Lecture 20
Dynamic Testing in Pile (Low Strain)

Welcome all, today's class we will be discussing about, dynamic soil, dynamic testing of pile. In last class we discuss about, dynamic testing of pile, particularly let into high testing strain. So the testing objective of the PDA, the pile drivability analyser test, was to find out, how much is the stress is, which are getting developed into the soil, as well as a pile material, particularly during impact load of pile driving or hammer impact, as well as, the, so that inshore like the stress which are developing because of them impact load are must lesser than the bearing capacity of, each of those material whether it is soil or

particularly the pipe material. In addiction we also discuss like, how by use of acceleration sensor, by use of strain sensors. How we can get an idea about, the amount of resistance offered, in the form of two resistances, or in the terms of skin fiction, from one inter, place, one location on multiple layers, which are possibly, providing some condition to use skin friction. Because your, depend upon whether the pile is fictional pile or enbearing pile. The component of skin friction or and resistance will cover, the load bearing capacity of the pile.

So we using acceleration sensor, which are precisely used to, to get an idea about, how much is the wave velocity, whether it is direct wave or reflected wave. And then we had, strain sensors, which are totally getting an ideal like, how much is the force are resistance officer, from different, different interfaces, where it is free standing pile, weather it is friction pile. We also discuss, starting with the toe or freestanding pile or teo pile are a enbearing pile, like how much, how you can actually interpret, the results based on reflected way from the, one is the way which is directly into used, at the acceleration sensors and strain sensors. And second one, which will go down and left from the teo level and again, start travelling towards sensors. So again, conceding we have consider in derivation of two second reflection, which is coming from the teo. And those components of acceleration, we it considered to find out, how much the force, you are getting actually in terms of and bearing and then, we also discuss, in case there is intermediate layer, between a pilot and the teo, which again offerings some kind of shaft resistance or skin friction. So that will again, cause some kind of heterogeneity or some kind of medium, which is again, cause some kind of reflection from inter, intermediate depth.

So again, some component of the inter, reflection will travel towards the sensor, against certain ports, sample travel down word stencil wave, as reflected from the bottom, it will again start, travelling towards the senses compressive. So we are discussing in detail like, what are the governing equations? How each of this Governor questions are coming into picture, what are the components, you are getting from to rejections and what are the component you are getting from skin friction. So once is you know, those values from a, typical strain time is there is a expression time is, it can get an idea about velocity time is as will as, four times history, which we are getting a different, different leaves. If you, so this way, you can get an idea, how much is the total resistance with pile, which already cast in situ offering, against external loading. So in today is lecture. Lecture 20, we will be discussing, again about dynamic testing of pile. But, this time we will be discussing about low strain test. The test which, which, which generate or the test govern by the response of the pile, against small strain shock waves.

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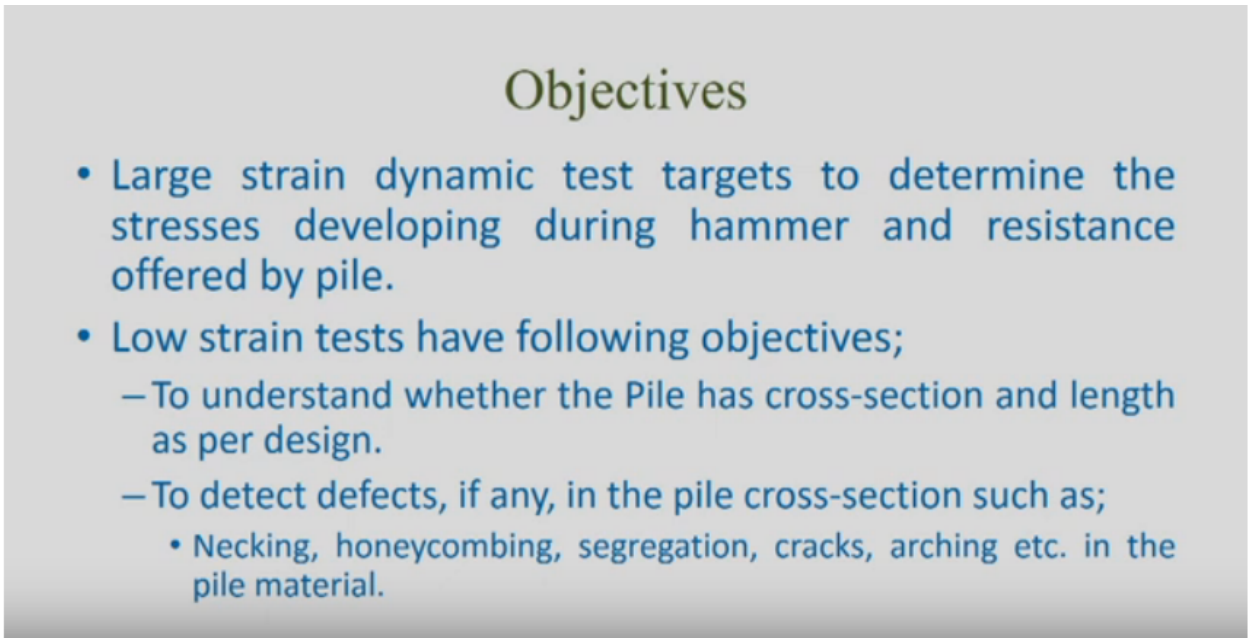

So, as we discussed large strain dynamic test, particularly the PDA which we discuss large strain. Targets, so there are two targets basically there. So what are the stresses which are developing the in the pile material, because of the hammer impact because weather it is board pile of cast into two pile. Finally the pile is remaining in the soil by the means of impact load, by the drop of the hammer. So because, once you start dropping hammer from the particular hide, there will be the some stresses developing the pile, all in the cross- section as well as some stresses will be the developing the interface has the pile, as well as the soil medium so in order to inshore whether those stress are much below then the bearing capacity of the material, this stress will be useful. And then, how was your resistance, offered by the pile against downloading, so that will enshore that, that, that, that, parameter whatever resistance, you take in design, while designing a pile is actually the same resistance offered by the pile in its two condition. When you come to low strain test that is what we want to discuss today, so those test are primer, primarily used for 2 objectives, one is to understand whether, the pile cross section as well as, the length of the pile; that is the cross section with diameter of the pile. If it is the circular cross section which diameter of the pile, if it's circular pile, if it's other cross section of may be spun pile.

So what is the characteristics of the cross-section, weather after casting in see to, similar cross section are achieved, in see to condition. Because, you're the cross-section is wearing, the resistance of the wire the pile, the load capacity of the pile or actual characteristics of the pile, will be different from whatever has been considered in the design parameter. So again, there will be a lot of uncertainty risk, once you presume something about, the cross-section as well as a length, which is completely different from, HR structure of the pile. So in order to understand, the cross section of the pile, as well as to understand the length of the pile, because we know, particularly when it is fictional pile, the length of the pile should be strong enough, sufficient enough, so that it should be capable of developing enough skin friction, which is required to support external load. So this is one object, where are you interested to find out, what is the cross section of a pile? What is the length of the pile? And then, you know this parameters, you can get an idea, how, how these parameters are actually matching with design consideration, it's like comparison between, whatever you consider in the design and whatever is actually, executed at the side of interest. Second thing, it's may be possible, because of certain regions, like the pile, concrete will Indigo or will

time to some kind of defects, some of them, as we mention their, like necking honeycombing, segregation, cracks, arching, etc. So these are different kind of defect, which, which are possible, when you are poring a concrete, into the pile cross section, coinciding in the length of the pile, there are more chances, you can have similar defects, different, different dubs. So, you have to pour concrete also in a control environment and your to do necessary, guidelines to follow, in order to ensure like this kinds of defect ,it is not there, that, that so this, we do generally when your casting concrete, for a particular pile. But, it may be possible lie, even after taking so much of care, it might be possible like, any of these kinds of effect, on a combination of these, or each of these may be are different, different dubs. And actually, win taken place, after the pile is cast in situ. So in order to understand, if the coasted of cross section, the pile and any cross section or at any length, as been witness in any kind of defect is like necking, honeycombing, segregation, cracks, arching.

Now what do happen when the defects are there the strength of the material, strength of the concrete, at that particular location, will not be, the one which consider in to account. So because of change in strength characteristics, because of each of these defects, it will have in a direct, it will have in a direct effect on the resistance offered by the pile, of the load carrying capacity of the pile. So two things of their, one is to enshore that the cross section or the physical damnation of the pile are as per the design. Second thing whatever material you are using, whether the material is able to achieve, the strength, whatever is you design it for, so those can we undershoot, once we are able to detect, what are the defected, if it's there. So this method can be used to find, to find out even the defects, so likes all these whatever as been discuses, so over all, once you a done with these kind of defects that will get you in a idea, like that design core section, the characteristics of the pile or meeting your design requirement, you are go to go for the, for low transfer mechanism or, or conisation of super structure on that, without much unsantnity of race cos servability compromise. So these are the basic objective, with which we, we are going to start about low strain test.

