Availability and Management of Groundwater Resources

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Lecture - 33
Estimation of Subsurface Runoff, Types of Wells, Well Hydraulics (Continued)

Welcome you all in the part 4 of the module 7 estimation of subsurface runoff, types of wells and well hydraulics. So, in the previous three different parts of the module seven lecture we have seen that the precipitation when it is reaching to the earth's surface first of all underneath the soil layer is becoming saturated. And then after infiltration and percolation the water reaches to the water table that is the upper layer of any unconfined aquifer.

The surplus rain water which falls on the surface, whose underneath soil has become saturated, that moves towards the topography in the form of runoff usually called as surface runoff. So, in the last three lectures we have understood the concept that runoff is the surplus precipitated water which are not having the ability of infiltration and percolation. That is; that follows only through the topography of the earth's surface and ultimately reaching to the stream or any river.

One more term we have understood in the previous lectures that the saturated content or saturated layer of the soil from there the water moves laterally and ultimately joins the bedrock or the bottom of the river bed and those amounts of water which moves laterally from the saturated layer of the underneath soil layer is termed as subsurface soil, subsurface runoff. That is termed as subsurface runoff.

So, two different terms we have made clear about the runoff and subsurface runoff in the past three lectures. Now today in this lecture we will concentrate on the topic types of wells.

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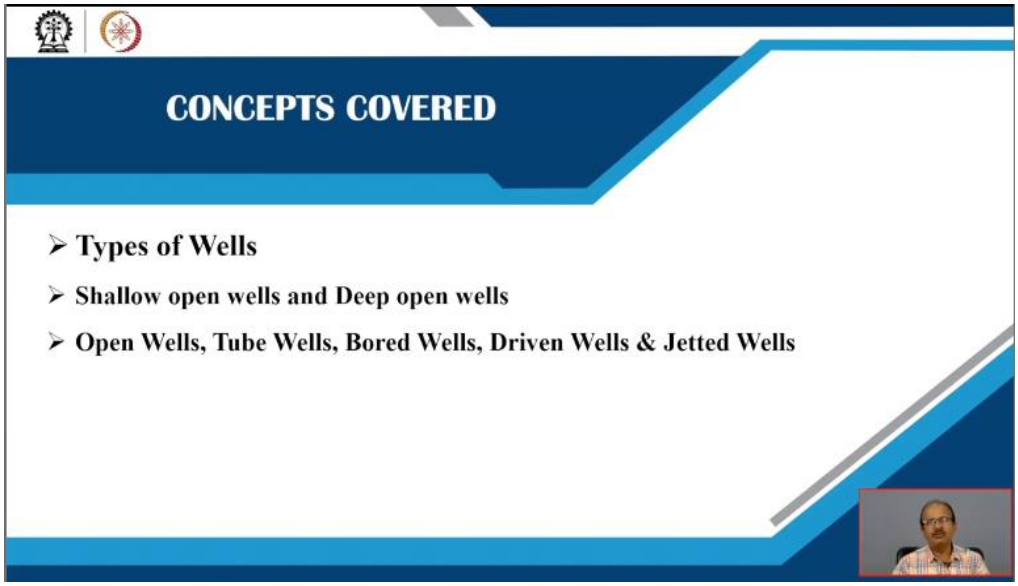

Because we know generally, we are withdrawing the water from any wells. So, here we will discuss types of wells, open wells and deep open wells, shallow open wells and deep open wells and some of the extra types of wells also named as board wells, driven wells, jetted wells. So, in this lecture I will try to clear the concept of the wells and its different types.

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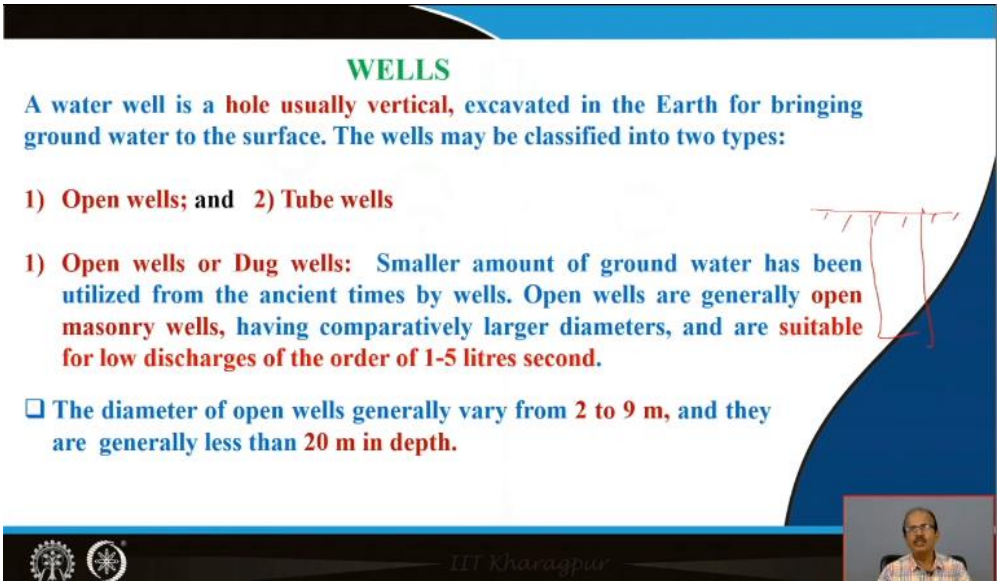

So, when a well, a water well is a hole. It is a hole usually vertically excavated in the earth; it is just excavated. See if this is the earth, so if this is the earth layer and it is excavated vertically generally for what for bringing the water to the surface, for bringing the water to the surface. So, this is generally called a water well which is just a hole in the earth's surface, usually vertical hole.

