Sustainable Architecture
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Lecture – 26
Water Conservation - I

Good morning. Welcome to the new week, week 6 for this ongoing course on Sustainable Architecture and in this week we will discuss about Water. So, how water should be treated, what should be our aims when we are using it in the built environment, buildings or large scale development. What should be our aim, how should we use it, how judiciously should we use it and before we learn about all of that, we should first of all see why at all are we discussing about water.

We have briefly touched upon this in the initial lectures of this course, where we were discussing about the need for sustainability and I will very quickly touch upon these points again.

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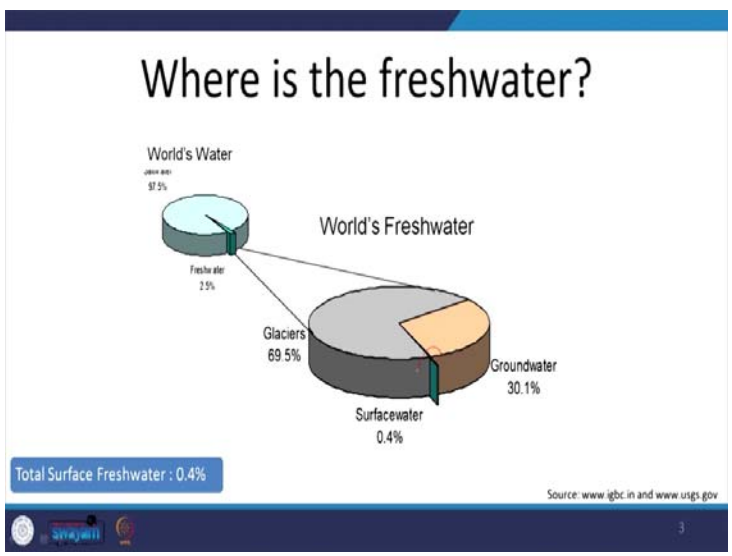

So, if we look at the overall water in the world which is available to us we would see that a very small amount of this total amount available is available for us to use which is good portable water. Rest all is either not portable for example, the seawater which we cannot use or of the water which is fresh, good for use it is logged in accessible areas. A part of this is also logged in accessible areas, but with the help of technology we have even reached, we have even accessed this ground water.

And, hence our overall water available has increased slightly from just 0.4 percent 0.2 percent exactly out of the total 100 percent water to slightly close to 0.5 percent, that is about it; it is still not a very large number. So, we anyways have very less amount of water available. And, since we have not been using the water resources judiciously we are in severe water crisis. This is not just in India, but across the world this is this scenario and that is why we are talking about conserving water, using it judiciously. So, these are some of the news clippings which you might have seen.

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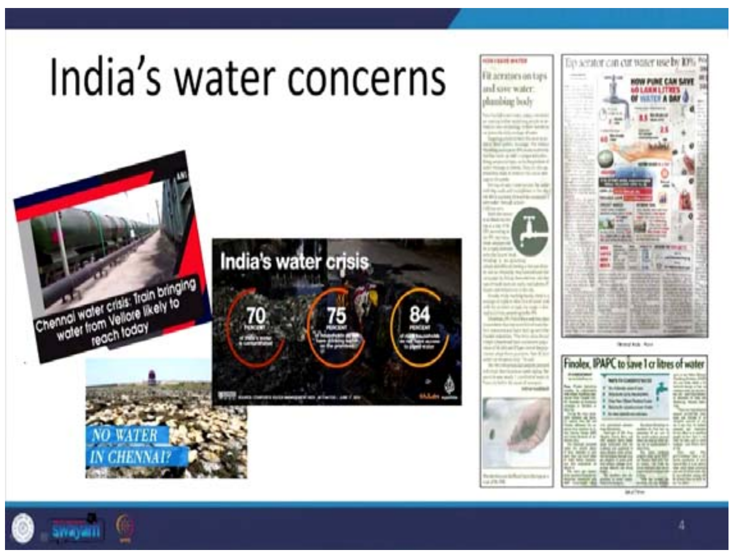

So, Chennai is totally drought stricken, there is no water for people to drink and water is being sent through trains to Chennai for people to use. And, if we look at some other cities which are making a conscious efforts towards reducing this wastage of water, we are talking about we see in the news clippings, we see in the news items; for example, these ones where the cities, the municipalities promoting some of the low flow fixtures and additions to these flow fixtures.

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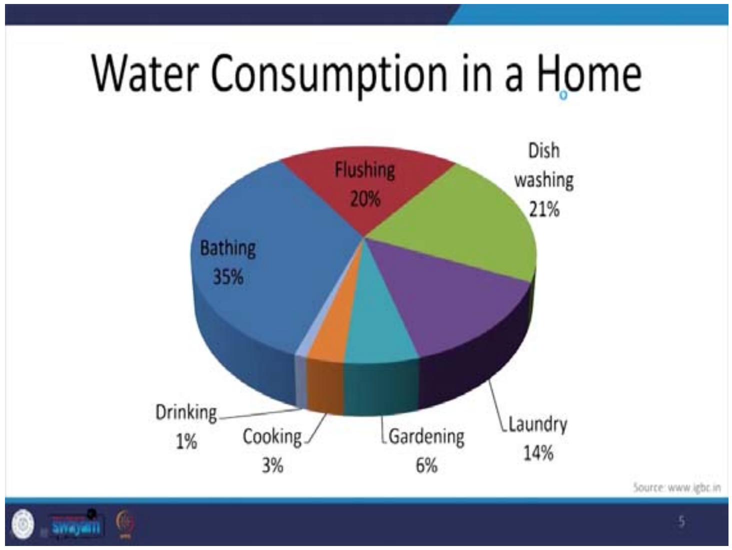