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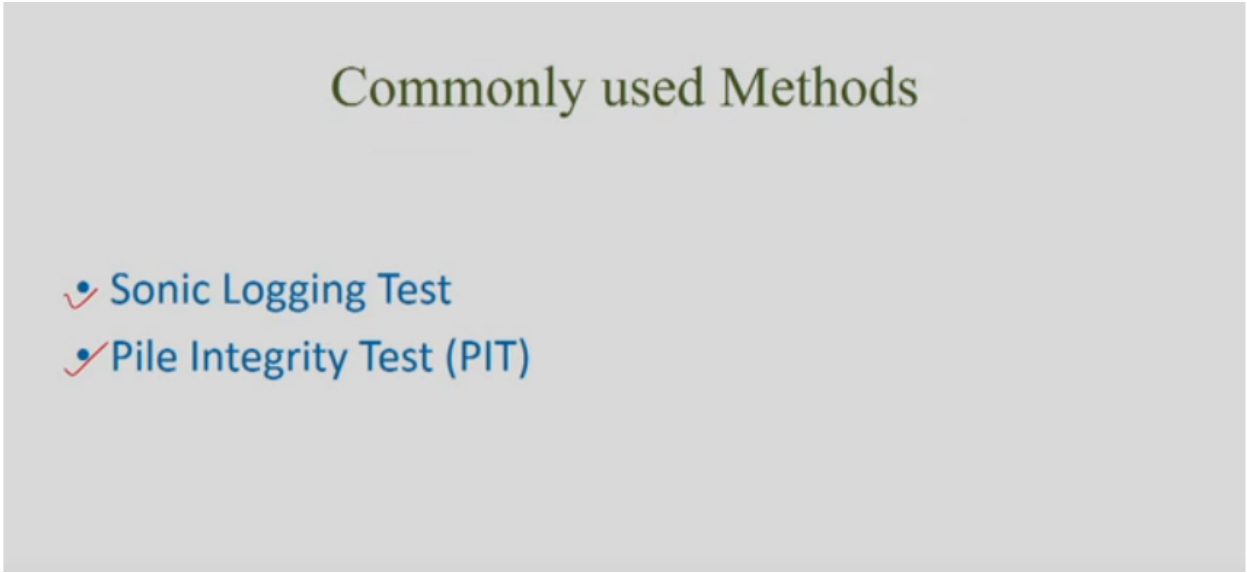

So, commonly used methods, as i mention like couple of methods, which are particularly used, in order to in situ the property, as well as the desired properties. So in this particular case they are two methods, one

is Sonic logging method which also called as, 'Cross so Sonic Logging' CSL. And then, you have pile integrity test are what is also integrated as PIT. So we are going to discuss about, these to method in today's class.

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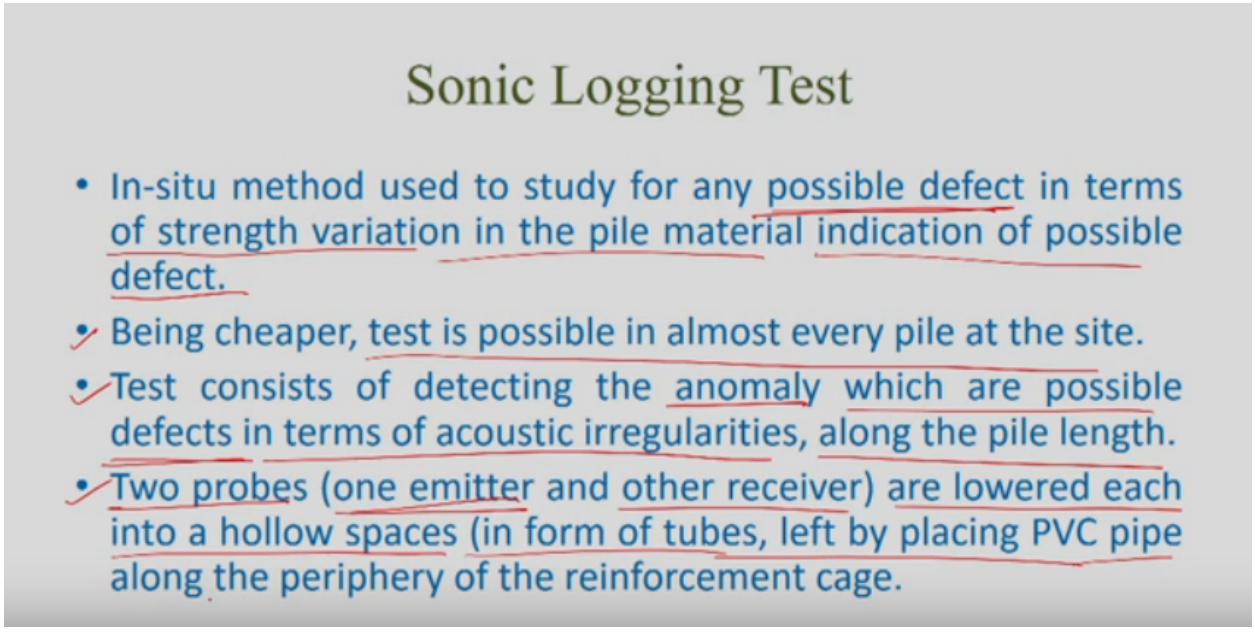

So, Sonic logging method, as a name suggested it's a in-situ test because we are interested in to find out, the characteristics in its in-situ condition. So it's an in-situ method which used to study, for any kind of possible defects. So this is the most important thing, you are interested into find out any possible kind of defect, which is exciting at the pile, it may be at the bottom of the pile, near the pile had, it may be at the some intermediate depth. So anywhere any kind of different degrees at the same intermediate so anywhere when defect is there, it is going to compromise the, load carrying characteristics of the pile and overall, the servability of the pile are the ferocity of the foundation. So this is, this method is particularly useful for identification of any defects, which are available at the pile in-situ condition, in terms of strength variation. So you are interest at to understand, if there is any kind of possible defect in pile, for that you are, you rather than, directly searching for the defects, you actually find out, how much is the strength of pile or the material which is use for pile costing at different, different cross section. So by doing this, we know like, in earlier method is also we understood, like depending upon what kinds of shock, what kind of disturbance you are creating in the material. The material is offering resistance, now how much resistance material of is, the depends upon the strength material is offering again that shock. So, in this particular case also we try to understand or we try to identify any possible deflects, custoding variation in its strength, against variation in its strength in the pile material which is possible indication of deflects. So whenever there is change in the strength characteristics, in compulsion to what, suppose strength of the material, of the pile cross section that is possibly indication of that pile subjected to some kind of defect, at the particular observation point.

So being cheaper, the crosshole sonic logging are CSL method, because it is cheaper, it is more convenient, so almost you can do this stress at the every pile. So if you remember courtly, when we

discussing about, high length test, we told like those test are a quiet time consuming and costlier also, so generally we do those kinds of test for 5 to 10 percent of total numbers of pile. However this test that is sonic login test, you can that test is quite cheaper, so as per the available literature, it is possible to do this kind of test almost for every pile. The test consists of, detecting the anomaly or the defect, in terms of strength of the pile material, which are possible indication of the defects, in terms of acoustic irregularities. So you are interested to find out the defect, all the anomaly, anomaly means, like what, whatever is supposed to strength of the material, but also strength condition your getting something, which is different from the suppose to strength, so that is known as the anomaly hear, so we are interested in to, detected into the anomaly, in terms of acoustic irregularities. We are going to generate some kind of acoustic emission, into the pile medium and depending upon the resistance by the medium again that, caustic disturbance you're going to quantify the variation in strength, in the strength or directly the defects you're going to, detect in the pile material. So it can, the test can be done, all along the pile length. So you do the test, along the pile length that is going to example, idea about at which, which particular depth is pile subjected to some kind of defect.

So while doing the test you generally used, two probes. Now, now we are going to number of methods so, so you made be known no in like whenever we going for, any kind of strength, measurement or any kind of registrar measurement, generally we used, minimum two kinds of probes, sensors. So one will be the receiver, another will be the emitter or the shores. So in this case also you are emitting the two probes, one is called as, 'emitter'. That is, which is emitting, the costing vibration or, or disturbance. And the other one is the receiver. So these are minimum two probes required, depending upon the cross section, you can go for multiple number of probes, but at the same time using one receiver, one, one emitter. So both these are lowered into Hollywood spaces, so what we do, generally when we go for, cast-in-situ pile, we, when we lower your reinforcement cage, you actually adjacent to the reinforcement cage, you actually, I put hollow PVC pipes, of course we certain clear dimension, between the reinforcement cage and the PVC pipe, in form of the tubes these are the hollow specs after that you do the concreting. So, the latest actually you can put your senses, also are the probes, into this hollow tubes, an depending upon the resistance offered to acoustic disturbance, which is generally created by emitter, there actually quantify the resistance, of the strength variation. So this PVC tubes we generally install as the along the Periphery of the reinforcement cage, by living a clear cover, between the reinforcement cage on the tubes.

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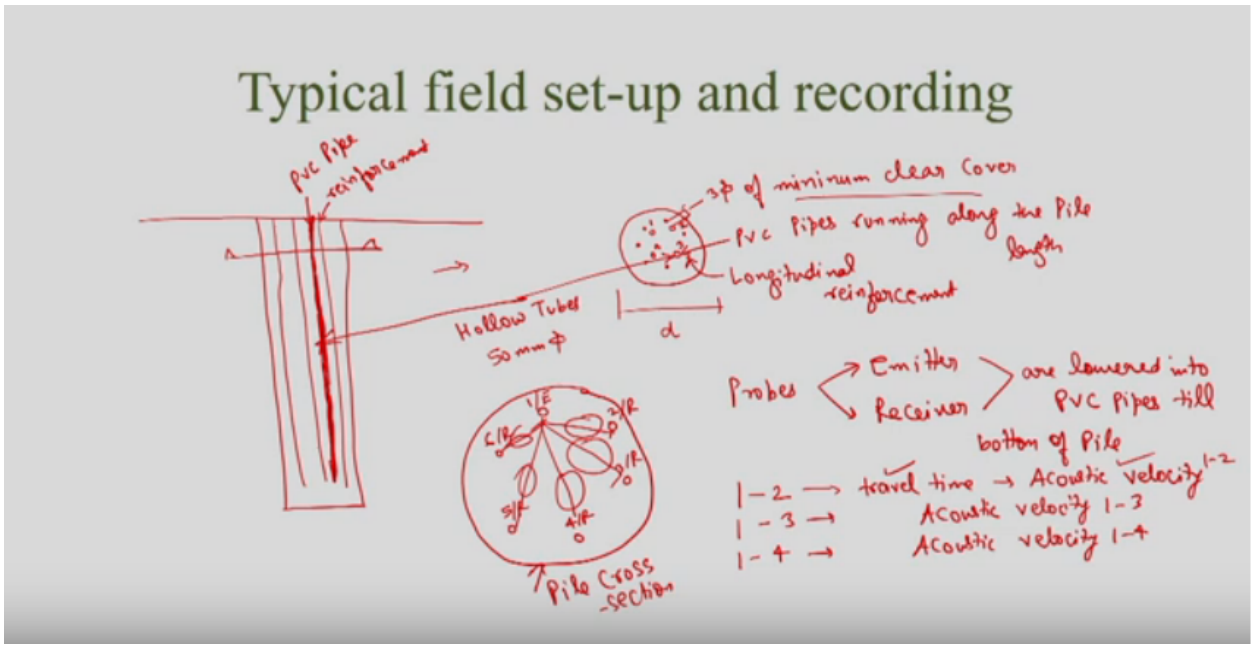

