Wastewater Treatment and Recycling
Prof. Manoj Kumar Tiwari
School of Water Resources
Indian Institute of Technology, Kharagpur

Lecture - 10
Sewage Quantity Estimation: Practice Problems

Hello friends. So, in this last class of the second week we will be taking couple of practice problems, quickly we discussed what we discussed in this week. So, we were discussing about the assessment, or quantification of the sewage how sewage is estimated. So, there is we need to basically first see for how much purpose, we want to design this facility sewage facilities, if it is for the purpose of design. And then we fix when we fix the design period we can do a population forecasting, because design period is always futuristic. So, that way we need to predict, or estimate, or forecast a population or the target population for which the sewer systems are to be designed.

Generally if we just want to estimate how much current sewage is generated from a city. So, we do not need this population forecasting of design period, what eventually we need what is the total population, or what is the per capita water consumption or water supply, or sewage generation that kind of information. So, the population or the target population plays a crucial role here, and that is very like critical to very important to estimate the target population, for which that sewer system is going to be served.

We have taken all we have already taken a worked out example of the population forecasting using three four major methods, which are used for population forecasting, we have taken the incremental increased geometric increase and arithmetic increase and, we have already solved a practice problems on to that. So, we will not taking problems on that of course, if there are further queries feel free to discuss that in the forum.

Apart from that we discuss that how the once our population is fixed, based on the per capita consumption how the sewage is estimated ok. Then how the peak flows are estimated the concept of peaking factor also we discussed, because there are variations hourly variations and, annual seasonal variations are also there in the quantity of sewage generation which eventually depends on the quantity of water consumed.

So, since our water consumption practices or water demand varies from season to season, we will consume more water in the summers as opposed to the in winters ok, all of us know that in winters it is difficult to like take bath from like very chilled water. So, you will use the minimum quantity of water, if you are not using the hot water while in summer there is no and you want to spend as much time as possible in your under the showers.

So, those kind of the water consumption practices varies the amount of waste generated also varies and, that adds to the that adds to the fluctuations in the quantity of sewage generation and since for the design purpose, we need to target the maximum load possible or the maximum quantity possible. So, we do a price certain peaking factors, we discussed how those peaking factors are can be used.

So, we apply certain peaking factors for the purpose and, then try to estimate the flow in the sewer lines. So, that is one aspect that we discussed what else we discussed in this week is what are the different forms of additions and subtractions ok. So, if there are industries generating some flow how that flow needs to be added to the sewer system, if there are private supplies let us say which has been obtained from surveys and all that so, that can be added up.

If there are any other sort of sources through which water is coming in that should be added up, the infiltration from the infiltration into the sewer lines also comes and all these get is add up to the sewer and, then if there are leakages or losses so, that are discounted in the estimation of the sewage flow. So, we will be taking couple of examples on that.

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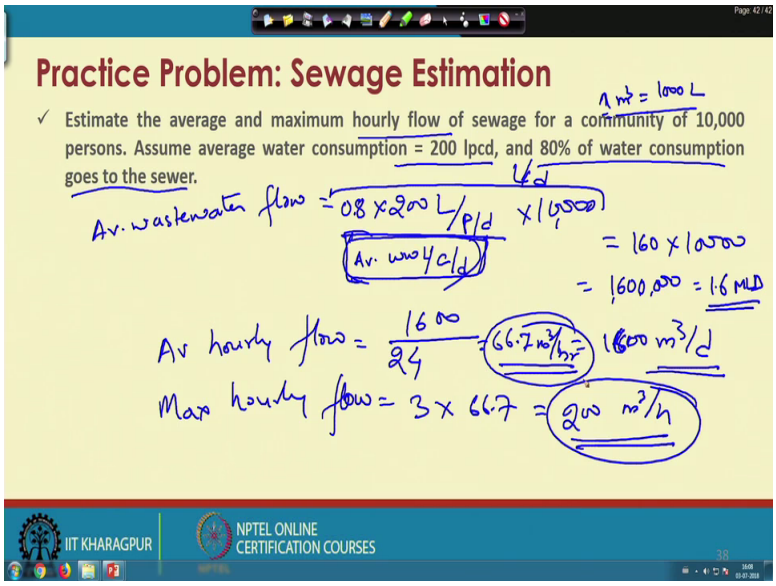

So, to begin with the very simple problem, which is on the sewage estimation. So, it says that estimate the sewage estimate the average and maximum hourly flow of a sewage, for a community of 10000 person assume average water consumption as 200 litres per capita per day and, 80 percent of water consumption goes to the sewer. So, it is a fairly simple problem ok.

