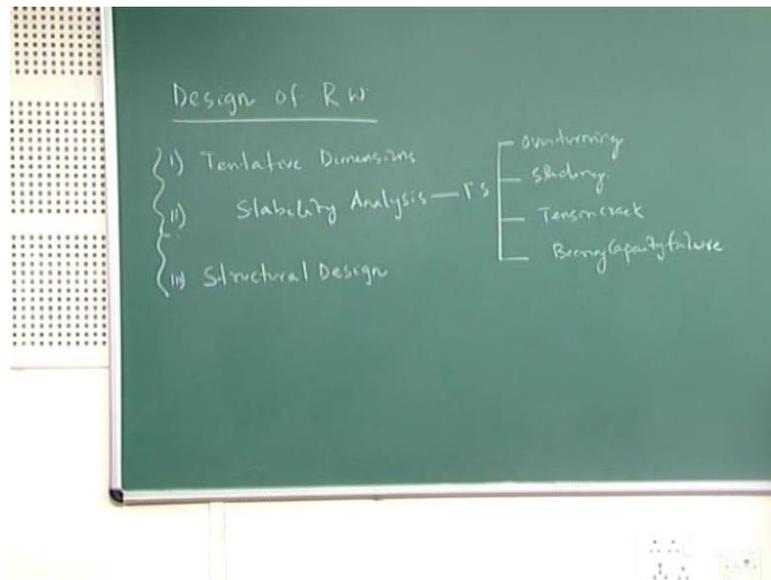


**Application of Soil Mechanics**  
**Prof. N. R. Patra**  
**Department of Civil Engineering**  
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**Lecture – 17**

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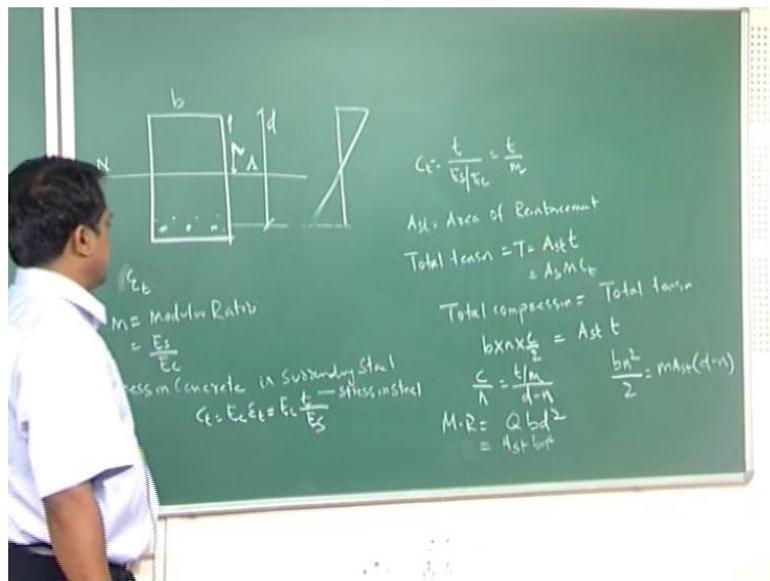
So, design of retaining wall earlier I have solved one problem where dimension have been given, if I start with the design of retaining wall. First one is your tentative dimensions in design of retaining wall known dimensions generally provided. So, first you go for some tentative dimensions once you have your dimensions tentative dimensions, then second part is your go for your stability analyses.

If your stability analysis has been checked if factor or of safety of four factor or safety factor of safety against overturning factor or of safety against sliding factor of safety against or you can say that tension crack, then factor of safety against bearing capacity failure, if this stability analysis is; that means, if whatever the means these four criteria of factor of safety if it is greater than the factor safety availability minimum factor of safety, then the stability analysis was this stability analysis.

Then third part will go for structural design though this structural design it is not falling in this geo technical engineering part, but a if of is basic idea of this design of r c c concrete, then you can go for you can you can a see where is the reinforcement bar to be provided, and how it has been distributed. So, this design of retaining wall particularly

this two parts is a more concerned about your geo technical point of you, and this is structural engineering part, but if I put in three this is complete design of retain walls; that means, tentative dimensions, then stability analysis stability analysis with respect a overturning movement with respect to sliding with respect to tension crack with respect to bearing capacity failure bearing capacity failure. So, this structural design in brief. I am just discussing in brief will start a problem of complete design of retaining wall.

