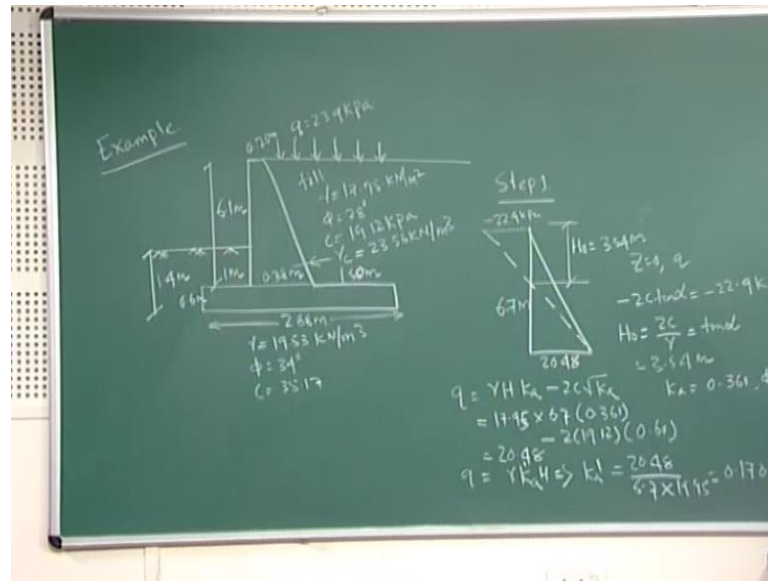


**Application of Soil mechanics**  
**Prof. N. R Patra**  
**Department of Civil Engineering**  
**Indian Institute of Technology, Kanpur**

**Lecture – 16**

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Let us solve one example per kindly bar retaining wall, and its stability analysis check this is the wall, and this dimensions has been given later on we will see where there was no dimensions of wall has been given you will have to start with scratch level.

And this is part of fill, and fill soil your gamma is equal to seventeen point nine five kilo newton per meter square phi is equal to twenty eight degree c is equal to nineteen point one two k p a, and you need to wait of concrete gamma c which is equal to twenty three point five six kilo newton per meter two, and this dimension is given these to this site is your six point one meter, and this is your one meter this zero point three eight meter.

And zero point three eight meter, then this is your zero point two five this part is zero point two five meter, and this is one point five five meter, and total is your two point eight eight one point five zero meters. So, total is two point eight eight meter, and there is a back feel at one end this is your one point four meter, and this is your zero point six meter, and this soil gamma is equal to nineteen point five three kilo newton per meter cube five is equal to thirty four degree c is equal to thirty five point one seven. You will

look at here in these case for example, this dimensions have been given of this retaining wall, and the soil material  $\gamma$  is equal to given five given  $c$  given this is a  $c$  pile soil definitely a tension twenty three point nine  $k p a$ , and there is a back soil also it is height is one point four meter, and also foundation soil properties are given with these given retaining wall it has been asked check this travelocity earlier we have force travelocity we say what is the condition for these stability analysis. So, check for this stability.

Before you go that the step one as it is a  $c$  pile soil look at this. So, total height is your six point seven meter, and this is your or calculator is twenty point four five, and this part is your height of tension crack  $h_0$  which comes to be three point five four meter. So, if you look at it  $q$  at  $z$  is equal to zero. So, this is equal to  $z$  is equal to zero  $z$  is equal to zero. So,  $q$  value of  $q$  will be minus two  $c$  done  $\alpha$  which is equal to minus twenty two point nine  $k p a$  a  $z$  is equal to zero  $q$  is equal to minus two  $c \tan \alpha$  which is equal to minus twenty two point nine minus twenty two point nine  $k p a$ , and  $h_0$ . Also you calculate  $h_0$  is equal to two  $c \gamma$ , which is equal to  $\tan \alpha$  which is equal to three point five four meter.

If you look at this this is a  $c$  pile soil; obviously, there will be a tension crack there will be a tension crack. So, there are two ways of for solution either you remove this tension crack, and you take this part of this, and find it out your pressure what will happen if there is a tension crack.

