NPTEL

NATIONAL PROGRAMME ON
TECHNOLOGY ENHANCED LEARNING

CDEEP
IIT BOMBAY

ADVANCED GEOTECHNICAL ENGINEERING

Prof. B.V.S. Viswanandham

Department of Civil Engineering

IIT Bombay
Lecture No.46

Module-5
Lecture-7 on Stability of Slopes

Welcome to course on advanced geotechnical engineering this is module 5 stability of slopes lecture 7 so in the previous lecture we introduced our selves to different slopes to the analysis method and in this lecture we will try to look into the slopes stability analysis method using some software which are basically based on the geo studio 2012.

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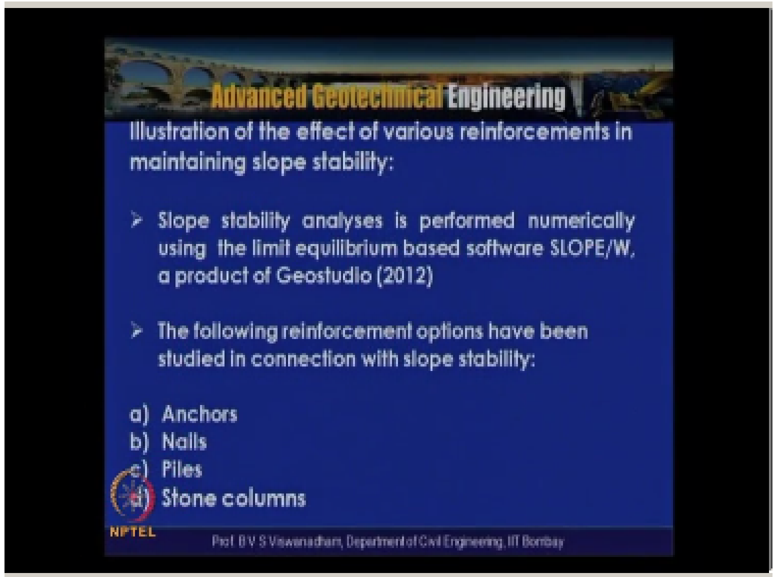

All this what we are going to demonstrate in this lecture is that how the effect of anchor will be there on the slope stability name you know how the name can increase the slope stability and then piles as critical enforcement that file members the discreetly based piles within the you know row of within the slope area and then finally we look into the slope columns and then we look size replacement of the slopes without any strengthen measures okay.

So in this particular slide we illustration of the effect of various reinforcement options in the slope stability are maintained in the slope stability are discussed so in the slope stability analysis it is performed numerically using limit equilibrium method based of software and which is the product of slope W by using slope W and it is a product of geo studio 2012 the following reinforcement options have been considered one is that anchor nails and piles and stone columns and attempt have been made to compare.

The analysis result with the let the results published in the literacy right attempts have been made to compare the results to the published literacy results now the example problem 1 illustration of the reinforcing mechanism of anchors and slopes.

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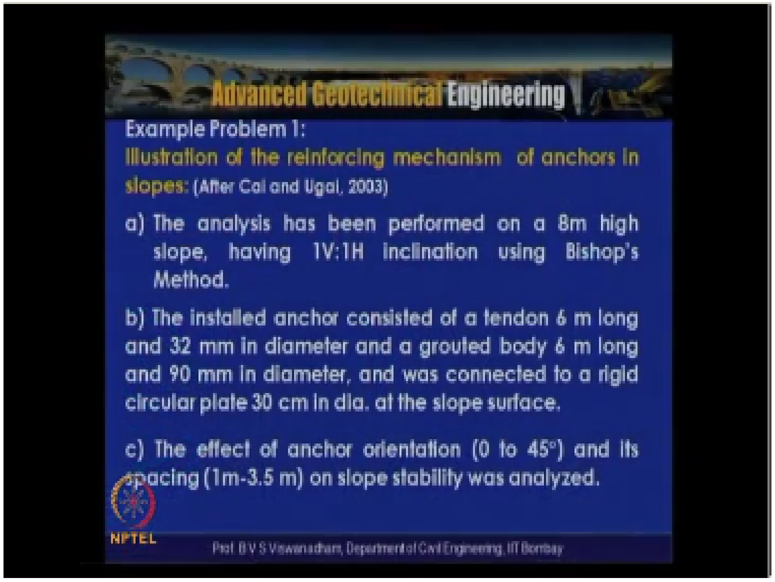

This is the theory part we actually have discussed in the previous lectures according to 2003 in this the analysis has been performed on 8meter high slope having 1 vertical 1 horizontal slope inclination and the analysis was performed by using bishops method the properties and configuration are actually given by cal and ugly in 2003 were considered by installed anchors consist of an tendon of having 6meter and 32 mm in diameter and a grouted body of 6m long.

And 90 mm diameter that means that entire length of the anchor is actually grouted with 90mm diameter and that tendon is about 32 mm and it was connected to a rigid circular plate of 300mm diameter in this slope surface so the anchor was actually based on the surface and with the different inclination was consider the anchor orientation with reference to the you know horizontal from vary.

From 0 to 45 degrees just to see the influence of anchor inclination on the slope stability and it is spacing if the spacing along the slopes surface that means that the spacing was actually considered in the range from 1 meter to 3.5 meter so what will be the you know optimal spacing you know spacing effect on the social media analysis of you know slope reinforcement anchors studying.

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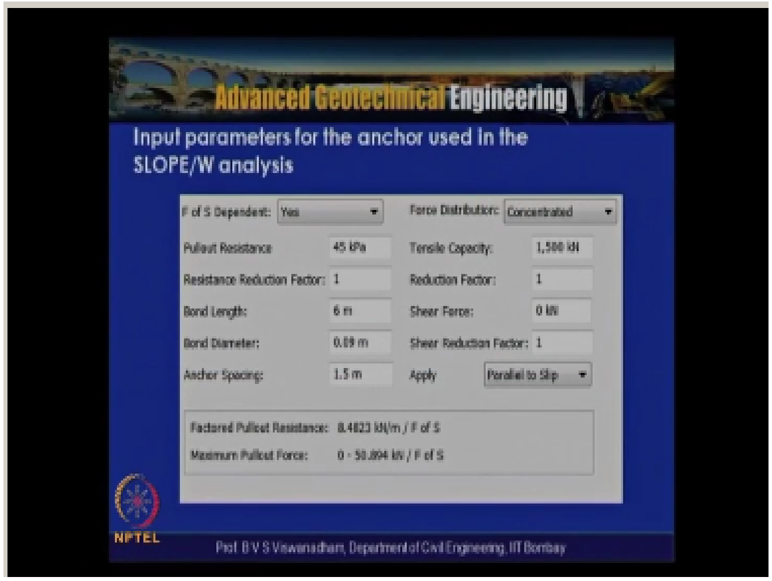

So this is the input file for the slope W with the anchor used in the slope W analysis and based on the calculations and details provided by the cal 2003 the tensile capacity was given as equivalent to that of the data which was given 59 kilo neutrons and no reduction factors are been given.

And bond diameter as been told diameter in body so the details have been on length that is the entire length is daughter so 6meters anchor spacing for this example which is actually shown 5 and factor coloration resistance and maximum resistance the ranges were actually given there.

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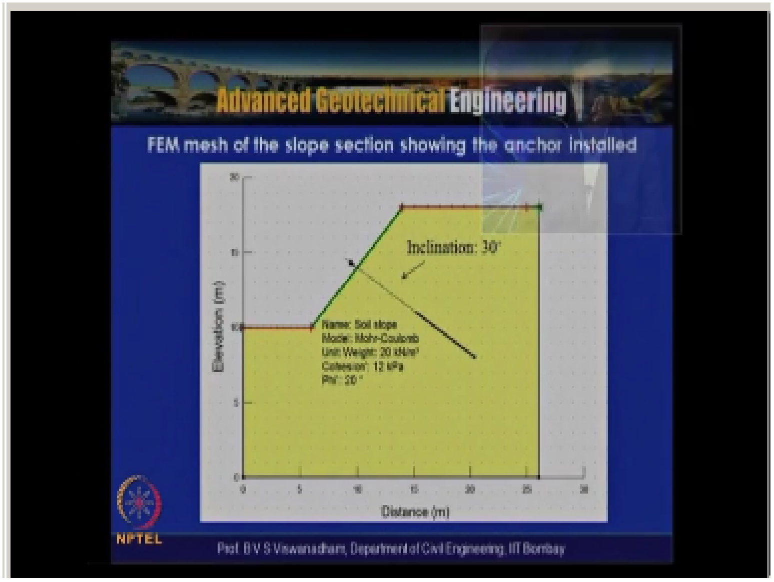

Now this is the FEM mesh of the slope section showing the anchor installed the cross section of the you know the slope with anchor and in this particular example the continuous inclination of the anchor with horizontal zone was considered so as it can be seen here this inclination with the horizontal is 30 degrees.

And here is you know plane which is actually placed and the slope configuration which is actually shown here so this is the horizontal distance and this is the elevation and the model is more coolant and unit weight is inclined from meter cube and coefficient 12 kilo Pascal and friction angle about 30 degrees so this is the analysis was done for comparison purposes with and without anchor.

