Geotechnical Measurements and Explorations

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Lecture No. # 07

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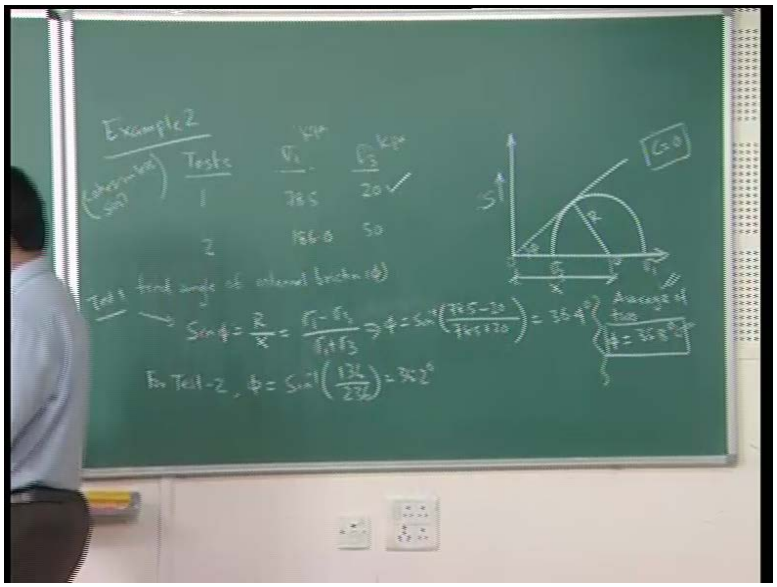

Example two: Tests, sigma one, sigma three. 1, 2, 78.5, 186.0, 20 and 50. This is in K p a, this is in K p a. Find angle of internal friction phi ((no audio 01:15 to 01:51)). Example two and this is for cohesion less soil test, there are two triaxial test results for cohesion less soil. In cohesion less soil, c is equal to zero, tests means test one and two. There are two tests has been done, and sigma one and sigma three is given, and it has been ask to find it out, angle of internal friction phi.

Now, for cohesion less soil, if I draw a mohr circle, the failure envelope will pass from the origin, as the unit cohesion is zero. So, it will touch the tangents will be here, (()) will be here. So, if I take it sin phi. So, sin phi is equal to R by x. So, this distance is say o. From o to here, it is x.

Now, what is R? R is equal to radius of mohr circle. So, you can find it out easily, R is equal to sigma one minus sigma three by two and x is equal to sigma one plus sigma

three by two. So, from there, it is equal to sigma one minus sigma three by sigma one plus sigma three. Then, phi is equal to sin inverse 78.5 minus 20, 78.5 plus 20. I have consider for this test set one. Then, from there you will get it 36.4 degree. For test two, this is test one. So, phi is equal to sin inverse 136 by 236 which is equal to 35.2 degree.

If we look at for test one, it is coming 36.4 degree. For test two, phi is coming 35.2 degree. Now, you take average of this two. Then, phi is equal to your 35.8 degree. In this case, as it is a cohesion less soil. So, if I draw a mohr circle, once again I am repeating, if I draw a mohr circle, the failure envelop it will pass through the origin as c is equal to zero, cohesion is equal to zero.

So, that is why for test one, if I consider this is sin phi, in terms of R by this. So, R is nothing but, radius of this mohr circle and x is your distance from origin to o. That means, it will be sigma one plus sigma three by two, this is your distance. So, then from there this phi value you can calculate, for test set of test one and test two. With these two tests, you can find it out, what is the average value of this two, then report it. This is of phi internal friction of the soil.