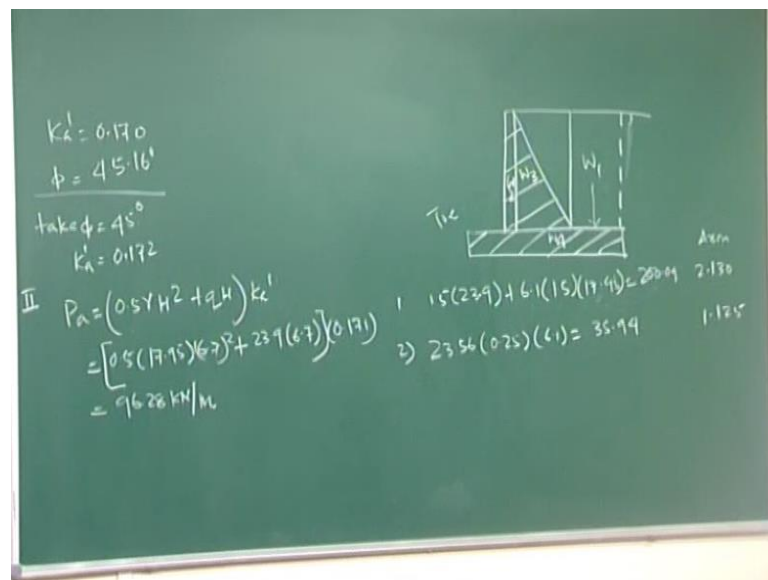
There will be gap between soil, and the wall over the period of time when the rainy season come water pore in side this, then be cracks will come. So, for these kind of problem you convert in to see pile soil into equivalent pile soil. So, it will be taken care of this. So, this  $c$  five has been converted into equivalent pile soil now if I converted into equivalent pile soil. So, if you look at this  $q$  is equal to  $\gamma h k a$  minus two  $c$  route over of  $k a$ . So, for  $\phi$  is equal to twenty eight degree  $k a$  is equal to zero point three six one for  $\phi$  is equal to twenty eight degree from these we can find it out seventeen point nine six nine five into  $h$  is equal to six point seven into  $k a$  is equal to zero point three six one minus two into nineteen point one two into zero point six zero which is equal to twenty point four eight.

So, if this this  $q$  is your this  $q$  is your  $c$  pile soil. If I convert this  $q$ , because I will have to convert equivalent soil of cohesionless soil, if I make it into  $q$  is equal into cohesionless

this earth pressure will be  $\gamma k_a' h$  which is equal to from there I can find it out what is the value of  $k_a'$  which is equal to twenty point four eight divided by six point seven into nineteen point nine, which comes out be one seven zero one seven zero. So, now, with this. If you look at this problem how the problem has been solve this problem can be take consider into two ways; one is you removed the tension crack, and the consider the after removing the tension cracks how much are pressure is coming that pressure you take into consider for analysis in that case other case, you take into consideration of c pile soil into equivalent cohesionless soil the reason is that for c pile soil there will be tension crack in that tension crack over the period of the time what will happen there is the gap between soil back fill soil as well as wall over the period of the time water will be accumulated, once the accumulation is there will be a bigger gap between this wall, and the soil. So, I make it into equivalent cohesionless soil.

So, first I calculate what is the value of  $q$  for c pile soil this comes to be twenty point for four eight, and taking in to without search are this is your  $q$  without search no search has been taken without search, then  $q$  is I make it into equivalent cohesionless soil  $k_a'$  is coming about zero point one seven zero.

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Now, with help of  $k_a'$  one seven zero with the modified value of soil we are taking c pile soil to equivalent pile soil with this  $k_a'$  coming about zero point one seven zero pie is coming about zero point a forty five point one six degree. Let us take five is

equal to forty five degree, and your  $k_a$  is equal to  $k_a'$  is equal to zero point one seven two.