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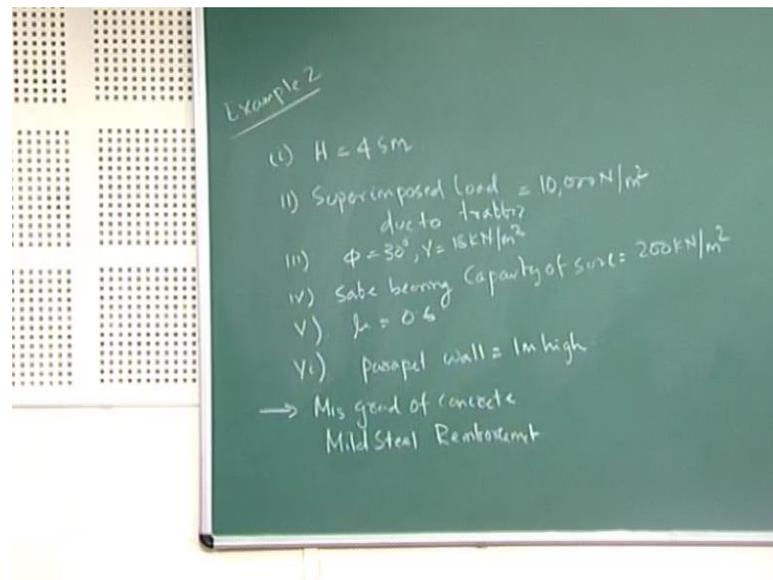
If you look at these this is your basic structural design generally in civil engineering second year course. So, if a cross section of the beam, and if I say this is my neutral axis, and this is b, and this part is your n, and this is your complete d, then you can say that this is your stress in steel. Suppose strain in concrete just surrounding in the steel just surrounding this steel if it is e s t, then modular ratio modular ratio m is equal to modular ratio which is equal to e s by e c. So, says in concrete surrounding still; that means, stay concrete of the surrounding still stress in concrete in surrounding steel, which is equal to c t is equal to e c stain, and it is your e c t by e s t is equal to strays in still t is equal to stress in steel.

So, again I can write it c t is equal to stress in concrete stress in concrete in the surroundings steel which is equal to t by e s by e c, which is equal to t by m is equal to modular ratio now if the area of reinforcement is a s t suppose let us say area of reinforcement area of reinforcement is a s t, then tension stress in the reinforcement is t.

So, total tension total tension I can write it total tension  $t$  is equal to area of steel in to  $t$  is equal to stress in steel. So, which is equal to  $a_s t_m c t$  no let us say  $b$  is equal to  $d$  is equal to effective depth of beam  $n$  is equal to depth of the neutral this is the  $n$   $n$  is equal to neutral axis from the top distance of the neutral from the top that is your  $n$ . If I write it in terms of total compression is equal to total tension from their I can find it out  $b$  into  $n$  into  $c$  by two this area  $b$  into  $n$  into  $c$  stress in concrete by two, which is equal to  $a_s t$  area of steel area of steel into stress into steel, and from these diagram from I can write it  $c$  by  $n$  is equal to  $t$  by  $m$  by  $d$  minus  $n$  by  $d$  minus  $n$ , and their equating this we can get is  $b n$  square by two is equal to  $m a_s t$  in to  $d$  minus  $n$ .

So, if you do it will coming out to moment of resistant is equal to  $a_s t b$  square moment of resistant id equal to  $I$  am just omitting, because this part is not in syllabus you should know how going for a structural design  $m$  is equal to you can write it  $q b d$  square, where are  $q$  is equal to constant in terms of  $n$ , and which is equal to area of steel into  $b d$  square this is your movement of resistant ones should known the moment resistant from ending movement that you can equate into movement of resistant by area of steel there. You can find it out ones you get the area of steel, then fine that how many number of what is the number of bars. What is the size of bars, how many number of bars to be provided at the compression side will see this working strays method for this particular structural design as for the highest code will see comes will solve a complete design problem of retaining wall starting for this scratch tentative dimensions stability analysis, and structural design. So, it has been as design a retaining wall for road.