So typical field setup is i mention here, so what I mean to say, when I say like, Cast in situ pile. So I'm showing here, may be the cross section, may the land of the pile, so this may be length of the pile of the in situ condition. Now here, I'm just putting, reinforcement if u see this same thing in the cross section may be here. So what I'm doing time to say here, suppose this is your pile cross section, diameter D they will be some reinforcement cages, depending upon the design purpose, how much the number of long in to reinforcement provided. So with respect to long in to reinforcement, do you actually provided PVC piles also, before, we actually start concreting. So those PVC pipes will be adjust to those of course clear cover will be there, that is 3 times the diameter 3 times 5 that is reinforcement diameter minimum clear cover, of minimum clear cover, between this and these. So, depending upon the cross section, you can put more number of PVC pipes, these pipes will be running along the pile length. So all along the pile length, if again you can see so this is your reinforcement so adjust in to the reinforcement may be, somewhere here, you can have these PVC pipes, PVC pipe or tube and this one indicate here, longitudinal reinforcement. Now, if you see here, the same reinforcement actually it is, these PVC pipes it is somewhere here or you can call it as, 'Hollow Tubes'.

Generally, 50mm diameter tubes are there, so it's like when you're lowering a concrete case or when you're preparing or reinforcement case, then you will be installing these PVC pipe along the Perry fairy of the reinforcement case after giving a minimum clear cover of 3 times reinforcement diameter between the reinforcement as the, as the less the PVC pile, when you lower it, once the concrete is done, these pile will be remain although there. So, the probe whatever I missed, mention here, so you can mention here like, probes, which are like emitter, as well as receiver both are lower into PVC piles. So, once your lower it, lower into PVC piles till bottom, bottom of pile. So, now you're lower it, so like depending upon the cross section has I mention here, so maybe you can number also here may be PVC pile one, two, three, four and so on. So, if, if you lower in receiver in, emitter in one, you can put receiver in two, if put, put emitter in one, you can put receiver in three, one four so, every time you will be getting, depending upon the distance between the source and the receiver, you will be getting, you will be actually detecting your acoustic time for the time after, which the disturbance, created by time it will be detected by the receiver.

So, every time you will be getting actually, the travel time, for acoustic velocity. So, it as one and tow so, depend upon the distance between, PVC pipe 1 and PVC pipe2 you can get an idea how much is the distance, how much is a travel time? Detected by the, receiver you can get actually the acoustic velocity, same think you can do for different, different combination and like keep the receiver emirates same PVC pipe but keep on shifting, you're a receiver everytime, you if shift your receiver whole, you will be getting, for different, different Diamond, direction you actually getting, how much is acoustic velocity, maybe 1, 2 then here also can get an idea about, acoustic velocity, 1,3 and then acoustic velocity, 1,4 it's like this receiver is there at one, metre is there at one, receiver is there at one time at, tube 2,one time at tube 3, onetime at tube 4, you starting doing the test. First of all you do the test at the bottom maybe in a maybe tube number 2 you put your receiver, you do that test, then go to the next level or slightly, full the both are receiver and diameter and again do the test and similarly. So, you do the test different, different location and every time you will get an idea about, travel time versus velocity. Travel time but depths are acoustic velocity versus depth. Now once these the, the receiver as well as the meter, which is the same in the surfaces you can should the receiver, from maybe probe number are a div number 2,2 div number 3. Again start doing the same time test, from the bottom to the surface. So, if taking it, again I can put a slightly bigger size circle, are pile cross section table for section.

So, the probe is like 1 is here, 2 is here, 3 is here, 4 is here, 5 is here and 6 is here. So, I told about 12, 13, 14, 15, if I'm putting receiver here, emitter here, everytime putting receiver here, or here, or here, or here, or here, everytime it is going to give me, how much is the cost of velocity, which is directly in indication about, the quality of the material, quality of the propagation medium. So, if you are putting emitter at 1 receiver at 2. So, actually detecting how much is the acoustic velocity in this particular range or how much the strength this range, then you goes to 1 and 3 in will you retargeting for this, 1and4, 1and5, 1and6. So, there is are you will be actually getting, idea about, overall how much is a stand radiation here. So, some kind of defective their here or here or here or here or here you can get an idea because any kind of defect, will be actually compromising the standard that material, our resistance of the material again a costing disturbance should that I will be indicated by particularly drilling and your travel time or reduction the velocity, of velocity of propagation through that medium. So, there as you can do that as same test you are do that different, different debs, is I am mention use doing test from the bottom, then you moved to next shallow adapt, next shallow adapt. And same you can get an idea about, how much the acoustic velocity, though at the cross section. Then you compared, with the standard value of a constant velocity, for that construction material to use, you can get an idea, at which particular depth, there is tactics change in the velocity, which is possible indication that affect, the particular depth all if it is not then you can ensure, though out the cross section you are a this thing. Understand the material is almost consistent. Another thing will depend, upon because you are actually lowering, the emitter as well as receiver. So, once you reach particular depth, you can actually compare that particular depth with the lemtho pile that will also ensure, your are you're the bottoms cross section also, the concrete strength is proper. That means if you going is the bottom, of the order to of the pile. And then first you to do the, use of first test in the pile teo, than compared with their acoustic velocity that is going to give me an idea about, how much is the in testiness or how much is the strength of the material, at that pile teo. So, there's you can get, you can ensure, the quality or understand the material, although the length of pile a mention here.

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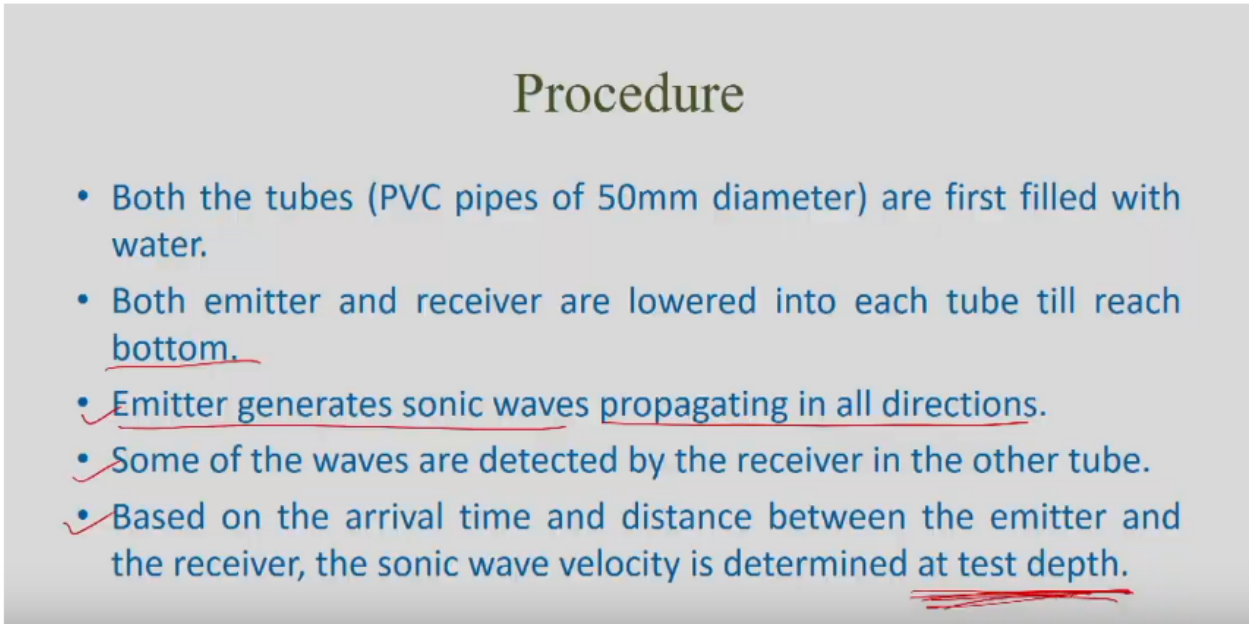

So, both are tube PVC pipe almost, 50mm diameter are first filled with water once concreting done, if filled those filled water. Then you are lowered than meter as well as, the receiver into each tube that will ensure that that the I mean meter and the receiver lower into the each of the tube till the bottom. That well ensure like you are actually ensuring the quality of the concrete, throughout the perception starting with the base. Because again depending upon, the characteristic base also the lower load can pile can whereby. So, emitter generates, sonic waves, are disturbance in terms of Sonic waves. So, emitter generates and then depending upon, the cross-section, it will actually travel in all the passable detraction, as I mention earlier slide, also. So, depending upon the meter, depending upon the source only that particular, detraction between, in a which the receiver is a captu the, the source which disturbance created by the meter, will be detected for the receiver. But actually it will be travelling are it will be propagation, an all the direction. That is important to remember, not like the emitter this only generating the disturbance, in the direction of receiver, is not however you are not able to receive, other disturbance in because there is no received to detector thinks then some of waves are getting detected by the receiver, in the other tube, you know in this tube actually, lower are receiver that is going to give me an idea about, the travel time, the distance between, the source and the receiver and depends upon a time, when the receiver detect, the arrival of Sonic disturbance, you can get an idea about, propagation velocity there. Base on the arrival time as well as distance, between the emitter and the receiver, the sonic wave velocity can be determined, again depending upon, because each of this emitter actual receiver are test to the surface, recording assembly, by means of connecting cables. So, depending upon the length of the cables and markings will be there that is going to give me an idea, you are doing this test, at which particular depth. So, depth equally important, because if you dot major that depth you will, you will never, be able to understand, like the variation, in strength is corresponding, to which particular depth or the depth of the defect is you cannot be able to locate. So, that why a very much identical to, recording the time of travel, at the receiver it is equally important that, we should lower the know the depth that at actually doing the test.