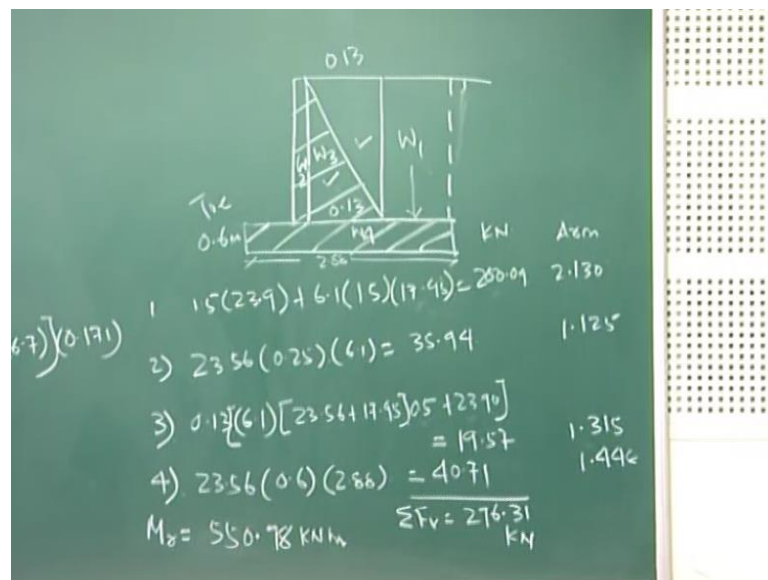
Now, with this you find it out your  $p_a$  value now step two find the value of the  $p_a$ ; that means, earth pressure  $p_a$  is equal to zero point five  $\gamma h^2$  this is, because of soil  $p_a$  is equal to zero point five  $\gamma h^2$  this is, because of soil plus  $q$  into  $h$  this, because of your searchers  $k_a'$  from there, it is coming out to be zero point  $\gamma$  is equal to seventeen point nine five into six point seven whole square plus twenty three point nine twenty three point nine into six point seven into zero point one seven one which is equal to ninety six point two eight kilo newton per meter. So, once you get the  $p_a$  value active are pressure value, then we can go for stability analysis, if I redraw this retaining wall is like this than your value will be it will like this than it will be done with this.

Now if I make into in this way let us say this is my this is my completely whatever part of the soil retaining this is my retaining wall remember this is the wall this the wall, and these part will retain soil mass both this part if I put it into this complete part is your  $w_1$ , and then this is your  $w_2$ , then this is your  $w_3$ , then this is your  $w_4$ , then from this for four part like part one one what is the weight of the part one point five one point five into twenty three point nine plus six point one into one point five into seventeen point nine five which is equal to two hundred point zero nine, and its or arm how much it is acting from this from the toe this distance is given about two point one three zero, then you can find it out also for movement, then for part two look at this part one part one.

If you look at this part one; that means, I am considering I am considering this part is your this is your  $w_1$  this is your  $w_1$ ; that means, this is coming about one point five if you look at it one point five into twenty three point nine what is twenty three point nine twenty three point nine is your search search upto this, then six point one this height is your six point one if you look at here this is to this height is your six point one, and this height six point one six point one into one five into weight of soil seventeen point nine five unit weight of soil seventeen point nine five kilo newton per sorry meter cube. So, it will be your kilo newton meter cube. So, these comes out to be two hundred point zero nine this is your  $w_1$ , and how far it is from toe, because you have to find it out moment resisting.

As well as this moment your, then how far it is than one point five divided two it is you zero point seven five, then plus this plus this it is coming two point one three meter from this toe now come to second part  $w_2$   $w_2$  is equal to how much is your weight of concrete weight of concrete is your twenty three point five six. So, it will be twenty three point five six into zero point two five into six point one it is equal to thirty five point nine four, and it comes out to be one point one two five look at here twenty three point five six is your this part. If I make it into this is your point two five into twenty three point five six is your unit weight of concrete, and your height is your six point five. So, how far the distance is acting this distance is one meter point two five divided by two. So, this is your one point one two five meter one two five meter, this load is coming about this all is your kilo newton.

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Then come to third part come to third part if you look at this third part third part is coming to be this as well as this third part is coming to me this as well as this one is your concrete, and other is your soil two triangle is there. So, if I put into zero point one three how the zero point three come it into picture zero point three eight minus zero point two five. So, this part will be your zero point one three from here to here from here to here will be your zero point one three. So, it will be your zero point one three or zero point one three. So, I have taken this part into common zero point one three into six point one into twenty three point five six plus seventeen point nine five into zero five plus twenty three point nine zero how it has been come zero point one three into six point one, this

side is your six point into twenty three point five six twenty three point five six is your unit weight of concrete, then seventeen point nine five, this is your soil filling of this unit weight of soil into zero point five area of triangle will be half a into b. So, that is why for both the common area. So, it will be both zero point five it will be common, then twenty three point nine into zero point one three above this this search as already been acted there is a search from three point nine. So, it is putting as twenty three point nine into zero point one three totally it is coming about to be nineteen point five seven, and the liber arm liber arm is coming one three five.