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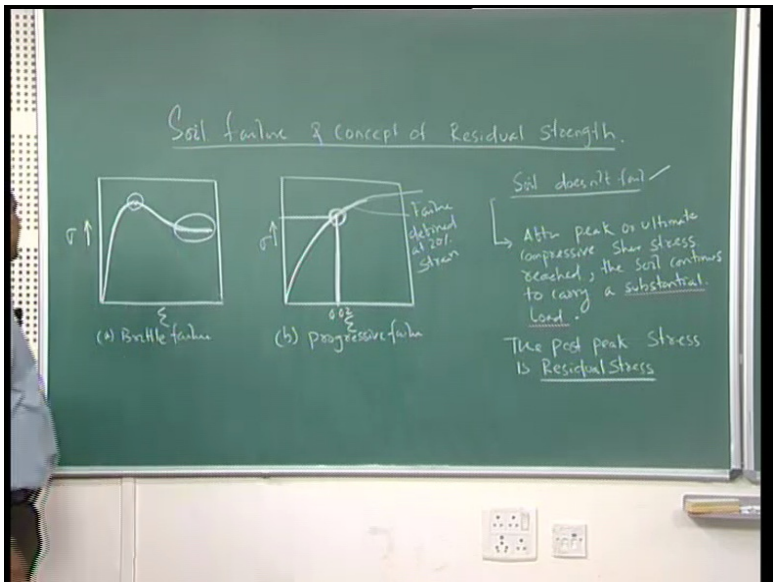

Then, next part of this, we will start this soil failure and concept of residual strength ((no audio 06:45 to 08:22)). If I say, soil does not fail. That means, after you can say, after peak or ultimate compressive shear stress reached the soil continuos to carry a substantial load ((no audio 09:25 to 10:20)).

Now, the most important thing is soil failure and concept of residual strength. The moment I say soil failure, what does it mean. That means, soil is that soil is completely fail or it is not failing, it is attending some peak may be some ultimate. After that, it also take some load. If I say, soil does not fail, it would not fail. Is this sentence correct? In some part, it will be correct.

There are two diagrams, it has been drawn. One is for brittle failure, other is for progressive failure. If we look at here, in case of brittle means soil will attain, after the peak or ultimate. This stress versus strain, the stress will increase with increase in strain, it will reach somewhere else in the peak. This is called peak or ultimate compressive shear stress reached. Then, after that what will happen. Soil does not fail completely, after that it will take some load. That means, the post peak stress is called residual stress. Similarly, another part is, there are two kinds of failure. One is your brittle failure, other is your progressive failure. Progressive failure means, with increase in strain, stress increases. It will go like this and somewhere else it will continue.

So that means, in that case, failure particularly you cannot get a peak or ultimate value. In that case, generally 20 percent of strain, the corresponding stress is defined as your failure. So, failure defined at 20 percent of strain. That means, at 20 percent of strain. What is your stress? This point is your failure. Even if beyond this, means soil carriages to continue to carry substantial load. That means, this is your, you can say that this is your residual strength.

These particularly this strength, after you can say that, what do you mean by, somebody will ask what do you mean by residual strength. The strength after peak, or ultimate compressive shear stress, or may be failure stress at a defined strain, that is called your residual stress.

In case one, this is your peak or ultimate compressive shear stress. After that, it will also soil will carry some load. Soil will not going to fail completely, we cannot say that, it will soil fail, it does not mean that it will come to zero.

Means, after some, after peak or ultimate, the soil will continue to carry load, some load and it will be go like this. The post peak stress or may be the post stress after defined failure strain, that is called your residual stress.

Now, with this two at what condition you can say that, it will be a brittle failure ((no audio 14:14 to 14:25)). There are different cases, soil is dense ((no audio 14:33 to 16:54)). .

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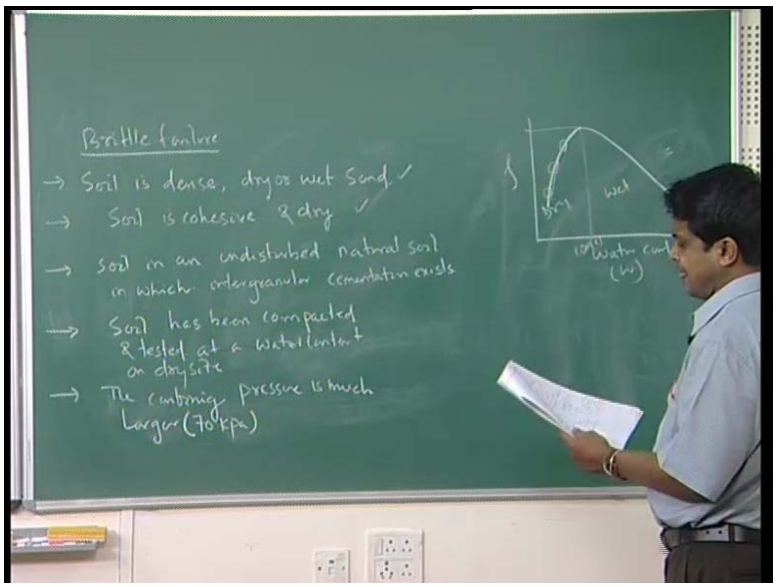

