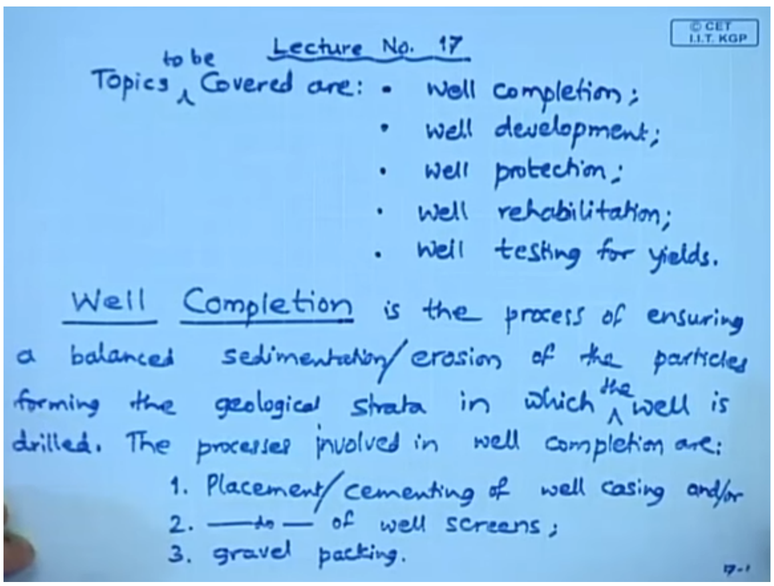
Ground Water Hydrology
Prof. Dr.Venkappayya R. Desai
Department of Civil Engineering
Indian Institute of Technology – Kharaghpur

Module No # 04
Lecture No # 17
Well Completion; Well Development; Well Protection; Well Rehabilitation; Well Testing for Yields

Welcome to this 17th lecture which is on well completion.

(Refer Slide Time: 00:35)



So the topics covered in this lecture well completion followed by well development followed by well protection then it moves on to well rehabilitation and lastly well testing for yield. So now we will start with the first topic of this lecture that is on well completion. So this well completion it is the process in which basically a permanent nature of well is established.

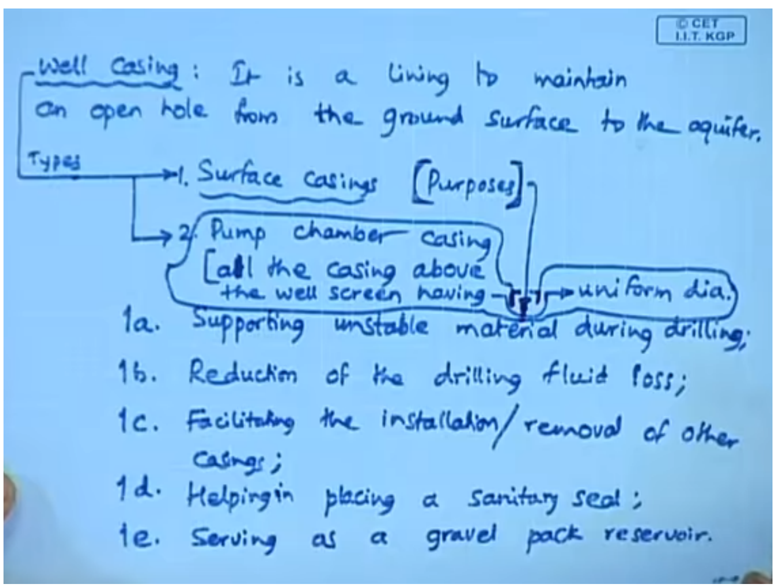
Whenever as well is dug so it is we are disturbing the land profile by drilling a well once this land profile is disturbed so that we get we can harness the groundwater we can extract ground water. So then what happens is so the there is a possibility that there is erosion undesirable erosion or sedimentation of all different sizes of soil particles. So it can range from smaller particles smallest clay to even boulders even it may not g up to boulders but definitely it can go up to gravel or as well.