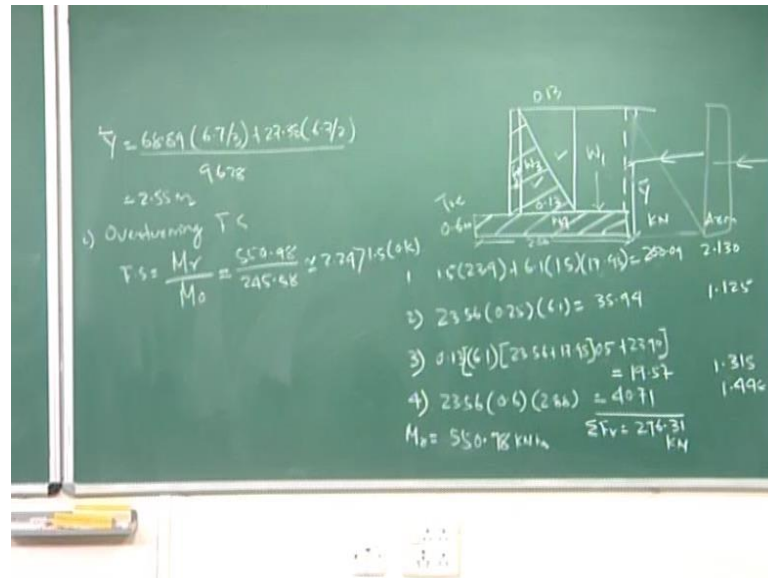
If you look at here this is one, then point two five one point two five, and point one three it will be acting upon where liber arm will acting upon where, then this will be from c g to this distance will your one point one five meter then four part is your last part at the base this is your twenty three point five six into zero point six into two point eight eight which is about to forty point seven one twenty three point five six is your unit weight of concrete zero point is this thickness. If you look at here this thickness is zero point six this part is your two point eight eight. So, this is your two point eight eight this is two point eight eight, and this will be your zero point six meter, and this coming about this is coming about forty point seven one kilo newton, and the liber arm is coming about one point four four eight, now if I take it.

So, f of b total vertical force these all my vertical forces coming out to be two ninety six point three one kilo newton, and moment of resistance from these, if I take moment of resistance moment of resistance coming about to be five five zero point nine eight how you'll get moment of resistance this vertical load into this arm this distance this is giving your moment of resistance this vertical load, and this arm this is giving your moment of resistance this into this this into this this into this from there, and moment of resistance coming about five five zero point nine eight this is your kilo newton meter. This is your kilo newton meter.

Now once you get into your first part is your half diagram, and then convert it into equivalent soil equivalent cohesionless soil from there we get a value k prime modified value of active r pressure there we get value of five, and once you get the value of five modified or equivalent value of five from there. You get your active r pressure p a value than once you get it, then we have to find it out how much is yourself weight, if this is the structure of retaining wall this dimension how you want to make it part by part. So,

this mistake cannot be occurred. So, we got this how much vertical load coming, and how far this load is from the toe. So, that moment of resistance which can calculated about the toe once this calculation is over, then we proceed for stability analysis now this p a.

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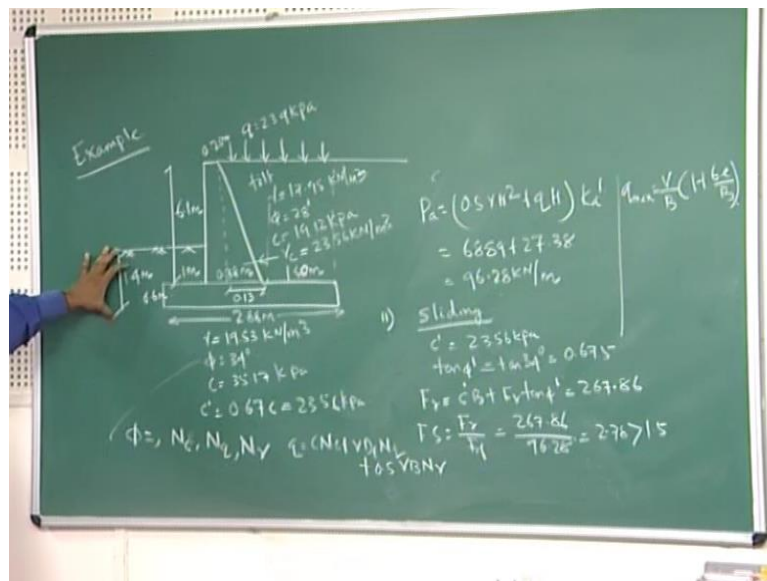