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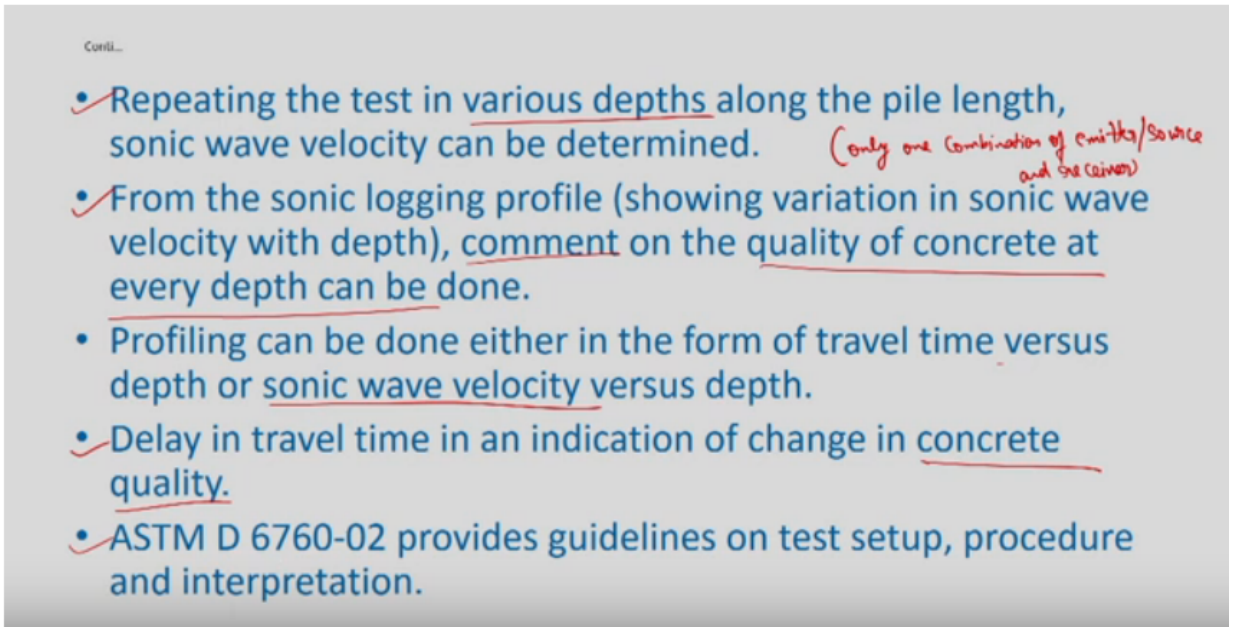

So, repeating test at the test various depths so, here I am talking about, only one combination, only one combination, of source of emitter or source and receiver. So, you have to, we very careful, it's not like you do test at the bottom, in a one tube, then change it to another to and do that test again the bottom know you are 2 actually finish those test at a different, different depths, considering 12 for emitter, 12 for receiver do the test for entire depth. And then you repeat that test keeping the emitter at the same tube. But shifting the receiver to maybe some other tube. So, it like at each test or the test should be done it different, different location or different, different depths consisting the placement of receiver the as well as the emitter in same tube, like receiver the same tube and a emitter that tube at the starting of the test, will remain in the same, to till the end of the test. But both you should be separate. Okay? From Sonic login profile, you can understand, if that the distance between the source and the receiver if it is same or you are having just one emitter or 22 of there. Then actually based on, the travel time, between the along the death or if the distance, change in between the source and diameter or receiver. Then between the, how sonic velocity is wearing with respect to that you can get an idea. So, from the sonic logging profile what you get you actually get how much the acoustic velocity at observation point test do for different, different depths. So, how, how is the sonic glass velocity, is wearing throughout the depths same place test to do for different number of, tube versant you can take an average and that will give you on an average, how what is the correct test of your pile cross section and different, different depths or overall positioning the pile, overall dimensions in pile. So, comment so, this going to help you, in, in commenting an overall quality, of the concrete overall quality, of the concrete at any depth or throughout the pile length. So, profiling can be done, in any form of travel time, is a mention if the distance between, the receiver and resource, same you can interpret in terms of travel time or you are putting more number of 24 receivers, you can wear it will be better you can determine the value of directly the Sonic wave velocity. So, it's going to give you versus in sonic wave velocity with respect to the depth. Now we know like a your compact concrete for particular density. So, depend a upon that particular density medial the are there will be some, registration of or the are there will be some kind of, acoustic wave propagation velocity that particular medium.

Yes the density of the concrete is going to change, it will effect on your, acoustic velocity or travel time between the emitter, as well as a receiver. So, there will be delay in travel time that means medium offering less resistance, bayoneting offering less resistance that will be delay in time by, which the receiver actually indication your acoustic signal. So, this is delay, this indication of change in the concrete quality. ASTM D 6760-02 also provide guidelines, which on by actually you can do the feel setup like depending, upon the cross-section what is the minimum distance, between, PVC tube. And what is the minimum clear cover distance and so, on. And also what is the procedure to use how much is the depth; aver to take the recording and then how you go for interpretation part. Because interpretation is very important, because this field gating is going to give you, is going to comment on the quality of the concrete. Now based on the quality of the concrete, you are getting from typical field record, you are going to decide, whether to, to accept this particular pile, which has been acoustic, in C to or you are to reject on the pile consider the quality of the concrete overall, along the cross section of the pile. So, that important decisions, because a if, if in the design requirements, is no point, in keeping that pile, as structural member you have to actually rejected the pile. So, those a decision making is to be done, based on expect opinion as well as curtail position.

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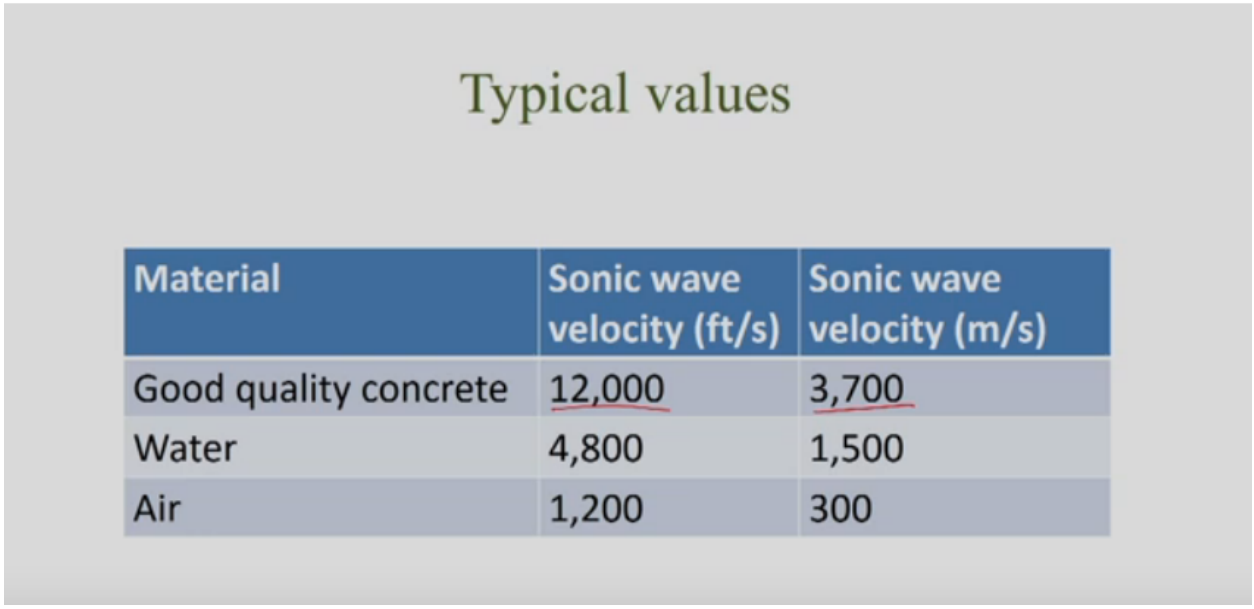

Now I have been telling repeatedly, like depending upon, the quality of the concrete, it is offering more resistance or less resistance again acoustic disturbance. So, good quality concrete, provide resistance or are a sonic wave velocity, population can we 12000 fit for second are equal to 3700 meter per second. So, if some changing in the this, propagation velocity maybe 3000 28 100 that is going idea, like the quality concrete, is not as per there design consideration. Same way in team what are it is 4800 foot per second, 1500 metre per second in team here it is 1200 foot per second of 300 meter per second. So, same way depending upon the material, which doing the test you can get in idea on a on a average are what is depending, upon the, strength of the material density of the medium, how much is the resection medium,

should offer and how much is a medium, is actually offering. So, that is identification of the animal or comment on the quality of the concrete.