So, when we see large amount of water is actually consumed in residential buildings, in houses; we are here segregating the industrial usage. Because, the water that has to be used for industries is a different discussion altogether. And, here we will be restricting our discussion around the water consumption, water conservation for residential buildings largely, that is where a large part of saving can also come.

So, if you look at the division of this water consumption in a home, we see that the maximum percentage of water is actually consumed for bathing, it is then followed by flushing. So, because the kind of WCs which we are using now, we are gradually shifting from the Indian style, these squat pans more and more to the European toilets. The flushing requirement in India in residential buildings, homes is also increasing, it is changing. It is then followed by dishwashing which is still quite low in Indian homes and then all others like laundry, gardening, cooking and drinking. So, this is the overall distribution of water consumption within a house.

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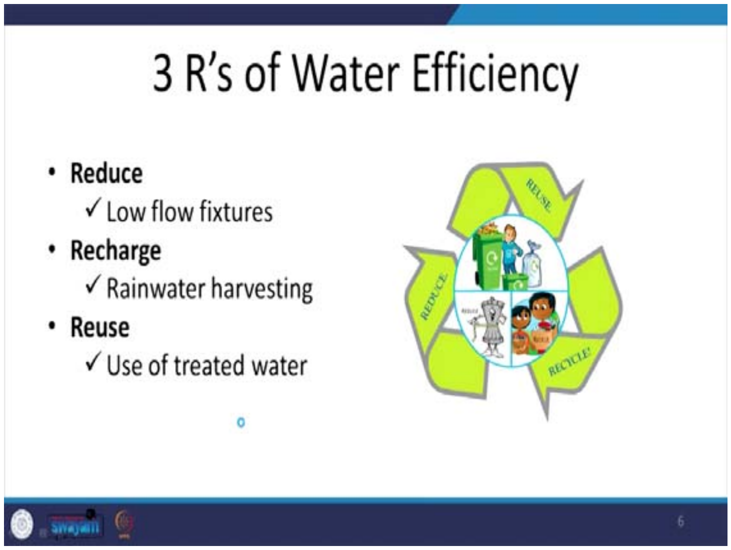

Now, if we have to improve the efficiency of how water is used, we are talking about the 3 R's. So, first of all we should reduce, we should reduce the amount of water consumption in the residents. Now how do we do it? We will talk about it in subsequent slides, but the first measure is to reduce the amount of water consumed. The next is recharge; so, we reduce and then we recharge. So, we capture the rainwater as we have also seen in the previous weeks discussions on storm water management.

So, we actually capture the storm water, the rain water in the form of rain water harvesting. So, we first reduce and then we recharge, parallelly and the third one is reuse, reuse is after treating. So, we first treat the waste water and then reuse it for different purposes. How this 3 R's will be achieved when we are talking about sustainable buildings or sustainable built environment?

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So, the approach is to first of all reduce the amount of water consumed with the help of low flow fixtures or also through the use of enhanced irrigation systems. Because, gardening or landscape is a major consumer of water in any building or in any other built environment. Once, we have reduced the amount of water which is going to be consumed in a building; we treat the waste water which is through on site STP: Sewage Treatment Plants.

So, then we treat the wastewater, whatever has been wasted after the usage we capture it and then we treat it and reuse it. In addition to this STP we also capture the rainwater through rainwater harvesting to make up for the use in the building. So, that we do not have to depend upon the underground water systems or we have to reduce the load on the municipal systems. Because, the municipal water systems are actually drawing water from the surface aquifers, largely surface aquifers and also the underground water.

We have to reduce our dependency on all of these water resources and we have to become water independent. So, we can capture the rain water and use it throughout the year should be the ideal scenario. If not then at least getting close to it is what the intent should be and in addition to these that is water metering systems.

Now, it is established that anything that is measured and monitored is what we value and vice versa whatever we value we measure and monitor. And, once we are able to measure and monitor that what is happening, what is going where we are able to improve upon the system.

So, if we know that this is the head wave water is getting lost, water is getting wasted we will treat it. But, if we do not even know where the water is getting wasted, where it is going we cannot improve upon the efficiency of the system. So, we need to have in place the water metering systems. Let us go over each one of these in detail through the course of this week discussions on water. So, first of all we will talk about the goals of water efficiency.

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The first and the foremost is to reduce the quantity of water which is consumed in a building, that is first and that in turn leads to reduction of municipal water supply and treatment burden. So, if we capture the rainwater, if we reduced the use and we capture we will be reducing the burden on municipal water supply. And, also if we treat our own waste water, we will be reducing the burden on the municipal treatment plants. So, this is the goal of water efficiency. So, the first is to reduce the quantity of water needed.

