**Application of Soil Mechanics**
**Prof. N. R. Patra**
**Department of Civil Engineering**
**Indian Institute of Technology, Kanpur**

**Lecture – 34**

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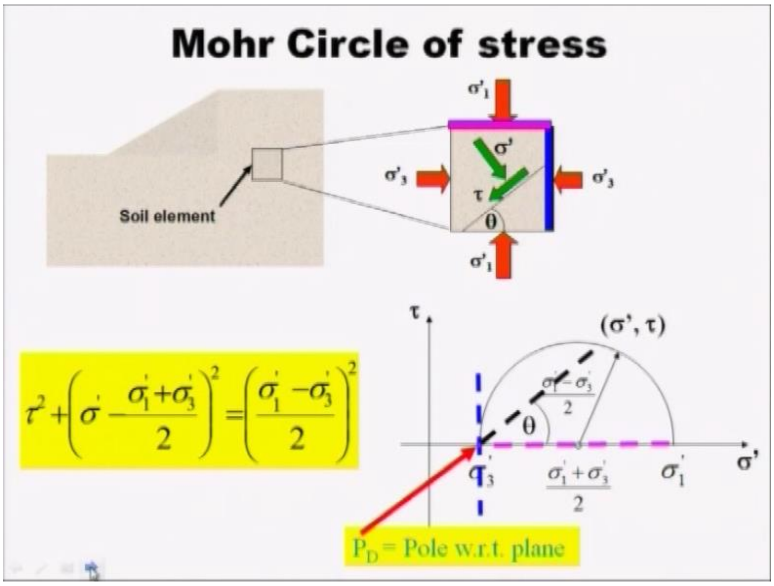


Up to last class. So, we are finish this basic about your a, and stresses in the solve must now continues with this more, and circle stresses. We have discourse this what is the pole with respect to pole. We can find it out the failure envelope, and this sigma in tu at failure.

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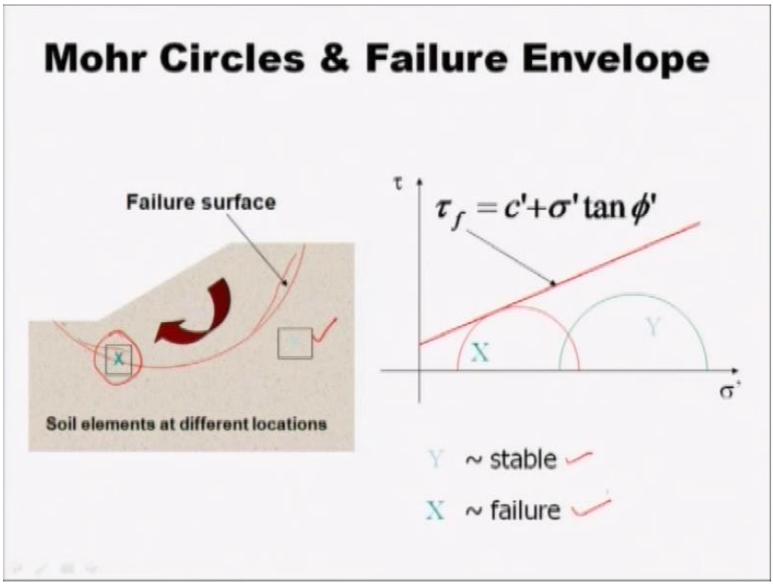


Now, if we look at this more circle, and failure, and envelope. If this is the failure surface this is the failure surface, and soil elements are different location one can say that a soil element in side this failure envelope or soil elements outside this failure envelope. So, for failure in side this failure envelope tu at is equal to c prime plus sigma prime than pi now let us take a soil element to y let us take soil element y outside this failure surface. Now if I draw the mohr circle. Now it is not touching the failure envelope; that means, this soil element is stable; that means, soil element taken at position y it is stable, if I take a soil element belong the failure surface, and draw the mohr circle soil element belong the failure surface. Let us say a, and draw the mohr circle; that means, we will task the failure envelope; that means, soil element along the failure surface, it is called it is in failure.

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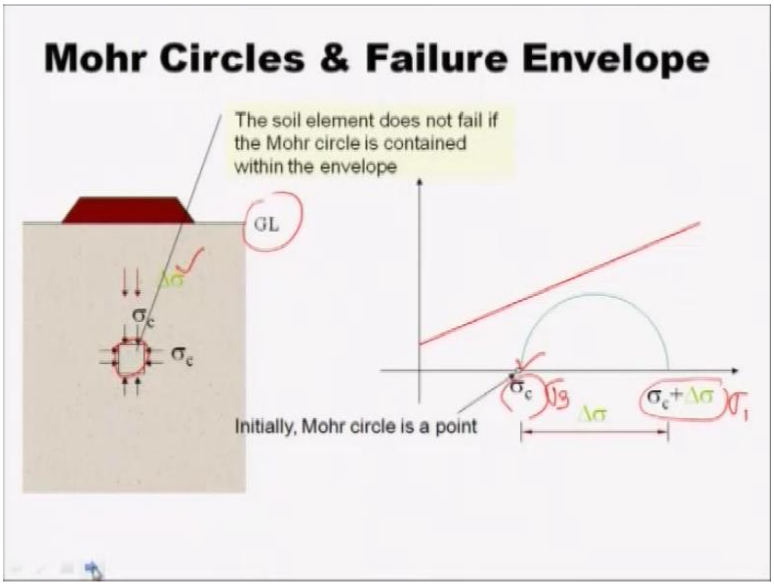


Now, initially suppose this is a ground surface ground label this is your ground label initially take a soil element at position of y at position of at point y. So, in this case what happen sigma thee three sigma c is your conferring pressure three sigma c is your con faring pressure. So, initially mohr circle is a point mohr circle is a point now your additional search are let us say now a additional search are delta sigma which adding additional search are the delta sigma now this mohr circles as be built up sigma c plus delta sigma this will be your sigma one this is your sigma one, and this is your we can say that sigma three. Now again in increase this; that means, what will happen this soil element does not fail, if the more circle is contained within this envelop; that means, if the mohr circle is below this envelop soil element is not going to fail.

