BHARAT INSTITUTE OF ENGGINEERING AND TECHNOLOGY

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LECTURE NOTES

ON

WATER SUPPLY & WASTE WATER ENGINEERING

CIVIL, 5TH SEMESTER

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Quantity of water

While designing the water Supplying scheme for a town or city it is necessary to determine the total quantity of water required for various purposes by the city.

First duty of the engineer to determine the water demand then to findout the suitable water sources from where the demand can be weak.

Types of demand

The various types of water demand of a city or town are.

i) Domestic water demand
ii) Commercial and industrial demand
iii) Fire demand
iv) Demand for public uses
v) Compensated losses demand

i) Domestic water demand

It includes the quantity of water required in the houses for drinking, bathing cooking, washing etc. The quantity of water required for domestic use mainly

the habits, social status, climatic conditions and customs of the people In India on an average the domestic consumption of water under normal condition is about 135 /day per capita as per IS 1172 - 1171

ii) Commercial and industrial demand.

Commercial building and commercial centers include office building, warehouse Stores, hotels, shopping centres, health centres, school cinema hall, railway and bus station, etc The water requirement of commercial and public Places may be upto 45l per day per capita.

water required in the industries mainly depend on the type and size of industry which are existing in the city The quantity of water required by industry in terms of per capita demand The water required by bacheries, paper mills, cotton, mills cloth mills, sugar refineries etc comes under industrial use. The quantity of water demand for industrial purpose in around 20 - 25% of the total demand of the city.

iii) Fire demand

Fire demand is calculated by using refrain empirical formula.

i) Kuchling's formulae - $3182\sqrt{P}$

ii) Bustons formulae - $5663\sqrt{P}$

iii) National board formulae - $4640\sqrt{P}(1-0.01\sqrt{P})$

iv) Freeman formulae - $1135.5\left(\frac{P}{10}+10\right)$

where P - Population city in thousand.

Qu Calculate the fire demand of a city where population is 40,75,00 use Kuchling's formula, Freeman formula - Bustons formula

Given data.

Population = 40,75,000

$P = 4075$

Calculating the fire demand by using

i) Kuchling formulae = $3182\sqrt{P}$

$3182\sqrt{4075}$

$= 203125.28$ lt/d/capita.

ii) Bustons formulae.

$= 5663\sqrt{P}$

$= 5663\sqrt{4075}$

$= 361501.75$ lit/day/capita.

iii) Freeman formulae

$$= 1135.5\left(\frac{P}{10}+10\right)$$

$$= 1135.5\left(\frac{4075}{10}+10\right)$$

$$= 474071.25 \text{ lit/day/capita}$$

iv) Demand for public use

Quantity of water requirement for Public utility purposes such as for washing & sprinking of roads cleaning of sewers watering for public paths, gardens, public fountains, etc comes under public demand to meet the water demand for public use provision of 5% of the total consumption is made by designing the water works for a city.

v) Compensated losses demand

All the water which goes in the distribution pipe doesn't reach the consumers some portion of this is wasted in the pipelines due to defective Pipe joints and broken Pipes and fittings Sometimes consumer keep open they are not using the water and allow continuous.

Forcasting population

Following are the standard method by which forecasting of population is done

i) Arithmical increase method
ii) Geometrical increase method
iii) Incremental increase method
iv) Decremental decrease method

i) Arithmatical ~~increase~~ increase method

This method is based on the assumption that the population is increased at a constant rate. The rate of change of Population with time is constant. The Population after an decade can be determine by the formulae

$$P_n = P_0 + n\bar{x}$$

where

P_n = Population after n decade

n = no of decade

P_0 = last Population

$\bar{x}$ = average

Q) The following data have been noted from the census department

Year	Population
1940	8000
1950	12,000
1960	17,000
1970	22,500

Calculate the probable population in the year 1980, 1990, 2000 use arithmetical increase method.