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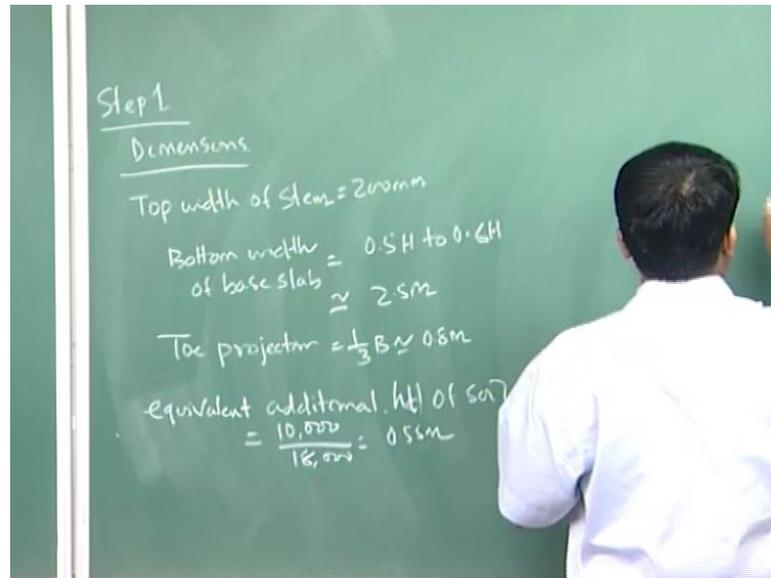


Example problem two or you can write it example two; that means, design retaining wall for road for the following requirement first one is height of the wall from the bottom of base of to the top of steel height of wall which is equal to four point five meter it is from the bottom of base to top of the stem, then superimpose load due to traffic super imposed load due to traffic which is equal to ten thousands newton per meter square, and phi is equal to angle phi; that means, filling soil angle phi is equal to it is a phi is equal to thirty degrees safe bearing capacity of soil safe bearing capacity of soil safe bearing capacity of soil which is equal to two hundred kilo newton per meter square.

And unit weight of soil unit weight; that means, gamma is equal to eighteen kilo newton per meter q coefficient of friction between concrete, and ground coefficient of friction between concrete, and ground which is equal to zero point six a parapet wall generally for road construction what happens both the sides of the road one parapet wall has been provided. So, that has be give a also a parapet wall of which is equal to one meter high has been provided. So, you will have to design wall taking into consideration of m fifteen grade of concrete, and mild steel reinforcement mild steel reinforcement this is example to it is nothing has been given it look at this yesterdays example the dimensions has been given, and the depth has been given you have check only stability now example two in these case there is nothing only height is given four point five meter, and how much your supper imposed load, because of traffic it is ten thousand newton meter square, and filling soil of you need to weight eighteen kilo newton per meter square five is equal to

thirty degree also said being capacity of is given two hundred kilo newton per meter q concrete, and the soil is equal to zero point six there is parapet wall both the sides which is one meter height above these.

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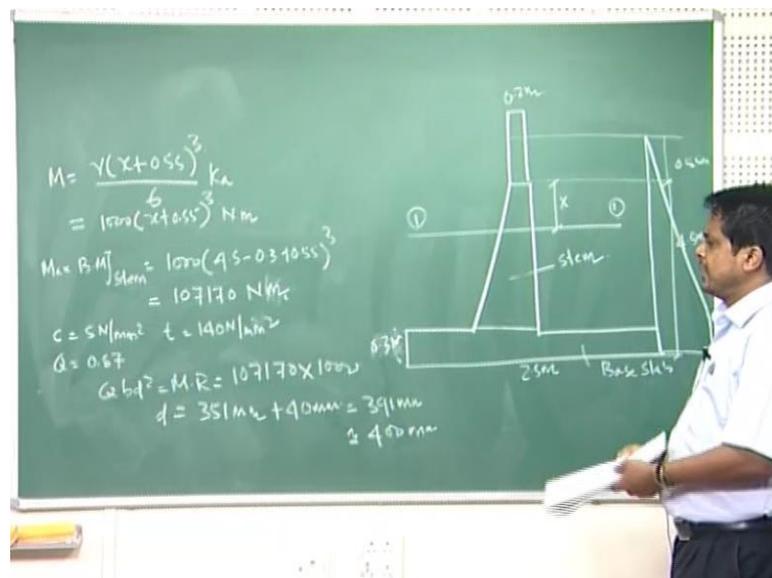
So, you will have to use grade of concrete mild steel reinforcement do this design completely do this design. So, what is the step one step one id dimensions know will have to particularly this conditions will have to identify the dimensions what are the dimensions to taking for you retaining wall, then once dimensions will have to take, then once dimensions has been established, then will go for your stability analysis which is second step, and third step is structural design in second in first step let us a top width of stem which is equal to two hundred mm. So, bottom width of base slab, which is equal to zero point five h to zero point six h now let us provide say from zero point five h to zero point six h, because h is given four point five meter total high.