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How do we do that? What are the strategies? Let us look at some of the strategies which are highly efficient, extremely efficient; one of these is dry composting toilets. Now, its the basic concept of dry composting toilet is to use the soil, to use the excreta and let it dry.

So, that it totally disintegrates and composts to give us good manure which can further be used in the fields for gardening, for as a manure. Now, in this particular system there is no water which actually goes into the sewer. So, there is no waste water which is generated because, there is no water which is used for flushing.

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So, instead of flushing with water what actually happens is as you can see in this particular image that there is seat, there is a WC and instead of using water there is sawdust which is mixed with the lime; both of these are sprinkled on the soil after the use. So, instead of water only the dry matter is used, now this dry matter actually helps to absorb any water content which is there in the soil which is collected in the tub or there may be a case where it is collected in the form of a chamber here.

Now, here the water is totally absorbed and the dry waste for example, this is left to dry and disintegrate on its own leading to formation of a very rich compost. Now, this can actually be used as manure in the gardens; this is the basic idea of a dry composting toilet. Unfortunately, because of the psychological barrier we are not able to use dry composting toilets very commonly and it is not a very popular concept.

But, sooner or later we will have to come back to this concept of dry composting toilets. If we see how the under the Swatch Bharath mission, the toilets have been promoted which was an extremely good step which was a good initiative by the Government of India where toilets were provided to each household which did not have one. So, that open defecation can be controlled and it has been controlled almost brought down to 0 percent. But, in turn because now every household has a toilet and we are used to using water for flushing, the water usage in all the villages, everywhere has tremendously gone high.

And, where does this water come from? It is limited, this water is coming through pumping off underground water. And that is causing a drop, severe drop in the underground water tables across the country, even in the rural areas. Now, where we are intending through sustainable architecture a reduction in the consumption of water, a practice like this where we are using water in the toilets will have to be stopped sooner or later if we want to survive, if we want to sustain.

And, dry composting toilet is an excellent strategy for doing the same. There are several wonderful case studies where dry composting toilets are being used and they are successfully run in individual buildings as well as large community buildings as well. There besides dry composting toilet we also have some water efficient plumbing fixtures which are not 0 consumption water, but they consume very less amount of water for example, the waterless urinal.

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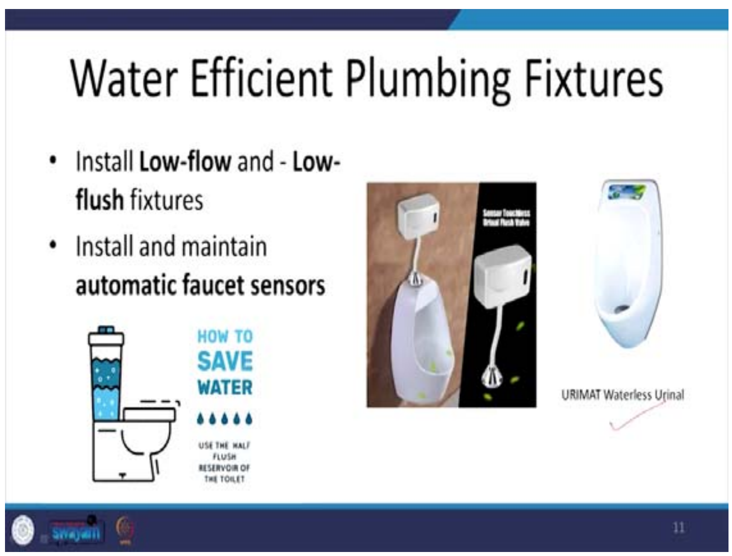

So, instead of flushing with a substantial amount of water these waterless urinals they use some gel kind of a material to capture the urine and keep the urinal odor free and eliminating the need for flushing, that is what the waterless urinal does. This is 0 water flow, but slightly more consuming we are talking about water consumption here; slightly more consuming fixtures are also there, but which are better than the conventional ones. So, these are the low flow and low flush fixtures.

So, the first step would be ideal step would be to use fixtures which are 0 water consuming. If not then we will install low flow and low flush fixtures, we will also encourage the use of automatic faucet sensors where the flushing automatically happens when it is used. So, you cannot flush it, you do not flush it unnecessarily, it is automated with the help of some sensors. So, first of all we select an efficient plumbing fixture, in addition to that we also install the low flow fixtures.

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So, while with this low flow we mean that for the same pressure we reduce the amount of water which is being consumed by installing the flow restrictors or the flow aerators. So, in this flow instead of just water there is a lot of air which is mixed with the help of this aerator which is installed here which is what we were seeing in the newspaper clipping, where the city of Pune was promoting the use of fixing aerators in the taps.

So, with the help of this the pressure is maintained, but the amount of water which is consumed is reduced, this is the low flow fixture. So, in the market today there are variety of these fixtures, low flow fixtures which are available. We also have provisions for adding up the aerators to the existing fixtures which are there. So, that provision is also there and market is reasonably ready, competently ready and there are variety of these products which are available.