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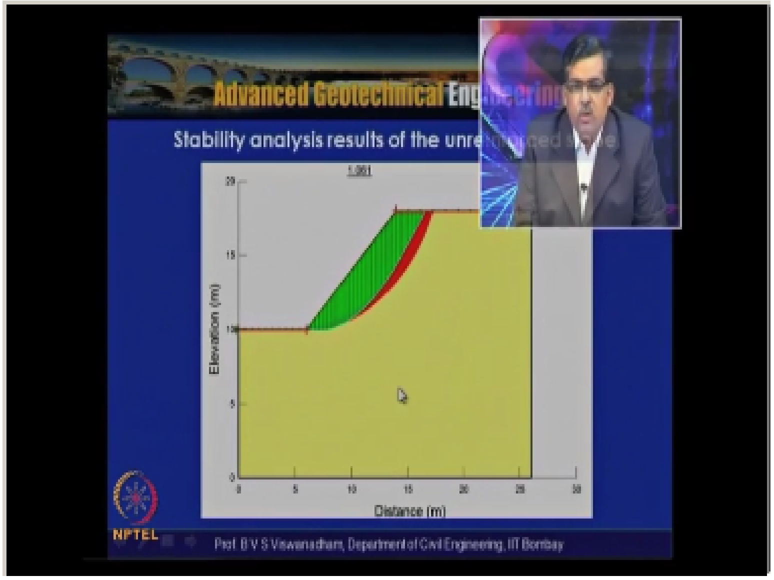

So this is stability analysis results of the unreinforced slope and for configuration which is considered the least factor of safety is obtained by using bishops method as 1.061 so the stability analysis which is the results of unreinforced slope version and this is the joules of you know the potential failure surface so this heals the factor of safety of 1.61

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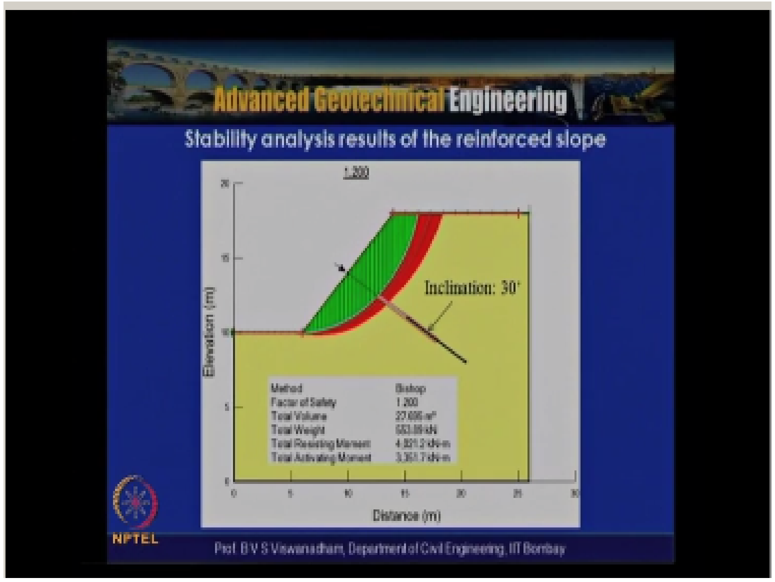

Now the similar configuration is analyzed with anchor where in this anchor was actually inclined at 30 degrees so the factor of safety which is actually shown the here 1.2 so there is an improvement in the factor of safety for a given type of nail and for given type of anchor and for a given anchor inclination.

And it can be seen here that total resistance moment is more than the total activity moment so here the presence of anchor answers the stability and also contributes to the you know the change the quick surface that means the quick surface goes away from the face of the slope so this can be you know observed from the cross section which is actually shown here.

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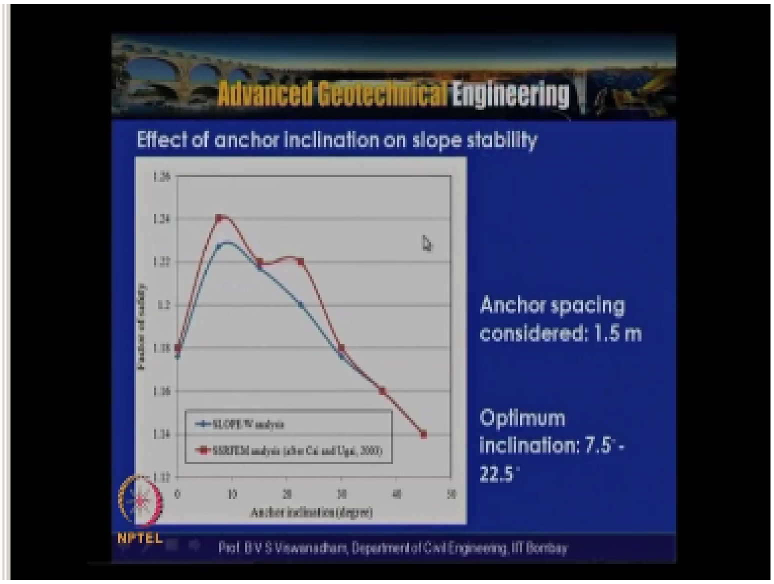

Now in this particular graph which is actually shown here anchor inclination with horizontal is plotted on the x axis and factor of safety which is nothing but the resulting moment by drive moment which is obtained by cal in 2003 and the analysis results were actually combined so in this the parametric study was carried out where in the anchor inclination is about 0 degrees when anchor you know.

Both you know the analysis done by you know FEM analysis is done by cal in 2003 and the present analysis want to have you know good agreement but in that tend which is actually presented in increase in the need in inclination there is the increase in the factor of safety from 0 degrees when the anger inclination is increased there is a increase in factor of safety and further increase beyond 10 degrees here is the decrease in the factor of safety.

So this indicates that there is an optimum you know inclination of the anchor which contributes to be you know the resultant the factor of safety so here it actually both from the cal in 2003 and the present analysis by using slope W program it actually says that about 12 to 10 degrees the optimum about 9 to 10 degrees there is an optimum you know factor of optimal inclination of the anchor where there is increase in factor of safety but with increase in the anchor inclination there is a increase in factor safety.

And similar trend was actually also reported by cal and you can see that increase in the anchor inclination decrease in factor of safety so this lead to know instability of this slope so one need to consider that the slope analysis using the slope inclination measures the decrease upon the slope configuration with.

The slope inclination or that slope inclination and one need to understand that there is the importance of this angle inclination on the slope stability which is not that you know each and every slope as same angle inclination but it depend upon the types of geometry after dual analysis one need to set the optimal inclinations for the you know given problem.

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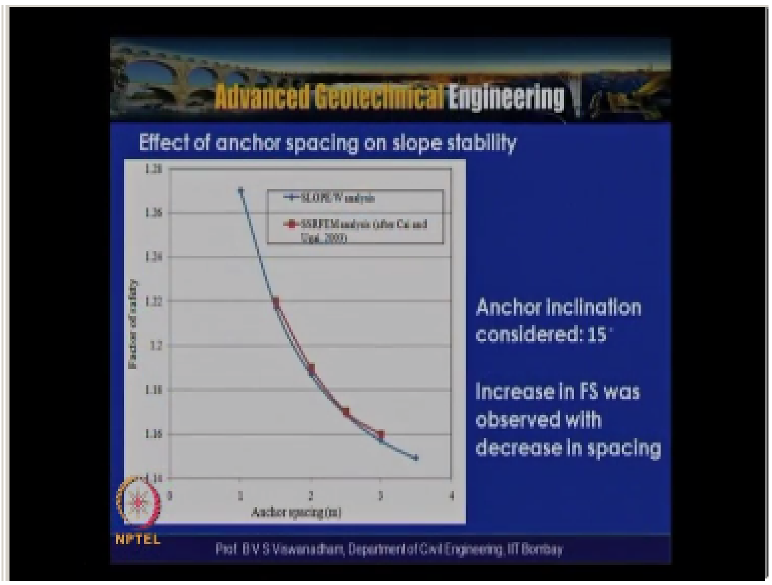

Now in this slide factor of safety variation with the anchor spacing so it can be seen that within increase in anchor spacing from because it varied from one meter to 3.5 meter at one meter anchor spacing was increase in the factors was about 1.27 but with the increase in anchor spacing that is the central distance of anchor spacing along the length of the slope it appears that there is a decrease in factor of safety.

And these analysis results also with increment with cal 2003 so in this particular slide anchor inclination is consider about 50 degrees so for 15 degrees this anchor inclination what it can been seen that there is a decrease in the factor of safety increase in the anchor spacing so increase in factor of safety was observed with decrease in spacing.

So it appears that for a given anchoring inclination the anchor spacing between 1 to 1.5 meter for the given slope inclination and is found to be you know ideal and also it depends upon one also need to consider the position of the anchor here also from the distance that means that where you are actually putting the anchor that is at the you know unit distance also in this particular case the anchor was actually located a single row of anchor was located in the mid distance of the slope.