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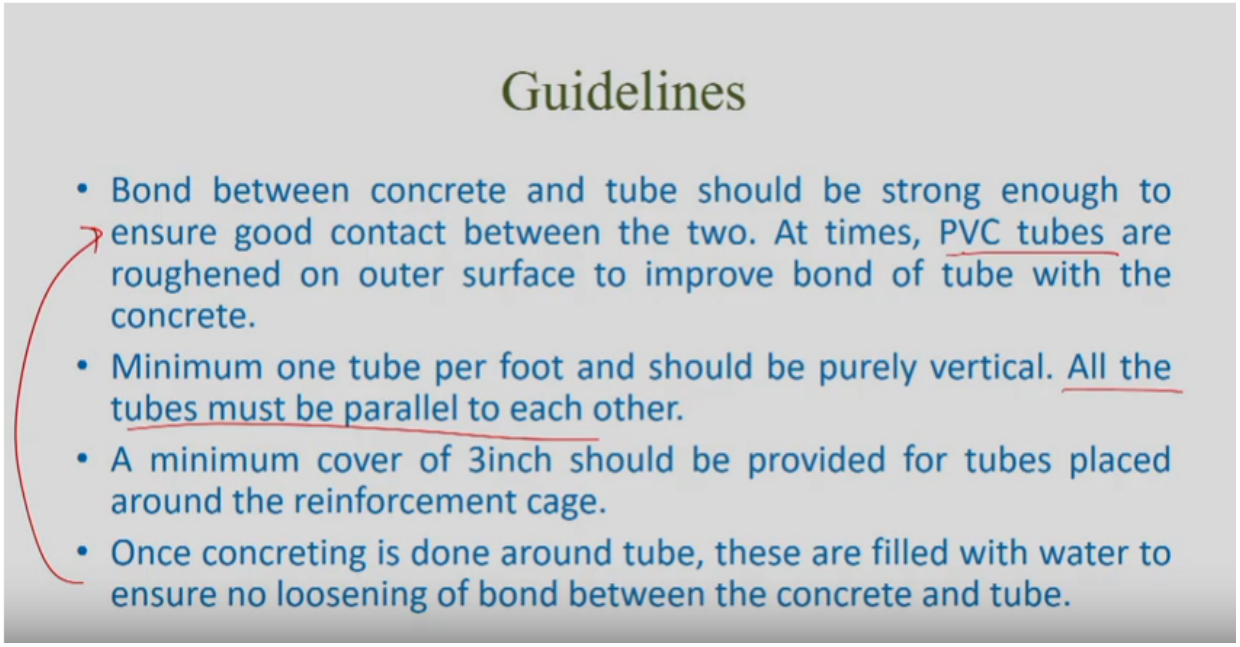

Now this about, the interpretation power, how you do that test. So, bond between the concrete, which is actually casted it C2 covering reinforcement as well as and tube. So, that you should the bond between the concrete as well as that tube should be strong enough, to insert a good contact, between the two, because to the bond between tow is not intact there will be weakly of signal, which is generated from the emitter, because the same signal I will not be transferred from the PVC pipe to the, adjust in and concrete. So, the contact force a the, the, the, the concrete, between the two medium the concrete as well as is PP PVC pipe is to be ensure be to be very good. At times PVC pipe there is in order to avoid any kind of sleep age, any kind of gas that forgot people does do at times they a PVC pipe outer, Periphery is also, a refund or maybe, some kind of scratching can be done. So, that there will be some kind of good morning, between PVC pipe as well as the concrete. Meaning of 12 per foot should be purely vertical and, and should be provided, Desire like not, more than one tube, I mean should be provided, in this dimension moreover the tube whatever as mean provided, because each time you, you lower are the receiver and the emitter you actually going to getting, the idea about the depth of the test base on the length of the cable, which is inside the tube.

So, in case tube is not properly vertical, interpretation of depth, also around. Again all the tube should parallel. So, it its if its vertical, at each of the placing, out the tube, there it will also parallel otherwise, the distant between, the receiver the emitter if it varying, it will actually varying effect it will actually compromise your results quality, because it travel time will do the travel time will remain same, but distant between the source and receiver if the change, is it will have positive or negative, fact on the calculator, acoustic velocity. A minimum cover of 3inch. So, it was I mention 3 times, rain meter you can concreting, mean of cover of 3inch shout be provided, between the reinforcement tube, upon concreting round tube the same concreter, the same concreting fill will, water to ensure no loosening of the bond

because when a tube are filled with water, there will be same gain in the celebrate, of pile water pile tube. So, that will ensure like as well as do that concreting, the they not be any kind of sleep age between as well as concreting. Because again bond to compromise a bond on values, in order to ensure that the appointment, as Intact as possible, immediately after, concreting, you feel this tubes with water.

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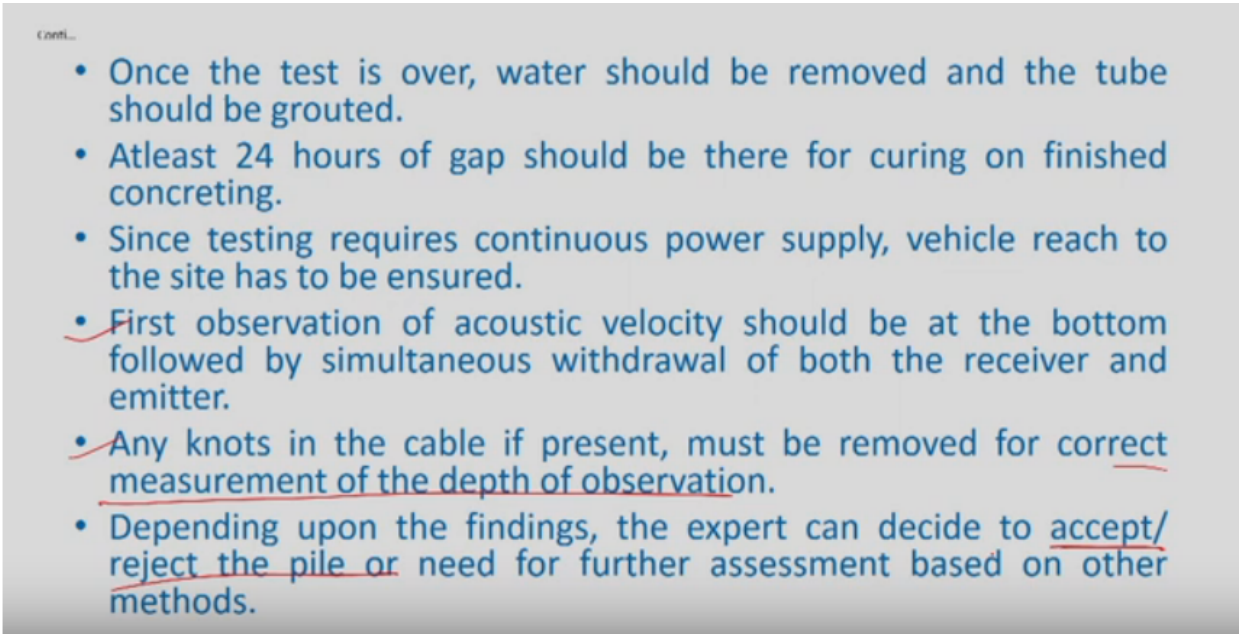

So, that once the test is done water should be removed test is mean a I mean when the test, considering lowering of receiver in each of the those tube, at don e like overall for particular pile, once the observation done you can remove those water and tube should be next with the should be grouted with the uppermost, the test is done. At least after 24 hours during. So, ones concreting late and of followed by, 24 hours of curing of the concrete that is the minimum time after, which have to do that is not before that, because before that the concreting, will not be getting the sufficient strength. So, generally it is decided like after 24 hours curing, after casting 24 hours curing then only do that as. So, seen the testing require, continualness, power supply this is like one consideration, considering, the filed as thing, because you have continue supply of the power.

So, you to also ensure like, the vehicle, which is use for a power supply, should be able to reach the said. Otherwise they will not by power supply and there will be some, complication. Again first observation of acoustic velocity should be done, at the bottom, of the tube. So, keep on the lowering once you see ok it is bottom, you can start doing a test that will be ideally should be equal to the length, pile as well, then you can lower. I mean you can pull both are the receiver as well as meter by equal amount. So, that both reach same depth again for next test pot her test and vertically pulling up at every time you will be actually repeating the teat at different, different location. So, any notes in the cable it present, where times after continuances use, of the this kind of probes, what you see like there same kind napes notes. But if those are there you to remove because not is mean is you are actually, over estimate at the depth. So, in Oder get popper and testing about the depth of the observation any not of say for, present should be removed should be, should be a unfolded for correct measurement of the depth observation. Then

depending upon on the findings the expect can decide is, I mention depending upon on the findings, like ideally concerting strength concreting, a the propagation velocity should be something but once you go for actually feel measurement, if you find concreting quality are the acoustic wave velocity significant lower. Then what, what was supports, to the then expect decide whether to accept, how to the reject the pile considering, the quality of the concreting, above from here filed observation. So, that is also that is another observation, which can be done here, again there is my general disturbance are some I mean at leading if you does reacquire like this stress not going to give you confident outcome in Oder comment on the expectance or rejection of the pile you can go for it will assessment, by use on other methods also