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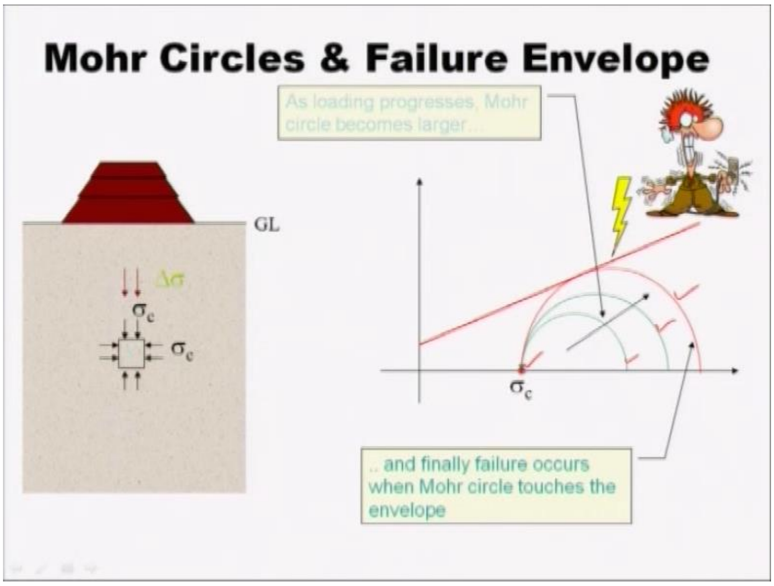


Now, at additional. So, as loading progress mohr circle become larger initially, it is a point initially it is a point adding searcher now this is mohr circle become larger, and larger finally, failure occurs finally, failure occurs when this mohr circle touches this envelop; that means, when this mohr circle touches this envelop failure envelop. So, finally, that means, failure occurs. So, this is the about stress stress stress rate, and the mohr circle, and how this failure envelop this is basically this explains how this failure occurs.

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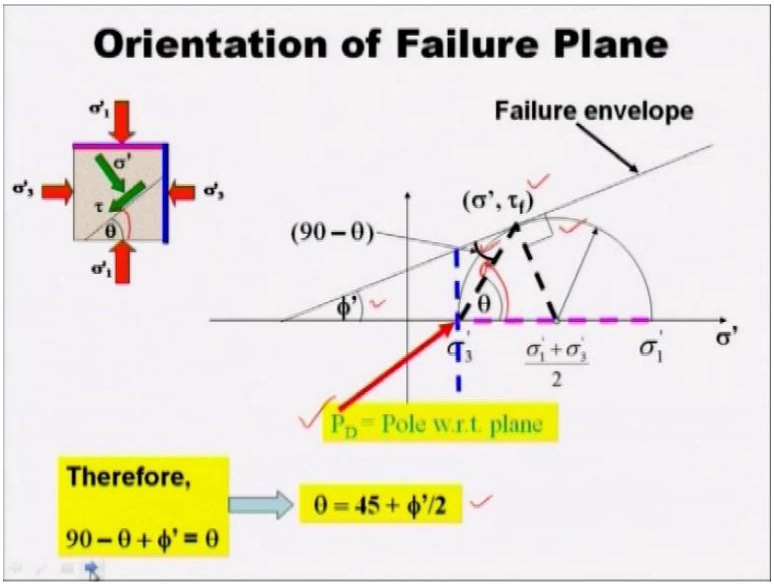

Now, if would take this failure envelop failure envelop, and if you take this a sigma three, and sigma one identify this pole pole with respect plane, and draw the failure envelop with respect to pole at angle tita it is anti, then draw with a angle anti tita draw the failure plane where it touches where it touches your mohr failure envelop that that if your sigma, and tu at failure plane. So, now, this angle is ninety degree so; obviously, this angle will be ninety degree mains tita. Now if I draw it total angle if I make in to total ninety minus tita ninety minus tita plus five prime is equal to tita simple geometry from their you can get it tita is equal to forty five degree plus five by two.

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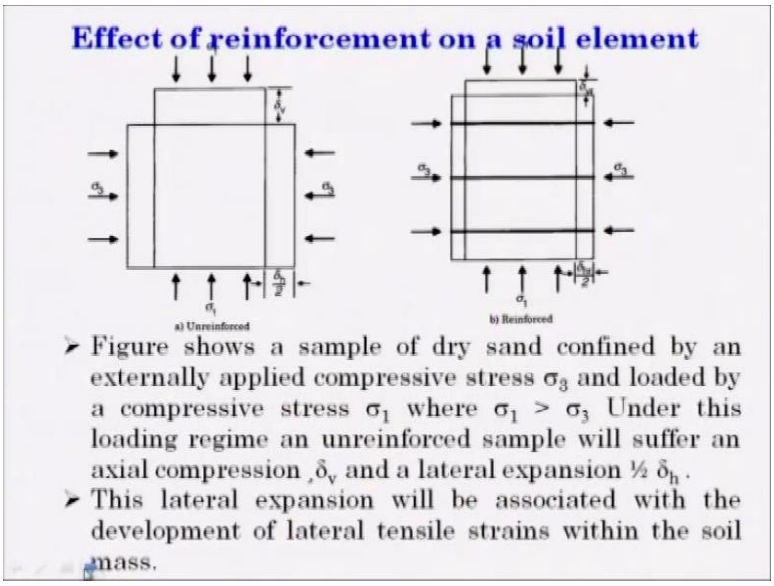


Now, next step is your effect of reinforcement on a soil element there are two figures one is your on reinforcement other is your reinforce a figure shows a simple sand confined by an externally applied load applied stress a sigma three applied compiling stress a sigma three, and and loaded by a compressive stress sigma one, and loaded by a compressive stress sigma one where sigma one let us say sigma one is a grater, then sigma one three under this loading regime an reinforce sample will suffer an axial compression let us say axial compression of delta v, and lateral expansion what will happen if this is the soil element if this is the soil element sigma three is your confining or compressive stress, and sigma one is your vertical compressive stress if sigma.

One is greater than sigma three what will happen this will try to compress. So, this amount of vertical compression is delta v, and lateral expansion it will compress at the same time it will expand in lateral direction. So, lateral expansion will be delta h by two this lateral expansion will be associated with the development of lateral tensile strains within the soil mass ones this lateral expansion will occurs. So, the this will be as associated with the development of lateral tensile strain within the soil mass.

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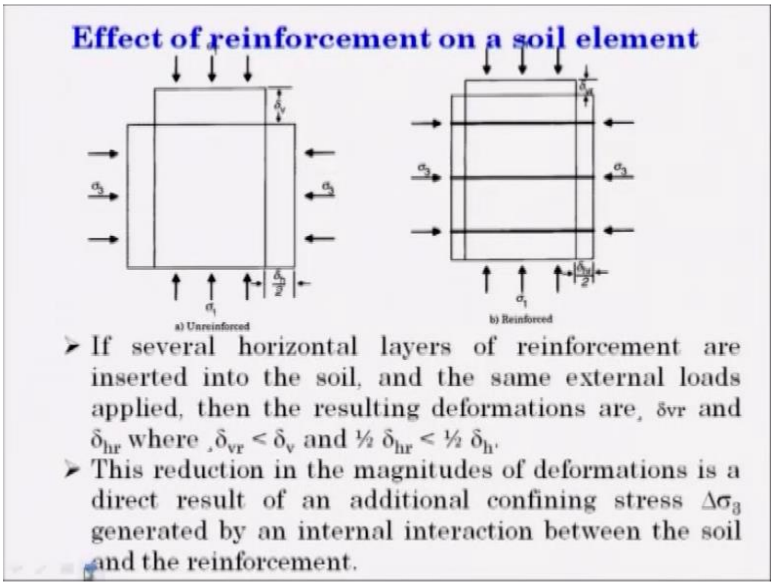


If several horizontal layers of reinforcement are inserted into the soil like figure b reinforcement one like several horizontal layers; that means, layer one layer two layer three reinforcement are inserted in to the soil. The same external load applied whatever the on reinforce case external load sigma one in there, if the same for reinforce condition as been applied, then the resulting deformation are resulting deformation are delta v r delta v r, and delta h r in lateral it is your delta h r sold dealt b r is less, then delta v if you compare with a this, this dealt v r is less, then delta v, and half delta h r half delta h r h half delta h r less, then delta h by two; that means, expansion in vertical expansion in lateral in case of reinforce case it will be less as compare to in case of on reinforce case these reduction magnitudes of deformation is a direct result of an additional confining stress delta sigma three generated by an internal internal interaction between the soil, and the reinforcement this will be this reduction will be, because of this, because of this interaction between the soil, and the reinforcing element this reduction if you look at this vertical deformation is delta v, and with this reinforcement it is your delta v r, and it is less than your delta v this reduction, because of your interaction between soil, and reinforcement.