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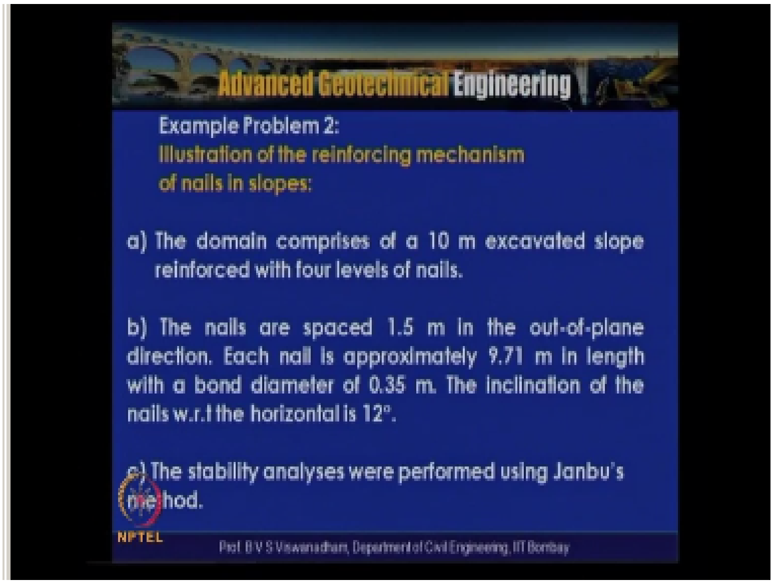

Now after having discussed this slope stability analysis is problem by using anchors now we actually have discussed about influence of inclination and influence of you know the layout of the names on the this example illustrate the reinforcement of nails and slopes and this basically 10 meter x2 slope reinforced with 4 rows of nails it was consent and the nails are placed at 1.5 meter in this example and they are out of the direction and each nail is approximately about 9.8 meters in length if a bond of diameter of 0.35 meter.

The inclination of the nail was kept with respect to horizontal is 12 degrees and for a difference stability analysis profound by using janbus method so in this particular example the reinforcing mechanism of nails and slopes was is discussed and say 10 meter high you know actual slope and with reinforce with 4 rows of nails.

And that is at 4 levels the nails are actually placed generally in the case of as the process proceeds the top bottom approach is adopted and the nails were installed and the next level of done the nails are placed 1.5 meter both in horizontal and vertical direction that is SV=SH=1.5 meter and each nail length is about 9.8 meters that is the length of the nail is equal to the height of the slope was considered and bond diameter is about 0.35 meter inclination of the nail with horizontal is about 30 days.

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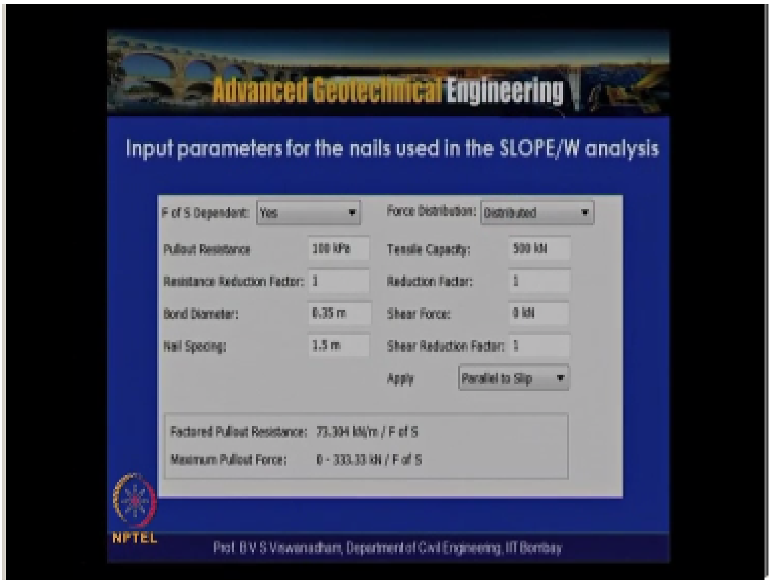

So this is the, you know typical input parameters for the slope W analysis the details were actually given when in the as the input of the analysis.

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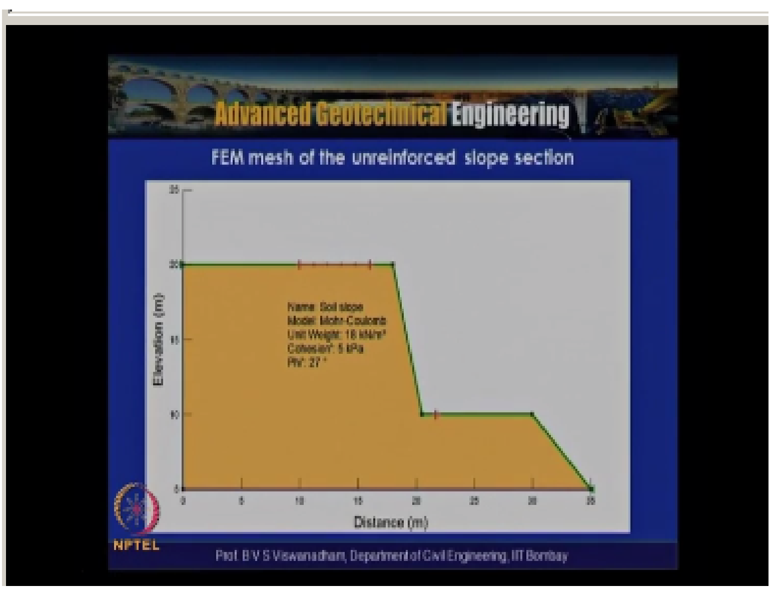

And this is the you know the typical cross section of the reinforced slope section where in the property are actually taken of 5 kilo Pascal and 27 degrees is an friction angle and this slope is having you know the inclination which is actually shown in the figure with this level at 10 meters and this is particular inclination is about 79 degrees between 63 to 79 degrees horizontal.

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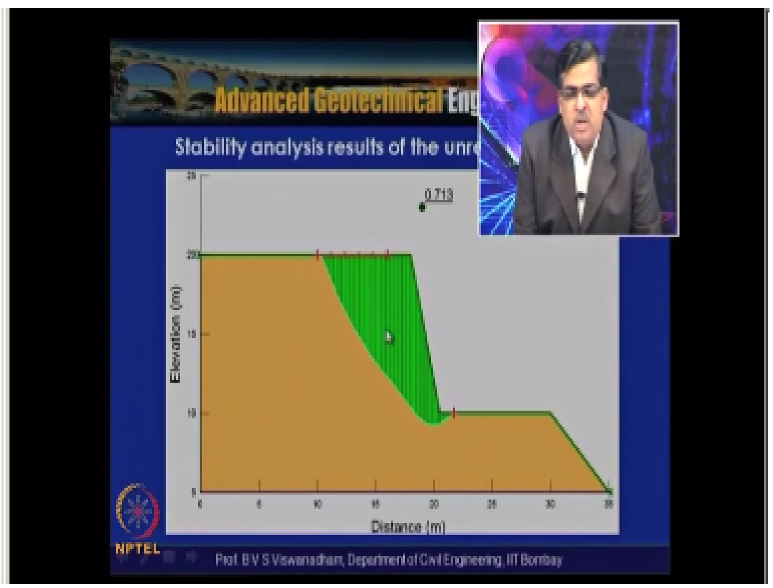

And this is the stability analysis results of the unreinforced slope it can seen that for this particular type of properties which are given the slope actually has already you know born below the factor of safety of 1 so this stability analysis results of the unreinforced the slope cross section is shown here and which actually implies that the slope is undergone failure now the stability analysis which is the results of the slope has shown where it can be seen.

That nails inclined at 12 degrees placed at you know distance with 1.5 meter in the vertical direction and you can see that these are the length of the nails which will be 9.71 meters length of the nails and this is having to the point 0.35 meters diameter greater body and this is the you know surface which is actually obtained the factor of the resulting factor safety is inclined about 2.158 again the total resistance force is about 15 kilo Newton and activating force is about 700 kilo Newton's so this is you know the you know the stability analysis of the slope reinforcing with names.

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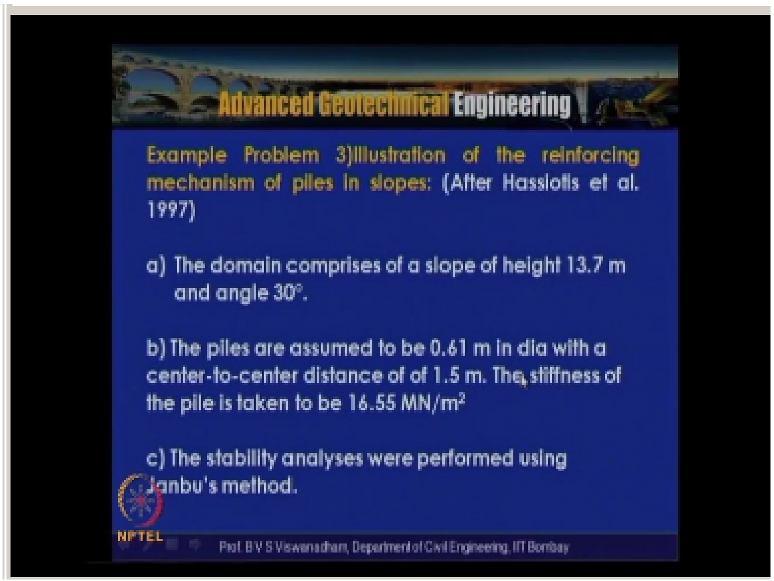

Now this is an example 3 basically this is illustration of the reinforcing mechanism of piles and slopes and hassiolls et al in 1997 are given the stability analysis of this slopes reinforced with piles by using friction method and the similar configuration properties are actually given by assoils et al in 1997 and this domain comprises of a slope of height of 13.7 meter height and angle 30 degrees and the slope is actually having very flat inclination one vertical closed to horizontal inclination.