So, let us provide two point five meter; that means, bottom width b is equal two point five meter. So, toe projection, then your toe projection toe projections is equal to one third b which is equal to say zero point eight meter there is supper imposed load, because of traffic. So, you can say that equivalent additional height of soil corresponding to if look at if this is my wall in this wall just I am drawing this is my wall in this wall what has been asked this wall dimensions has to provided when what thinks what has been asked in these wall once height has been retains by means of soil mark. So, that road has

to be constructed, and this there is traffic load is coming, because of road construction this is about ten thousand newton per meter square if there is traffic load. So, I can take it traffic load to equivalent soil load I can convert it. So, that can be calculated to be easy there to way both we can do it equivalent soil load convert it or you can calculate, because of soil as well as due to your traffic load supper impose load both you can audit, and you can find it also are presser.

So, equivalent additional height of soil corresponding to supper imposed load equivalent additional height of soil, because of your supper imposed load which is equal to ten thousand divided by eighteen thousand. So, it is coming about zero point five five meter zero point five five meter. So, eighteen thousand is unit weight of soil is given. So, that is your eighteen thousand. Now if I draw this, if I draw a complete picture how the diagram of these looks like.

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Now above these this is the height of wall from here to here both four point five above these this parapet wall you can say that. So, let us put it this height is zero point two meter two point five meter two point five meter, and these part of the here to here here to here is four point five meter, and equivalent additional height of soil. So, let us say this is about this about kind of zero point five five meter. So, now I can draw this distribution diagram consider only one single triangle. So, this will be four point five meter plus zero point five five meter. Now consider is section one one depth x from the soil surface I

have consider is section say one, and one at the distance of x for this wall from this wall now consider its section at a distance x from the wall.

We can find it out what is the bending movement bending movement section one one bending movement is equal to  $\gamma x + 0.55 \frac{q}{6} k$  a thirty degree value you can put it. So, it will coming all the value if put it it will coming one thousand into x plus zero point five five zero point five five q newton meter. So, let us assume that zero point three meter thickness of best, if this best let us assume this is zero point three meter, and I say earlier there are different tentative dimensions I put it from that dimensions you can assume on of the dimensions of this is a zero point three meter.

So, maximum bending movement for the stem if this is my stem this is the stem, and this is your base slab. So, what is maximum bending movement maximum bending movement for stem this will be coming out to be one thousand into four point five minus zero point three plus zero point five five whole q how it has come this height is from here to here four point five, and this four point meter this thickness zero point three has been deducted. So, four point minus zero point three three this is your equivalent height taking into such as we have consider zero point five five. So, this value has been put it. So, maximum bending movement is coming about to be one zero seven one seven zero newton meter now per m fifteen grade concrete m fifteen grade concrete; that means, c is equal to five newton per mm square, then trace in steal that is mild steel is given.

So, trace in steal will be one forty newton per m square now per m fifteen, and mild steel q value will be coming out zero point eight seven this calculation stayed earlier in brief you can get it from the code also form their  $q b d^2$  square is equal to movement of resistant which is equal to one zero seven one seven zero into into it is a newton meter into one thousand meter I convert into one thousand means mm, and from their you can find it out putting the value of b b value is you can take it zero point two putting the value of sari b value is equal to per meter if could take it, and you can find it out d is equal to three fifty one mm. So, effective depth of the which is equal to three fifty one mm you add it you add it forty mm forty mm for clear that will come about three ninety one mm you say that it is four hundred mm. Now I assume mean thickness base slab is equal to four hundred mm four hundred mm.