Now, what are the conditions for brittle failure. The moment I say, there are two failure. One is your brittle failure, other is your progressive failure. Then, start with this soil is in dense condition, and it may be dry or wet sand, case one. Case two, soil is cohesive and dry. Case three, soil in an undisturbed conditions, at which particularly intergranular cementation exists. Then, case four soil has been compacted and tested at a water content on dry site.

The moment say that, let us say, compacts and curve ((no audio 17:50 to 18:01)), it says soil has been compacted and tested at a water content on dry site. If this is my o m c, and this is your maximum dry density, this site is called dry site, this is called wet site. This is called dry site, because this water content is less than your o m c, and here the water content is more than this your o m c. If soil compacted and tested at a water content on the dry site, then you can exhibit brittle failure.

Then, last part is your, if the confining pressure is much larger, say 70 K p a, also in that case, there you will observe that this brittle failure of the soil occur.

Then, where this progressive failure occurs? Any idea. Now, the moment I say, soil has been compacted and tested at a water content on dry site. Definitely, soil has been compacted and tested on a water content on the wet site. If this is my dry site, and this is my wet site. So, soil compacted on this, definitely this is going to give progressive failure.

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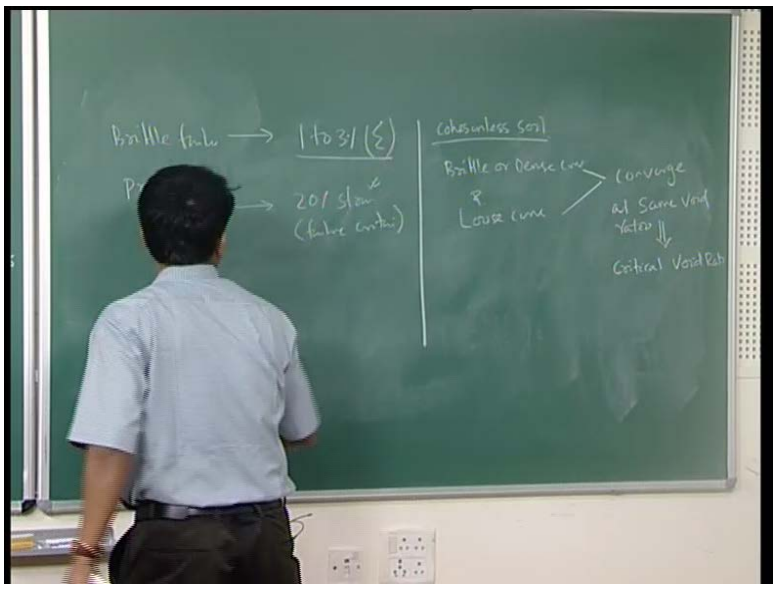

Now, what are the conditions, in case of progressive failure, the stress versus strain, if I plot it, it will increase with increase in strain. So, may be increase in stress, the strain will increase. So, in that case particularly, if you say brittle failure, it generally happen 1 to 3 percent of strain. Then, in case of progressive failure in soil mechanics or geotechnical engineering, we define 20 percent strain as a failure criteria ((no audio 20:40 to 20:49)).

So, what is the permissible strength, the moment we say that, brittle failure or progressive failure, where it should be defined. In case of brittle failure, the strain generally 1 to 3 percent of the strain observe. In case of progressive failure, generally it is 20 percent of strain has been defined. 20 percent of strain in geotechnical engineering has been defined, 20 percent of strain, with that corresponding, what is a stress, that is your failure stress.

One more example, cohesion less soil. Brittle or dense and loose curve, both will converge at same void ratio, this is termed as critical void ratio.