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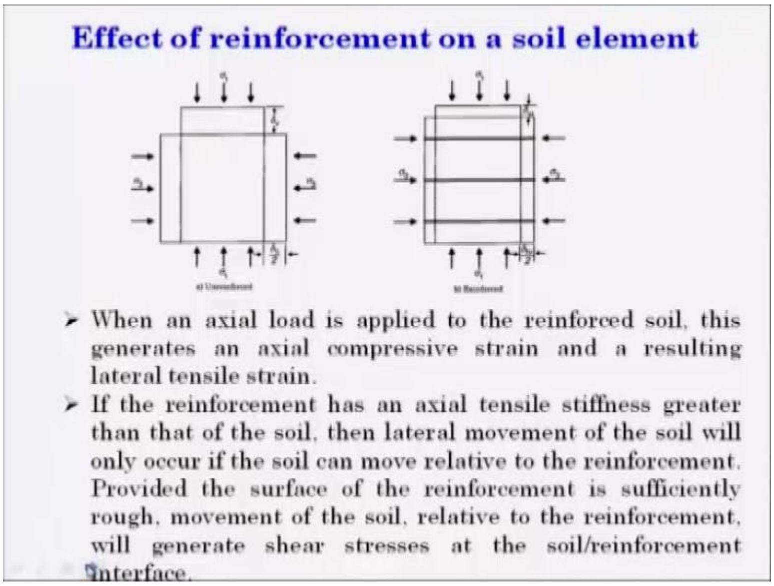


When an axial load is applied to the reinforced soil this generates an axial compressive strain, and a resulting a lateral strain when an axial load is applied to the reinforced soil axial load is applied to the reinforced soil this generates axial compressive strain, and resulting a lateral strain, and a resulting a lateral strain. If the reinforcement as an axial tensile stiffness grater than that of soil; that means, if the reinforcement these are the reinforcement if the reinforcement as an axial tensile stiffness axial tensile stiffness is greater, then your lateral greater than that of your soil, then the lateral movement of soil will only occur if the soil can move relative to the reinforcement provided this surface of the reinforcement is sufficiently rough, and movement of the soil, and relative to the reinforcement will generate shear stresses at the soil reinforcement interface.

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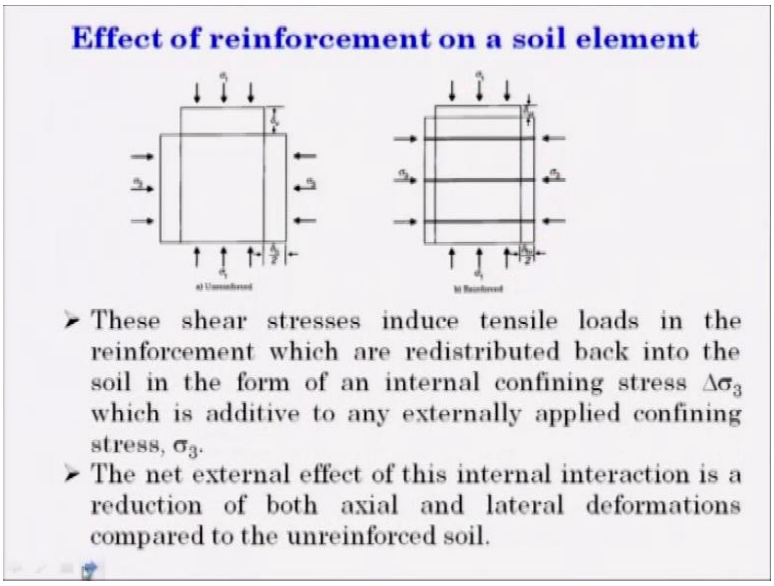


These shear stresses induce tensile loads in the reinforcement which are redistributed back into the soil in the form of an internal confining stress delta sigma three internal confining stress delta sigma three which is additive to any external applied confining stress of sigma three. The net external effect of this internal interaction is a reduction of both axial, and lateral deformation compared to the unreinforced soil, because of a internal interaction between the soil, and the reinforcing material the net result will be it is reduction of your both axial, and lateral deformation as compared to your unreinforced soil.

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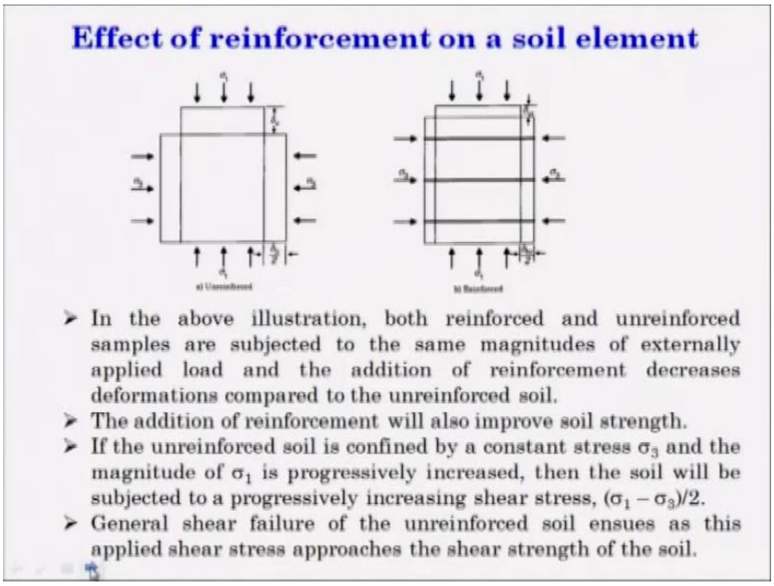

Similarly, in the above illustration both reinforced, and unreinforced samples are subjected to the same magnitudes of externally applied load, and the addition of reinforcement decreases deformation compared to the unreinforced soil as I said compared to your unreinforced, and this reinforced soil as a less deformation the addition of reinforcement will also improve also soil strength it will also improve your soil strength; that means, it will improve your bearing capacity. If the unreinforced soil is confined by a constant stress sigma three, and the magnitudes of sigma one is progressively increased, then the soil will be subjected to a progressively increasing shear stress of sigma one mains sigma three by two general shear failure of the unreinforced soil ensure as this applied shear stress approaches this your strength of the soil.