And it is the materials; the soil and rock materials, stone materials these are being excavated. And then when the water table comes from their water accumulates in this vertical whole life structure and from there, we are just withdrawing the water for the different purposes which is called as well. This well may be classified into two types. First is the open well and second is the two tube wells.

We have seen also several dug wells and tube wells we have seen at different places. So, open wells or dug wells, generally these are smaller amount of groundwater has been utilized from ancient times by wells. So, early if we will see the past history generally that time the technology was not available. So, many more wells were there and all the wells were of the open or dug wells category.

So, open wells are generally open machinery wells having comparatively larger diameter. And are suitable for low discharges of the say of the order of 1 to 5 litre per second. So, this is the just the discharge rate from those very open holes dug wells. So, the diameter of open wells, generally vary from 2 to 9 meter. The dug wells diameter varies from 2 to 9 meter and they are generally less than 20 meter in depth. So, these are called as the open well or dug wells.

So, depth is also not too much less than 20 meters. So, and from there the people were excavating the just withdrawing the water for their different purposes. So, this is about the first we have understood about the well and categorized into two types; that is open well and tube wells. So, open wells, I am just discussing it is having a very low discharge rate that is 1 to 5 litre per second.
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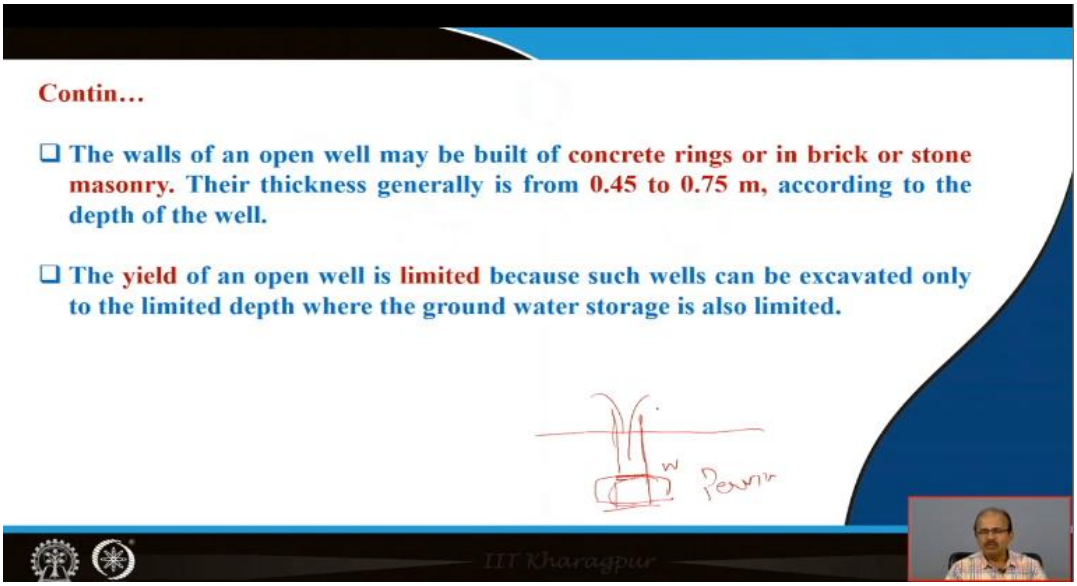

So, this the open wells, the walls of the open well may be built up of concrete rings or in brick or stone machinery and it is thickness also generally vary from 0.45 to 0.75 meter according to the depth of the well. So, this is the, it is well, generally remains from 0.45 to 0.75 meter thickness. Now the yield of an open well is limited; yield is very limited because such wells can be excavated only to the limited depth only where the groundwater storage is also limited.

So, some well may be excavated at a portion where the aquifer is having because without the aquifer it will not have water. So, definitely the well is being excavated in the area to certain depth and just after seeing the water so, this is the water level. So, if you meter depth they are taking it and this is the your open dug well. So, from there the water are being excavated. But from the yield point of view, it is not so good well.

Because it is very limited and groundwater storage is also not because this has met only one pervious formation. So, only one formation; very limited amount of water that can be excavated and that can be withdrawn from the area. So, open well generally is having the limited yielding.

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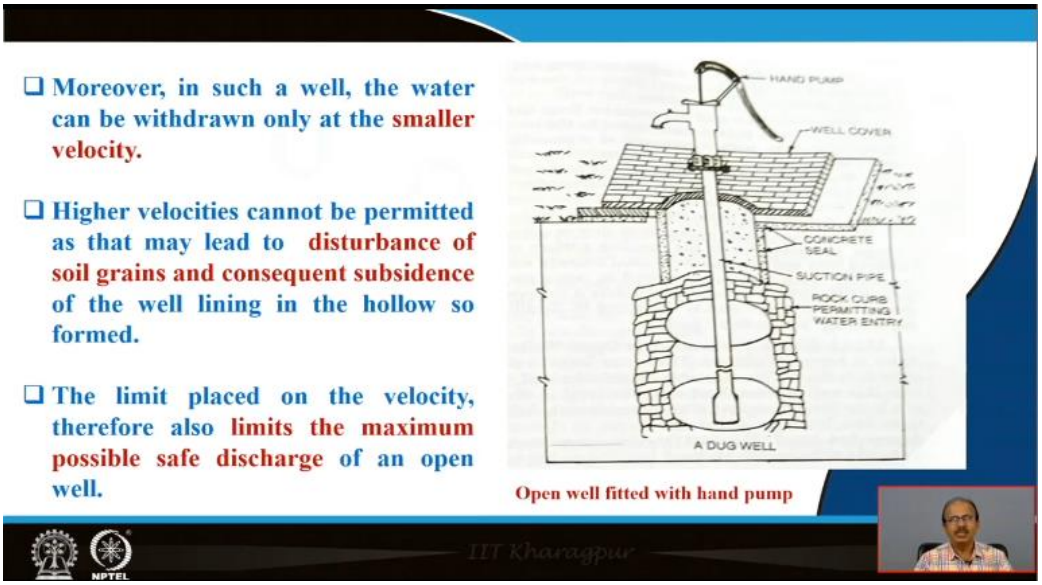

Now in such an open well, the water can be withdrawn only at smaller velocity also. You can see the example of the open well and in this open well one hand pump has been fitted. So, here you can see in such type of well the water can be withdrawn, it can be withdrawn but only at a smaller velocity. Higher velocity cannot be permitted why as that may lead to disturbance of soil grains and consequently subsidence. So, higher velocity is not permitted from this type of open well.