Ans)

year	Population	Increase in Population
1940	8000	
		4000
1950	12000	
		5000
1960	17000	
		5500
1970	22500	

$\bar{x} = 4833.33$

for 1980 $P_n = P_0 + n\bar{x}$

$P_n = 22500 + 4833.33$

$= 27333.33$

for 1990 $P_n = P_0 + n\bar{x}$

$= 22,500 + 2 \times 4833.33$

$= 32166.66$

for 2000 $P_n = P_0 + nx$

$= 22500 + 3 \times 4833.33$

$= 36999.99$

2)

Year	Population
1940	25,000
1950	28,000
1960	32,500
1970	40,000
1980	45,000

Find the 1990, 2000, 2010 population by using arithmetical increase method

→

Year	Population	Increase in population
1940	25,000	3000
1950	28,000	4500
1960	32,5000	7500
1970	40,000	5000
1980	45,000	

$\bar{x} = 5000$

for 1990 = $P_n = P_0 + n\bar{x}$

$= 45000 + 1 \times 5000$

$= 50000$

For 2000 = $P_n = P_0 + n\bar{x}$

$= 45000 + 2 \times 5000$

$= 55000$

For 2010 $P_n = P_0 + n\bar{x}$

$= 45000 + 3 \times 5000$

$= 60,000$

Geometrical Increase method

This method is based on the assumption that the percentage increase in population from decade remain constant in this method the average percentage of growth of two decade in determine the population forecasting on the basic that percentage increase the population forecasting done on the basic increase population forecasting done on the basic chang decade will be the same as the population percentage as the average percentage is If the population end of n decad will be

$P_n = P\left(1 + \frac{I}{100}\right)^n$

$P_n = P_0\left(1 + \frac{r}{100}\right)^n$

Q) Forecast the population of a city by using geometrical increase method calculate the population in 1980, 1990, 2000

Year	Population	Increase in Population	Increase (%) Population
1940	8000	4000	50%
1950	12000	5000	41.66%
1960	17000	5500	32.35%
1970	22500		
			$\bar{r}$ = 41.33%

Population in 1980 = $P_0\left(1+\frac{r}{100}\right)^n$

$= 22500\left(1+\frac{41.33}{100}\right)^1$

$= 31799$

Population in 1990

$= 22500\left(1+\frac{41.33}{100}\right)^2$

$= 44941$

Population in 2000

$= 22500\left(1+\frac{41.33}{100}\right)^3$

$= 63516$

4

Q) The population of five already known from 1940 to 1980 are given below. find the population in decades, 1990, 2000 2010 By using arithmetical increase method & geometrical increase method.

Year	Population	Increase in Population	Increase Population %
1940	25000		
1950	28000	3000	12%
1960	32500	4500	16.07%
1970	40000	7500	23.07%
1980	45000	5000	12.5%
		$\bar{x}$ 5000	$K = \frac{63.64}{4} = 15.9$

Arithmetical increase method

Population in 1990 = $P_0 + n\bar{x}$

= 45000 + 1 × 5000

= 50000

Population in 2000 = $P_0 + n\bar{x}$

= 45000 + 2 × 5000

= 55000

Population in 2010 = $P_0 + n\bar{x}$

= 45000 + 3 × 5000

= 60000

Incremental increase method

This method is improvement over the above tune 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

$$P_n = P_{+n}(la + lc) - P_{+n}(\bar{x} + \bar{y})$$

Forecast the population of a city by means of incremental increase method calculate the Population in 1980, 1990, 2000

year	Population
1940	8000
1950	12000
1960	17000
1970	22500

year	Population	Increase in Population	Incremental increase
1940	8000	4000	1000
1950	12000	5000	5000
1960	17000	5500	
1970	22500		

$\bar{x} = la\ 4833$ $\quad \bar{y} = 750$

In 1980

$P_n = 90 + n(\bar{x} + \bar{y})$

$= 22500 + 1(4833 + 750)$

$= 28083$

In 1990

$P_n = P_0 + n(\bar{x} + \bar{y})$

$= 22500 + 2(4833 + 750)$

$= 33666$

In 2000

$P_n = 22500 + 3(4833 + 750)$

$= 39249$

* Decremental decrase method

It has been seen that all life grow with-in limited space - If the complete growth a very old city is it will be seen that the term has shape which indicates that daily growth takes place at an increasing rate latest growth is at a decreasing rate which indicates that saturating limit is reached. In this method the average decrease in the percentge increase is worked out and is then subtracted from latest % for each successive decade.