So therefore there is a need to maintain this balance and that is precisely done in this well. So completion basically this well completion is the process of ensuring balanced sedimentation stroke erosion of the particles forming the geological strata in which the well is drilled. So this the world balanced sedimentation or erosion so this is to do that so the processed involved in well completion are so the first one is that is a placement or cementing of a well casing.

So here this is and stroke R so this is a placement of well screen and so this is a placement of gravel packing or simply gravel packing. So these three or all of these three processes are involved in this well completion. So now let us briefly discuss what this well casing or well screen or what this gravel packing are and how to they help in this well completion process. Where in a balanced sedimentation or erosion.

So that it attains the steady state and so that the geological formation will remain so that is ensured. First let us discuss about this that is well casing.

(Refer Slide Time: 07:22)



So here so this so this well casing basically it is to maintain so it is a lining to maintain in open hole from the ground surface to the aquifer. So basically here what is done is some cover is provided so that so this is the opening the open hall from the ground surface because see the thing is unless we ensure a continuous that is supply of ground water.

So well will not supply ground water so well will not serve its purpose so therefore this well casing is very important were in the porosity or rather the perforated nature of the ground is maintained. So through which the infiltration takes place and so this when is talk of infiltration so it involved percolation which generally in the vertically downwards direction as well as see page which is generally in lateral direction.

So therefore so this well casing essentially ensures that so the well get the necessary the ground water storage into the aquifer so through which the well draws its water and here so there are this one that is a so the this well casing. So this is here you can say this is a types or say the first one is the surface casings and followed by so there is a pump chamber casing so these are all self-explanatory.

So here the surface casing is at surface level and what it does is a through the upper strata of unstable or fractured material. So it is installed and then relatively into a stable and relatively impermeable material. So here so it serves various purpose such as the it supports unstable material during drilling reduces loss of drilling fluid facilitates installation of removal of casing aiding and packing placing a sanitary seal and lastly it is serves as a reservoir for a gravel.

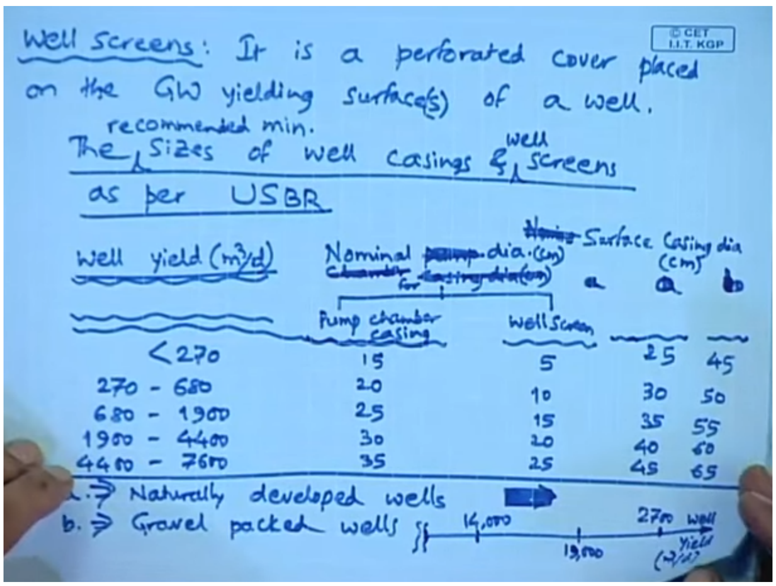
So basically this is a surface casing so here you can say the purposes of surface casing which are installed at the surface level are let me write here a say let us say 1A that means 1 refers to surface casing and then A refers to the first purpose. So this is supporting unstable material during drilling that is during well drilling and next it is the next purpose is reduction of the drilling fluid loss.

So this is also this purpose is also achieved by surface casing the third one the third purpose is facilitating the installation or removal of other casing. So there may be other casing so that is they either the installation or the removal so that is facilitate and fourthly so it is a helping in packing am sorry placing sanitary seal. So this is also one of the important purposes of surface casing and then lastly it is serving as a gravel pack reservoir that means whenever we need gravel pack.