Why? Because the disturbance of soil grains and consequent subsidence may take place through the well lining may it fall the total material may fall in the hollow structure which I formed for taking out the water from the well. So, the limit placed on the velocity limits the maximum possible safe discharge of an open well. So, that is why the higher velocity is not permitted because there may be the case of subsidence, falling off the wall in the hollow structure which has been made.

So, in this way we can see that this dug well, open dug well is having a limited yield because it met only a limited pervious formation also, porous formation also. And in the porous formation very limited amount of water also remains there. So, this is very open; type of open well is one of the oldest types of well.

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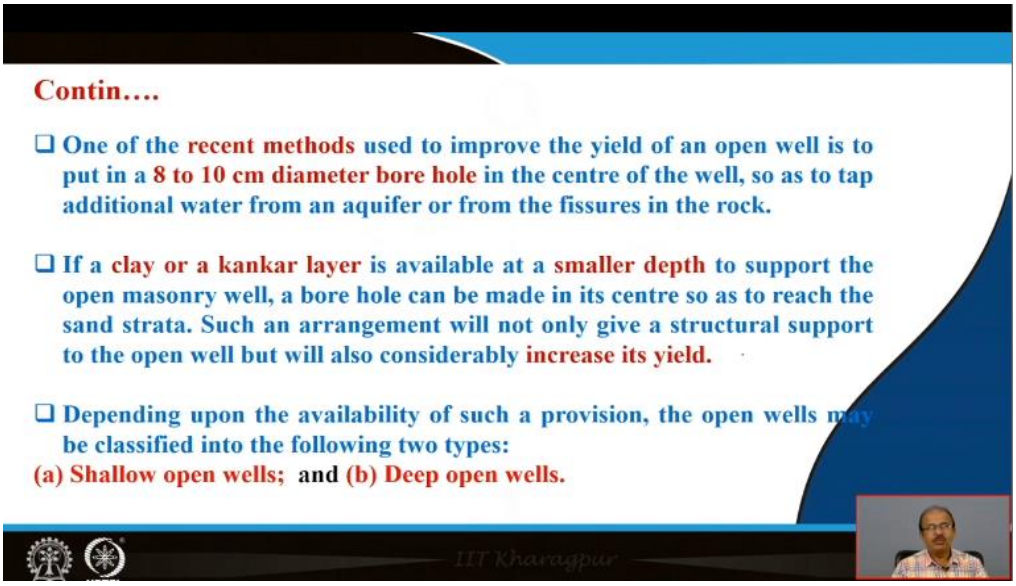

One of the recent methods used to improve the yield of an open well is to put a 8 to 10 centimeter diameter bore hole in the center of the well. What you have seen in the previous figure, here also. This is the if you will just take it out so this is the case of the open well, open dug well. Now for since this type of open well is having limited yield. So, for increasing the yield of the dug well what new technology suggests that just put a tube well inside.

So, here 8 to10 centimeter diameter bore hole is made and, in this borehole, generally where it will is being fixed. So, this is one of the recent methods which improve the yield through it improvement of the yield can also take place. And for this 8 to10 centimeter diameter bore hole in the center of the well is generally done and then so why to tap the additional water from an aquifer or from the fissures in the rock we have read already.

That in the alluvial formations in the sandy formations we are having the pore space from which we can withdraw the water. But in some hard rock formations in which the cracks and fishes remain there also the water remains. And from there also we can tap the water with such type of advancement in the technology. So, if a clay or kankar layer is available at a smaller depth, if a clay or kankar layer is meeting say for a little depth, smaller depth to support the open masonry well a borehole can be made in its center.

It can be made in the centers, why? To reach the sand strata. Such an arrangement will not only give a structural support to the well but also considerably increase the yield of the open dug well. So, for this generally the borewell helps in increasing the yield of the dug well also. Now depending upon the ability of such a provision the open dug well may be classified into two different types. The first is the shallow open wells and second is the deep open wells.

So, these two categories of the open well and these on the basis of ability of the provision of your making of borehole.

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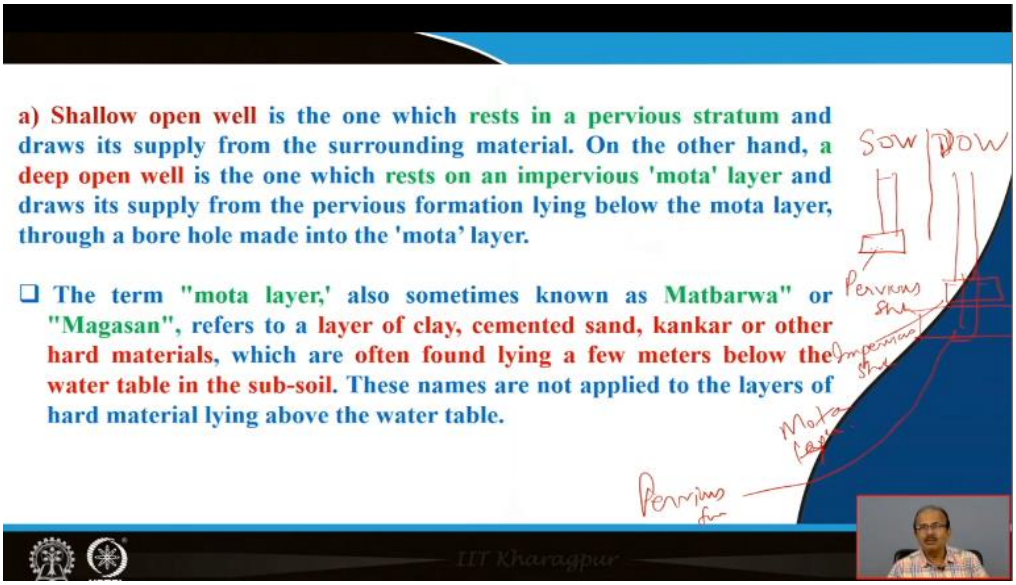