And the piles are assumed to be of about 600 mm and diameter with center to center distance of about 1.5 meter is that the piles are actually placed you know as discussed in the while discussing the theory but the you know piles stability depends upon the slopes and within the slope so here it says that the sloping the spacing of let us say 2.5d approximately for sloping the 2.5d was consider but the spacing you know the piles would tend to behave like a individual you know individual piles.

So when the spacing there is a possibility that achieved is developed into so what will actually happen is that the piles will you know attack the load in the form of you know when they undergo the soil along the region with then piles and that prevents the moment of the piles you know the moment of the piles the moment of the slope so hence this slope stability can be enhanced so the stiffness of the file is taken as 16.55 mega Newton for meter square and this stability analysis was performed on by using janbus method .

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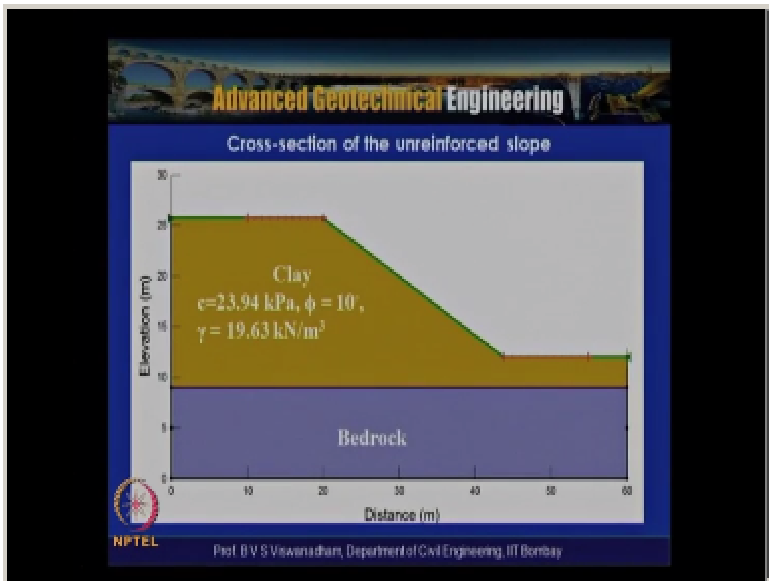

So this is the cross section of unreinforced slope where in the slope height which is you know by having on vertical inclination the position is about 23.94 kilo Pascal and fiction of 10 degrees and γ 19.63 kilometers was considered and here this is the cross section of the unreinforced slope and the pile was assumed to be located at 5 meter from the top if the slope there is the possibility that pile can be located you know at a distance.

From the literature it has been found out that in the location of the piles is at you know at the distance from here there is the possibility that there is a good formation of the reason for having the stability of a slope the pile is actually placed at the you know crystal of the slope and there is the possibility that it can be in front of the pile moment protected the pile with you know pile which is motion which is actually beyond may be subjected to the failure.

So the research study which is actually carried out at IIT Bombay means if this is the distance lx and if the distance ll horizontal distance if lx/l=0.5 you know the maximum factor of safety and maximum performance can be ensured so this here piles are actually placed in a single row and the space relative 1.5 meter distance intact here also possibility that if the x of the piles are connected.

And then also contribute to the you know additional stability and sometimes for some application like in landslides when the failures are here the piles are actually upper portion are actually committed and these are actually called as sub walls and arrest the moment and events so this is symmetric analysis so this is the stability analysis of the slope for the given configuration and the properties.

The slope factor safety is around 1.10 the factor of safety is imported by the set is supported by 0.8 and the stability analysis of the slope find place at slope where in it actually says that it is about 1.29 is about 1.3 so this is actually found to be in bound to be toe of the it actually analysis results of the reinforced slope factor safety has improved it is about 1.29 and as a report by hassiotis et al 1.30 good increment with the results published by set in 1997.

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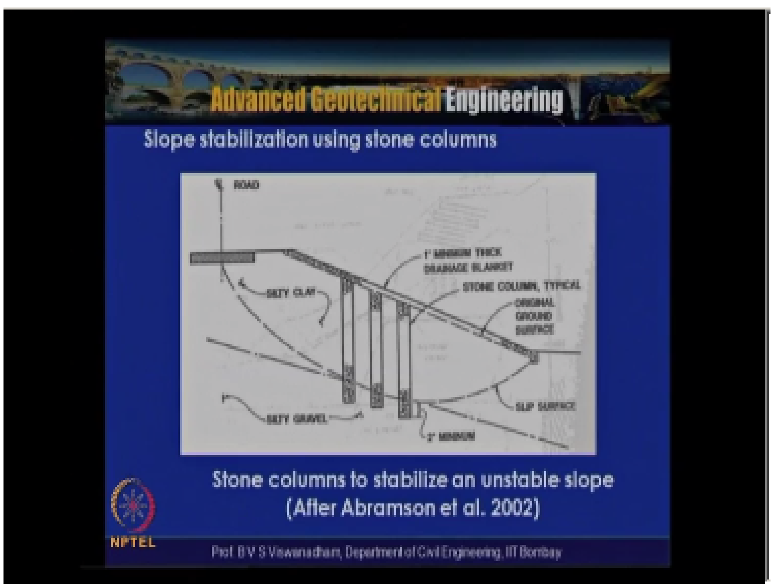

Now after having the stability analysis using piles and we also said that one of the methods for enhancing the slope stability particularly the slopes below the you know vertical structures where unstable slopes can actually lead to the you know the moments of the coil and induce lateral forces on the piles supporting the structure and this was one of the application where it was used in other areas where this was actually used for increase the stability of a slope.

So we actually have discussed this scheme saying that if you are actually having piles if you are having piles and which are actually having you know the charge which is actually having sides from 10mm to 40mm, 50 mm and well graded mix if it is there is the possibility that the factor of safety can increase and then we also have discussed that when you use the stone columns to stabilize an unstable slope the pile.

The granular pile which are actually placed can serve as a capacity as well as the you know capacity of having you know adequate drainage so that the actually pore water pressure which are actually possible that they can build up during the you know the construction of slope called you know in the field they can actually contribute to the dilation of this pore water pressure even after increase in the factor of safety so here the slope satiation column here.

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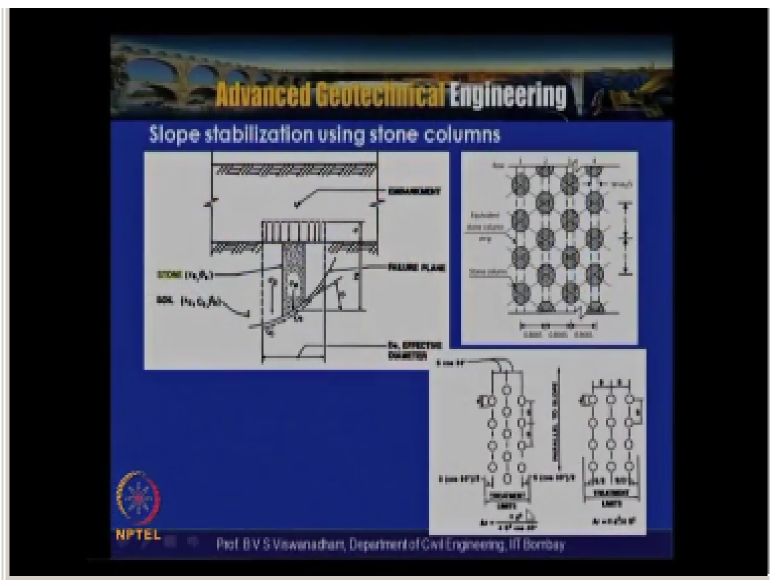

Once again you know this is already shown which is actually one of the patterns of the arrangements where the tangent factor is actually arranged like this and it can be seen that the each pile or stone column contribute you know certain area so this is nothing but right diameter of the stone column to the stabbing area and that is called as area ratio so here this is for the square layout and this is for the these two are for the, the triangle layout but if you look into here when there is a certain load.

And when you have got stone column with high stiffness the clay are ground having you know low stiffness you know the stress concentration makes it to attack the forces that is stone and sigma stone and sigma ground trying to load which is actually which is applied on to the you know the composition system so by using you know method we can actually find you know the composite shear strength parameters and this stable is carried out .