So the surface casing will provide that from that this one from it is storage so these are the purposes of surface casing and then so this now in the next coming to the pump chamber so here it consists of al casings above the screen in wells of uniform diameter. So next is so where as this surface casing so they are at this is at the surface level whereas pump chamber casing so these are at the so or all the casing above the well screen having uniform diameter.

So here I am writing here having a uniform so this is a pump chamber casing okay. Whereas surface casing is at the surface level so this is regarding the placement of well casing and many time so this cementing is also required because simply placing a well casing is not good enough so it has to be held there. So therefore for that cementing is required so for that we may use a cementing material such as the ordinary port line cement or any other binding material.

(Refer Slide Time: 17:41)



So which will hold in positing this well casing and then so next will go to that is the well screen. So here in the well screen so it is basically it is some kind of a this one perforation that is on the well between the lateral surface of the well and so through which only a limited there this one that is a will limited amounted of soil particle will be will be allowed to load and so here so this so well screen it is a perforated cover placed on the ground water yielding surface or surfaces of well.

So and here so this is so depending upon the formation and also the well casing also differs and of course the depending upon the well yield. So the that is the say for example the well casing as well as the screen so the size of the sizes of well casings and screens well screens the recommended minimum sizes of well casing and well screens as per the USBR United States

Bureau of Reclamation. So they are as follows so they are based on the well yield in meter cube per day.

And so nominal pump chamber casing dia so that is in centimeter and surface casing dia so that is also in centimeters for so this is for A, B, C. So here this A refers to it is naturally developed wells B refers to gravel packs well and C refers to I am sorry this is A and B and then the nominal screen diameter nominal pump chamber casing diameter and here let me also give so that is.

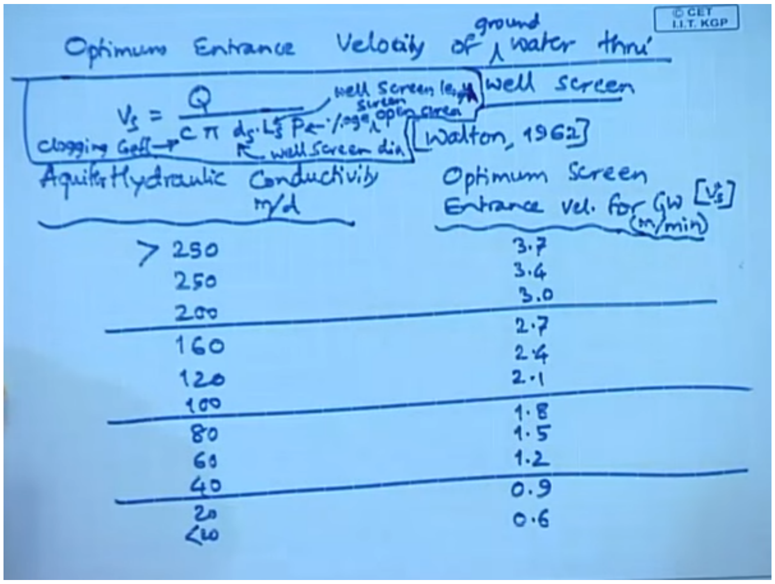
So here let me do it like this nominal diameter and centimeter of so here this is for pumped chamber casing and then well screen. So essentially we have so this is our this is our first column that is the well yield meters this so the next column is the nominal diameter for pump chamber casing and nominal diameter by well screen. And then followed by so this is the surface casing this let me call this A and then this B.

So here so this is well yield so there are various things are there so this is less than 270 then 270 to 680 and then 680 to 1900 and then 1900 to 4400 and they will not go beyond this one. And let us although there are many more are given so let us say 4400 to 7600 and for this nominal pump chamber so this is 15, 20, 25 30 and then 35 in centimeters. So that is the nominal diameter for pump chamber casing and then similarly nominal screen diameter is 5 for well screen.

That is 5, 10, 15, 20 and 25 and so here the surface casing so the diameter that is a for diameter naturally developed wells okay C is not there this is or naturally developed wells. So that is a 25, 30, 35, 40, 45 and then similarly so here it is for gravel pack well. So this 45, 50, 55, 60, 65 so this is taken from US Bureau of Reclamation and of course same this 5 centimeter gap that goes on.