So, average what will be the average wastewater flow, if you try to see this ok, first let us estimate average flow, and then will try to get the maximum flow. So, one person is assume average water consumption is 200 liters per capita per day right. So, one person is consuming 200 liters of water in a day ok, 200 liters of water is being consumed per person in a day in one day right. And 80 percent of water consumption goes to the sewer. So, if we multiply this number with 0.8, we get this the average wastewater produced per capita per day right.

So, this the water that we have got this is the average, wastewater per capita per day in liters ok, in liters per capita per day, this is the what we have got this, this is the estimate for this. Now, this is per person right and this total community size is 10000 persons, there are 10000 people ok. So, if we multiply this with 10000 right. So, what we get now is the average wastewater generated per day, there question of per capita has now finished, because we have considered the, we are now estimating for the entire population.

So, for the total population for the overall population, it is 10000 into 0.8 into 200 liters per day ok. So, now, this quantity is actually in liters per day, the sewage generation in liters per day right. So, that is your estimate, now if we want to we can this is an liters per day and we know that there are 1000 liters in 1 meter cube.

So, if you want to let say determined in meter cube, because generally capacity we give in the million liters per day or that that kind of thing that also we can do. So, if you want to give it in a million liters per day means we need to divided by10 to the power 6. So, if we multiply this total so, this becomes 1.6 million liters per day, 1.6 MLD is being generated, or if you want to put in a meter cube. So, we need to remove this 3 so, this becomes 1.6 not 0.1 1600 meter cube per day right.

So, this is the average wastewater flow in a day, now we need to determine the average and maximum hourly flow right. So, what is the average hourly flow so, 1600 is coming in a day in a day there are 24 hours in one day. So, we divide 1600 by 24 and what we get is then, 66.7 something like that right. So, 66.7 meter cube per hour is the flow average flow. And then if you want to determine the maximum hourly flow so, what is going to be the maximum hourly flow, well we need to apply a peaking factor and as we discussed that generally the peaking factor for a maximum day in a year is taken twice of an average day and, when we go into the hourly so, we take further 1.5 average hourly flow on a maximum day into 1.5.

So, for hourly 1.5 into 2 3 becomes a peaking factor, you can refer to the previous class on that. So, our peaking factor is 3 so, we multiply 66.7 v 3 and then we get 200 meter cube per hour as maximum hourly flow. So, these are our answers for the question and that is how we can estimate the average hourly flow and maximum hourly flow in the sewage, given the population and criteria here, we have ignored all other parameters all other there is no other inflow, there is no other outflow all those things, we have if we ignore them then these are the values that we can estimate from here.

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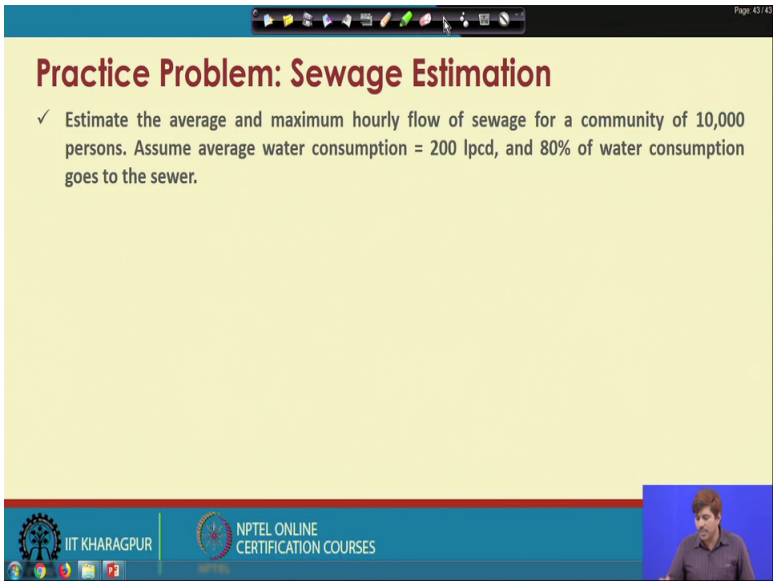