Q)

Year	Population	∆ Increase Population	Incremental increase
1940	25000		
		3000	
1950	28000		1500
		4500	
1960	32500		3000
		7500	
1970	40000		-2500
		5000	
1980	45000		

$\bar{x} = 5000 \quad \bar{y} = 666$

for 1940

$P_n = P_0 + n(\bar{x} + \bar{y})$

$= 45000 + 1(5000 + 660)$

$= 50066$

for 2000

$= 45000 + 2(5000 + 666)$

$= 456332$

for 2010 $= 45000 + 3(5000 + 666)$

$= 61998$

1) Decremental decrease method

Year	Population	increase in population	Percentage increase	Percentage decrease
1940	25000	3000	$\frac{3000}{25000} \times 100$ 12%	-4.7%
1950	28000	4500	16.07%	-7
1960	33500	7500	23.07%	10.57
1970	40000	5000	12.5%	
1980	45000			-0.17%

1940 $= 12.5 - 0(-0.17)$

$= 12.67\%$

$P_n = 45000 + \frac{12.67}{100} \times 45000$

$= 50,701.5$

2000 = 12.67 - (-0.17)

= 12.84

$P_n = 50701.5 \times \frac{12.84}{100} \times 50701.5$

= 57211.5

2010 = 12.84 - (-0.17)

= 13.10%

$P_n = 57211.5 + \frac{13.01}{100} \times 57211.5$

= 64654.7

Impurities of water

i) Suspended impurities

These impurities are dispersion of solid particles that are longe enough to be removed by filtration on Surface and heavier ones settle down the Suspended particles which have the same specific gravity as of water are mixed in the water Suspended impurities include clay, algyes, bungi, organic and inorganic matters and mineral matters, etc These all impurities are macrosopic and cause turbidity in water.

ii) Colloidal ~~impurities~~ impurities

It is very finely divided dispersion of particles in water this particles are small the those cannot be removed by ordinary filters and are not visible to the naked eyes as a matter of fact all the colloidal impurities are electrically charged and remain in continuous motion. These colloidal impurities are generally associated with organic matter contain in bacteric and are the cheap source of epidemics.

- Dissolved impurities:-

Some impurities are dissolved in water when it moves over rock soil etc Solid liquids & gases dissolved in natural water these dissolved impurities make contain organic compound in organic shorts greises etc. The concentration of totele disaved Solid is usully expressed in P.P.M (Parts per million and is obtained by when residue obten evolporation of water sample. From a Filter Sample.

different test of water:-

The following are the test which are done during water analyse

i) Physical test
ii) Chemical test
iii) Biological test

- Physical test:-

1) Temperature:- (Thermometer)

The temperature of water is measured by means of ordinary thermometers.

⇒ The most dissolved temperature for Public Supply is between 10°c to 15°c

⇒ The most dissolved temperature For Public Supply is between 10°c to 15°c

2) Colour test:- (Colourimeter / Tintometer)

The colour of water usually due to Presents of organic meter of Colloidal metal but Some time it is also due to dissolved organic in organic impurities.

=) Bebere testing the colour of water last of all total Suspended Should be removed from the water by centrifugal force in a specific apparatus.

=> After testing the colour of water last of all total Suspended should be removed from the water by centrifugal force in a specific apporatus.

-> After this colour of water is compend with standard colour discs. The acceptable limit for domestic water is 5 PPM the reiectable limit for water is 10 PPM -> Porumisable colour domatic water is 5 PPM on (Platinum Cobalt scale).

3) Turbidity :- (Silica Scal measure)

It is cause due to presente of Suspended & Colloidal metal in the water. The character & amount of turbidity depends of the type of Soils over which the water has moved ground water are generally turbidity then the surface water Jackson turbidity baysis turbidity.

turbidity rod, nephelemetric turbidity apparatus (NTU) unit.