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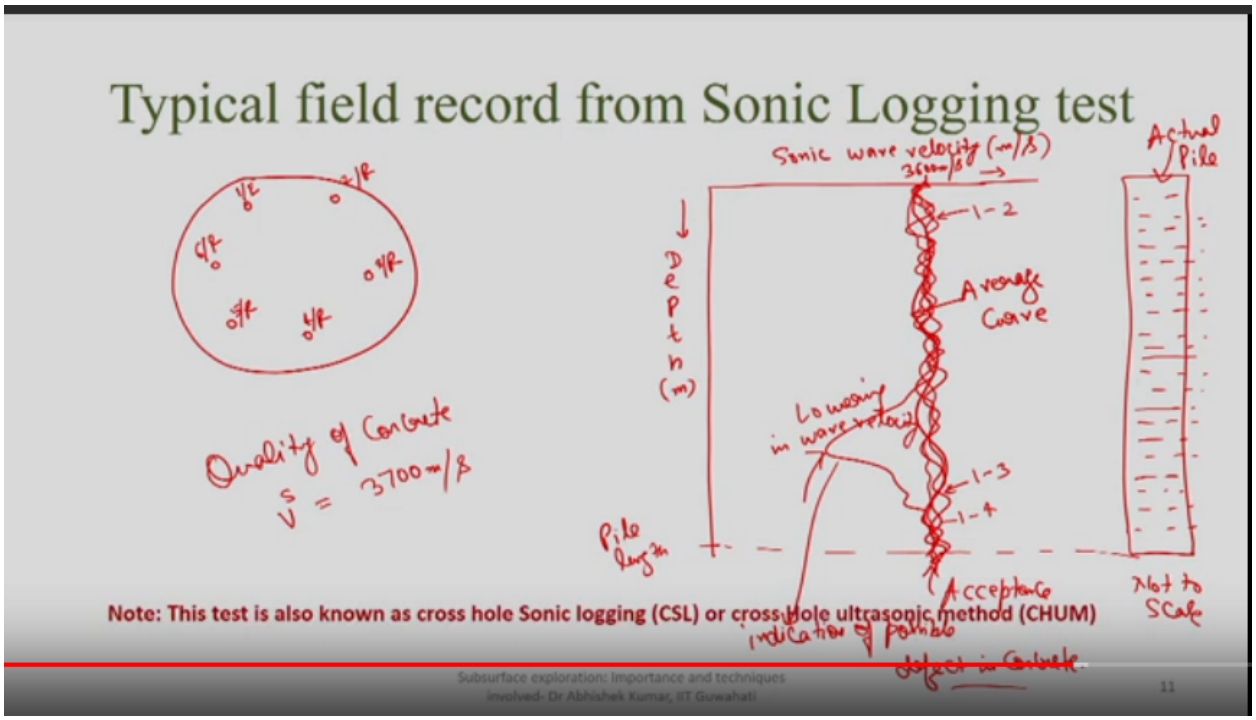

So, typically field record mention here, you can consider maybe this is so; this is 1, 2, 3, 4, 5, 6. So, one emitter then I am considering two receiver, three as a receiver, four as a receiver, five as a receiver and six as a receiver. So, depend upon a cross section, you can actually play those thinks. And now if typical look as a mention, will we something like sonic wave velocity typically, foot per second or meter per second, ingesting direction and there direction in between depth, typically meter which will we maximum will be you can considering pile length all length of PVC tube, which available win in the pile. Now you starting doing test. So, was are a maybe pile length, actual pile, this is a cross section of course, it's not toe skill. So, you get test different, different depths. Every time you do that as you can have more number of that as in between also. So, these dotted lines are showing actually, the location and which, have done the test, so between 12, 14, 13 and 16 and so on. Has I mention like depending upon the quality of the concrete, of concrete as you seen in the table, velocity of sonic wave, equal to 3700 metre per second. So if I consider this no defected in the quality a there is no compromise, in the quality of the concrete, you may get something like this field record, though out the depth, it may be from one and two like the receiver is at one and the emirates at one and receiver is at a two, same you can do the test, at other location also, may be one and three and so on, one and four and so on. And then you can have may be one average curve,

average curve that is going to give use, this is like sonic wave velocity, this in case, from considering again here, like 37 100 if I am considering here 36 100 meter per second I can consider throughout the depth, your quality of the concrete is sufficiently good. So, I can go for acceptance, on the other hand, you can have so, in case there is some kind of defect what will do? You will have some kind of disturbance here, something like that. So this possible thing which is lowering in wave velocity, so this is an indication of possible defect, in concrete, it can be because of honey combing, it can be because of arching, it can be because of necking and so on and so forth. Any reason which is responsible for delay in your detection of signal at the receiver is possible indication of compromise on quality of reduction the quality of any kind of to possible defect, in a concrete. Okay? Now, the test is also known as crosshole sonic logging method or CSL or crosshole ultra sonic method that is CHUM.

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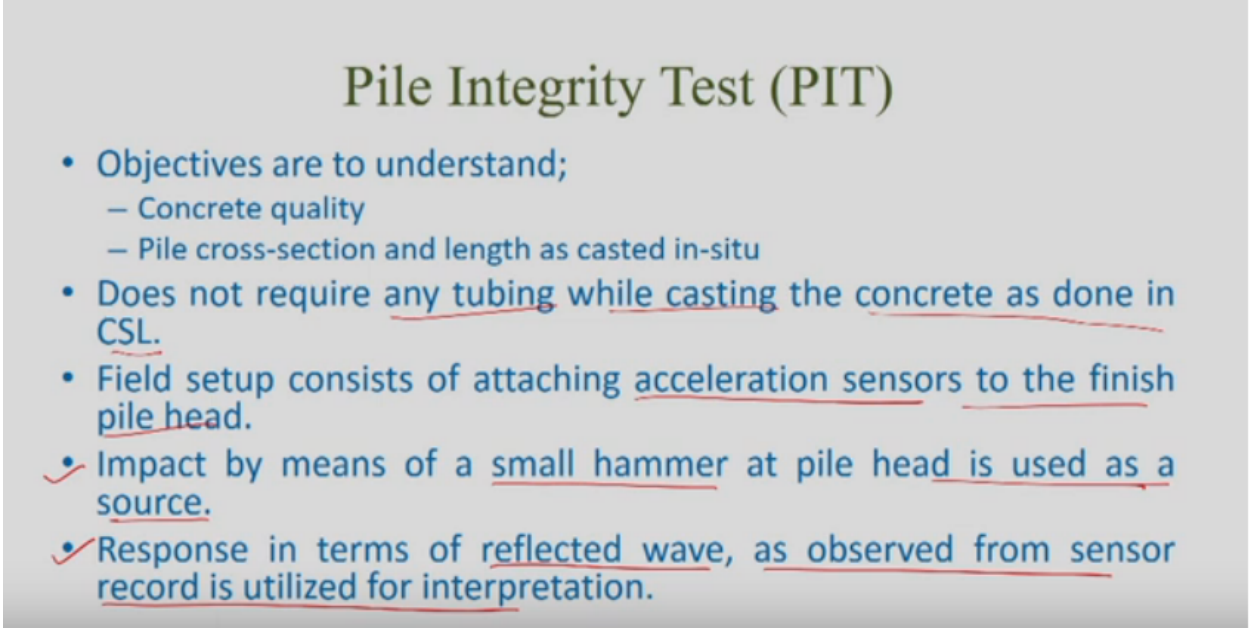

Now, I am going to discuss another method here, pile integrity test, so object of this test, as I mention like the previous on method that is, like a sonic logging method, you have to put PVC pipe, at the time of casting and then by lowering the clothes and doing the test: that usually comment on the quality of the concrete throughout the depth. So, in this particular method, also you, you try to assess, the concrete quality, the cross-section, the length of the pile, so overall basically your commenting on whether the pile, considering the quality of the concrete or considering the physical damage or the pile, whether the pile is, as per the design and then, ofcourse it will help you in decision making part. So, the previous one method required, placing a hollow tubes, while casting, how and this method you don't require any such thing, you can actually, do the test from the surface observation. So, it's does not require any kind of tubing, while casting the concrete crosshole sonic logging method. The field setup consists of attaching acceleration sensors to the finish pile head. So, you we not do any kind of tubing there or any kind of lowering of the flow, simply you can do that test by testing the acceleration sensors to your finish pile line, at the surface, because once you're concrete is as done, lateral on also do the test by just putting the sensors on the finish pile head, which will be visible on to the surface, because rash out the portion will be under ground. Now, in this particular case the test in the impact load will be by means of a small

hammer, at the pile head is used as a source. So, you actually providing some kind of impact load, as very much similar to a PDA, because of this impact load, there will be some kind of disturbance or velocity, will be propagating, throughout the pile depth and depending upon the response of the pile, against this disturbance, which will be recorded in terms of reflected wave, either from the and the depth or may be intermediate location you are going to get an idea about, the cross section of the pile throughout. So, the response incomes of reflected wave, as a observed from sensor record, is used for interpretation part. So, what it means to say, like if the cross section of the pile is uniform throughout, a everytime you do the test, you will get depending upon the quality of the pile, depending upon the length of the pile, you should get, you reflected wave after certain time interval t well but if, at shallow depth only you're having some kind of, increase impedance or reduction in impedance: that will have direct defect on your that time of arrival of your wave here. So that way you can commend weather of the cross section of pile is uniform throughout weather they some defect their and so on a so forth. So, guideline for field set up.

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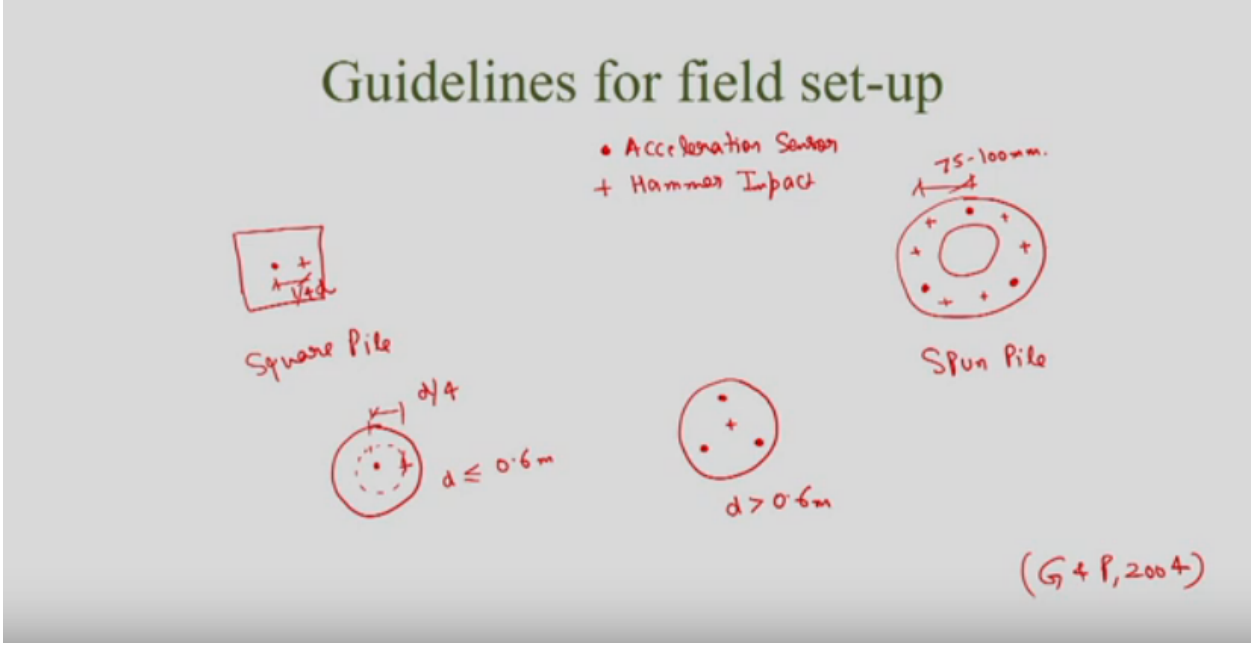