Now, if we look at the green building rating systems, these rating systems emphasize upon reducing the consumption of water from the baseline. Now, we need to have a baseline from which the reduction in consumption can be calculated.

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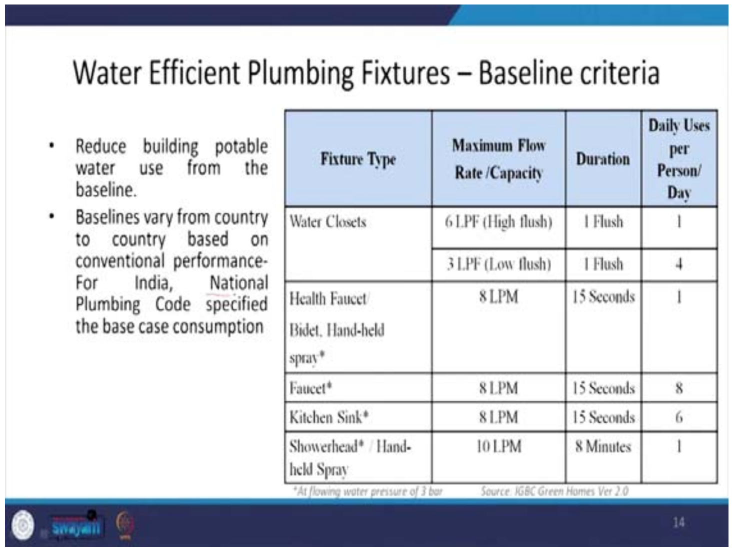

So, this baseline criteria for India is given by the National Plumbing Code and this is what is followed by the NBC and other green building rating systems as well. So, if we look at this table so, the baseline criteria is in terms of the fixture type and the maximum flow or rate capacity; maximum flow rate or capacity for this fixture.

For example, for water closet, for a full flush it says 6 litres per flush is the conventional water consumption. And, in a day per person 1 flush is assumed, this is what the baseline criteria is; for a half flush, for a low flush around 3 litre per flush is consumed for conventional fixtures and 4 flushes 4 uses per person per day are taken as the baseline.

So, similarly for all other fixture types for example, health faucet or faucet, kitchen sink, shower head or handheld spray their flow rates, the durations and also number of users per person per day are given for a baseline. Now, with the help of this baseline the consumption, conventional water consumption, baseline water consumption for a building, any building can be calculated. This is as per LEED, I am taking example of LEED here; different rating systems have different baselines which they have taken largely from the existing codes.

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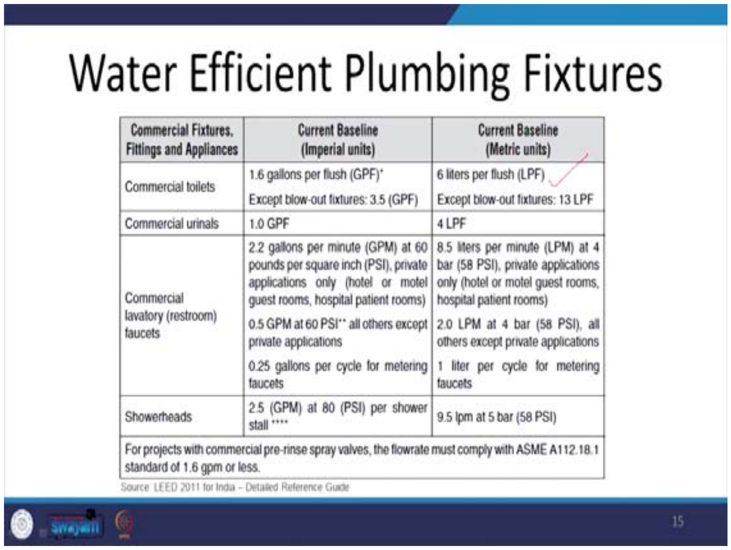

Water Efficient Plumbing Fixtures

Commercial Fixtures, Fittings and Appliances	Current Baseline (Imperial units)	Current Baseline (Metric units)
Commercial toilets	1.6 gallons per flush (GPF)* Except blow-out fixtures: 3.5 (GPF)	6 liters per flush (LPF) Except blow-out fixtures: 13 LPF
Commercial urinals	1.0 GPF	4 LPF
Commercial lavatory (restroom) faucets	2.2 gallons per minute (GPM) at 60 pounds per square inch (PSI), private applications only (hotel or motel guest rooms, hospital patient rooms) 0.5 GPM at 60 PSI** all others except private applications 0.25 gallons per cycle for metering faucets	8.5 liters per minute (LPM) at 4 bar (58 PSI), private applications only (hotel or motel guest rooms, hospital patient rooms) 2.0 LPM at 4 bar (58 PSI), all others except private applications 1 liter per cycle for metering faucets
Showerheads	2.5 (GPM) at 80 (PSI) per shower stall ****	9.5 lpm at 5 bar (58 PSI)
For projects with commercial pre-rinse spray valves, the flowrate must comply with ASME A112.18.1 standard of 1.6 gpm or less.		

