Geosynthetics Engineering: In Theory and Practices
Prof. J. N. Mandal
Department of Civil Engineering
Indian Institute of Technology, Bombay

Lecture - 34
Geosynthetics for Reinforced Soil Retaining Walls

Dear student warm welcome to NPTEL phase 2 video course on geosynthetics engineering in theory and practice. My name is Professor J N Mandal department of civil engineering, Indian institute of technology, Bombay, Mumbai, India. The lecture number is 34, name of the course geosynthetics engineering in theory and practice. This is module 6, lecture number 34 geosynthetics for reinforced soil retaining wall. Now, I will address recap of previous lecture.

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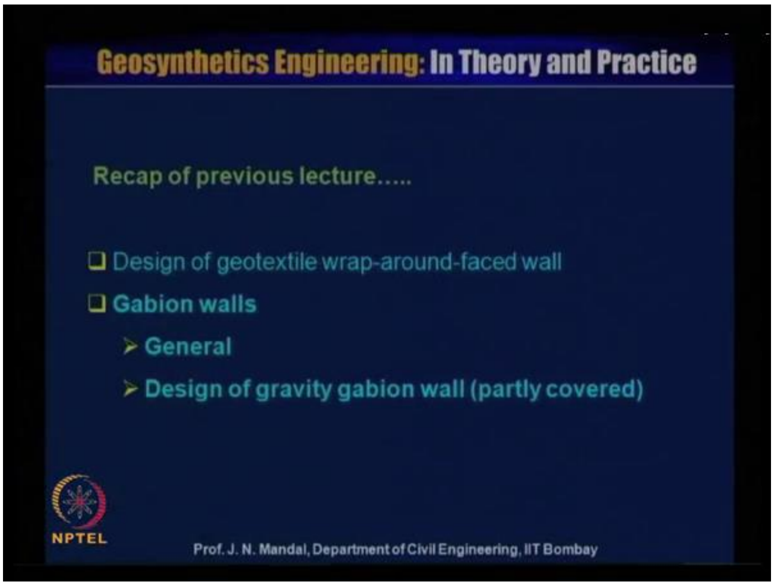

We covered design of geotextile wrap around faced wall then in gabion wall I talk about general. And also design of gravity gabion wall that partly covered.

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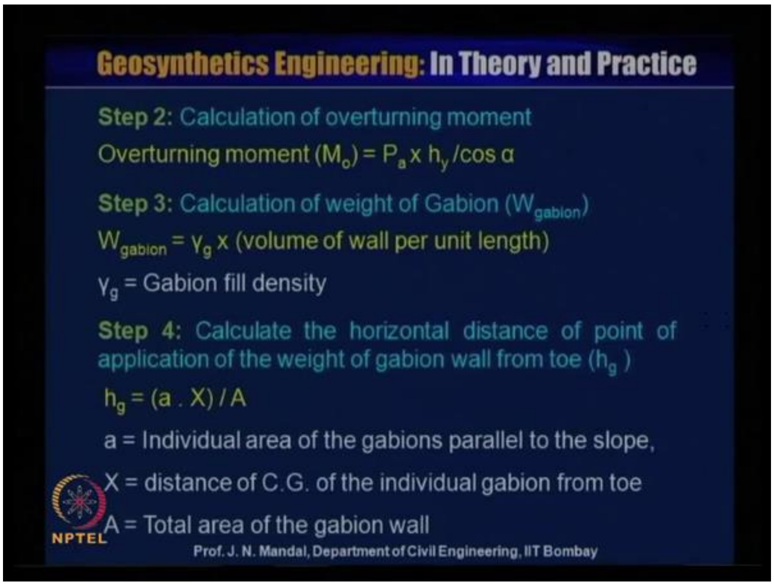

Now for the design, we will follow step 2, calculation of the overturning moment, that is overturning moment Mo is equal to P of a into h y by cos of alpha. So, this overturning moment you can calculate, you know the h y, which we discussed. Also earlier, you know alpha, you know P a so you can calculate overturning moment Mo. Step 3, calculation of the weight of gabion that is W gabion, W gabion is equal to gamma into g, which is gabion fill density into volume of the wall per unit length. Step 4, calculate the horizontal distance of point of application, of the weight of the gabion wall from toe that is h of g. So, you have to calculate that what is h of g, that means h g is equal to a into X divided by A. Where, A is the individual area of gabion parallel to the slope so I just mention also this earlier.