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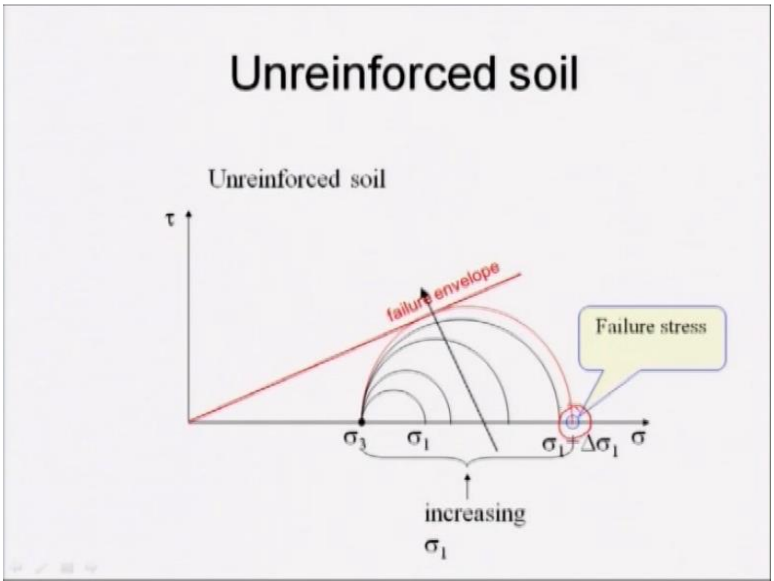


Now, for unreinforced soil this is my failure envelop now the movement we increase increasing; that means, if you look at this increasing in sigma one this failure stress be this more circle we increasing to will failure envelop this is your failure stress sigma one pulse delta sigma one.

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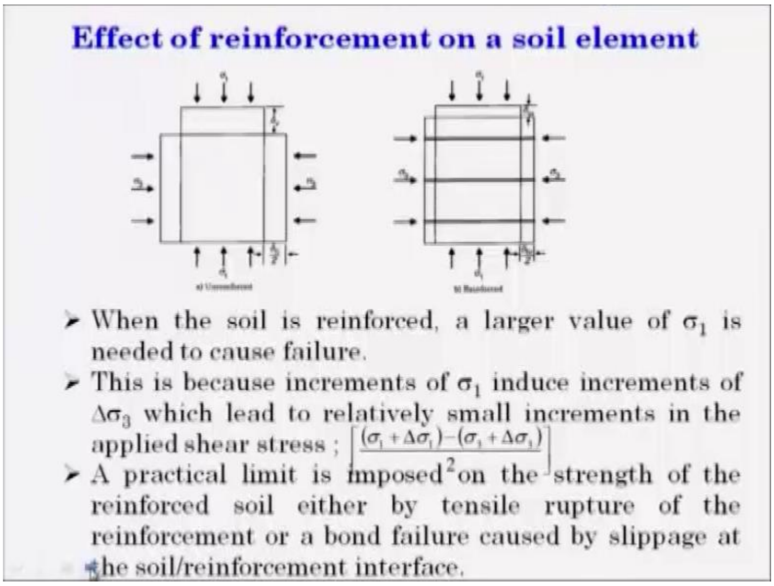


Now, effect of next parties your effect of reinforcement on a soil element one the soil element reinforced; that means, a larger value of sigma one is needed to cause failure; that means, one this soil reinforced whatever the earlier part of your sigma one; that means, you will need to how a larger value of sigma one for this failure; that means, you need to how delta sigma one will be more this is become increment of sigma one induce increments of delta sigma three which lead to relatively small increment in applied your stress; that means, sigma one is delta sigma one mains sigma three mains delta sigma three by two a piratical limit is imposed on the strength of the reinforced soil either by tensile rupture rupture of the reinforcement or a bond failure caused by slippage at the soil reinforcement interface.

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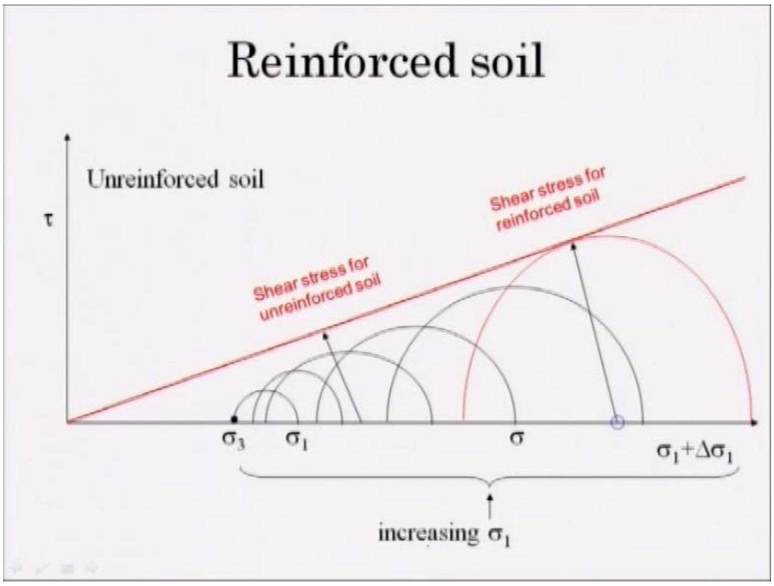


Now, look at this reinforced soil. So, this is the sigma three shear stress for unreinforced soil, and shear stress for reinforced soil if I go initially it is a point as a example for a unreinforcement soil both is comparing are some sigma one, and sigma three now it is increasing as a applied the company pressure; that means, increasing sorry as a applied this such as; that means, it will increase your sigma one. So, if a look at these this mohr circle shear stress at the reinforced the mohr circle at the which touched the failure envelop is a larger as compare to your unreinforced; that means, increase will be; that means, you need to half more delta sigma one to get the failure.