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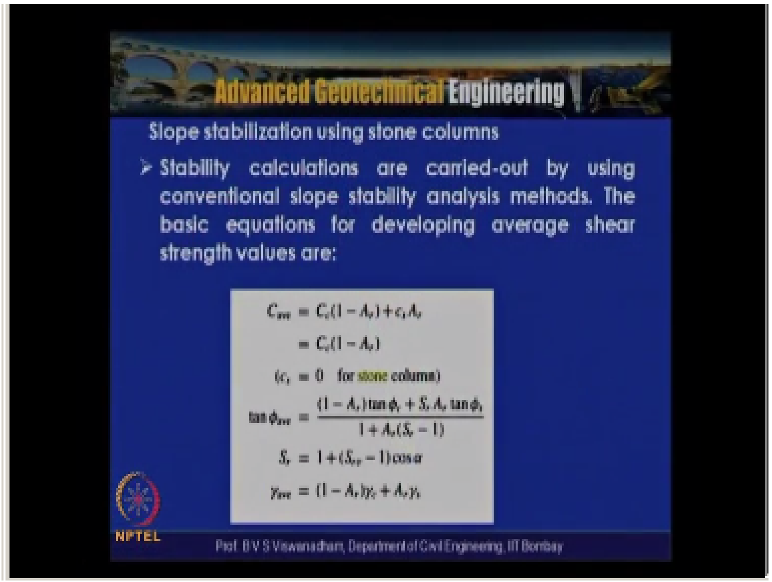

By using the convectional slope stability methods where in we actually assumed that piles are the stone columns as the individual elements and also calculated properties by using the shear stress parameter where c average is actually obtained as the coefficient into stone column as stone is actually from piles so that is equal to 0 and similarly pile average is obtained based on the accept ratio and the other parameters are actually given.

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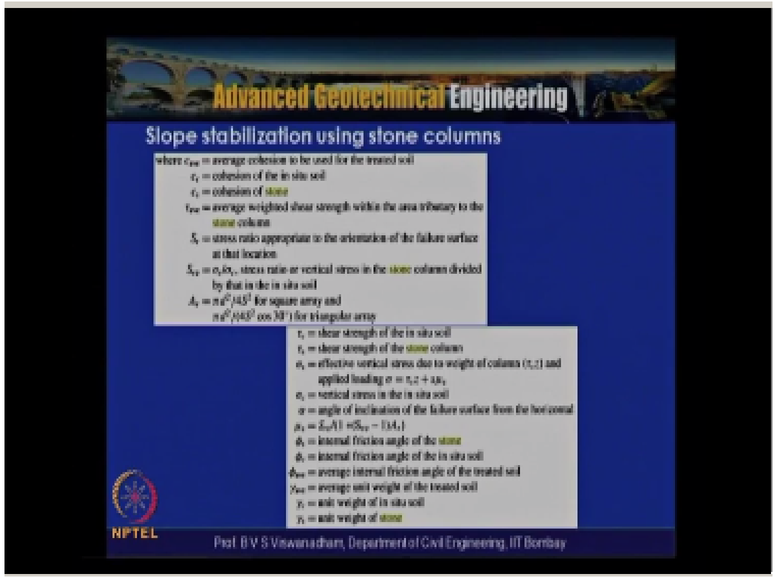

So these are notations these are actually shown here once again in these self shear analysis the using stone columns so the analysis problem which was considered the slope actually having 13.7 meter height and 30 so inclination and the stone columns are assumed to be 1 meters in diameter and the central spacing is about 3 meters and they are assumed to be triangle pattern and the stability analysis is performed by using jab bus method.

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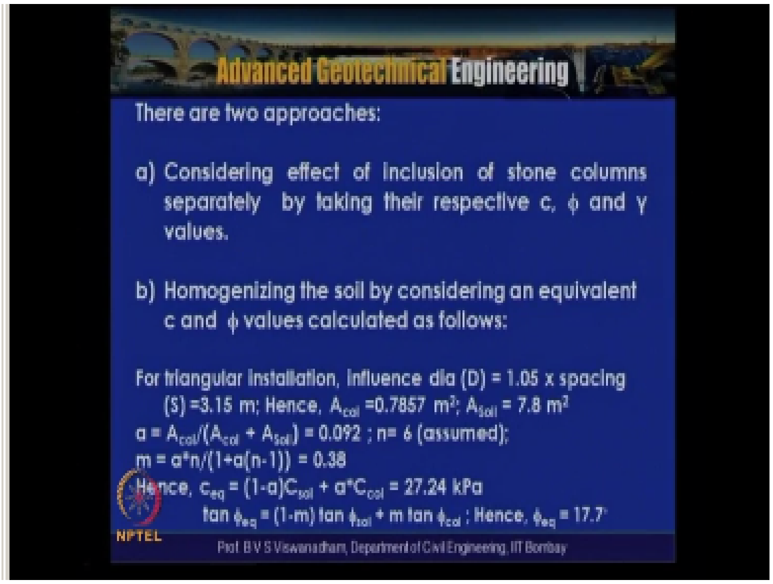

So considering the effect of inclusion of stone columns separately and by taking the respective c ϕ and γ values both the cases were actually done so here what is done here is that we actually have got soil at number of locations these stone columns placed in you know at within the slope which is actually considered and the respective soil parameters were actually considered that is one way.

But the method which is actually proposed for analyzing this is actually calculating the average shear stress parameter Newton based on the you know stress concentration factor so for triangular installation the influence the increase in diameter can be obtained as 1.05 in the spacing so here the spacing is actually assumed as 3.15 meter hence we can actually you know calculate the influence diameter.

So this 1.05 in spacing is 3meters os the influence diameter is about 3.15 meters that is the you know each pile or stone column you know characters the area diameter which is equivalent to 3.15 meter and the area of the column which is nothing but diameter of the stone column is about one meter so which is about 1.787 meter square and the area of the soil is 7.8 meter square so area ratio which is nothing but a column divided by a column plus a soil so based on that what we 0.09.

And these stress concentration factor assumed as n=6 and it actually varies from you know 4 to you know 10 but here it is assumed in the 6 and the validate of m which is actually computed as the area replacement ratio into n that is stress concentration divided by 1+a.1-1 which is obtained as 0.38 so c equivalent is equal to 1-a.c soil +a.c column.

So with that what we have got is that 27.24 kilo Pascal similarly the tan ϕ equivalent is obtained as 1-mtan ϕ soil+mtanϕcolumn so this is equivalent to ϕ=71.7 so this is so these are the you know the resultant parameters for the you know joules which is actually influenced by the you know presence of stone columns in the slope.

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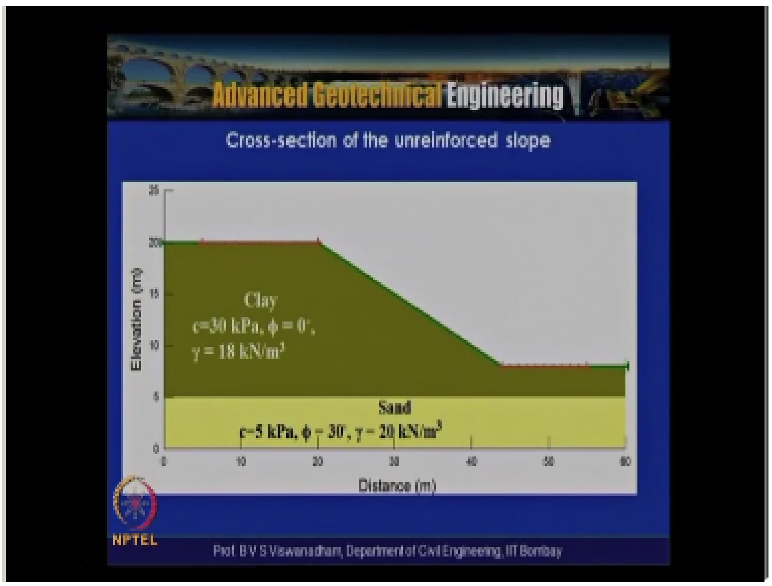

So this is cross section of the unreinforced slope is actually shown here where in we have the same properties which are actually taken the properties are clay which is actually having in 30 Pascal and ϕ=0 and the sand actually having you know properties of fiction angle of 30 degrees and γ 20 kilo meter is considered now method 1 not considering inclusion within the slope and here 4 rows of stone columns are actually shown here so this is the joule which is you know strengthen by that the stone columns here.

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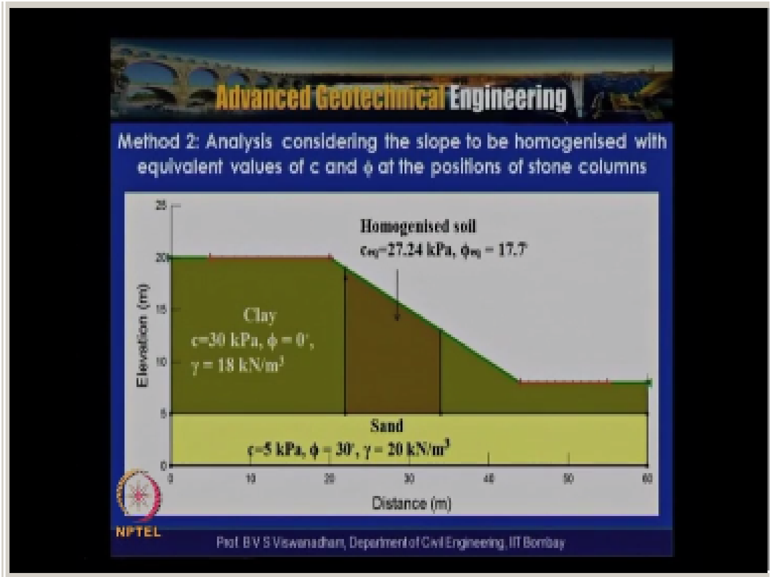

And then by using method 2 analysis considering slopes to be homogeneous with equivalent the values of c and ϕ with positions of the stone columns and rest of the portions here the properties of soils were given but here in this zone the equivalent like stone is 33 Pascal's where c is equal to 37.24 and ϕ=17.7 was actually given so you know then the results are actually compared without any two columns and with homogenous c and ϕ.