Now shallow open well is one in which rest in the previous stratum and draws its supply from the surrounding material. So, shallow open well will also, we can construct in such a pervious stratum. So, that yield may increase from the area from the well. If yield is remaining good in the formation, then definitely the well will be beneficial to the people to the community. So, shallow open well is the one such type of well which rests in the previous stratum means full of your water.

And draws it is supply from the surrounding material. On the other hand, a deep open well, this is the case of the shallow open well; on the other end deep open well is the one which rests on an impervious mota layer. Impervious mota layer and draw it; supply from the previous formation lying below the mota layer through a borehole made into the mota layer. So, this is the basic difference between the shallow open well and the deep open well.

So, the two conditions are there; shallow open well and deep open well. So, two different types of conditions are there. One will rest this well rest in the previous stratum. So, definitely if it is pervious, it is having the pore spaces it can hold the water from here, we may get some better yield. Because we maybe draw some more amount of water from this type of well. But second the deep one this well is a bit deeper one.

And this deep well is resting on an impervious start it is resting in this was pervious, this is impervious this was impervious starter. So, this rest on the impervious starter generally this impervious stratum is called as mota layer. This is strata is called as mota layer. So, layer this is called a mota layer. And draws from this well it draws its supply of water from the previous formation, which is lying below the mota layer. So, here is the pervious formation.

Here we were getting no mota layer only the pervious formation. Here it is deep open well which rests on the mota layer and below the mota layer is the pervious formation here the pervious formation rest remains formation. So, what is happening; borewell is just made into the mota layer and then the water is being withdrawn from the this your just from the deep open well. So, through a borehole made into the mota layer because through mota layer.

It will come to the pervious formation and then we can stack the water from such type of deep open well. So, the term mota layer, what is mota layer the term mota layer is sometimes known matbarwa or magasan which refers to a clay which is highly porous but poorly permeable, cemented sand. Sand is good it is porous but since it has become cemented. So, it is porosity has decreased conquer or other hard materials which are often found lying a few meters below the water table in the subsoil.

So, this is usually; we are meeting during boring you can see it also. Generally, the layer of clay, cemented sand, conquer all other hard materials which are known as matbarwa or mota layer or magasan. So, these names are not applied to the layers of hard material lying above the water table. So, generally some specific term is here mota layer.

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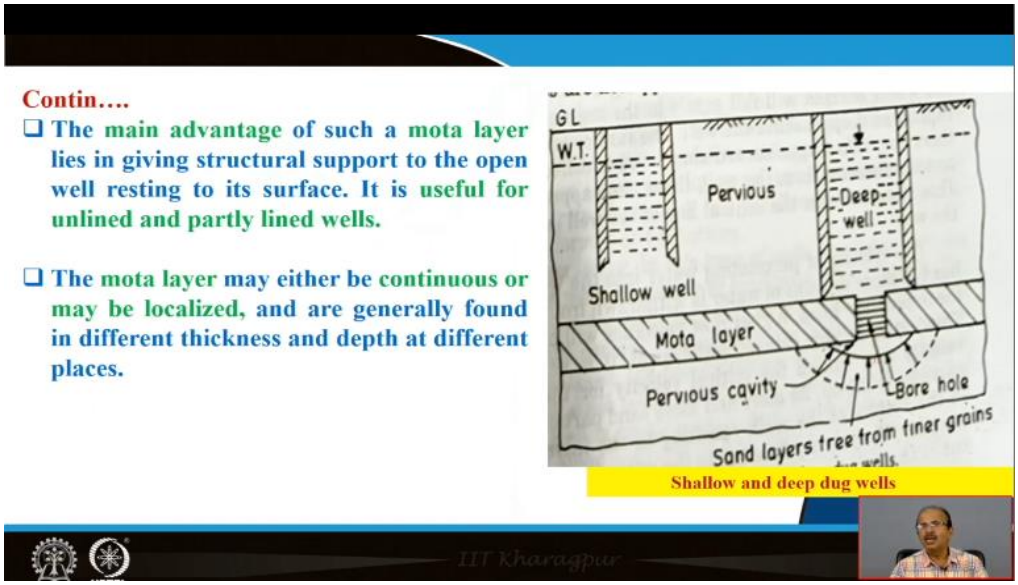

So, what we have seen; that the main advantage of such a mota layer, lies in giving structural support to open well resting to it is because this mota layer will just hold the deep well, open well. So, it is useful for unlined and partly line wells. So, unlined, generally dug well remains unlined no side wall is your concreted. So, this generally supports this mota layer; supports and then below it is having the pervious layer formation.

So, from here if you are just making a borewell. So, from here the; through the borehole the water comes in this well, deep well and through the from here it is being just taken it out for different purposes. So, the open wells is categorized into shallow open wells and deep open wells. We have seen that shallow open well rest on the pervious formation. Relatively a better yield of these shallow formations and deep open well rest on the mota layer.

And then below the mota layer is having your pervious formation and then the water we can just withdraw the water from such types of well. So, the mota layer may either be continuous or may be localized. Maybe a localized only and are generally found in different thickness and depth at different places. So, its thickness and depth varies from place to place. But it helps in the just the itself in its structural support.