If you look at this p a, it is acting how far from this y bar distance, this y bar is coming about to be sixty eight point eight nine into six point seven by three plus twenty seven point three eight into six point seven by two by your ninety six point two eight which is equal to two point five five meter two point five five meter. If you look at here the value of sixty eight point eight nine sixty eight point eight nine, then twenty seven point three eight sixty eight point eight nine coming from where r pressure, because of your soil I have already remove that one. If I remove this step one than is will be clear how this problem has been solved what I done is p a value is calculated as zero point gamma h square plus q h into k prime from there, it is coming sixty eight point eight nine plus twenty seven point three eight that is coming about ninety six point two eight kilo newton per meter. If you look at sixty eight point eight nine this is your r pressure let a r pressure, because of your soil, and twenty seven point three eight, because of your search arc from this I am taking sixty eight point eight nine with this the height will your this r pressure is your six point seven it will be kind of triangular.

So, it will acted upon by six point seven by three than twenty seven point three eight

twenty seven point three eight is your search  $r$ , because of your search  $r$  it will be acting upon by half of six point seven by two this is coming to be two point five five meter once you get your resistance  $y$  bar; that means, at what distance at what distance this active  $r$  pressure is acted below the base this is your nothing, but your  $y$  bar  $y$  bar than you find it out all about your first one is your over turning of your factor of safety over turning factor of safety. So, this factor of safety is equal to moment of resistance by moment of over turning this come to be moment of resistance is five five zero five five zero point nine eight by your moment of what is the moment of ninety six point two eight this is your into two point five five this coming out to be this coming out to be your value of two forty five point five eight it comes to be two point two four which is greater than one point five this is this is now next factor  $f t$  once the overturning factor  $f t$  is check next factor  $f t$  is your sliding, sliding factor  $f t$ .

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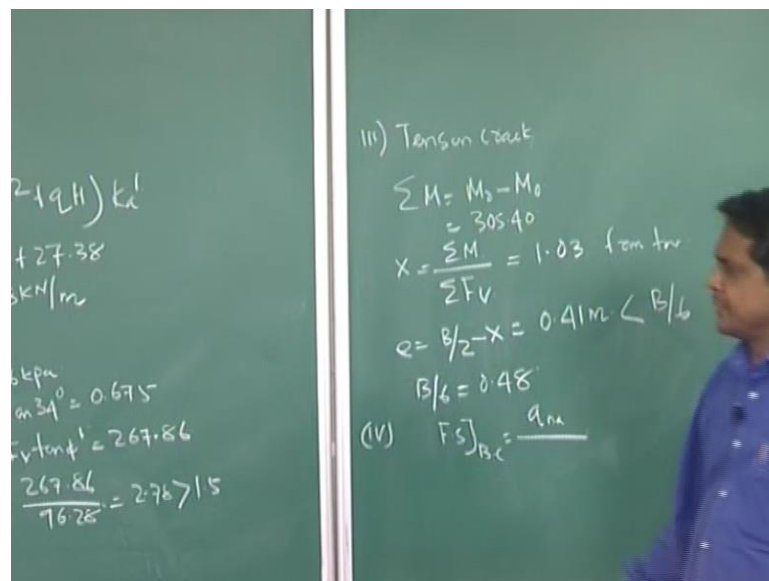


next is your sliding factor  $f t$  what is base soil value base soil value is  $c$  is equal to thirty five point one seven. So,  $c$  prime which is equal to zero point six seven of  $c$ . So, which value will be this value or twenty three point five six it is given other factor factor is taken zero point six seven. So, modified value of  $c$  will be of twenty three point five six k p a now from here for factor  $f t$  again for sliding this is for sliding, and now for sliding. So, prime is equal to twenty three point five six k p a than  $\tan \phi$  prime is equal  $\tan$  thirty four degree which is equal to zero point six seven five. So, this resist force this resisting force is equal to  $c$  prime into  $b$  plus  $f v$  into  $\tan \phi$  prime which is coming



about two sixty seven point eight six. Now factor  $f_t$  is equal to  $f_r$  by  $f_d$  which is equal to two sixty seven point eight six by your  $f_t$  ninety six this is your force ninety six point two eight which is equal to two point seven eight greater than one point five greater than one point five now out what are the stability check one is your overturning moment, second is your sliding, third is your would be less than equal to  $b$  by six fourth is your bearing capacity check with this two slide two check one is your overturning, and and sliding the factor  $f_t$  is it is greater than this what is the minimum requirement for this factor safety.