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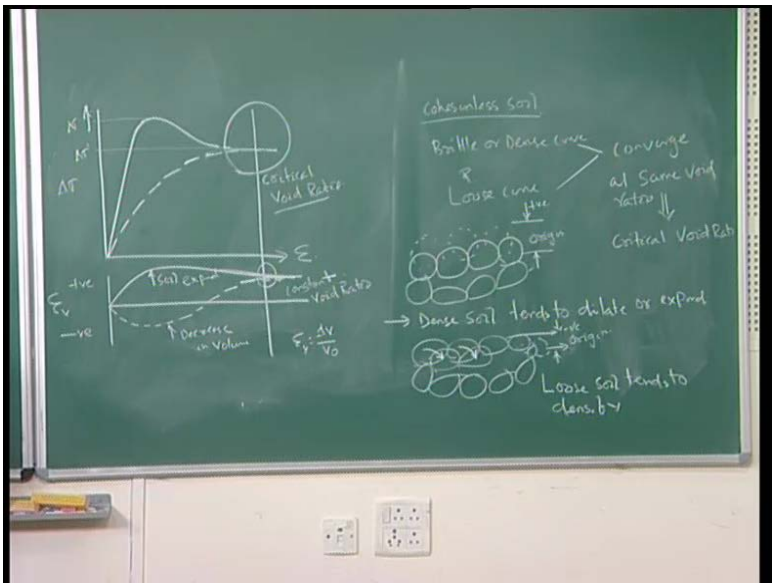

Now, if I draw ((no audio 22:39 to 22:51)) stress versus strain, taking both these curves. For example, in a soil let us say cohesion less soil, both brittle. Brittle failure means both dense curve, as well as progressive failure loose curve, it converge at some at the same void ratio, it converge at the same void ratio, that is called critical void ratio.

If I draw, if I plot the same curves, brittle failure may brittle curve, as well as loose curve in the same plot. Let us see, this is case one. Stress versus strain, progressive or loose ((no audio 24:02 to 24:36)). Change in volume also plot it, positive, negative ((no audio 24:44 to 24:59)), constant void ratio ((no audio 25:06 to 25:19)), this is critical void ratio ((no audio 25:22 to 25:38)).

Now, both these parts, both these curves, I plot it in a single curve. If you look at here, this is brittle failure, so brittle failure, this brittle curve, where it exists, in case of dense soil. Particularly, I am taking example of cohesion less soil for loose curve, it is for loose soil, this is progressive failure occurs. So, at some point of time, both these curves converge at the same void ratio. The moment it converge means, at this point, this void ratio for both this same soil has same, means there is no change at the same void ratio, there is no change in void ratio. That conditions, it is called critical void ratio.

The moment you say critical void ratio, if I take a dense soil ((no audio 26:57 to 28:44)), loose soil tends to densify ((no audio 28:54 to 29:05)). If you look at this why they converge at the same void ratio. After certain part, certain period, they both the soils will

converge, say brittle or dense or loose, both will converge at the same void ratio that is called critical void ratio.

What will happen, in the both these cases. In case of dense soil, what will happen, it is already dense. That means, it is already dense means, it will go go go certain point it will dense, then all of sudden the soil tends to dilate or expand, the moment soil tends to dilate or expand. The interlocking effect has gone; interlocking effect of the soil has gone. So, what will happen, it tends to expand and dilate means, it will go in the positive science side. That means, the volume, volume will, if you look at here is soil expand, here it is decrease in volume.

In dense soil, once this interlocking effect has gone and soil tends to dilate or expand, it will expand expand expand after up to the certain volume. Then, it remains converge some points it remains constant or converge.

Then, in case of loose soil, what will happen. This will try to tends to densify. That means, it will densify or it will decrease in volume, densify densify decrease in volume. After certain time or certain period, the decrease in volume will will not be no more there. That means, it will remains constant. Both these cases, it will merge somewhere else or the same critical or may be constant void ratio, at the same or constant void ratio, that is called critical void ratio ((no audio 31:31 to 31:43)).