Because these deep open wells generally remain unlined and partly lined. So, for the stability point of view it helps the mota layer helps a lot. So, this we have seen.

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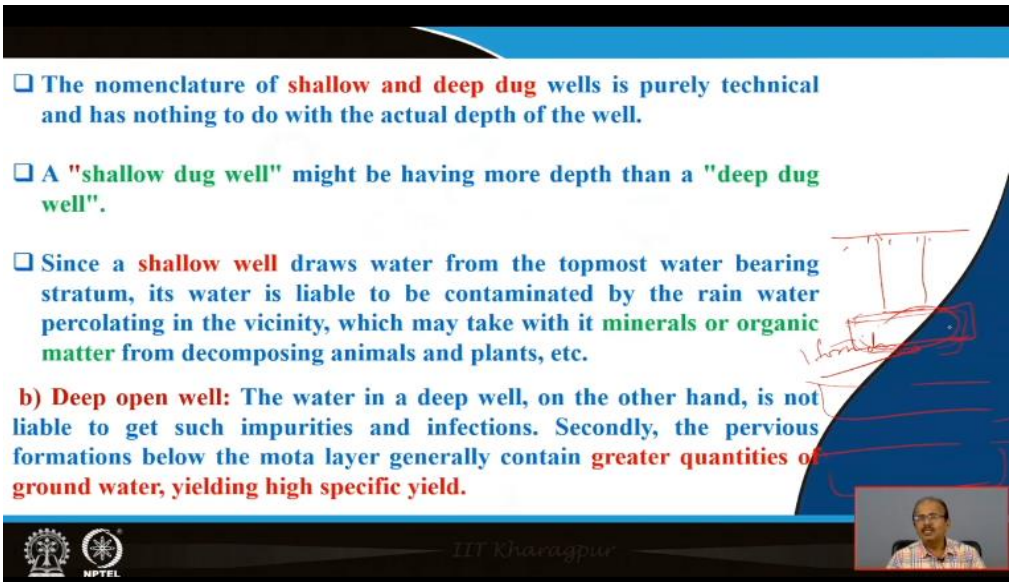

Now the nomenclature of shallow and deep dug wells is purely technical and had nothing to do with the actual depth of the well. So, certain limit has not been fixed just technically we can say it shallow well at deep dug well. A shallow dug well might be having more depth than a deep dug well maybe. So, since the shallow well draws water from the topmost we order bearing stratum we have seen the I told you that is the shallow well, only this well this is the earth's surface.

So, it is the shallow well is for a few meters depth only and if the water is coming in such type of well. So, this is only one formation. Only one formation that is one formation means one pervious formation very limited amount of water it can be withdraw for different purposes. So, shallow deep well draws water from the topmost water bearing stratum. This is the topmost, below it may be some other formation also.

So, as we go down the different formation we can see. But generally, the shallow will draw water from the top most water bearing stratum. It is water reliable to be contaminated since it is just at the top. So, may be contaminated by rain water, percolating in the vicinity or which may take with it minerals or organic matter from the composing animal and plants. So, this there is a chance of the contamination in such type of shallow open well because it is just resting on the first your pervious formation, inside the surface.

So, because of some sort of your percolation of the rain water or the some of the industrial influent if it is coming by leaching it may just pollute this type of water which is resting in the shallow well. Now deep well the water and deep well on the other hand is not liable to get such impurities and infections means that maybe that deep open well may remain free from contamination.

Secondly the pervious formation below the mota layer generally contains greater quantities of water and also giving high specific yield. So, this is good for the deep open well because like shallow well it; this such type of well remains free from contamination. So, this is the advantage of the deep open well over the shallow open well.

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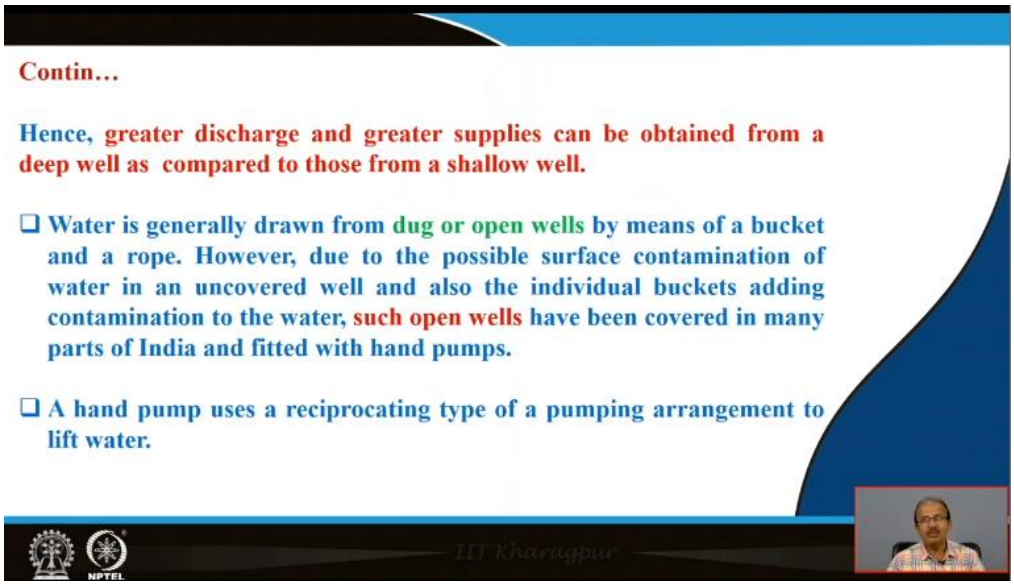

Now we can conclude that greater discharge and greater supplies can be obtained from a deep well as compared to those from shallow well. So, this is from the deep well we can have a very good discharge also and huge amount of supply can be obtained, water supply we can get from such types of deep well. Now water in generally drawn from dug or open wells by means of bucket and rope.