So, depending upon GNP in 2004 and given guidelines, which not, which you can you can get an idea, like get to put a acceleration sensors, where to put here, so this is like acceleration meter, or acceleration sensors and then you can have may be hammer impact. So, in case it is a square pile, in case of square pile though not where the very effect, very much effect is, so if this your acceleration sensor and this tour hammer impact, the minimum distance between the two should be, 1 by 4 times d, similarly in case of spun pile, so this is your inner diameter, this is your outer diameter of spun pile, so you have, acceleration sensors here, you are having impact load, or the hammer impact. So the minimum distance between hammer impact and this one should be, 75 to 100 the distance may the minimum distance between here, acceleration sensors as well as your hammer impact that is this thing. Similar in case of circular pile, this is the minimum disturbance between the two, should be d by 4, this is particularly, than your diameter the pile is less than, points 6 meter, is a diameter is more than point 6 metre, you can have actually hammer impact, in between and then acceleration sensors, all around, this is for d is greater than 0. 6 meter. So,

this is going to give me an idea about, how to place the sensor as well as, hammer impact position, for PIT test.

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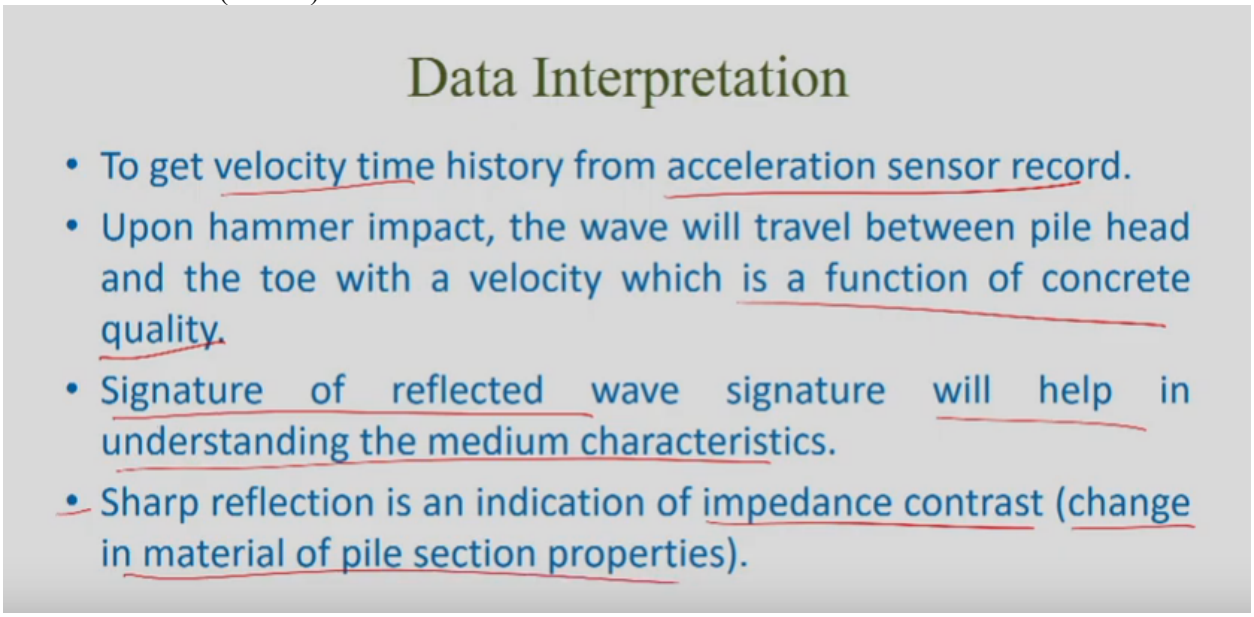

Data interpretation as I mention here, in order to get the velocity time history, because you have to get an idea or commend on impedance contrast, on the material or the or, or directly the, change in the cross section of the pile. So, you have to get an idea about, velocity time history, because that is going to give you, how much is the velocity or propagation through the pile medium. So, this is generally get from acceleration sensor by integration, upon hammer impact, the wave will travel between pile head and toe, with the velocity which is a function of concrete quality. So, the concrete quality is good, you will the velocity equal to standard one, if the concrete quality is bad or the density is too low, there will be reduction in the propagation velocity as well as. So, depending upon the signature of reflected wave, signature means, base typically based on the, arrival time of reflected wave between the pile head and toe, this will help you, in understanding the medium characteristics. Medium characteristics I am again, I am telling like concrete quality as well as, the cross section of the pile. So, sharp reflection is an indication of impedance contrast: that is change in material properties, of the pile, other than the design parameter. So, same wave you can get an idea, about this thing, what I mean to say?

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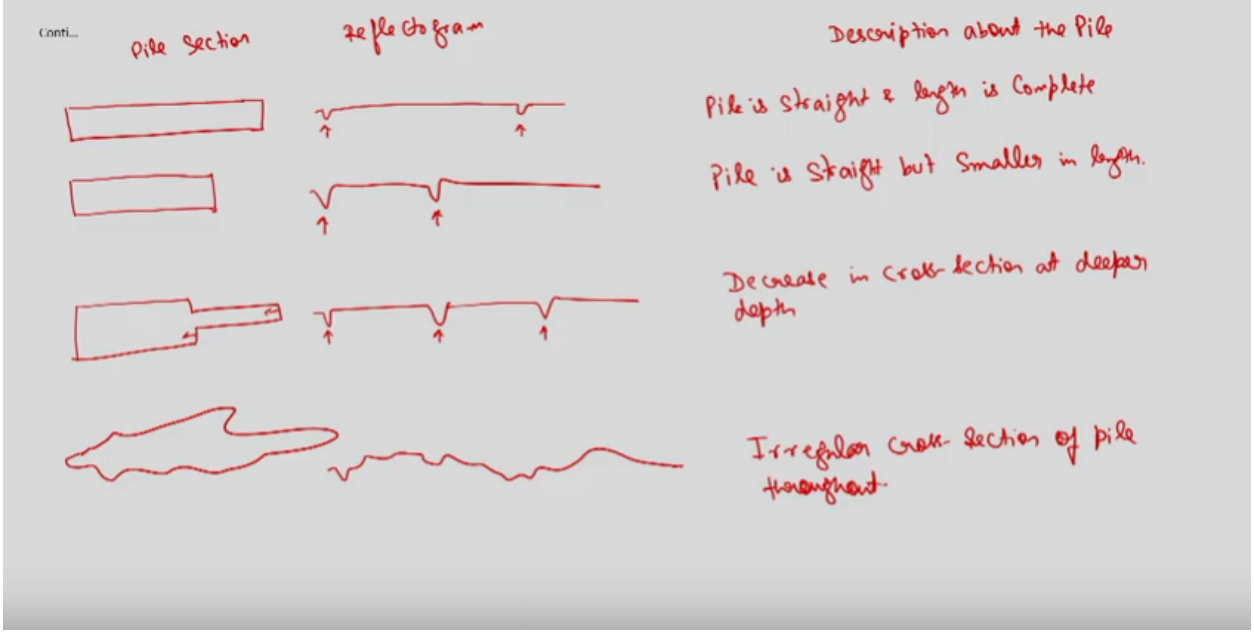

So, this is a pile, again says here, in terms of if this is your pile, if I am considering like pile is straight and length is complete. So, in this particular case, whatever disturbance your created the surface, after time may be, 2 LY it, after time 2 L, you get actually very, clear peak. Okay. I can put may be, reduced one here, what I mean to say here? If a pile is straight, as well as length is complete, you will get very, clear peak. So, this is like, when you have the impact load, when the reflected wave is receiver at the surface, so pile is impact, when the pile is actually, reduction, when there is reduction in the length of the pile, caused in c2, in comparison to this, what will happen? You will get something which is earlier than that, like this. So, this is the reflected if so pile is straight but, but smaller in length, same way, if there is change in the medium characteristics of pile like this, so you will has something like this, like this but, first reflection will be from this interface and then, later on the wave reflected from the actual two of the pile, will be received at the pile head. So, this is like decrease actual in a decrease in, cross section at deeper depth, these all are given, so same way lie there is continues change in the cross section of the pile, like this, if you see, the same thing you will get, continusely, disturbed acceleration sensor this is like, a reflectogram, this is pile section and this is command or description about pile, about the pile. So, this is like irregular cross section, irregular cross section of pile throughout. So, that's all you can get an idea about, based on a reflectometer, you can get an idea about, whether the pile is straight whether the pile is having increase in the cross section, decrease in the cross section or the end of the pile is file is fixed or free depending upon the cross section.