→ Acceptable 1PPM & rejectable limit 5PPM

⇒ Turbidity is a measured of the resistance of water to the passage of light through it turbidity is expressed in parts per million The turbidity produced by 1 milligram of Silica in 1 liter of distled water is the unit of turbidity in other words turbidity Produce by 1 Parts of divided of Silica in million Parts of distilled water is the standard unit.

4) Taste & Odour:-

Taste & odour in water may be due to the presence of dead or living organism dissolved gases such as hydrogen Sulphide. methane. Carbon dioxide or oxygen combined with organic matter mineral Substances such as Sodium Chloride Fe Compounds. in Carbonate & Sulphate of other. Substance.

The test of these are done by sance s smell and test because this are present in such small.

Propertion that is dibbicult to detect them by chemical analysis.

-> The adour of water also changes the temperature the odour may be classibied as bishy, mouldy, Steetish smell vegetable greasy the cdour of both cold & hot water should ~~by~~ be determine.

=> The water having bad smell or o'dour objectichable & should not be Supplyied to the public.

=> The intensity of adour are measure in terms of thershold odour. number acceptable limit 1 to 3 (unit)

ii) Chemical Test:-

In the chemical analysis of water those test does test are done that water will reval the Sanitary quality of the water.

-> The Chemical test involved the determination total solid, hardness, PH values, chlorides, Iron & manganic, organic metal etc.

1) Total solid test :-

These include the solids in Suspension, Colloidal & in dis-Solved from the quantity Suspended solid is determinated by filtering the sample of water through to a fine filter drying and weighting. The acceptabee limit of total solid of 200 PPM rejectable limit 2000 PPM

2) Hardness :-

It is the properties water which Prevents the lathering of the it is caused due to presents of Carbonates & Sulphate Calcium of water hardness usuall expressed in miligram/ or PPM Calcium Carbonate of water.

- Temporary hardness
- Parmanent hardness
- Calcium = $CaCO_3$

Magnesium = MgO

Carbonate = $NO_2 CO_3$

Acceptable limit of hardness is 200 PPM us for rejectable is 600 PPM

P.H :-

PH is measure by Potentiometer ground water has P.H value 6.5 to 8.5 graund water is consider. Sobt it contains 0 to 60 PPM wardness.

Aadic water causes corrusion and alacalike water causes crustation.

Chloride contain:-

It is estimated by mohry methed in which dg water is tailed we Standard AgO_3 Solution using K_2CrO acceptabl limit drinking water is 250 PPM and rejectable limit is 100 PPM

(Potassium chromate)

Biological host :-

Nitrogen contain :-

It indect the Presence of organe meter of Occous in the From

1) Free amonick - Recent Pollution (0.15 PPM
2) Organicamonia - quantity nitrogen belon decompontion started (0.3 PP
3) Nitrite - Partially decompotion condition (0)
4) Nitrate - old pollution (45 PPM)

Freeamonia + organic amonia = kiedahe hitrogen amonia.

Nitrate is not harm us it is fulling oxydised but much of nitrate helbes bacts because is caused blue baby diease mathemoglobionomice.

Florides :-

It has to prevent, dentell cavitiyes up to 1 PPM access value (<1.5 PPM) resels in the colouretion of thith old mottlion of thith.

Metals:-

Ca, Na, k, mn, mg, zn are non toxic metals according to with assumed limit of arsenic in drinking water is 0.01 PPM

Dis-Solved Gases:-

CO_2 biological activity give bad test and water becomes Porossive explosive tendency H_2 bad test on order to determine O_2 water 10% Solution of k, mn O_4 is explosed to 27°c Per 4 hours s the amount of oxygen absorved is determined.

Biological water quality Parameters:-

Biological test is determined by bacteriacali or as chemicali test The teste for coli ferms are

1) Membrance filter technique.
2) Most Probable no
3) Coli ferm index.