We have seen also in villages still the people are even in the urban areas also still the people are just taking out water from the by means of bucket and rope. However due to the possible surface contamination of water in an uncovered well. Because this is the uncovered well and also the

individual buckets mean lots of people are coming to the well so they are using their own bucket and rope. So, huge of individual buckets is also just adding contamination to water.

So, in such, then from the dug well it may contaminate. Because it is at your cellular depth also and second thing that it is individuals' different individuals are using its their own rope and buckets for taking out the water. So, the chances of the contamination is increasing in such type of well. So, such open wells have been covered in many parts of India and now after seeing these things now open wells are remaining covered in many parts of India.

And in some may be fitted with hand pumps and some it may be fitted with hand pumps. So, a hand pump uses a reciprocating type of pumping arrangement to lift water. So, this is the arrangement of the hand pump which may be fitted in a covered open well.

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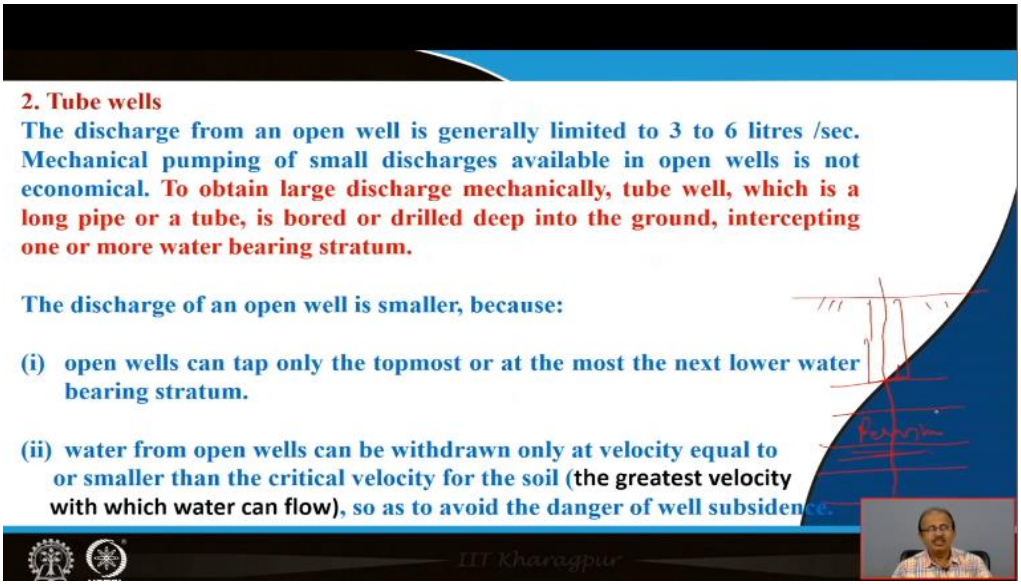

So, this is the generally the criteria for having the tube well and the tube well which is the well generally we are seeing at different places. The tube well is the discharge from an open well generally limited to 3 to 6 litre per second. So, this is the general discharge level that is 3 to 6 litre per second and mechanical pumping of small discharges available in open wells is not economical through the some well open well if you are just putting some mechanical pumping arrangement and taking on water.

So, it is not economical. So, for this to obtain large discharge mechanically tube well which is a long pipe or a tube is bored or drilled deep into the ground. Intercepting when it is going deep into the ground definitely it is intercepting one or more water bearing stratum. Because I just now I have discussed that if this is the earth's surface. So, if this is the well so this is the shallow well and deep well will rest on the mota layer then the pervious stratum will come.

Then again if suppose some impervious stratum, again pervious stratum is coming, so in the case of tube well we are just boring two different layers also. So, the chances of getting good amount of water in the tube well is too high because it is meeting the different formation of water. So, large amount of water yield also we can get in such type of ways. So, the discharge of an open well is smaller by because open wells can tap only the topmost or at the most the next lower water bearing stratum.

The next lower water bearings return. So, generally open well is tapping the topmost layer of the water stratum your previous stratum or the next lower. Water from the open wells can be withdrawn only at velocity equal to or smaller than the critical velocity for the soil. Means the greatest velocity which is water can flow. So, what is happening it is avoiding the danger of well subsidence. So, that is why the discharge of an open well remains smaller compared to your other wells.

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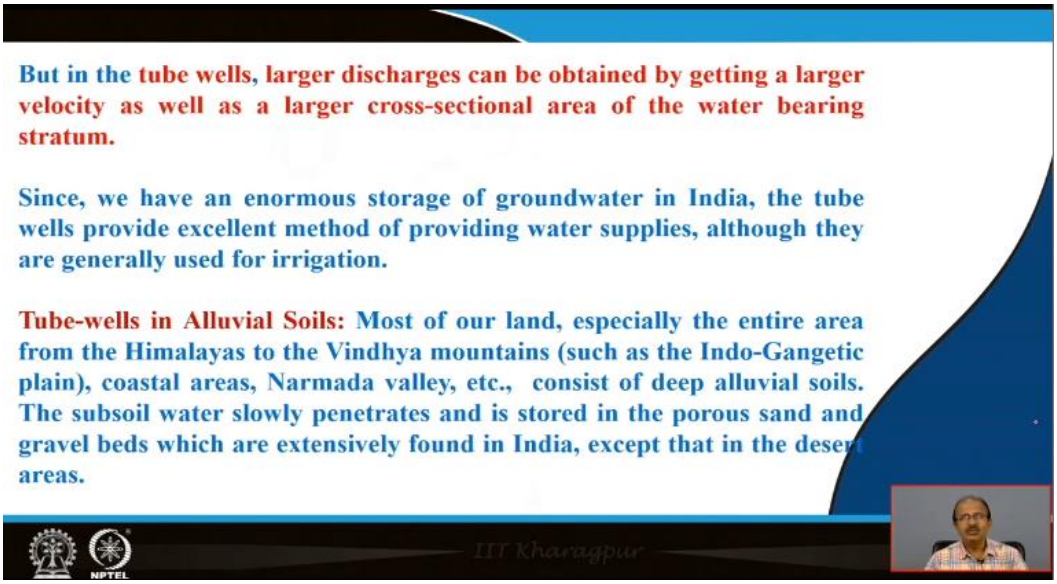