So, now what we have assume we assume thickness base slab is equal to zero point three, now it is coming about to be thickness of the base slab is coming about the zero point four. So, you take it thickness of the base slab; that means, these part is equal to zero point four mm zero point four meter or four hundred mm. So, it has starting from zero point two two zero point four meter. So, it has been done how this base slab thickness. If I considering it first find it out bending movement, then section of the x, then once you gets what in section of a if find it out bending movement, and base of the stem base of the stem once will get the bedding movement at the this is your maximum bedding movement of the base of stem.

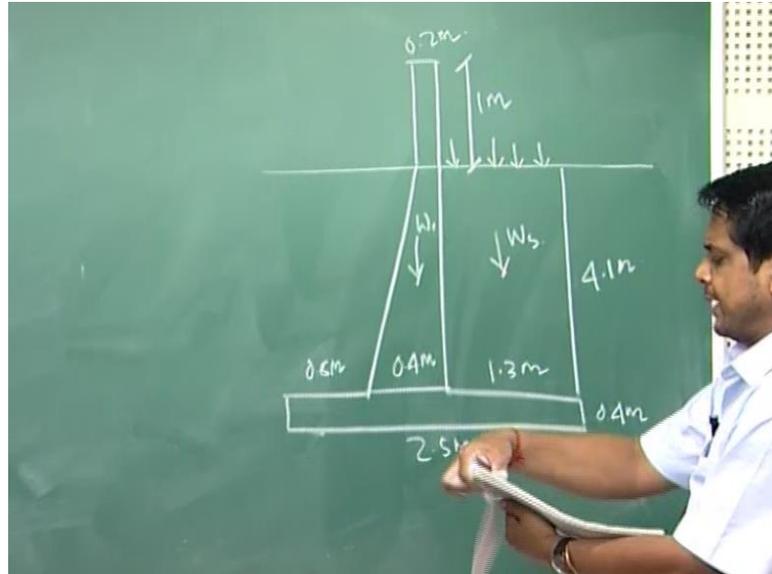
hen once you gets maximum bending movement stem as it is given m fifteen grade concrete, and mild steel reinforcement for m fifteen grade of concrete  $c$  is equal to this is called concrete, this is height newton per mm square for mild steel reinforcement, trace steel is equal to hundred fourteen for mm square for m fifteen  $c$  is equal to height newton per m m square  $t$  is equal to hundred forty newton per meter square hundred forty newton per mm square  $q$  is equal to zero point eight seven. Now you bedding movement of the base is equal to it is called movement average which is equal to  $q b d$  square.

So, movement of resistant to calculate one zero seven one seven zero newton meter, and from there you find it out what is the  $d$  value is coming about your zero point four mm or sorry four hundred mm or zero point four meter. So, with these help with these help. Now I m fixings it this my zero point two this is my zero point four this is zero point three, and this height is four point five plus zero point five five, and also also earlier we have done that one is your base width letter is provided is two point point five this is your two point five now this part is coming about this part is take it assume at zero point eight meter as I solved earlier now this covers all together your tenanting dimensions of the dimensions of the retaining wall; that means, zero point eight meters zero point three meters two point five meters zero point four meters zero point two meters soil kill is here now once the these has been established. Now next type will have to go for stability analysis will have to go for stability analysis.

Step one has been over that mean dimensions of the retaining wall step two is your stability analysis in these stability I can write it I can write it this is my  $w_1$ , and this base  $w_2$   $w_1$  is weight if stem  $w_t$  is a base slap is a base slap. Now this would be  $w$

s that is your weight of soil. Now if have remove, if I make it a clear picture of how the w one, and w two concept to any tool would be more clarified.