Source: LEED 2011 for India – Detailed Reference Guide

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For example, this one comes directly from the National Plumbing Code. So, these baselines are coming from some or the other code, they may vary or they may also remain the same, but this baseline calculation metric is provided for any green building rating system.

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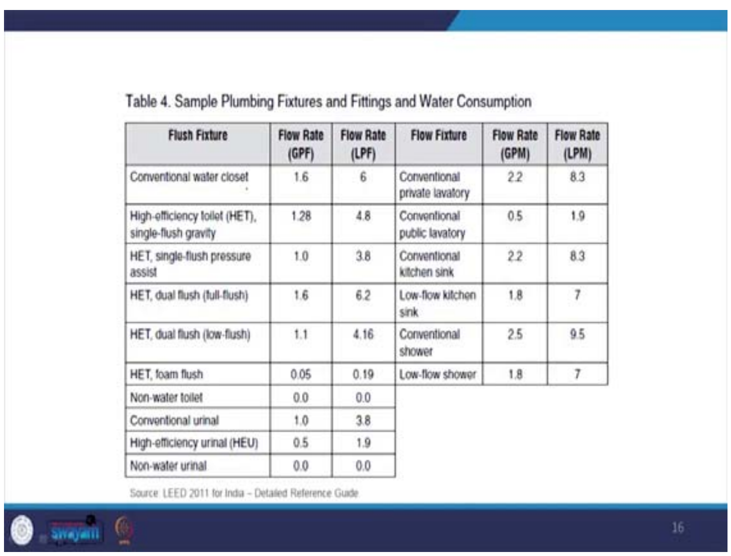

Table 4. Sample Plumbing Fixtures and Fittings and Water Consumption

Flush Fixture	Flow Rate (GPF)	Flow Rate (LPF)	Flow Fixture	Flow Rate (GPM)	Flow Rate (LPM)
Conventional water closet	1.6	6	Conventional private lavatory	2.2	8.3
High-efficiency toilet (HET), single-flush gravity	1.28	4.8	Conventional public lavatory	0.5	1.9
HET, single-flush pressure assist	1.0	3.8	Conventional kitchen sink	2.2	8.3
HET, dual flush (full-flush)	1.6	6.2	Low-flow kitchen sink	1.8	7
HET, dual flush (low-flush)	1.1	4.16	Conventional shower	2.5	9.5
HET, foam flush	0.05	0.19	Low-flow shower	1.8	7
Non-water toilet	0.0	0.0			
Conventional urinal	1.0	3.8			
High-efficiency urinal (HEU)	0.5	1.9			
Non-water urinal	0.0	0.0			

Source: LEED 2011 for India – Detailed Reference Guide

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Here this particular table shows some of the plumbing fixtures and their flow rates; this includes the conventional fixtures and the more advanced and high tech ones. For example, a conventional water closet consumed 6 litre per flush which is what the baseline says the for the conventional WC. While, if you look at the high efficiency toilet, this flow rate has been reduced to 4.8. So, then our fixtures which are available in the market which offer us this and not just this around 3.8 litre per flush fixtures are also available.

We can also see for others for example, the conventional urinal. It consumes around 3.8 litres per flush, while a non-water urinal, a water is waterless urinal consumes only 0 litres because it is water less. So, we can save directly. So, with the help of this right selection low flow fixture, we can reduce the amount of water which is going to be consumed.

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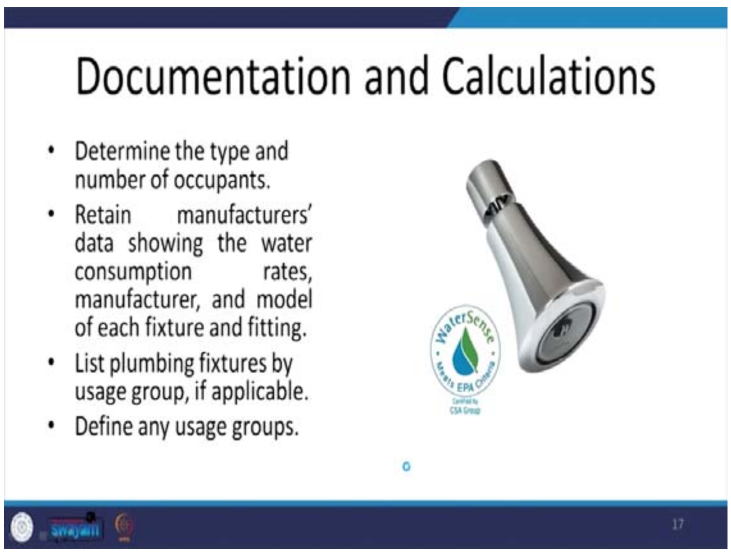

And, as per the Green Building Rating Systems we have to document this reduction in the consumption. For this proper calculations have to be done and we have to show how much water has been saved. Now, to calculate the first thing that we have to do is we have to know the baseline case, we have to establish the baseline case. For the baseline case the requirement of water for the conventional fixtures is given as per the codes or the rating system whatever we are following. In addition to that we also require the occupancy.