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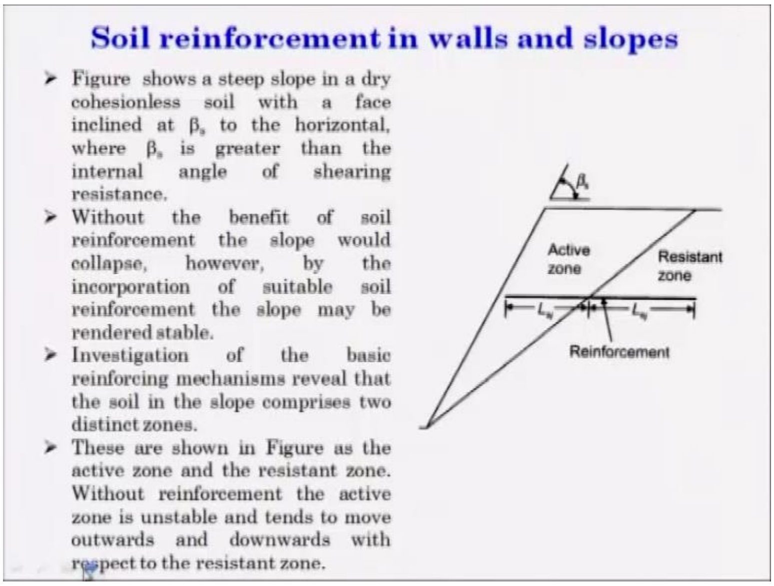

So, what does it mean the more more circle is more larger; that means, figure. So, just t slope in dry cohesion less soil with a face inclined at a angle beta a to the horizontal where beta is is if I provide. If I provided the reinforcement; that means, a steep slope in a will generate a, because it required larger low to get the failure. So, beta if I if I make it at a angle of beta s it is greater than that internal angle of shearing resentence that is your five without the benefit of soil reinforcement this slope would collapse; that means, without this without this soil reinforcement if I do not provide this soil reinforcement it is not it is not possible to provide the provide a steep slope; that means, slope may collapse may.

So; however, if I incorporate or you can incorporate a suitable soil reinforcement soil may be rendered to stable same soil, if it is not stable, if we provide it, it is possible to how way steep slope investigation of basic reinforcing mechanisms reveal that the soil in the slope comprises two distinct zones soil in the slope comprises two distinct zone now there are it is shown in figure. So, without reinforcement without reinforcement the active zone is unstable, and tends to move outward, and downward with respect to resistance zone there are two zones one is your active zone anther is your resistance zone. If we look at this figure; that means, there are two distinct zone; one is your active zone anther is you resistance zone without providing this this active zone not stable.

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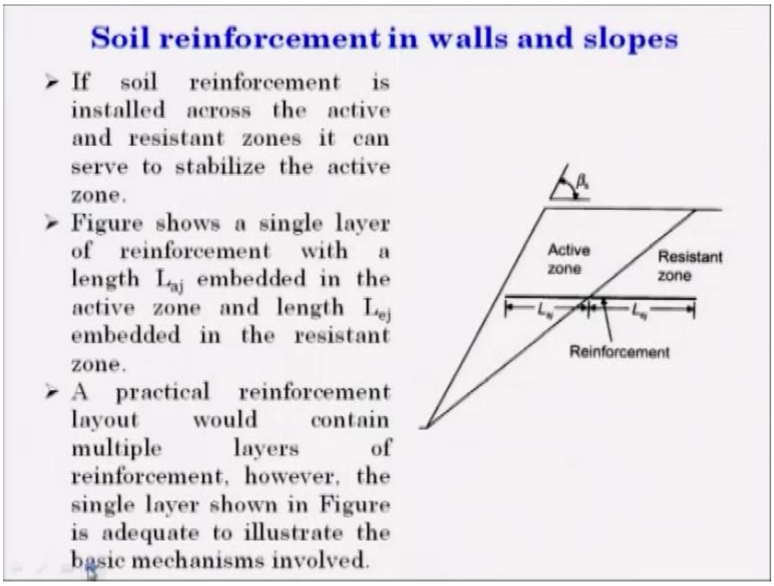


If the soil reinforcement is involved across the adequate registration the zone it can solve to stable the the active zone, if your going to provide a soil reinforcement both active as we as in registrant zone, then it is going to make stable the active zone a single layer of reinforcement in the figure in figure with a length of l a j; that means, embedded in the active zone an length l e j embedded in resistant zone a practical reinforcement layer layout would contain multiple layers this is just for a example it showing an a one layer. If go to practical case it is multiple layers multiple layers are reinforcement; however, single layers shown in figure for a illustration.

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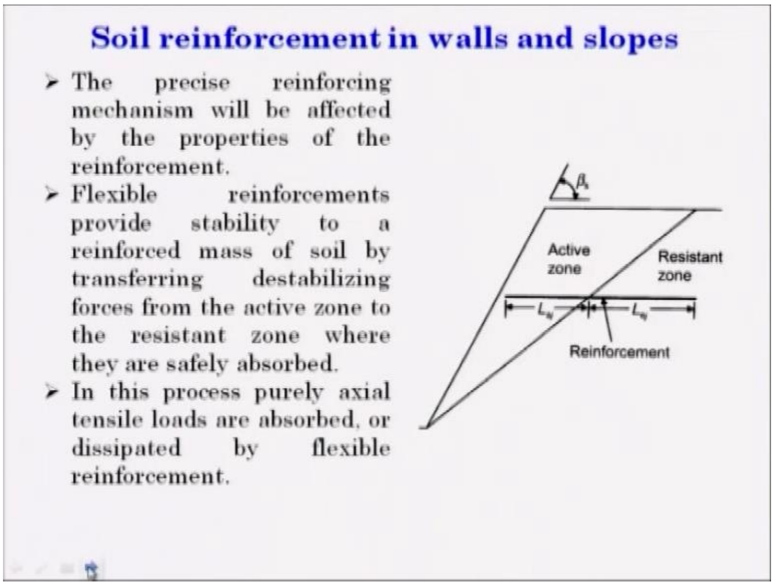


The precise reinforcing mechanism will be affected by the properties of the reinforcement defiantly this reinforcing mechanism will be affected the are reinforcing reinforcing properties of this reinforcing material flexible reinforcement provides stability to a reinforced mass of soil by transform transferring destabilizing forces for the active zone; that means, destabilizing forces for the active zone to the resistance zone to the resistance zone where they are safely absorbed in this process purely axial tensile loads are absorbed or dissipated by flexible reinforcement axial, and tensile loads whatever the axial axial are tensile load coming to the soil it will be dissipated by flexible reinforcement.

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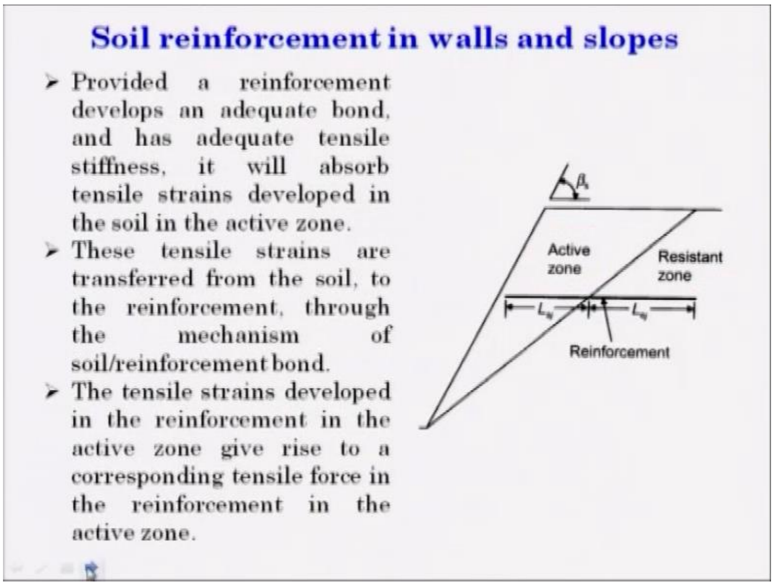


Provide a reinforcement develops an adequate bond how it will dissipated provided the reinforcement will proved an adequate bond between the soil as well as reinforcement this tensile strains are transferred from this soil to the reinforcement through the mechanism of soil reinforcement bond means whatever this particularly. If you see this lateral or vertical stress transfer to the reinforcement between soil to reinforcement, and this mechanism is called soil reinforcement bond; that means, they are should be a efficient bond between your soil as well as reinforcement the tensile strain development in the reinforcement in the active zone give rise to a corresponding tensile force in the reinforcement in the active zone.