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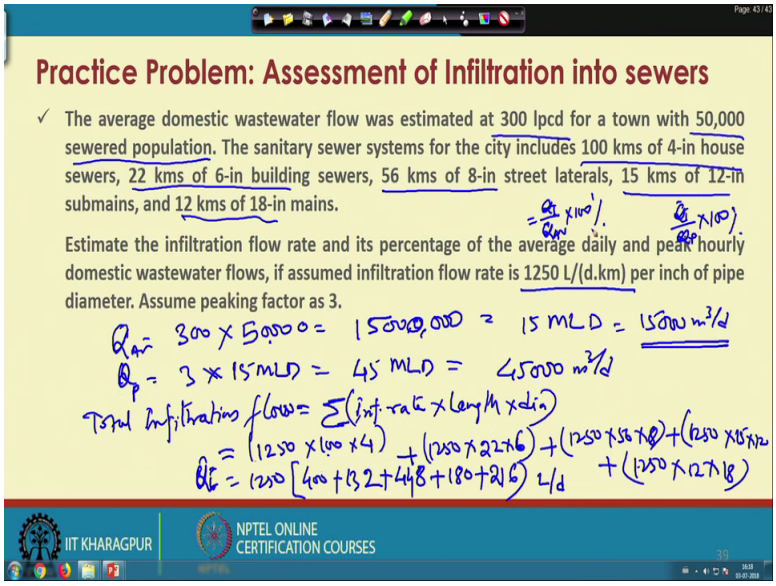

So, that is one example let us move to the next example, or next practice problem, for that which is onto the assessment of infiltration into sewers. So, how much infiltration capacity, or infiltration volume is being added to the sewer. The question is that the average domestic wastewater flow is given 300 lpcd liters per capita per day for a town, with a 50000 severed population. So, population is 50000 and average domestic wastewater flow, remember this is not the water demand, or this is not the water consumption pattern as was in the previous question.

This says that the wastewater flow directly. So, the directly wastewater flow is given to us right. So, that is 300 liters per capita per day and total population is 50000. The sanitary sewer system for the city includes pipe of different sizes. So, 100 kilometer of four inch house sewers, 22 kilometer of 6 inch 56 kilometer of 8 inch, 15 kilometer of 12 inch and 12 kilometer of 18 inch pipes are there in the total sewer system.

We need to estimate the infiltration flow rate and it is percentage to the average daily and peak hourly wastewater flows, if assumed infiltration flow rate is given to us. So, the infiltration rate is 1250 liters per day per kilometer per inch of pipe diameter and, the peaking factor can be typically let us say taken at 3 right. So, first thing we will calculate the average flow let us say average discharge in the sewer. So, total per person discharge is 300 while the total population is 50000 right. So, the total population is 50000 and total discharge is 300 liters so, if we multiply that what we get is 15000000.

So, this becomes let us say 15 million liters per day is the total amount which is being discharged, or we can say let us say 15000 meter cube per day right. So, that is the our wastewater generated at average and at peak for the peak flow, if we take the peaking factor is given as 3. So, we can later on convert to the hourly though. So, peak flow will be three times of this number 15 MLD so, that becomes 45 MLD or 45000 meter cube per day ok.

So, that is the discharge the average discharge this is say average and, this is the peak discharge right. Now, we need to calculate the total infiltration flow how much is the total infiltration flow. So, the infiltration flow will actually be dependent on the length and diameter of the pipe as is given. So, the infiltration rate is given to us right. So, total infiltration flow will be cumulative. So, there are different pipe sizes. So, summation of rate infiltration rate let us say infiltration rate, into the length of pipe into the dia of pipe ok. So, that will give us the sort of total infiltration.

So, now if you see want to see the total amount of infiltration from here. So, you have the infiltration rate is 1215 liters per day per kilometer per inch of pipe right. So, rate is 1250 into this is in liters. So, in liters per day per kilometer per inch, the length is 100 kilometers for the first zone of the pipe dia is 4 inch. So, this was per inch and per kilometers so, we are multiplying with kilometer and inch. So, the unit that we get of this

is liters per day simply, because we have multiply it with the length and the infiltration rate.

So, this is the for one pipe size similarly we will have 1250 into for the next is what 22 kilometers of 6 so, 22 into 6 plus the third size is 56 of 8 so, 1250 into 56 into 8 plus 1250 into 15 into 12 for 12 inch pipe and plus 1250 into 12 kilometers into 18 inch pipe ok. So, we need to basically add all this up in order to get the total infiltration generated. So, that way let us see 1250 is common in all of them right.