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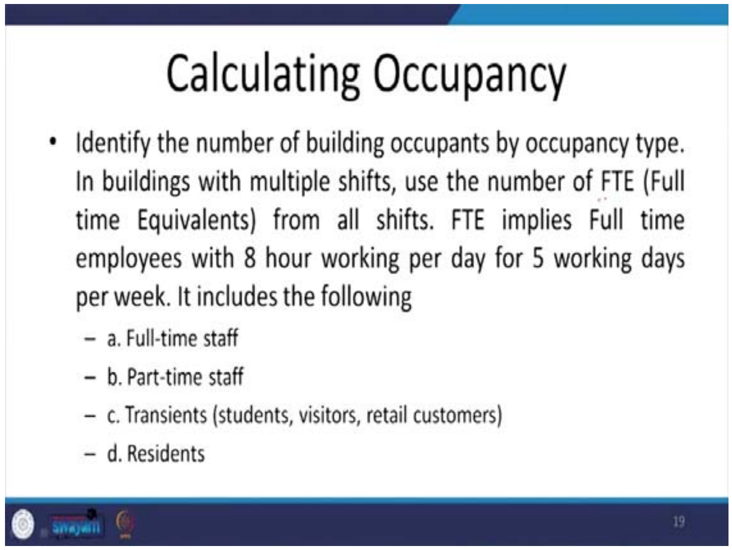

Now, this occupancy is calculated in terms of FTE which is the Full Time Equivalent. What is full time equivalent? It is the number of employees or occupants who are present for an 8 hour working per day for 5 working days per week, that is in case of an office building. In case often of a commercial building that we will calculate FTE.

The FTE calculation for residential buildings is slightly different, but it was on the same principle, that how many people are going to be staying in the in a particular given space for a given duration of time. So, for commercial buildings we calculate it for an 8 hour working per day for 5 working days per week. Now, it includes all types of occupants, they may be full time staff, they may be part time stuff, they may be transit population or they may also be the residents who are totally going to be there.

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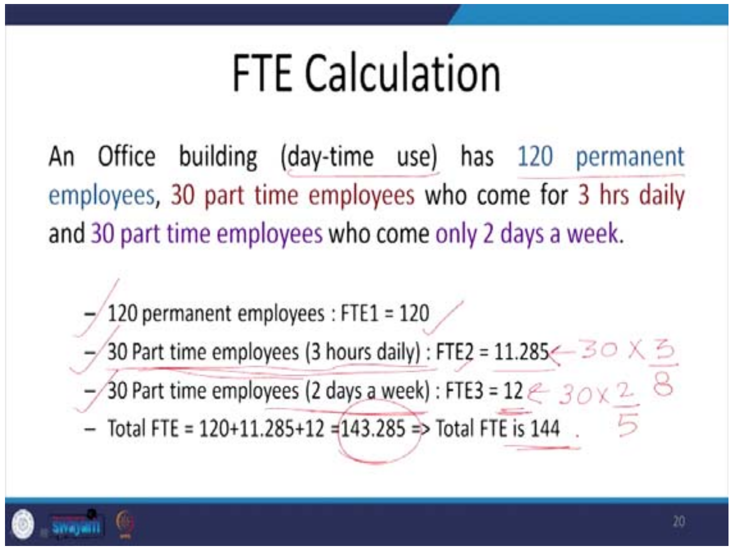

So, looking at one of the examples of this FTE calculation. For example, there is an office building which is a daytime use building which has 120 permanent employees, 30 part time employees who come for only 3 hours per day every day, 30 part time employees who come for 2 days a week. We have to calculate the total FTE and this will determine how much of water is required as a baseline calculation and how much reduction subsequently happens.

So, 120 permanent employees which are full time employees, the direct FTE will be 120 because they are there for 8 hours per day and for all the 5 days of the week. Now, next is the 30 part time employees who come only for 3 hours daily. So, for this we will calculate 30 which is the number of part time employees multiplied by 3 hours per day and divided by 8. Because, we calculate FTE for an 8 hour working day which will give us this 11.285.

This is the FTE equivalent for the part time employees. The next is 30 part time employees for a 2 day per week. So, this is 30 multiplied by 2 and we have 5 working days in a week so, this gives us a figure of 12. So, 30 part time employees who were working for 2 days a week are equivalent to 12 full time working employees. 30 part time employees who were working 3 hours daily are actually equivalent to 11.29 employees who are working full time.

So, the total FTE is 143.285 where we will round it off to 144. So, the first step towards this would be calculating FTE: Full Time Equivalents for any given building. Now, we already have the baselines which are available with us from the codes and we have the FTEs.