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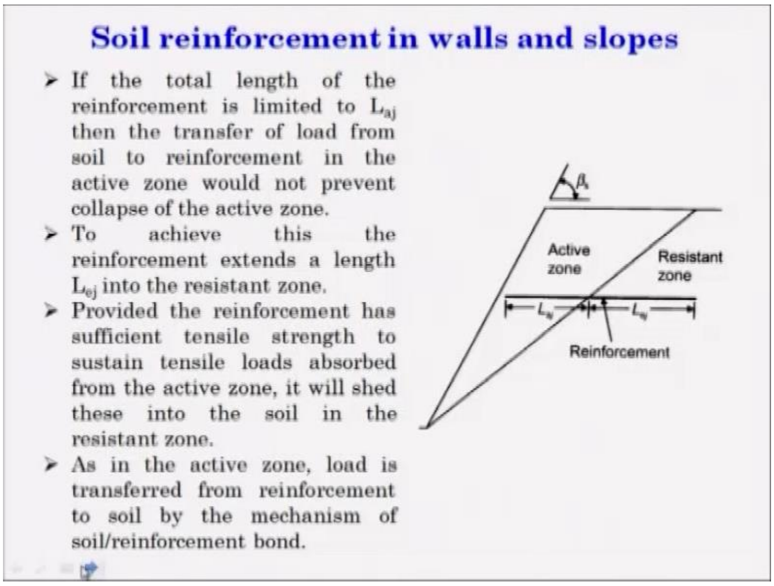


If the total length of the reinforcement is limited to say say I am not going to proved in resistance zone. So, suppose say total length of the reinforcement is limited to only l a j, then the transfer of load from soil to reinforcement in the active zone would not prevent collapse of the active zone, if I say this is my active zone. If I provide only reinforcement only if this is the active zone, if I provide only reinforcement up to the active zone, then it is not going to prevent collapse of the soil in the active zone to ask achieve this the reinforcement.

So, two makes your to bullock this failure the reinforcement as been extended behind your active zone zone that is called resistance zone provided the reinforcement has sufficient tensile strength it should also condition the reinforcement should have a sufficient a tensile load. So, that it will be obvious from the active zone it will be stated this in to the soil in the resistance zone; that means, it if it as a sufficient tensile stress what happen whatever lateral or vertical stress coming to this soil to reinforcement the reinforcement in the active zone it will transfer it will transfer this tensile this tensile strength behind your active zone that is called resistance zone as in the active zone load is transferred for reinforcement to be soil by mechanism of I say by mechanism of soil reinforcement bond this is called soil reinforcement bound bond between soil, and reinforcement this is called soil reinforcement bond.

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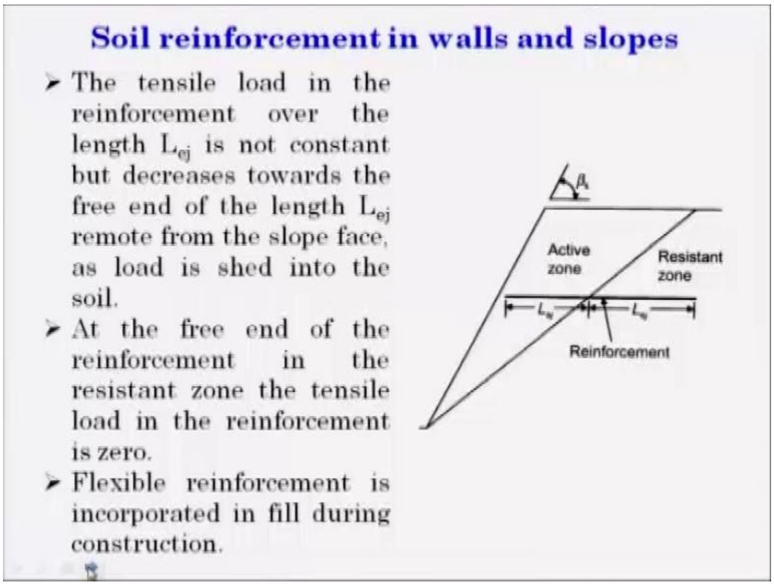


The tensile load in the reinforcement over the length l e j is not constant if a look at here tensile load in the reinforcement about the length l e j his not constant, but decreases towards free end of the length l e j; that means, we decreases a towards the free, and length of the l e j remote from this slope face remote from the slope face as the load is shed into the soil as the free end of the reinforcement in the resistance zone the tensile load in the reinforcement is zero at the free end of the reinforcement in the resistance zone the tensile load in the reinforcement is zero the tensile load in the reinforcement it will be zero here at the free end flexible reinforcement is incorporated in the fill during the construction what happen? The construction how the slope possible free paid. We have to construction to these slopes during the construction the flexible reinforcement as been provided like this.

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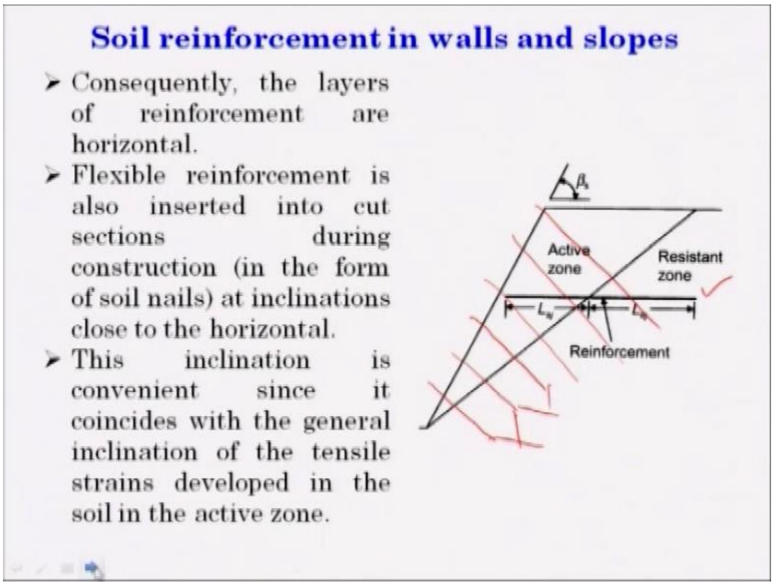


You will see consistently the layer reinforcement are horizontal generally the layers are reinforcement layers of reinforcement are horizontal flexible reinforcement is all. So, inserted into cut section during construction in the form of soil nails in the form of soil nail at inclinations close to the horizontal same times what happened flexible reinforcement also we can provide along the slow in the form of soil nails. If I at a inclined if I provide a soil nail nail inside this slope that also possible either we provide during construction horizontal or may be some construction over, then we can provide soil nails in the form of inclined that also possible this inclination is convenient since it co coincides with a general inclination of the tensile strains developed in the soil in the active zone.