So the next level is so here let I can represent the various sizes of well yield so this is well yield. So that is in meter cube per day okay. So here let me represent this one after 7600 next is 14,000 next is 19,000 next is 27,000. So that means so some 7600 to 14,000 so this everything gets increase by 5 centimeters. So it is 40, 45, 50 similarly here it will 30, 35, 40 in similarly here it is 50, 55, 60 and then similarly here it is 50, 60, 70 only in this case whereas in this case there is 65, 70, 80, 90 so like that.

(Refer Slide Time: 27:38)



So these are the very this one and now we will move on to that is so there is also an equation that is given for the so that is optimum entrance velocity of water through a well screen water that means obviously this is ground water so this has been so this has been proposed by WALTON and WALTON in the year 1962. So that is the hydraulic conductivity in or other aquifer hydraulic conductivity in meter per day versus the optimum screen entrance velocity for ground water.

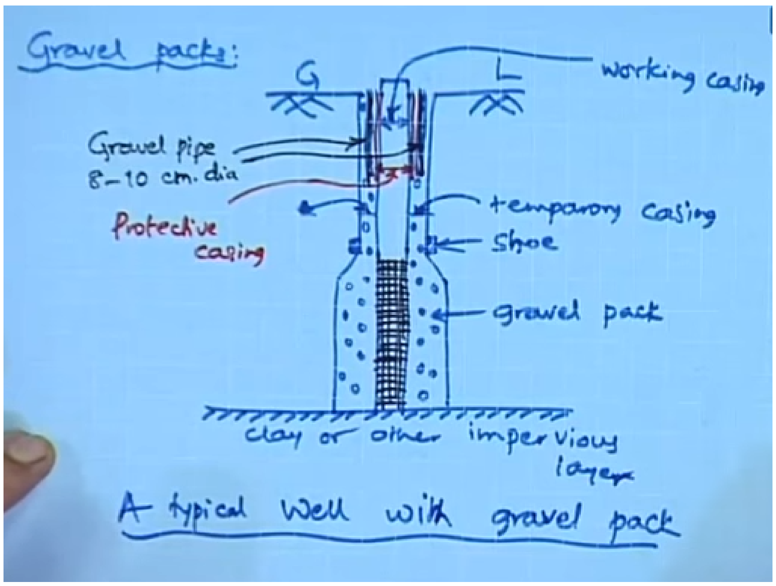
So that is in meter per minute so here so this is 250 then 250, 200, 160 after every three rows am going to write a horizontal line 160, 120, 100 next it is 80, 60, 40, 20 and less than 20. So the optimum screen entrance velocity so this is 3.7 this is all meter per minute 3.4 then 3, 2.7, 2.4, 2.1, 1.8, 1.5, 1.2, .9 and then .6. And here for this there is a formula that is let me write the formula here this is VS = Q / C Pi DS LS multiplied by P.

So this is VS is the so this is the optimum screen entrance velocity for ground water which is denoted by VS and then Q is obviously it is a discharge the well discharge and then the C is the clogging coefficient and so it is generally .5 and then said that DS is the well screen DIA and this LS is well screen length and then lastly this P is the percentage open area open area in screen percentage screen open area.

So basically so this is the formula based on this so this optimums screen entrance velocity is expressed by this formula that is Q the well discharge divided by C the clogging coefficient and multiplied by Pi multiplied by DS LS into P. Where P is the percentage screen open area and here so this is how the optimum entrance velocity once this optimum entrance velocity is ensured.

So then so we can expect that there will be the well will function better so next we will discuss about this gravel packs.