So, we can take let us say 1250 out first and then this is 100 into 400 plus this is 22 into 6, 132 this is 56 into 8, 448 plus this is 15 into 12 on 80 plus this is 12 into 18 216 right so, we add all this 400 plus 132 plus 448 plus 180 plus 216 and multiplied with a 1250 so, that will give us the total amount in liters per day ok, or we divided with the 10 to the power 6 times for say we will get in meter cube per day, sorry in million liters per day, or we divided with the 1000, then we will get in meters per day.

So, that way we can estimate the total amount of infiltration and, after that what we can do is so, that is what is being us estimate the infiltration flow rate and, we also need to estimate its percentage of the average daily and peak hourly domestic wastewater flows.

So, for average flow we will need in order to get the percentage. So, average flow is total fifteen MLD. So, let us say we are estimating it and meter cube per day ok. So, that will be means this is in liters so, we divided with the 1000 will get in the meter cube per day ok. So, average or the percentage this is of the total so, for this purpose this number or this is total infiltration flow.

So, let us call it let us call it Q I, the flow due to infiltration all right. So, for the percentage purpose we will get the percentage with the average daily will be Q I divided by Q average into 100, that will give this and with the peak hourly it will be Q I divided by the Q P into 100 ok. So, this will be in the percentage ok.

So, that is how we can estimate the how much contribution the infiltration is going to make in the flow coming into the sewers, in terms of percentage or in terms of quantity as well ok. So, this was an example where just one additional parameter was coming into the sewage, as we discussed during this week. So, there are different other additions can

coming in can come in. So, let us say you have one industry, or let us say you have in this question itself let us say ok, let us say we add another point that there are sorry.

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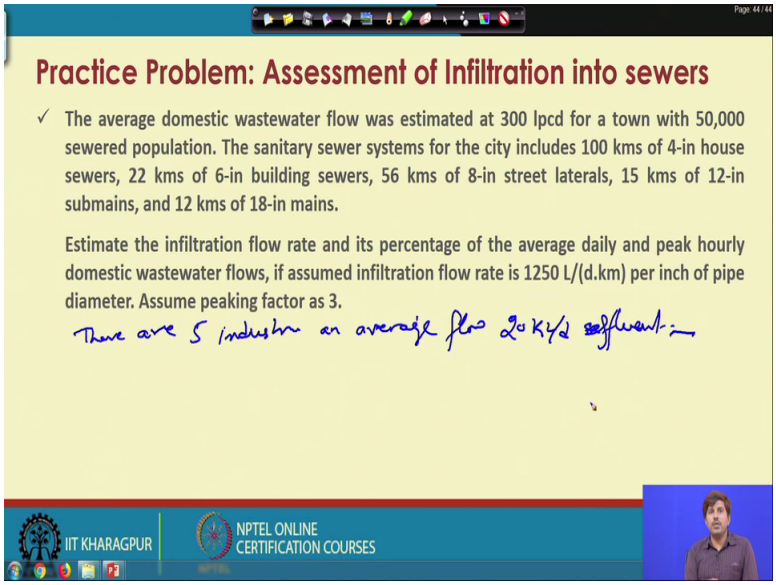

So, let us say there are five industries, with an average flow of let us say 20 kilolitres per day water, or 20 kilolitres per day sewage, or industrial effluent ok.

So, if that is the case we multiply number of industries with the total amount, or average amount their producing. So, we can get the contribution from industrial, sources if we argument, this question let us say a survey was made and found out that, there are this many number of private connections are there, or the contribution of private connections are there or it could be in the sector wise also. So, you divide in three sectors and this much number of population is average inflow due to private connections are this much for this population average inflow is this much, or for third generation of third group of population there is no input from the private connections.

So, we can estimate the contribution of these other factors as well in a similar way ok. That is pretty that will be pretty state forward actually, because we need to just counting and add it with the total volume over here. So, that way this estimation or assessment of sewage flow can be made. So, we will conclude this week discussion here and in the next week, we will be this week particularly we focused on to the assessment of the total quantity of sewage which is being generated.

So, we discuss the quantitative aspect of the wastewater or sewage, next week we will discuss the qualitative part of the wastewater. So, how wastewater is characterized, what are the different water quality parameters, in terms of which we characterize wastewater. So, those things we will discuss in the next week.

Thank you.