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Now, let us see this construction of your reinforced walls.

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Now, if I go there how it has been constructed, if you look at here it has been constructed over side by side, because this is a cross sectional view, it will go along the length wise.

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Then how it has been fixed it has been taking top, and fix in between two walls these are all kind of vapor metal link, then you can make it along the with direction.

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How it has been fix, if you look at the here it has been fixed at the intersection one wall one width each other. So, how it has been arranges. If I look it this is my wall other wall has to put it that means what happened this wall has something like ting ted or outsides there is a some group other wall halls has also same group. So, this is a boll, and socket joint it will fix inside. So, that it will be place in the in the vertical position of…

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Now, look at this once the wall has been there, then you can place your soil layer by layer.

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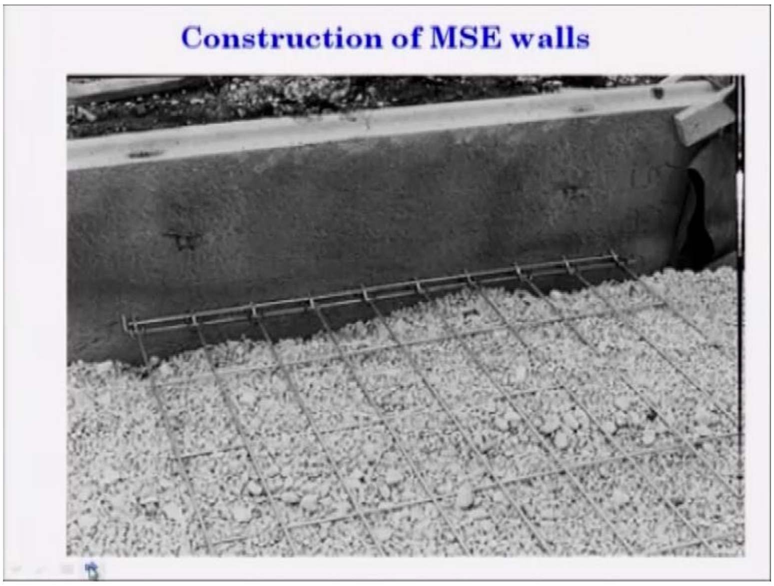


Now, this is this is the things w which to have discuss this reinforcement. Once you place a layer of soil, once you place a layer of soil along with this layer of soil, you can provide reinforce middle layer this is your enforcement layer in the form of or greet.

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Then this reinforcement has been properly tide, and fix in the soil mass you see earlier enforcement.

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In the case of mess these are all single reinforcement single reinforcement, in terms of flex small thin plates it has been placed with this spacing it has been placed in the layer f soil layer over this.

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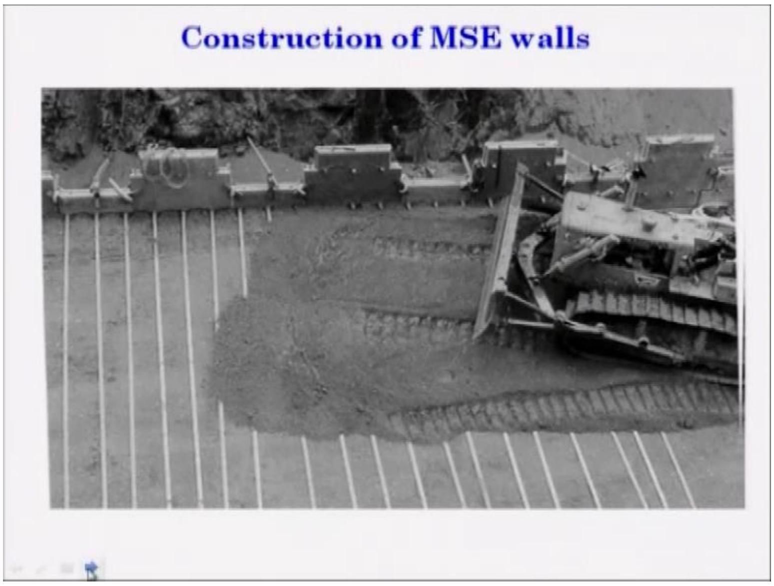


Then once this reinforcement has been placed above this reinforcement, you place again you start construction of another layer of soil must I am talking about how the construction has been done another layer of soil must you can place it over the once the reinforcement has been placed.

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Then you can do the roller in compact it by means a by rollering it ten’s that layer is over, then again you place another layer of reinforcement, then wheel a soil, then compact it. So, this construction will be layer by layer; that means, it is consisting of a soil layer compacted over this reinforcement, then soil layer compacted, then over this reinforcement.

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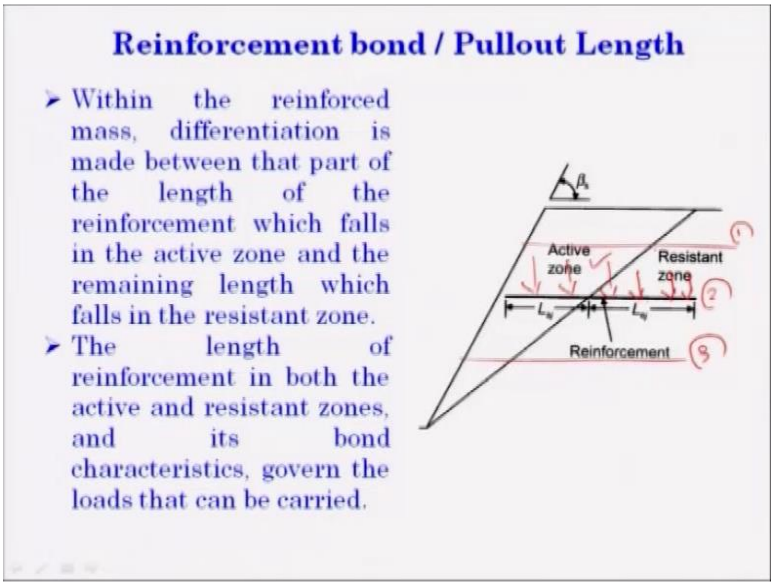


Next part is your enforcement bond or pull out length what is a pull out length within the reinforcement mass differentiation is made between that part of the length of the reinforcement which falls in the active zone, and the remaining length which falls in the resistance zone if you look at here if this is my slope if there is a reinforcement bar is there; that means, this is active zone generally you provide for stability. So, that this slock can be made. So, that it will be more stable, and there is a differentiate you can differentiation made it into a two parts length in the active zone length in the resistance zone.