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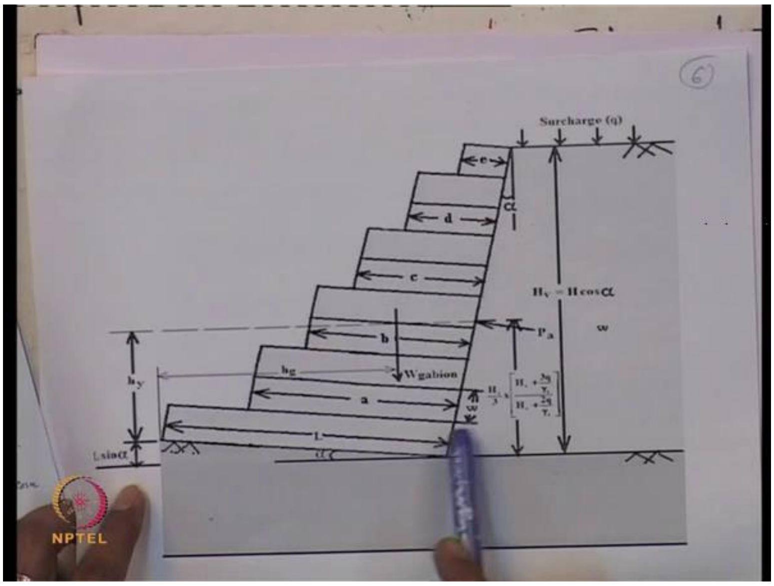

That, this is the A, that individual area of gabion parallel to the slope and then, you will be knowing, what will be the X distance, that means distance of the c t c g of the individual gabion, from the toe. And A is the total area of the gabion wall, you know this, you know this length, you know this width so you can calculate area. So, you can calculate what is the h of g that means, h g is equal to a into X divided by A.

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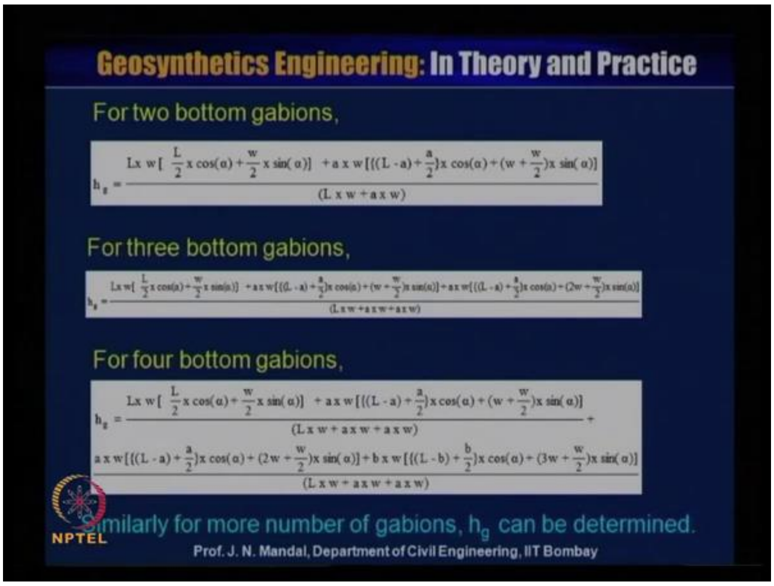

Now, you can also design for two bottom gabion or for three bottom gabion or four bottom gabion. This is from the geometry, you can solve this h of g for the two bottom gabion, this you know L, this is width. So, you know what is L 2 cos alpha into w by 2 into sin alpha plus a into w into L minus a plus a by 2 into cos alpha plus w plus, w by 2 into x sin alpha divided by L into w plus, a into w.

So, like this for two gabion wall from the geometry of this, from the geometry of the gabion, you can calculate that what is for the h g value for the two bottom or for the three bottom or for the four bottom of the gabion. So, like this you can obtain this from the geometry of this gabion, this is similarly, for more number of gabion h g can also be determined.

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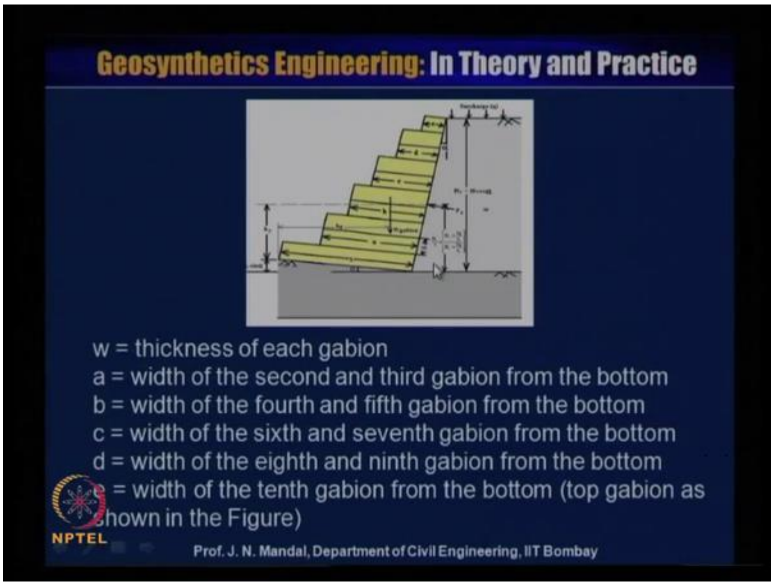

Now here, this w is equal to thickness of each gabion, each gabion has a thickness and a, here is the, a is the width of the second and the third gabion and this is the b, b is the width of the fourth and fifth gabion, that is from the bottom. And also the c, is the width of the six and seven, from the bottom and d is the width of the eight and the nine gabion, from the bottom. This is e, is the width of the tenth gabion from the bottom that means, top gabion here as shown. And apart from that there will be the surcharge load.