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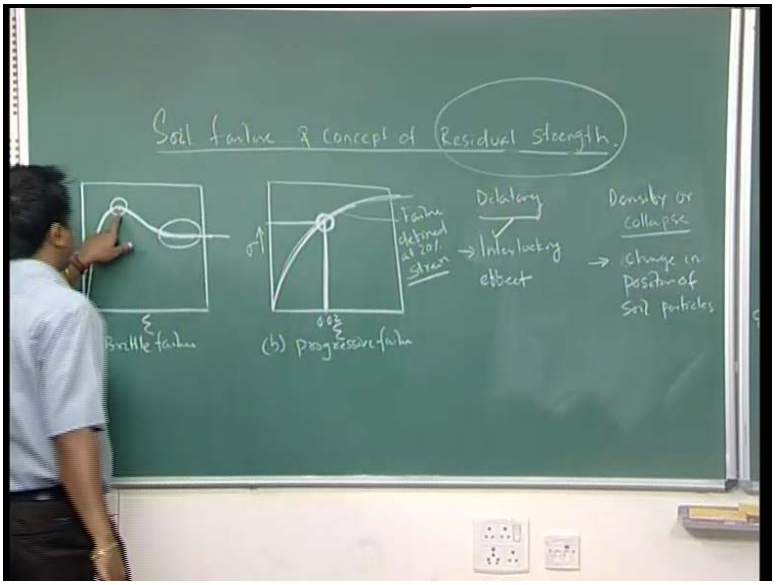

Now, if I say dilatency. One is called dilate, other is your soil tends to densify or collapse ((no audio 32:00 to 32:11)). Then in this case, it is interlocking effect. In this case, change in position ((no audio 32:34 to 32:49)). In this case, soil try to expand. The moment it says that, it try to expand. That means, interlocking effect of particles between this particle, it will loose, interlocking effect will loose, it will try to expand.

The moment you say that soil tends to densify or may be densify means, it tends to collapse. That means, change in position is going to happen, is in particle will change its own position from original position to it will be change positions. So, decrease in volume will be there. So, these are the two things. Dilatancy means interlocking effect, or densification or collapse means change in position of soil particles.

Now, if I summarize soil failure and concept of residual strength. That means, there are two kinds of failure. One is brittle failure, other is your progressive failure. In case of brittle failure, it will go it will go, it will attained peak or ultimate. After certain attaning peak or ultimate, it will continue. Soil is not failing completely, that means beyond peak or ultimate, it will take some strength, it will take the some load the strength will be there.

In case of progressive failure, with increase in stress, strain will be increase. In that case, the failure defined at 20 percent strain. That means, at 20 percent strain, failure has been defined. There is no clear failure, here in case of progressive failure. As in that case, with increase in stress, strain will increase. So, in that case, the 20 percent strain has been consider as failure. Now, these are the two conditions means, two failure. One is your brittle and progressive.

As I said, where this brittle failure is there, where progressive failure will be occur. Particularly dense soil, dense sand, in that case, brittle failure will be there. Also if I take a soil, in the compaction site of the dry site of the compaction curve, in that case, brittle failure occur.

Similarly, progressive failure if I take a soil of the wet site of the compaction curve. In that case, progressive failure will be there. Generally brittle failure, in that case the strain will be 1 to 3 percent. In case of progressive failure, it will be 20 percent as defined.

Now, both these curves, if I put it in a, if I superimpose in a single curve. That means, brittle as well as progressive. Then, what will happen, after certain time or certain period, what will happen, both will converge. The convergence is particularly it is called, that is called means at a constant void ratio, where brittle or dense curve or may be loose curve, it converge, that is called critical void ratio. That means, critical void ratio is beyond this, there is no more volume change.

So, in case of dense soil, the soil try to dilate or expand, this is because of your interlocking effect. In case of, particularly loose soil try to densify or collapse, it is because of change in position of the soil particles.

So, both if I plot in a volume change versus the strain, soil will expand expand and it remains after beyond that, the expansion will be stop. Then similarly, particularly in case of loose soil will try to decrease its volume, it decrease decrease decrease after certain point, no more further decrease in volume will occur. So, both the soil will be converge at certain point the at constant void ratio. Beyond that, there is no more change in volume. Remember, beyond that there is no more change in volume, that is called critical void ratio.

Now the, what is that residual strength? Residual strength means the strength beyond the failure, whatever is available, that is called residual. In case of brittle, soil will go and attained peak. After peak, whatever the available strength, that is called your residual strength. This is most important criteria means failure, soil failure criteria and the concept of residual strength, it will be required throughout this, particularly this course. So, this is the residual strength concept we have cleared. Then, dilatency also comes into picture. Then, what is your critical void ratio, all has been discussed.

Now, we will move to three parts of shear strength means, by means of triaxial. One is by means of U-U, C-U and C-D tests, one by one will proceed. Can you stop (( )).