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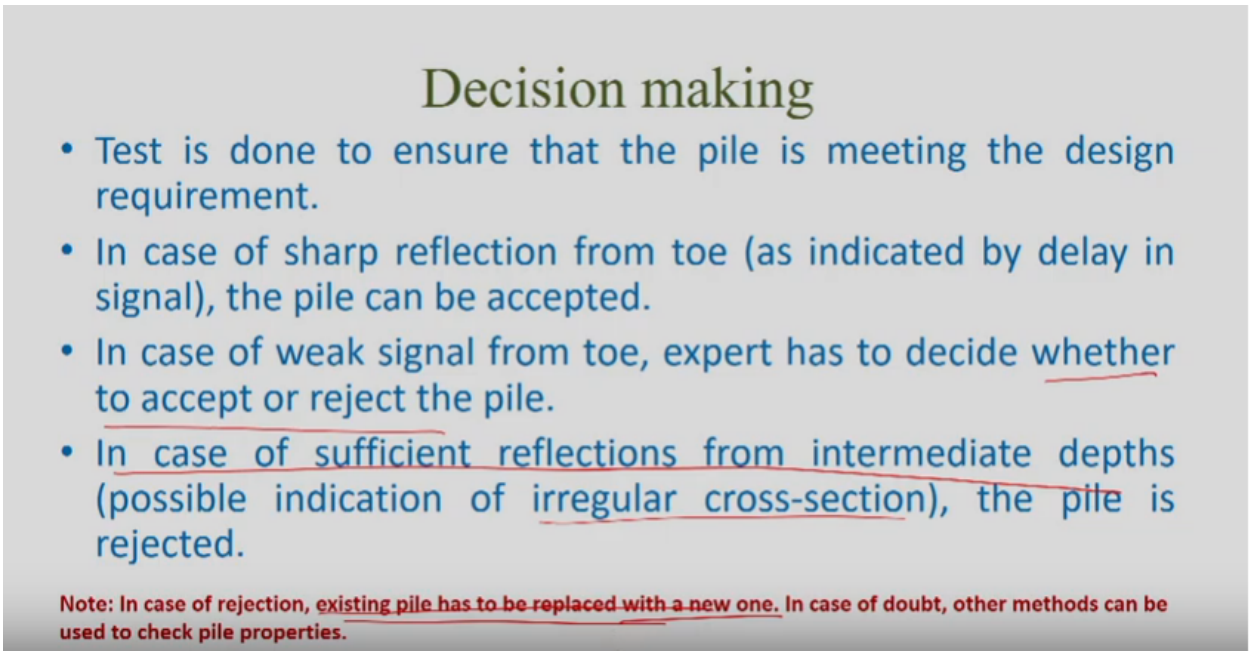

So, decision making the test is done to ensure that the pile is meeting the design requirement that is the cross section of the pile, length of the pile impedance contrast. In case of sharp reflection from the toe as indicated by delay in signal, the pile can be is considered as accepted, in case of weak signal, because of weak signal may be, because of concrete quality also, expert has to decide, depending upon how much weak is the signal, whether to accept or reject the pile. In case of sufficient reflections you're getting from intermediate depths, as I should here, complier irregularities, possible indication of, irregular cross section throughout, the pile has to be rejected. In case the pile is rejected that mean's, you cannot use that pile as actually load bearing member, you have to go for costing a new pile, the existing pile should be replaced with new pile. In case of doubt, you again, you can go other methods to check the command of this.

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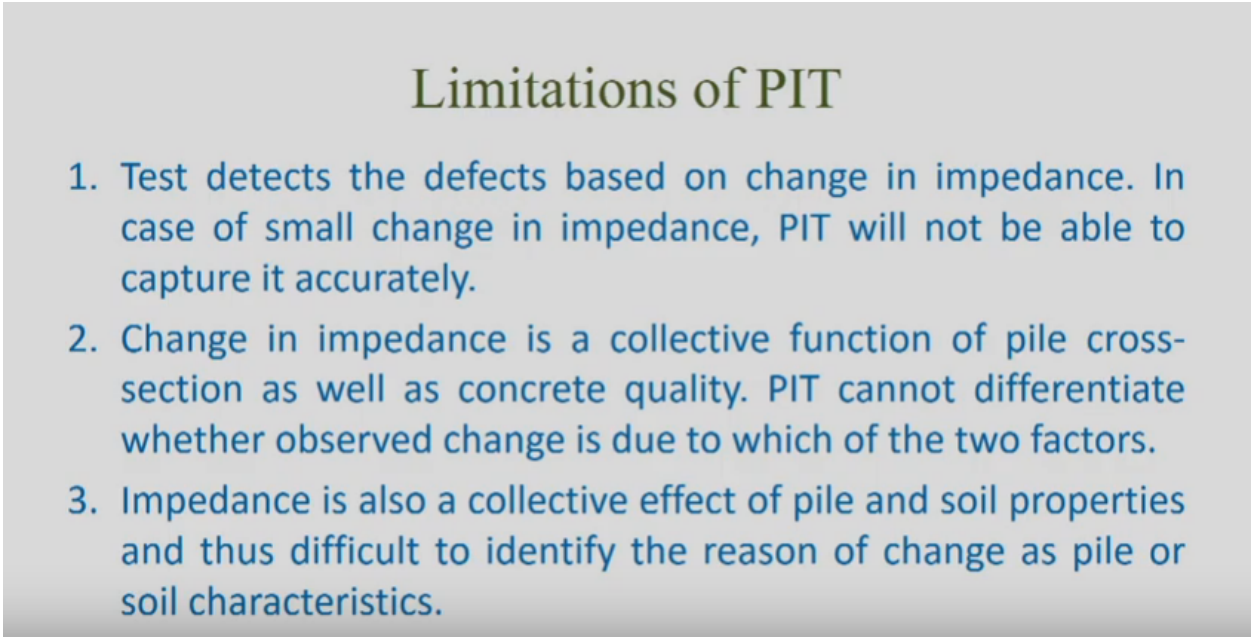

Now, there are certain limitations also, the test detects the defects based on change impedance. So, in case of there is minor change on the impedance probably the PIT or pile integrity test, will not be able to detect that. Again, the change in impedance is a collective effect of the reflection you're getting because of change in concrete quality or may be change in the pile cross section. So, it is difficult to distinguish between too based on your, recorded grand motion. Third thing the impedance can also be because of change in pile characteristics or may be the resistance offered along the pile shaft by the soil. So again, whether it is, going to be because of pile shaft or because of soil, which is available along the Perry fairy, it can coasted disturbed, change in the, the recording signature, but, it is difficult, to detect whether it is because of pile, whether it is because of soil.

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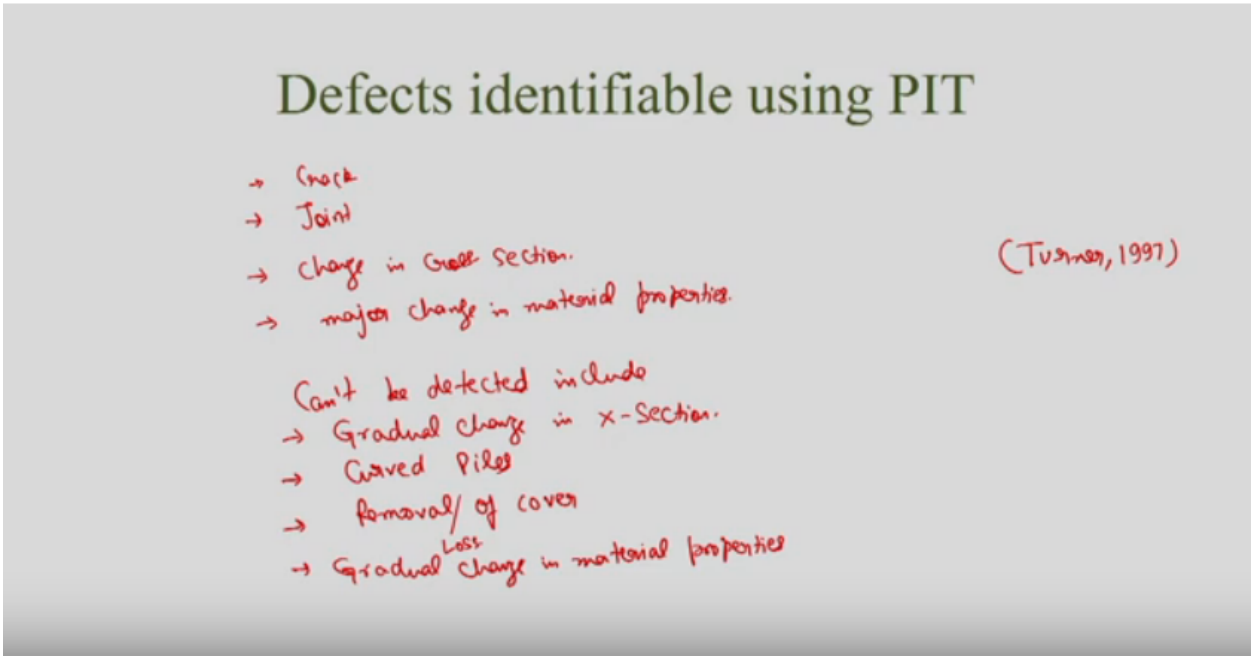

Defects which you can generally detect, you can using PIT or particularly, when there is in case of crack, you can detect, in case of joint, you can detect, in case of change in cross section can be detected and removal of cover major change in material properties. So, all these things can be detected by means of PIT what cannot be detected include, receiver gradual change in, change in this is aspect Turner 1997, gradual change in cross section, cannot be detected curve piles, cannot be distinguished and removal of cover removal of cover on loss of cover, so these things you cannot detect and gradual change in, change in material properties. So, major seeing material properties can be detected but, not gradual change in material properties. So this, with this actually I‘ve reached to the end of this, dynamic testing of pile chapter, so overall we have discuss about how the overall decision can be made depending upon the specific depending upon the quality of the concrete, depending upon the cross section or length of the pile, whether the pile which is actually coasted in c2, should be used as load bearing member, because finally it is going to effect the designer or the serviceability of the structure or it has to be rejected or you have to do some more test to given confidence whether the pile, which is actually coasted in c2, meet’s your actual design consideration. So, these are basically the main objectives when, when once you can go, one go for dynamic testing of the pile. So, with thus I stooped here. Thank you.