(Refer Slide Time: 33:28)



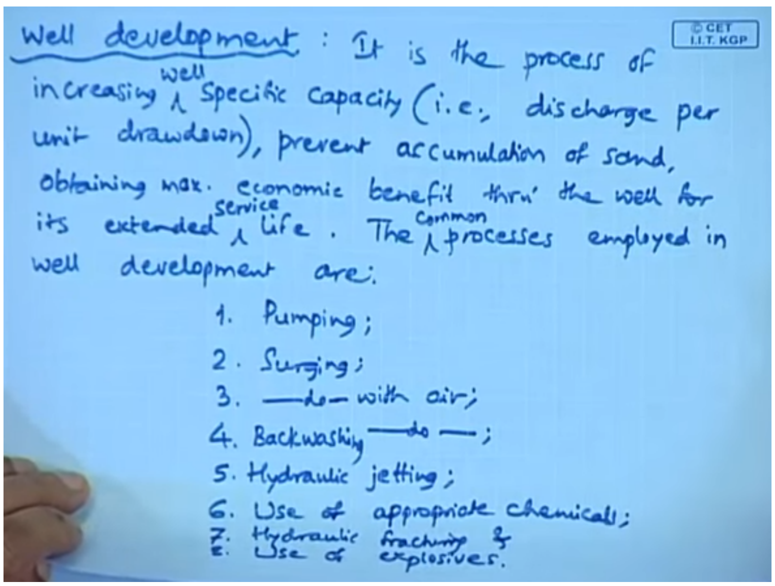
So this gravel packs basically they serve as they consist of gravel and then they serve as the via media a intermediate media between the aquifer material as well as the well so where in there is the hydraulic gradient and so this actually they will reduce the ground water velocity significantly and then this and so let me show a typical this one there is a it is suppose this is the well and here so this is the ground level and here so this is the ground shoe.

So this is the show just like our shoe which protects us against this one and in between there is and here so this screen goes on till the impervious layer so here clay or other impervious layer. And here so this is typically once so here you can say this is the gravel pack around here there is a so this is the well cap and here you can take this to this one. So this is the there is one more casing here let me show this and so let me and so here so this is the okay.

So this is the shoe and then this the gravel wall or gravel pack and here this is a so here this is a temporary casing I am sorry so this is a temporary casing and then here this is a working casing this this is intermediate this is the working casing and so the red one this is the protecting casing. So this is I have shown this with the red color and then followed by this black one so this is a gravel pipe so this is a gravel pipe which is 8 to 10 centimeter dia.

And then it is a temporary casing here which of course I already shown so this is a15 centimeter or more this one and then this is the top soil. This is typical and this is a gravel pack a well a typical well with gravel pack. So this is a how so the well completion is done so that well attains a stable configuration so that there is a balance erosion and sedimentation.

(Refer Slide Time: 40:23)



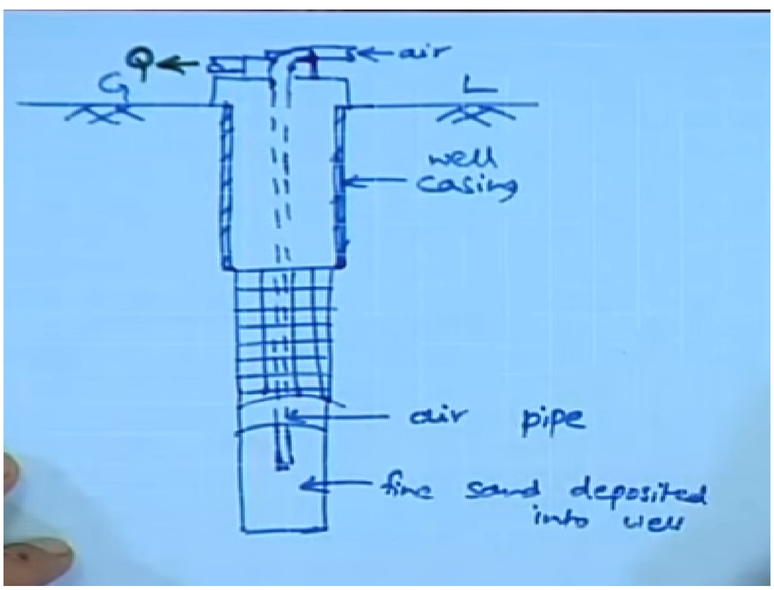
So next we will go to well development so that is the next topic of this lecture so essentially so this well-developed it is the process of increasing specific capacity increasing well specific capacity and let us recollect here so a specific capacity is the discharge per unit drawdown that is the specific capacity. And so additionally so this is prevent sanding that is accumulation of sand comma obtaining maximum economic benefit through the well for its extended service life.