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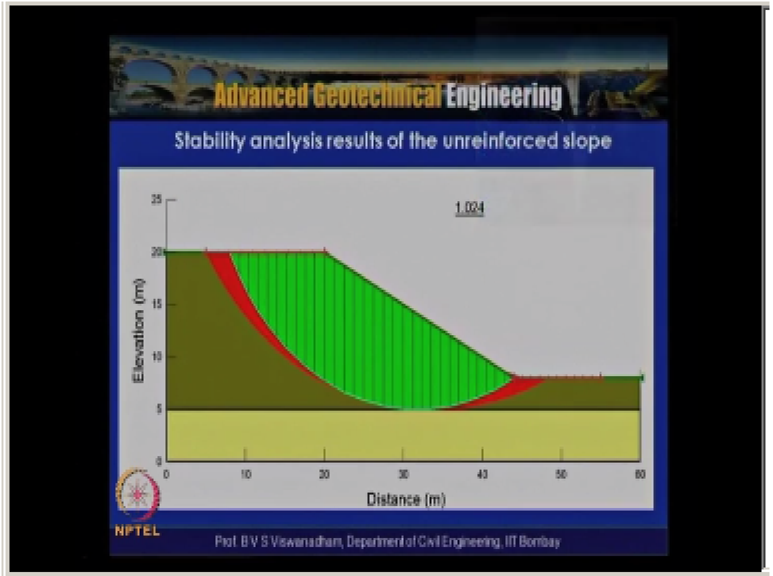

So these particular figures shows the cross section of a slope with you know without any stone columns that is it is actually an unreinforced slope the factor safety obtained about 1.4 to 0.4 so improvement of the you know factor of safety in the particular example the slope variation was considered now here this is the transitional phase slope with classify the stone results of safety where the slope is consider with the effect of 4 individual stone columns which is actually shown.

So where the factor of safety is found to be increased where in the factor of safety is obtained is about 13.04 now this is you know the by taking the step equivalent to properties in the joules influenced by the stone columns so the factor of safety was found to improve where in you have the factor of safety which is about 1.432 with the presence of stone columns so what these examples what we understood is that the in designing this slopes with stones columns.

First we have to decide the of the column depending upon the method of installation then the type of installation need to be selected once it is selected then you know the we have see the based on the you know the stone charge properties and then the gradation you need to select what is the you know the possible fiction angle for these stone metal which are used in stone columns the fiction actually varies from 38 to 42 degrees.

And which I assumed to be placed at density and then we proper layout has to selected generally the triangular layout was found to be you know to give you know uniform you know improvement in the stabilizing behavior so then after having selected and then we have to see the calculate the average shear stress parameters by using the average method which is suggested at get the c equivalent.

And y equivalent and this is depend upon the layer out of the stone columns and if the stone columns diameter is smaller then there is the possibility that the factor of safety cannot actually have much improvement and when we have actually have got this improved area the joules increase but there is the possibility that the factor safety increase for the entire slope.

So this is one you know application where in you know the slope stabilization can be enhanced by using this stone columns so in this particular analysis what has not be taken is that presence of stone columns when there is cp water or the slope is saturated when there is the possibility that these stone columns can also cat like dry in that case actually have got hybrid effects one is called you know for drainage other one is for reinforcing the slope.

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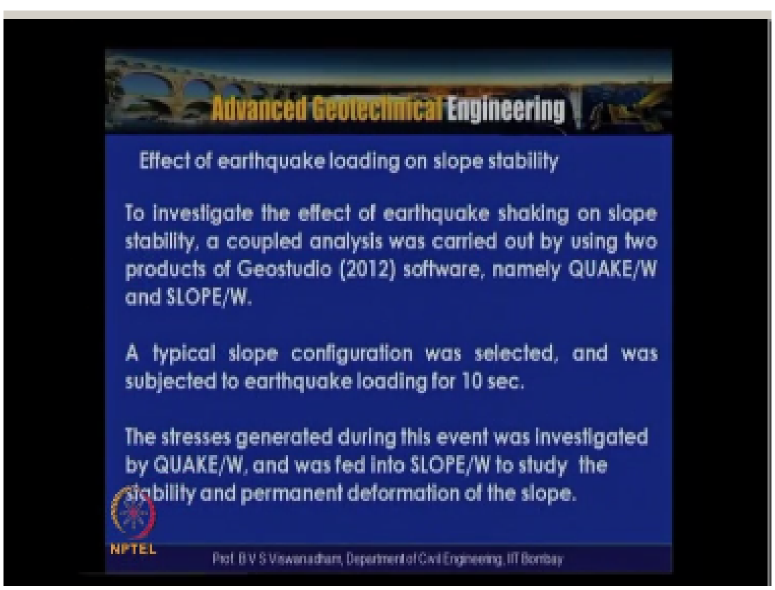

So after disused about some typical method of the you know slopes to be ready what we try to look into is that you know the how this you know earthquake loading can affect the slope stability so in order to investigate the effect of earthquake shaking on slope stability a coupled analysis was carried out by using you know joules of geo studio 2012 one is with W.

And one is slope W and here typically slope configuration was selected and was subjected to earthquake loading for about 10 seconds and the stress generated during the event was investigated by quake W sand was fed to slope W to study the stability and permanent deformation of the slope so this particular analysis was carried out by using you know the slope quake W and the slope W.

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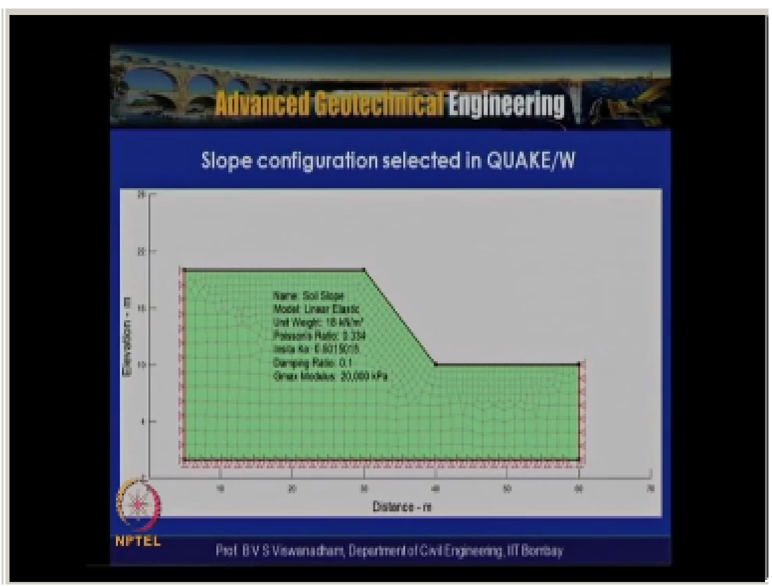

And this is the typical slope configurations selected in quake W where these soil slope which in the following properties is actually been shown here.

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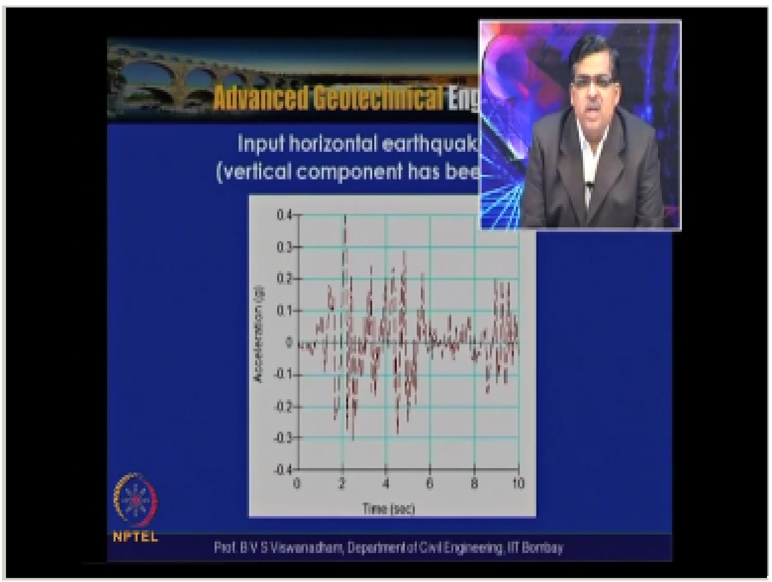

And this is the input horizontal earthquake record which is actually given and vertical component of as been ignored so with time seconds and then ax illation which is this motion is after estimating by seeing this input for a seeing this effect on the displacement subsequently the factor of safety is been related.