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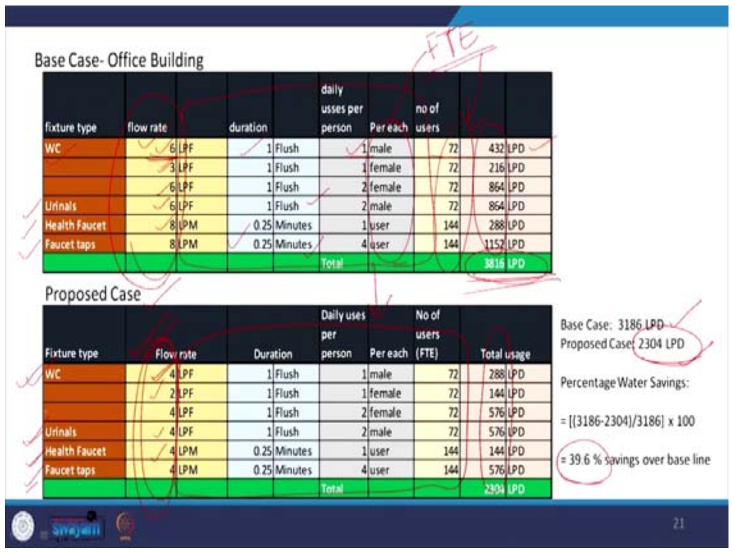

Once we have that, we will calculate the base case consumption, water consumption as shown on this slide. So, here we will write the different types of fixtures which are going to be which are installed in the building. And, how many of such fixtures, how many of uses will be required in the building that is coming from the baseline. The flow rate is what is given in the baseline for example: for WC, for a full flash it is 6 litre per flush, 3 and 6; again this is for males and females each.

So, we are looking at the number of users which is also coming from the baseline, we are looking at the duration of the flush or the seconds again coming from the baseline. So, this entire thing is actually coming from the baseline, this number of males and females is coming from the FTE data. So, we should be knowing that in the total FTE how many are males and how many are females. If it is not known then a percentage distribution and assumption will be taken and the FTEs distribution into male and female will be calculated.

In first case even the flow rates are coming from the base case tables. This number of users is actually coming from the FTE calculations, multiplying the number of users with the flow rates and durations and number of flushes; we will calculate the litres per day, the usage of water. And, we will calculate how much of water will be consumed on a daily basis, per day basis. Now, for proposing the new case which is for a sustainable building where water consumption has to be reduced, we will take the same fixture type, but the improved variety where this flow rate only will change.

So, instead of 6 which was prescribed as per the base case for a conventional fixture, we now choose an efficient fixture which has a flow rate of say 4 litre per flush as compared to the 6; 2 as compared to 3, again 4 as compared to 6 and 4 as compared to 8. So, here the documentation will be required where the specification, the manufacturers note will have to be saved while the fixtures are selected. Once these flow rates have been taken, the rest of the table remains the same which is exactly the same as the base case calculation table.

This has to be retained as the same, with the help of this change in flow rate the new total usage will be calculated. And, here we can see that while the base case water consumption was 3186 litre per day, the proposed case consumption was reduced to 2304 litre per day which implies that approximately a 40 percent savings over the baseline have been achieved; only by changing the type of fixture which is installed in the building.

So, selecting the right kind of fixture becomes a very important strategy and it has to be done right in the beginning. So, low flow fixtures and low flush fixtures have to be selected, they have to be chosen carefully.

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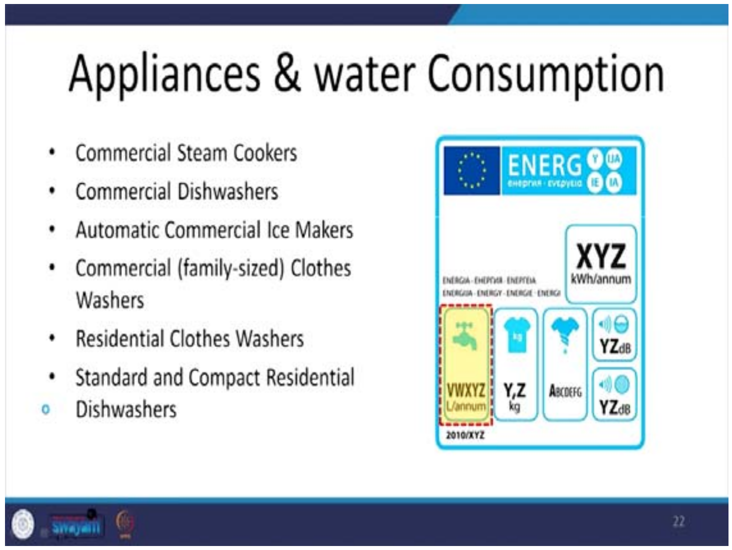

Besides that the water also gets consumed by the appliances within the household. So, here we are talking about the household. So, for example: the washers, the washing machines, the dishwashers. If there are commercial washers for example: it may be ah an apartment building where a laundry facility has been provided where there are community washers; so, they are commercial grade cloth washers. So, that may be there and other appliances. Now, while these appliances are selected, the manufacturer details have to be checked for their water at energy consumption.

Here we are talking about water consumption; so, the improved, technologically improved washing machines and dishwashers are available which consume lesser amount of water; they have to be selected over the conventional machines which consume more water. In addition to selecting all these the water metering has to be planned right in the beginning because, that will happen at the time of planning the plumbing layout. So, the water has to be metered for different types of consumption which is portable water consumption which is for human use.