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Now, you'll go for after the over will find out the tension crack; that means, in these case mate movement of is equal to movement of registrant is minus movement of the over turning which comes out be three zero five point four zero, and  $x$  is equal to movement by forces  $f_v$  is equal to one point zero three from toe; that means, force will be arc at a distance one point zero three from the two this is your from force.

So, these value of these  $e$  is coming about to be  $b$  by two minus  $x$ , and it is about to be zero point one meter, and again you check  $b$  by six value by six value is zero point for eight; that means,  $e$  is less than  $b$  by six; that means, there is no tension crack now third stability analysis criteria also satisfy; that means,  $e$  is less than equal to  $b$  by six; that means, there is no tension; that means,  $q$  maximum, and  $q$  minimum are positive, then third one is fourth one is you check in your daring capacity factor safety factor safety

against bearing capacity, which is equal to  $q_n$  a ultimate capacity of soil, and from is your how much your maximum how do gate  $q$  maximum  $q$  maximum, you will get it  $q$  maximum is equal to summation of  $v$  by  $b$  into one plus six  $e$  by  $b$   $b$  is your summation of vertical process  $b$  is your given two ninety six point three one kilo meter, and  $b$  it is your give two point eighty, and  $e$  also  $e$  value as we got is zero point four one  $q$  maximum also you get it, then you can find it also soil pressure soil pressure value means net above soil capacity these comes out be  $c_n c$  gamma  $d f n q$  plus zero point five gamma  $b$ , and gamma  $c$  value is given that is your twenty three point five six from value of five five is equal to thirty four degree from these value of five from these value of five you can find out  $n c n q$ , and  $n$  gamma  $n c n q$ , and gamma.

These are only bearing capacity of factor once you find out of your bearing capacity factor, then you can find it out  $q$  is equal to  $q_u$  is equal to  $c_n c$  plus gamma  $d f n q$  plus zero point five gamma  $b$ , and gamma gamma  $d f$  depth, you can take it one point four meter  $c_n c c$  value  $c$  prime value is your twenty three point five six gamma is given ninety three point ninety three  $d f$  is equal to one point four, and  $q$  you will get it from the value of the five, and gamma, and  $b n$  gamma.

Once you get  $q_u$ , then you can find it out net above fresher by dividing factor step you can find it out  $q_n$  a once you get  $q_n$  a you check your factor step again bearing capacity whether it is more than three or not in these case it is coming about we more than three; that means, it is also satisfy this I left for the students to calculate, and I have solve in details step by step. So, last one I left it. So, if I summaries into this I the example problem were the details wall is given wall dimension are given will see later on there will not alive wall dimension will start from these search here wall dimension has been given these value of gamma five  $c$  square  $c$ , and this is your filling soil, and this is your foundation soil plus as it is a  $c$  five soil. So, what will be happen? There will be tension crack will other. So, two overcome that will take it into equivalent soil it will taking care.

So, five as been modified to forty five degree, and  $k$  has come once you get five, and  $k$ , then find it out what is the active bar are pleasure, because of your soil as well as, then find it out wait of each component you divide into number of parts like  $w_1$   $w_2$   $w_3$   $w_4$  I made into wait of in each component kilo meter how far this wait is acted upon from the toe from their we can find it out what is mine resisting movement over trading movement is your arch pleasure. So, are got it, then you multiple force these

are will find it out your resisting movement, then once you get it, we can check. There are four stability criteria one is your over sorry, over trading second is your slightly hard is your tension crack fourth is your daring capacity all these how to check like these likes step two sliding it is more than one point five, it should not be less than one point, then it is stubble once these stability analysis has been satisfy, then you go for structure design will see how the structure the design has been done just in brief will see lateral on on may be in the next class.

Thank you.