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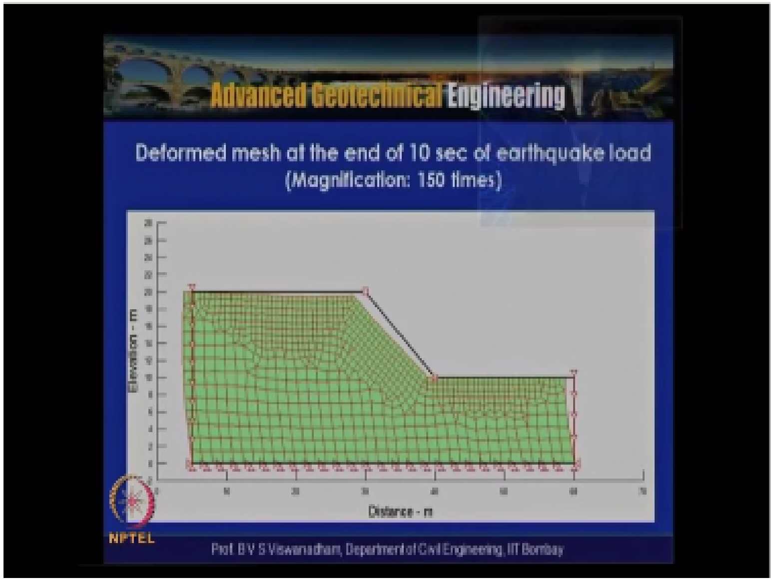

So this is the deformed mesh at the end of the 10 seconds of the earthquake load this is actually magnified by 50 times so it can be seen that the slope as actually undergone deformations.

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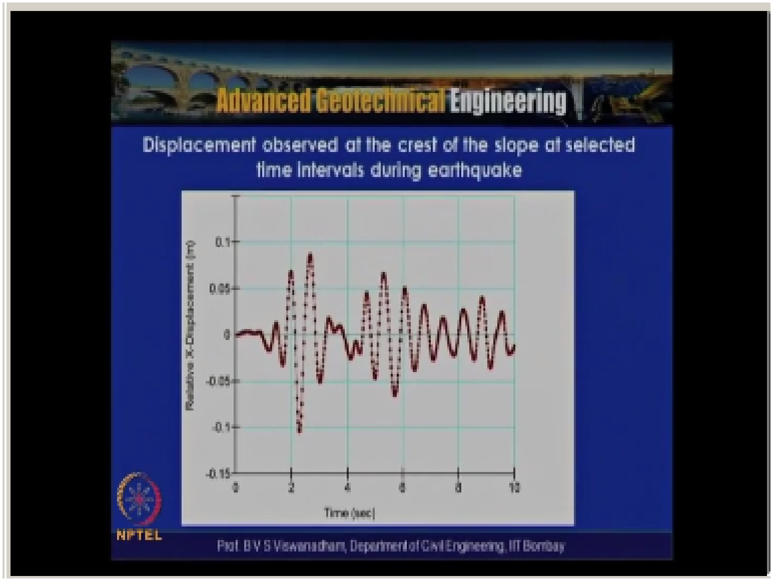

So the displacement observed at the crest of the slope of selected time intervals during earthquake are actually plotted so it can be seen that the crest displacements are actually engine from -0.1m to +0.1 meter because of the you know subjected to the ground motion so it is actually reported like this which is computed by using that quick W module.

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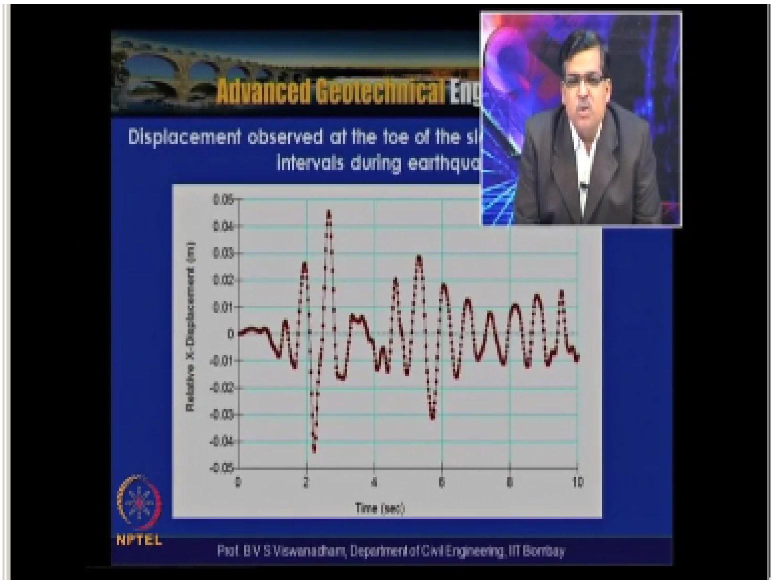

And this is the displacement observed at the toe of this slope have selected time intervals during earthquake it actually shows the slope moment is about -0.04meters to 0.04 meters which is actually reported as the maximum here so after computing the static and dynamic ground stresses earthquake in quick w and by using the equivalent dynamic approach stability analysis was carried out by using slope w and an initial static stability was performed by using the quake generated stresses to establish the factor of safety of this slope.

And then next what has been run is that variation with earthquake shake was monitored slope w by using the quick q newmork deformation analysis deformed configuration was deeded and the analysis was actually carried out by using stability analysis and the rate of change of velocity acieration deformation with time was also studied so in this particular analysis what has been done is that you know this particular analysis is found to be very applicable.

When you are actually constructed to the say you know when you are actually constructing on soils which are actually load for earthquake so where in you know if the embed which is actually coming above ground level this is about say more than 5 meter then there is you know performing this dynamic analysis and once this dynamic analysis is actually performed then suppose if case actually too are doing you know construction filling above the ground level and then we have to ensure that the slope displacement are within the limits after subjecting to the certain ground motion in such situations we have.

To see that if the you know the soil properties are inadequate there is a need for doing the sub soil by using in a appropriate you know improvement measures then enchased the minting the compute this stability analysis you know with this particular cases so this was actually done in analysis process in for the canal slopes where it has been taken that the limits for this displacements outline from the dynamic analysis were actually set like you know horizontal displacement.

If at all if it is there then it has been said that it should be you know more than the thickness of the filter which is provided in the and vertical displacement was found to be you know should not be more than free board which is actually maintained in the particular analysis so if the displacement which are actually resulted after subjected to dynamic loading less than this you know set parameters then we can actually ensure that you know the so.

And so configuration is actually stable again then it is so called earthquake loading and if the particular slopes which are actually been constructed or the source which are going to be constructed the appropriate this stability measures is like you know after construction if they are found to be you know the analysis was the proper analysis was not done during construction.

Then if they found that failure in appropriate slope stability method need to be you know considered and then used in the analysis so here the slope properties used in the slope stability analysis the surface is displaced by using the entry and the exit button and which is actually shown here then the initial factor in the static conditions it is actually obtained as 1.31.

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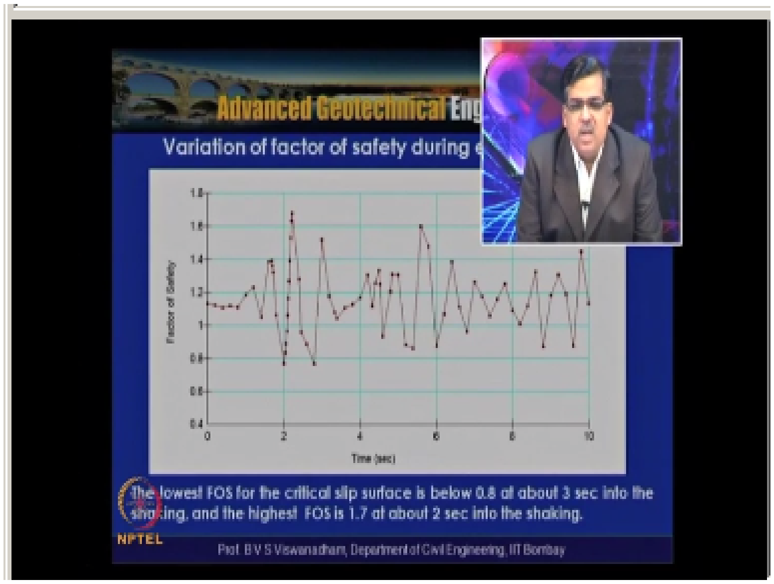

Then this is the you know particular graph which actually shows the variation of factor analysis safety during the earthquake event where the factor of safety with time which is found to be by you know varies with time the lowest factor of safety for critical surface phase is below 0.8 and that is about 3 second so means the slope has undergone the value into the shaking and the highest factor of safety to 1.7 at about 2 second.

So that particular you know configuration might have ensured by the factor of safety but it is found that you know which is subjected to and the average acieration during the shaking period which is obtained as you know which is plotted here so in this what has been done is that where the time in seconds is plotted on x axis with the average acieration range of -2 meters per second square and this is actually shown this is during the shaking period.