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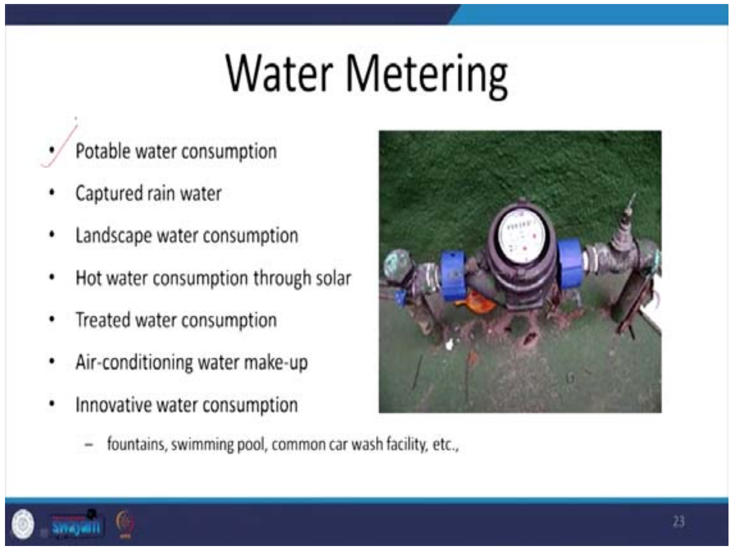

Captured rain waters so, how much of the rainwater has been captured; now this will help us in making a water balance chart. So, there will be estimations on the basis of which the sizes of the tanks and all other calculations will be done. But, on the basis of water metering the actual numbers will be substituted in the water balance diagram which we will subsequently see in the coming lectures..

The next is landscape water consumption; so, how much of the water is actually getting consumed in the gardening for landscape; hot water consumption through solar. So, if solar water heaters are provided which should ideally be provided, how much of the water is getting consumed is coming from the solar water heaters and being consumed. Then treated water consumption, how much of water is treated and consumed; air conditioning water make up and other innovative water consumption.

For example: for swimming pool, for common car wash facility. Suppose, there is a common car wash facility which is provided or there are fountains. So, all these have to be metered separately and all of this will actually go back into the water balance chart, where different inputs and outputs are given. In addition to this there will also be a head where we will measure the water which is going towards the treatment plant. So, how much of the water is going towards treatment plant and how much of the water is received from the treatment plant. And, then going into these different heads will be metered sufficiently.

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So, there are different types of water meters, these are flow meters which are available. So, there are flow meters for individual use, we can see here this is for educating each sensitizing each individual for limiting the water use which is a very good strategy, but again it comes at a price, it comes at a cost. So, besides that there are water meters for each dwelling unit and then there are municipal water supply meters which you might have seen installed in your homes, wherever the municipal water supply is coming.

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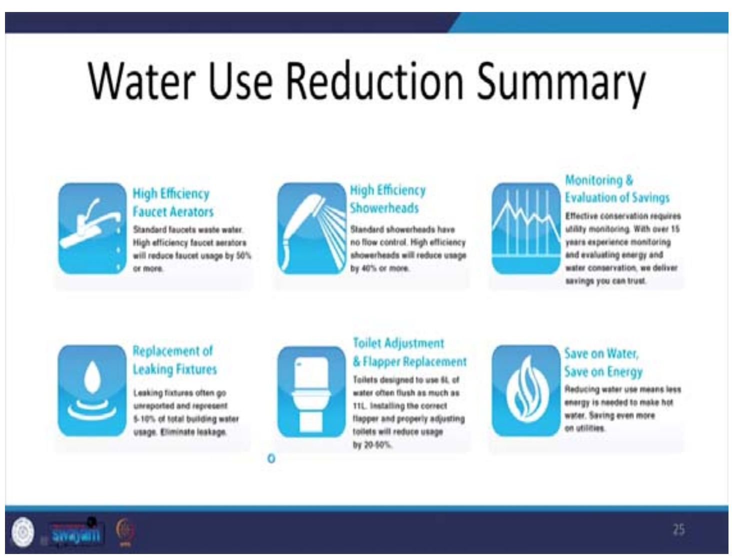

So, if we summarize the entire discussion of today's lecture, we have largely discussed about the water used reduction strategies. So, the first is the high efficiency faucet aerators, we also talked about high efficiency shower heads. So, not just shower heads, but also the flow fixtures, then monitoring an evaluation of savings which is what we discussed in water metering, replacement of leaking fixtures.

Now, nowhere we talk about installation of new low flow fixtures, the low flush fixtures, waterless urinals, dry composting toilets everything, but very essential is replacement of these leaking fixtures and timely management of that. This also can be noticed through monitoring and evaluation process metering. So, wherever the water consumption changes, while everything else remains the same this will be indicating that probably there is a leakage in the system, that is why the water consumption is increasing or there might be some other cause which needs to be identified and rectified..

Then toilet adjustment and flapper replacement; so, instead of using a high flow fixture changing it to use a low flow fixture and even high tech for the reduced flow; overall we are intending for saving water, reducing the water consumption. And, since it is all connected when we are talking about sustainability, it is a system thinking.

So, everything we do here has an impact on something or the other elsewhere. So, when we save on water we actually save on energy, because this water majority of the times is being pumped from the ground unfortunately. So, saving on water and also saving on energy. I will close my lecture here today and tomorrow we will discuss more on water conservation strategies and replenishment strategies.

Thank you, see you again.