So all this things firstly it is increasing the well specific capacity which is that means increasing the discharge per unit drawdown preventing the accumulation sand because once the sand is accumulated. So then it well discharge well reduce and because when the next is obtained the maximum economic benefit so that means quality water should be quality ground water should be extracted so over the extended service life of the well. So all these things are involved in the well development.

So the processes the common processes employed in well development are one pumping two it is surging three is surging with air and fourth is back washing again this is with air then followed by hydraulic jetting and use of appropriate chemicals hydraulic fracturing and lastly use of explosives. So these are some of the processes which ensure that they we can increase or if not maintain the initial level of specific capacity prevent accumulation of sand as well as obtain quality ground water as extended life of well.

And here say some of the typical this one so here I would like to bring it to the notice that is so here compressed air so basically as we all know so this air wash is very effective in removing the fine clogged particles and then so therefore we can unsure an increased we can maintain a high level of specific capacity or we can further increase the specific capacity and so therefore this so in this case the typically the air jet place a very important role.

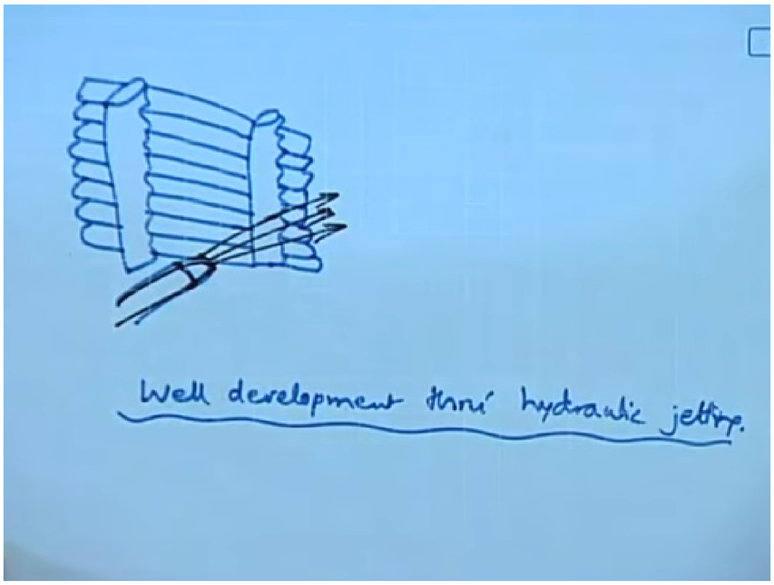
(Refer Slide Time: 47:03)



So in this case say suppose this is a well and here we have also the suppose this is the so this is the well casing and then here there is a below that so there is a well screen suppose this is a and then so there is also there is an air pipe and this air pipe. So this is the fine sand deposited into well so this is the air pipe and here there is a so typically so this is the air jet and in this case so this is the discharge so water is taken out here and this hair is here and then.

So there is a clamp here so let me use this so this is Q and then so here so this air is and air jet is let in through the this one the air pump and then so that what it does is so it will simply there is a blow the find sand which is deposited and so this one so the well is so this is basically a well development through compressed air and of course the same thing can also be done by this back washing through air and of course the various kinds of chemicals or this hydraulic jetting.

(Refer Slide Time: 51:28)



So this is in this hydraulic jetting I suppose so here is the suppose this is the screen material and so here what is done is so this is a well development through hydraulic jetting. So here it typically a hydraulic jet so what this does is a through this hydraulic jet so this the screen clogging are removed.

So in this case the well is developed and so this is also one of the methods of this one so will stop here and then continue in the next lecture on this one though we had planned to complete this well protection, well rehabilitation and testing of time of wells. So for want of time and so this is discussing this in the at the beginning of the next lecture and move on to the new chapter in the new module in the next lecture thank you