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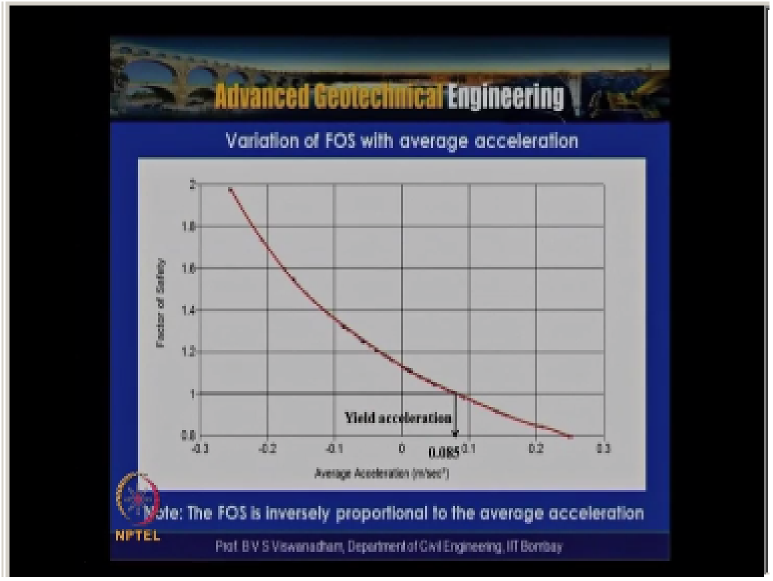

So variations of factor of safety with average of acieration so you can been seen that if the factor of safety was found into you know decrease or increase in the acieration and can be yield acieration is 0.085 where the factor of safety is inversely proportional to average aeration so with increase in you know the acieration the factor of safety found to increase and given problem is found to be with factor of safety is equal to 1 is about 0.085.

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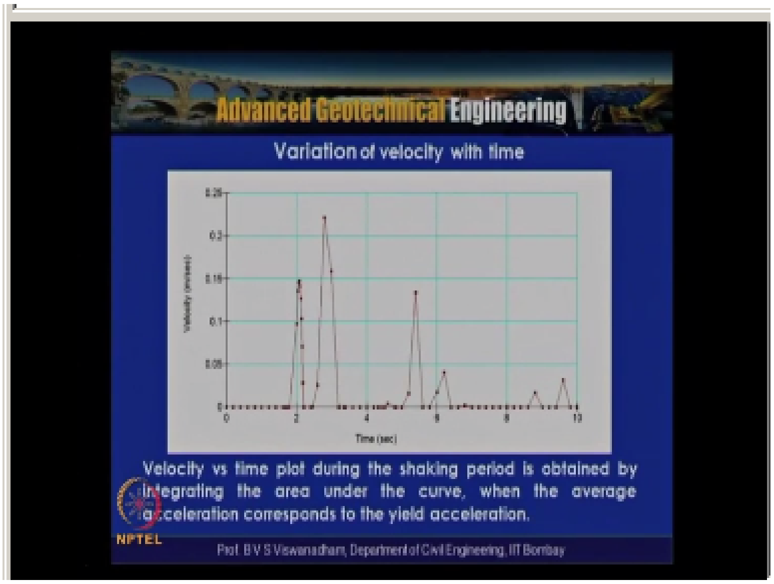

Now these are the plot which is actually showing the velocity variation with the time and the velocity time plot during shaking period is obtained by integrating the are on to the velocity and the average acieration corresponds to yield acieration.

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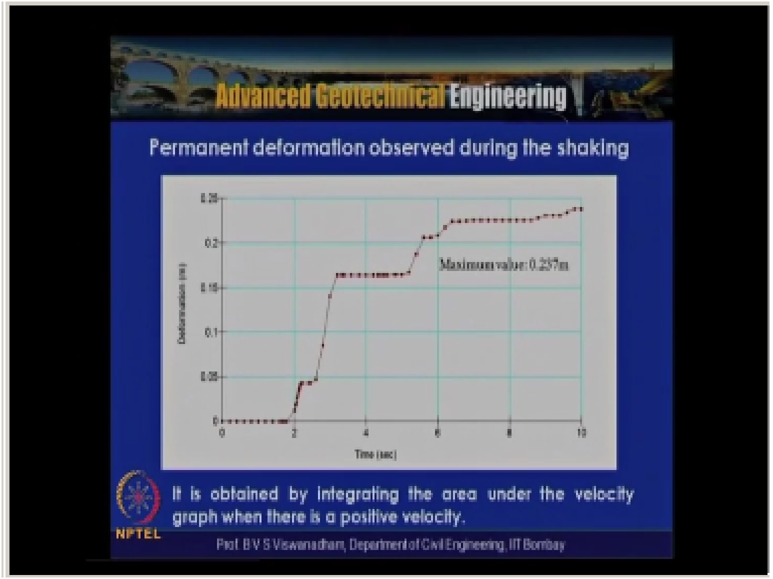

And these are the permanent observations observed during the shaking so in this case you know these facts time which is in seconds and then deformation are actually shown so the permanent deformation found to increase you know but at the end of third and, and then 0.18 meters and then which increase it to about the maximum value of permanent deformation is recorded as about 0.237.

So this was actually obtained by integrating the area when there is a positive velocity whatever the area of the velocity whatever the area which is actually there that has been there with the period of time to get the different deformation so the permanent deformation is scheduled to be about this valid.

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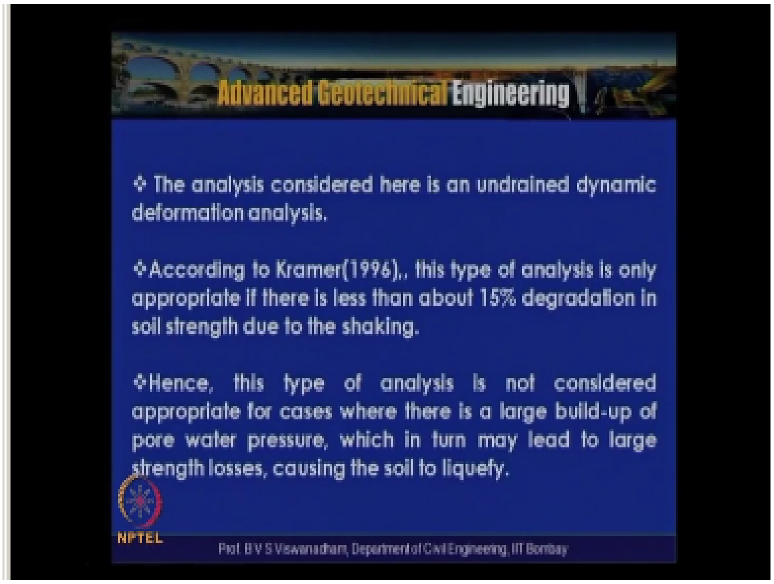

So this analysis was actually done by untrained analysis according to 1996 this type of analysis is only appropriate if there is less than about 15 % due to shaking and the strength of analysis is not when there is a large built of water pressure which will become need to large process causing soil to link so in this particular the lecture what we try to understand is that the stoke development we actually you know many starting from you know the method of sizes and then extending to this bishop method of slide.

And then lead to john burse method and many you know this investigation this instruments this elements between the slopes you know the bishops method of slides and nowadays analysis method that is called you know the horizontal method of particularly when we are actually trying to with analysis by using this is actually applied this is the method of analysis by using can actually refer to method in 2000.

Where he actually had prevent about you know method of sizes by using you know the horizontal method of soils so now after having consider this methods and then different methods like we have discussed some formation like nail slopes and anchor inclination slopes and then here also we have actually got different possibilities like anchor are acting and anchors are passive anchors example acting anchor examples nothing but visitor anchor in that case positive to certain type of the slope.

And that actually contribute goods to the ultra safety then also this methods can be extended for understanding deformation behavior particularly in selecting the proper layout of say nails where you know whether what should be the vertical spacing what should be the horizontal spacing and what is the inclined inclination which is important to be adopted so if these slopes which are actually constructed or going to be constructed in the area which are actually going for earthquakes.

Then the appropriate analysis is required to be performed and in that case the incorporation of this you know the analysis can be performed with let us say once we ensure that and optimal layout and that particular lays inclination slope can be you know subjected to in the dynamic analysis where in the dynamic the with the resultant method of source stability id due to joule reinforcement we can see the deformations of the slopes are under control.

In case if they are not there, there is a requirement change in the design then we also have discussed about analysis for using the student columns and typical that there is a need for the further work in this particular method you know method particularly by using analysis for using stone columns and the another important application what has been discussed is the slope analysis by using time columns where in the limited you know data was actually available.

And particularly for when the slopes like expansive soil slopes when they are actually subjected to lateral move and this is one of the options if we expensive soil is actually not having amount surface if the possibility that if we actually consider this using the line column for increasing the you the stability so in this particular module of we try to use ourselves to different methods of slopes analysis.

As well as the you know different analysis method actually have solved the number of examples where in particularly without any you know strengthening measure so this actually gives a important of this particular module and well this technique is actually discussed tell me interesting slopes and also from the, the new slopes which are under construction.

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NATIONAL PROGRAMME ON
TECHNOLOGY ENHANCED LERNING

NPTEL
Principal Investigator
IIT Bombay

Prof. R. K. Shevgaonkar
Prof. A. N. Chandorkar

HEAD CDEEP
Prof.V.M.Gadre

Producer
Arun Kalwankar

Project Manager
M. Sangeeta Shrivastava

Online Editor/Digital Video Editor
Tushar Deshpande

Digital Video Cameraman
Amin Shaikh

Jr.Technical Assistants
Vijay Kedare

Project Attendant
Ravi Paswan
Vinayak Raut