500
Average		4,833	+750

Thepopulationattheendofvariousdecadewillbeasfollows:

Year	Expectedpopulation
1980	$22,500+1(4833+750)=28,083$
1990	$28,083+1(4833+750)=33,666$
2000	$33,666+1(4833+750)=39,249$

AnswerbyusingDecreasingRateMethod:

Year	Population	Increasein Population	Percentageincrease in population	Decreaseinthe%age increase
1940	8000	-----	-----	-----
1950	12000	4000	$(4000/8000)*100=50$	-----
1960	17000	5000	$(5000/12000)*100= 41.7$	+ 8.3
1970	22500	5500	$(5500/17000)*100= 32.4$	+ 9.3
Total		14500		17.6
Average		4833		8.8

Thepopulationattheendofvariousdecadewillbeasfollows:

Year	net %age increase in population	ExpectedPopulation
1980	$32.4-8.8=23.6$	$22,500+(23.6/100)*22,500=27,810$
1990	$23.6-8.8=14.8$	$27,810+(14.8/100)*27,810=31,926$
2000	$14.8-8.8=6.0$	$31,926+(6.0/100)*31,926=33,842$

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