The length of the reinforcement in both active, and resistance zones, and its bond characteristics govern the loads that can be carried this length this particular length will be decided based on the whatever the load it particularly that layer. If I am taking let us say there are three layers of reinforcement layer one layer two layer three. So, these reinforcement of l a j banes length along the active zone length along the resistance zone it will be decided based on these whatever the load carried by how much load, because between these to these are field by this is field by the soil. So, this will be decided the load coming on to this reinforcement the length of the reinforcement falling in the resistance zone is the bond length generally.

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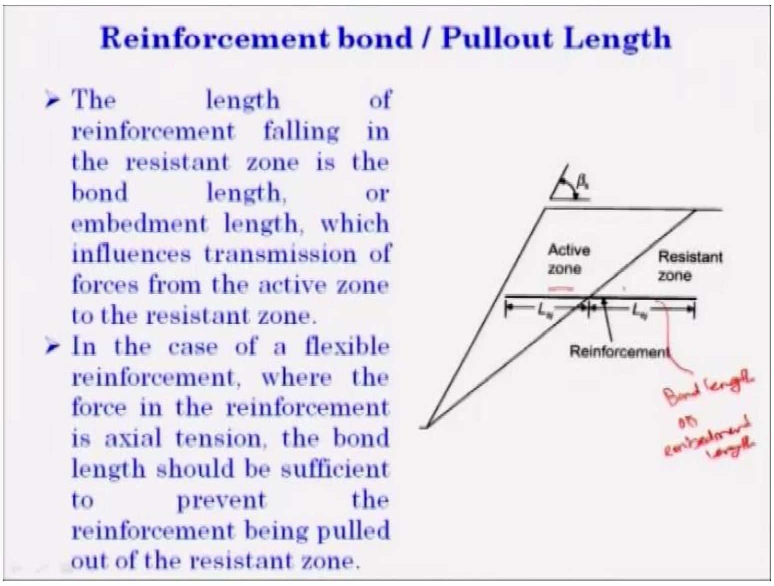


The length of the reinforcement falling in the resistance zone is the a bond length or the or the embedment length or the embedment length or the embedment length particularly here you I can say this is bond length or embedded or embedment length, which influence transmission of forces from active zone to resistance zone; that means, if there is x there are there is exes force in the active zone it will transmit this force from active zone to resistance zone, and this length is called bond length or embedment length.

In case of flexible reinforcement reinforcement, where the force in the reinforcement is axial tension the bond length should be sufficient to prevent reinforcement being pulled out of here resistance zone; that means, why this resistance zone. If you look at here if there is a soil along with this if this is a wall along with this wall this reinforcement has been connected what will happened there should be a sufficient length beyond your active zone why once this wall is pulling away from this field this will this will try to pull also your reinforcement; that means, there should be a sufficient length beyond your active zone. So, that there is a bond between your resistance zone, and soil. So, that it can resist this pull out it can resist this pull out force of your entire reinforcement that is the basic region.

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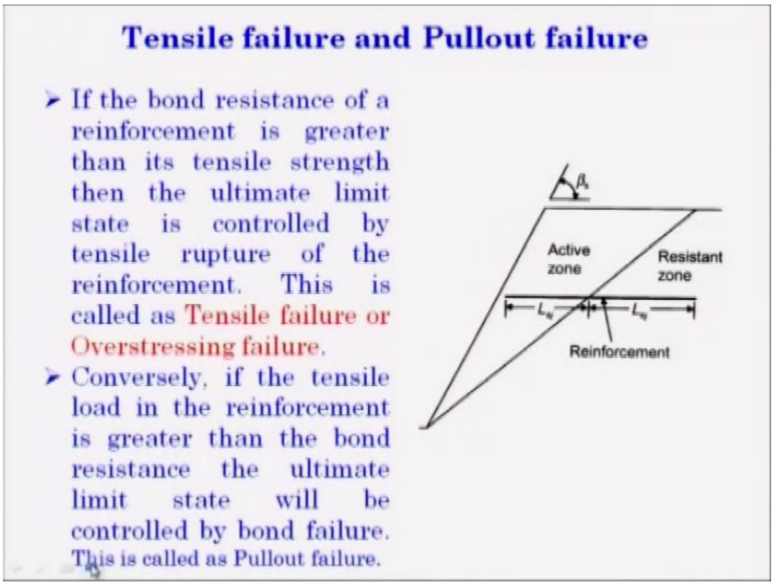


If the bond resistance of a reinforcement is greater than its tensile strength, if the bond resistance of a reinforcement look at here if the bond resistance of the reinforcement is greater than tensile strength of the reinforcement, then the ultimate limit state is controlled by tensile rupture of the reinforcement this is called tensile failure or over stressing failure conversely, if the tensile load in the reinforcement is greater than the bond resistance the ultimate limit state will be controlled by bond failure. If the tensile re rent there are two things one is your bond resistance of reinforcement is greater than your tensile strength of the reinforcement; that means, whatever the bond resistance coming whatever the bond resistance there in the reinforcement.

If it is greater than your tensile strength, then then you can say that it will be tensile failure; that means, ultimate limit state is control by tensile rupture it bond resistance is greater than tensile if tensile resistance is greater than your bond, then the ultimate limit of state will be control by bond failure means which about the minimum that will be control means ultimate limit will be control. So, it will be limited there in past case it will be ultimate limits that is control by the tensile rapture second case it will be control by your bond failure this is called as a pull out failure. If your ultimate limits state will be controlled by bond failure, then this is called pull out failure.

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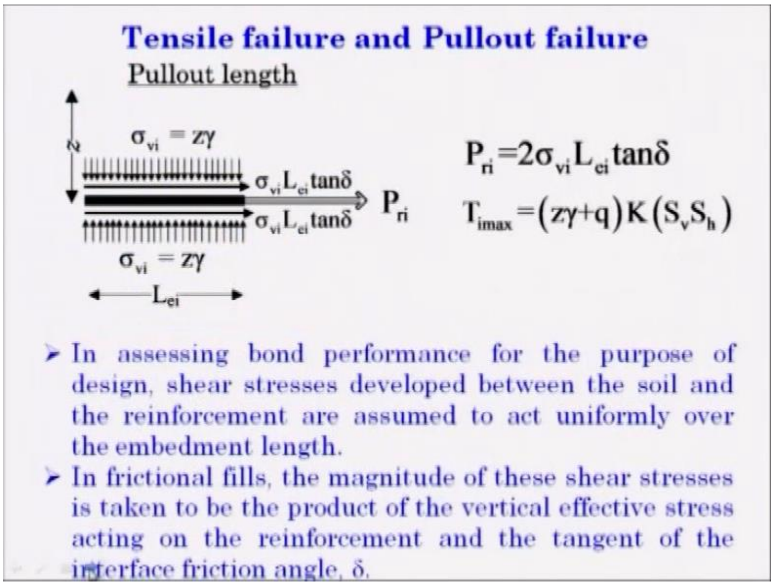


I can stop it here then next we can go for next class tensile failure, and pull out failure detail derisiveness.