Now, but in the tube wells larger discharges can be obtained by getting a larger velocity as well as larger cross-sectional area of the water bearing stratum. This can be, we can get it in tubers large discharge, we are getting a larger velocity also from a larger cross-sectional area of water bearing stratum. So, many stratums are coming, water bearing stratum is coming in the case of tube well. So, since we have an enormous storage of groundwater in India the tubers provide excellent method of providing water supplies although they are generally used for irrigation.

Generally, for education purpose, even for drinking purpose also people are taking out water from the tube wells. In alluvial soils we can see from the entire from Himalayas to India's mountains Indo-Gangnetic plain, coastal areas, Narmada valley these all are our part of our Indian subcontinent consists of deep alluvial soils. And the subsoil water slowly penetrates and is stored in the porous sand and gravel beds which are extensively found in India except in the desert prone areas of Rajasthan because etcetera.

So, generally this tube well is working very well in the alluvial soils, alluvial sands are very much poorer sand.

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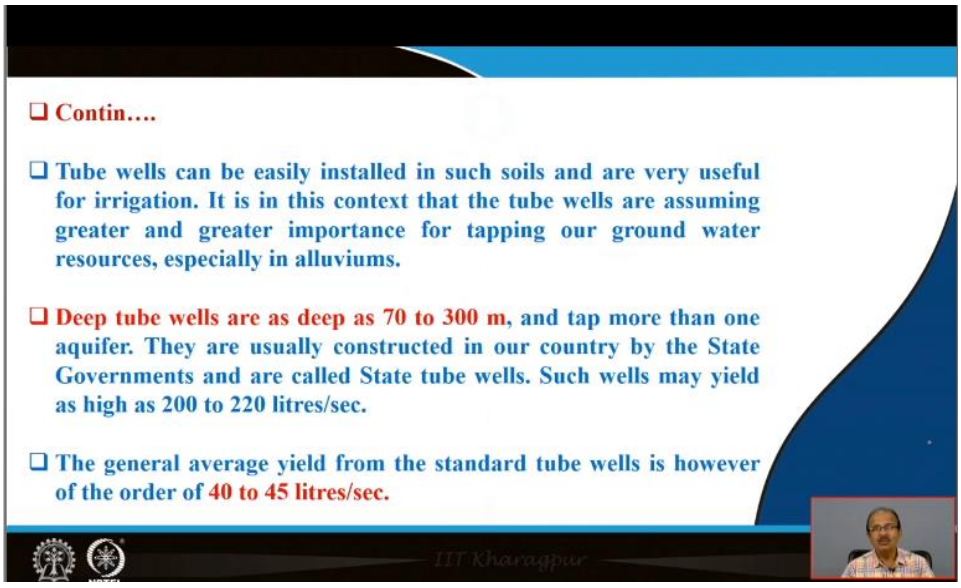

So, tubers can easily be installed in such soil also very useful for irrigation. It is in this context that the tube wells are assuming greater and greater importance for tapping our groundwater resources, especially in alluviums. Deep tube wells are as deep as 70 to 300 meters also and it is tapping more

than one aquifer but they are generally constructed by the state government or are and are called the state tube wells.

Such wells may lead and may give us the yield of as high as 200 to 220 litre per second. So, just compare the value of yield from such type of well. So, deep tube wells are having very good yield also. The general average yield from the standard tube wells however of the order of 42 to 45 litre. So, this is the general average it will

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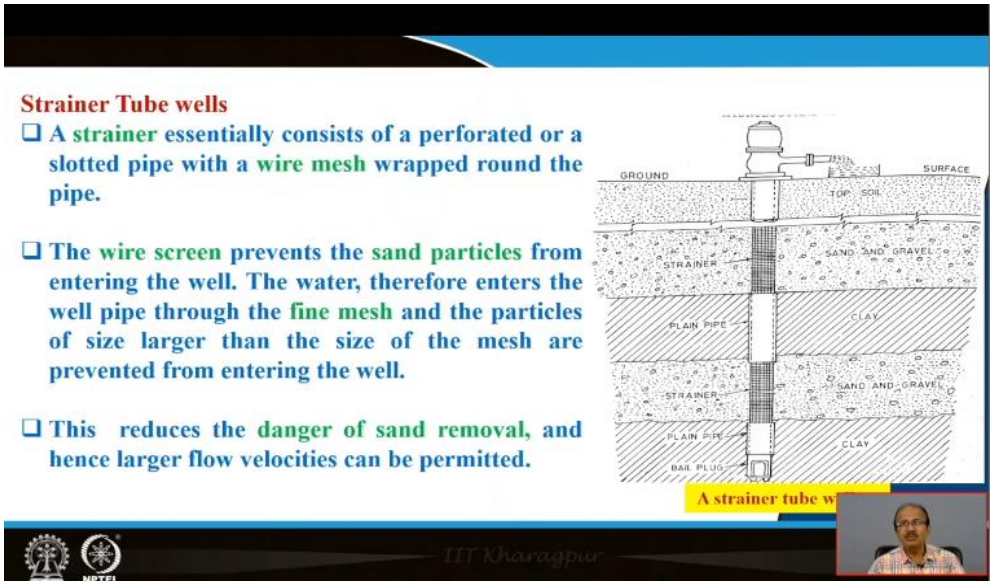

Now some of the strainer type of tubers, we are also having strainer is generally consists of a perforated or slotted pipe. We can see here these are the strainers slotted and perforated slotted pipe with a wire mesh having wire mesh wrapped around the pipe. The wire skin this what will the role of the wires in the wire skin just prevent is the sand particle from entering the well. So, the water therefore enters the well pipe through the fine mesh, very fine mesh.