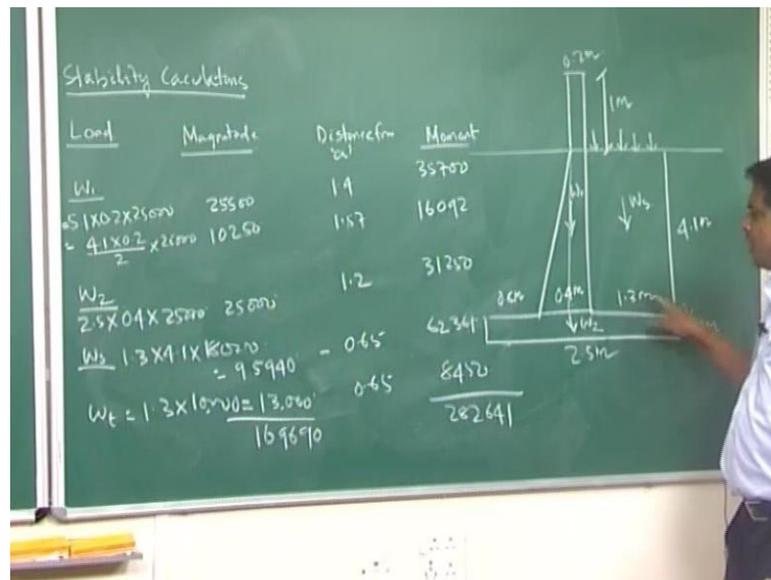
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One meter zero point two meter this way would be w one this is your zero point four meters this is zero point eight meters, this is again you take it zero point four meter generally the base width you have assume zero point three generally this width, and this width would kept it same zero point four meter. So, again this comes out to be one point three meter, and this is your two point five meter. And now if I join it.

This is your w s this coming out to be four point one meter this is your search hours this is your search hours. Now with these with these will have to do advance tentative dimensions has been be fixed with these you have go for stability calculations you go for your stability calculations.

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So, now this stability calculation; that means factor or of set as to be checked. Now you can find it out has on is your column. If I write it load, because of w one w two, and this is my w two, and w s, and if I write it a magnitude of load, and distance from a this is my distance from a, and you can find it out movement about a load magnitude, and distance from a, then movement. So, w one is coming about to be, if I write w one it is to come out to be five point one into point two into twenty five thousand. So, and it is coming about to there are two w one. If I make it to w one into two parts look at here there are two parts; that means, w one four plus one point one this is total am taking five point one into point two into twenty five thousands twenty five thousand is your unit weight of concrete part one, then these part. If I take into it will be four point one into point two divided by two into twenty five thousand look at these in these case this is a triangle in these part point two will go this will be point two.

So, this will be half four point one this side into point two into weight of concrete. So, magnitude is coming about two five five zero zero, and it is coming about, then two five zero, and distance from a one point four, and one point five seven, if a look at here zero point eight distance from these will be a point two plus point one. So, one point for the total distance is this is coming from year to year is one point four, and distance will be coming one point five seven one point five seven, this is not zero point eight exactly distance from a I can write it in these case are I have taken either way we can find it out the movement either way you can find it out the movement about to or you can

movement about to also hill. So, I have taken for a clarification yesterday also I have done movement about a this time am taking this movement about a is this side also both way it is correct both way it is correct.

So, I have taken distance from here. So, the movement is coming about three five seven zero zero, and it is coming about one one six zero nine two similarly  $w_2$  similarly  $w_2$  is equal to two point five into zero point four into two five twenty five thousand if you look at  $w_2$  weight of best laugh, this is your two point five zero point four or weight of concrete, and this comes out to be. And similarly  $w_s$  weight of soil retaining it is one point three into four point one into eighteen thousand eighteen thousand is your unit weight of soil, and it value is coming about to nine five nine four zero  $w_t$  weight of this top one, this will be your one point three this comes out to be one point three into one thousand ten thousand one point three into ten thousand, this load about this is coming ten thousand; that is your super impose load this will be acted on the one point three about this. So, this value is coming about to be thirteen thousand, and this  $w_2$  it is one point two, and this lebrun  $w_s$  it is about zero point six five, and this is also zero point six five.

Now it is coming about moment is coming about three one two five zero, and six two three six one, and eight four five zero, if I total forces magnitude of forces will be one six nine six nine zero in this case it is coming two eight two six four one two eight two six four one, this is one way of doing this stability calculation as I said either you consider moment about these or you can consider movement about these there will be not any problem once we find it out magnitude process you; that means,  $b$ , and movements you can stay this ability has we have solved yesterday; that means, you can go for  $x$  bar; that means,  $w_t$  is your  $x$  bar distance on this point distance from this point as well as you can find it out moment of registers factor or of safety factor or of safety against this  $d$  also this things this things be solved in the next class.

Thanks a lot.