And the particles of size larger than the size of mesh are prevented from entering the well. So, those types of particles are not entering into the well. So, the standard type of tube wells reduces the danger of sand removal and hence larger flow velocities can be permitted in such types of tube well.

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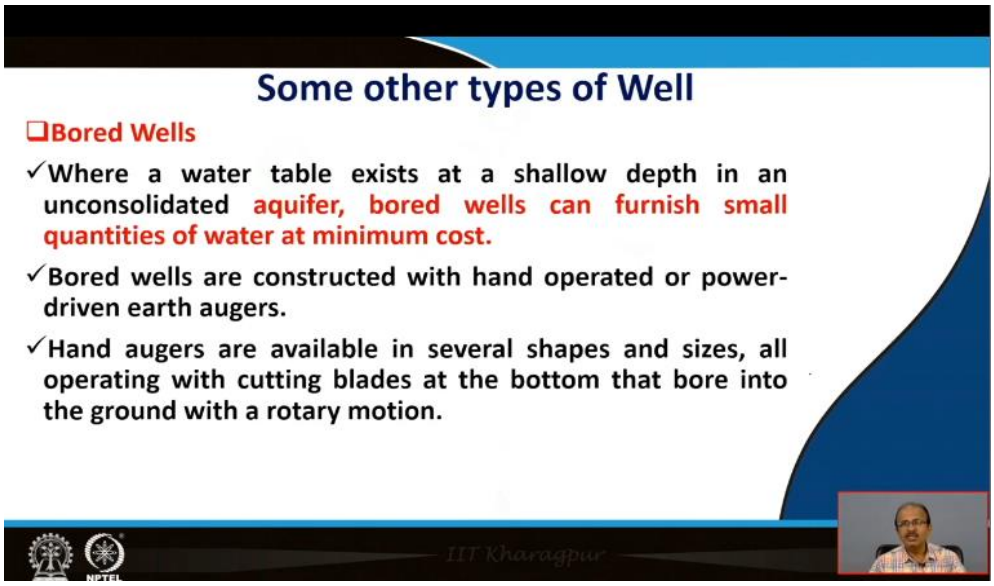

Now some other types of wells are also available. Such as board wells where a water table exists at shallow depth in an unconsolidated aquifer, borewells can furnish small quantity of water at minimum cost. Bored wells are also constructed with hand operated or power-driven earth augers. So, no need to have some heavy machine for its construction. Hand augers are available in several shapes and sizes, all operating with cutting blades at the bottom that bore into the ground with a rotary motion.

With the rotary motion just, the blade is cutting and the hole is just we are making the hole for bored wells.

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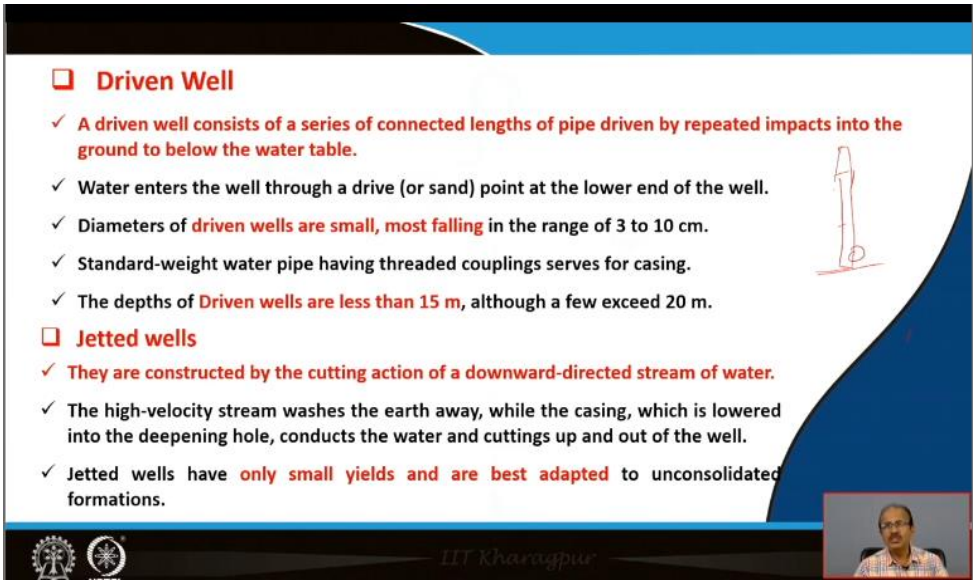

Some other types of wells are the driven well, driven well consist of series of connected length of pipe driven by repeated impacts into the ground to below the water table. Just going down to down and down. The water enters the well through a drive or sand point at the lower end of the well. So, just at the lower end of the well several types of these are having the several lengths of pipe. So, here at the end of the well some sand opening remains from there the water enters into it.

Diameters of driven wells are small most falling in the range of 3 to 10 centimeter. Standard weight water pipe having threaded coupling serves for casing and the depths of driven wells are less than 15 meters although if you see 20 meters. So, this is the usual depths of your driven base. Now next is the jetted wells. They are constructed by the cutting action of downward directed stream of water. So, there we can see the jetted example of jetted wells.

The high velocity steam washes the earth away while the casing which is lowered into the deepening hole, conducts the water and cutting up the, cutting up and out of the well. So, this type of jetted wells have only small yield and are best adopted in the unconsolidated type of formations. So, these are a few of the examples or views of the details about the wells in general we are getting in the nature.

So, these wells are having storage of water from the aquifer and from there, we are just taking out the water for different purposes. So, with this we have discussed the surface runoff and the types of waves. Thank you very much.