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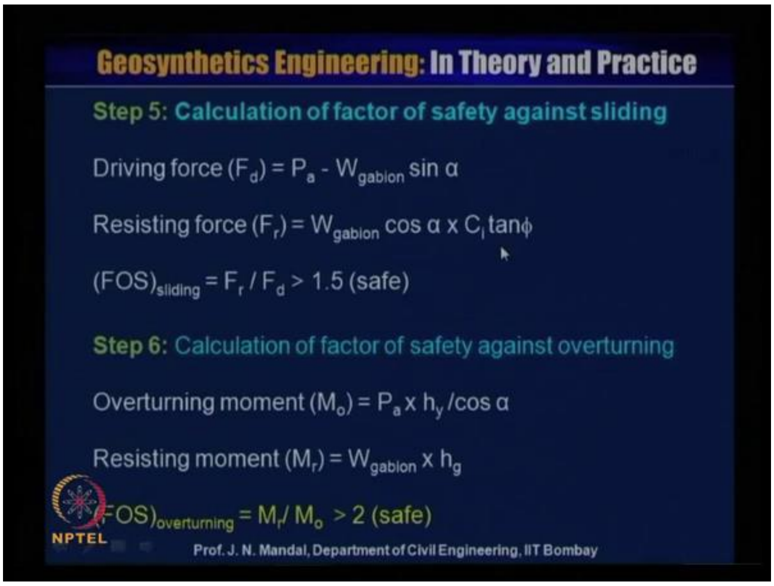

Step 5, at a calculation of factor of safety against sliding that means you have to calculate driving force Fd is equal to Pa minus W gabion into sin alpha. Resisting force Fr, is equal to W gabion into cos alpha into Ci tan phi. So, then you calculate what will be the factor of safety against sliding, is equal to Fr by Fd, it should be greater than 1.5 then, it is safe.

Step 6, calculation of factor of safety against overturning so overturning moment Mo is equal to Pa into hy by cos alpha. And resisting moment M r is equal to W gabion into hg, we know hg hy and pa so you can calculate what will be the overturning moment, as well as resisting moment. So, you can calculate what will be the factor of safety against overturning, is equal to M r by Mo that will be greater than 2 then, it is the safe.

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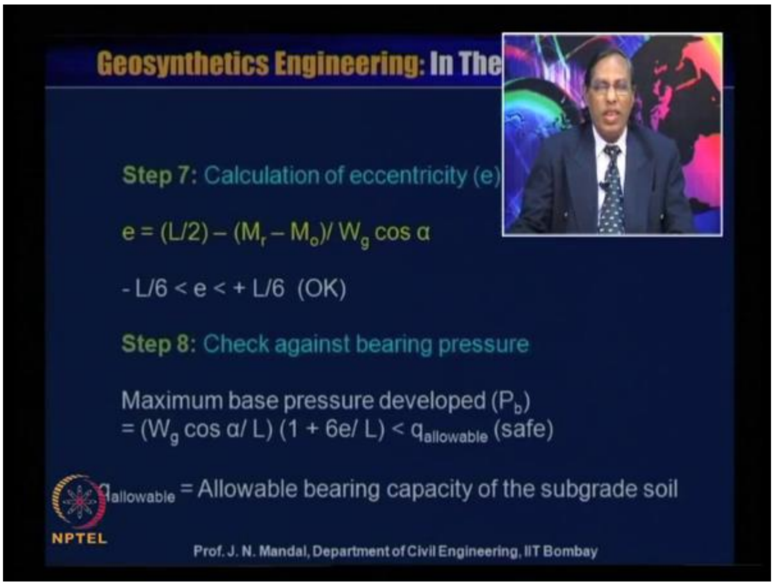

Step 7, calculation of eccentricity e so e can be calculated you know equation, L by 2 minus Mr minus Mo divided by Wg cos alpha. And here, that it should be minus L by e should be greater than minus L by 6 and less than plus L by 6 then, it is okay so you have to check this. When will solve the problem, we will show you step 8, check against bearing pressure. So, maximum base pressure developed Pb is equal to Wg cos alpha divided by L into 1 plus 6 e divided by L. This should be less than q of allowable then, it is safe so q allowable is the allowable bearing capacity of the subgrade soil.

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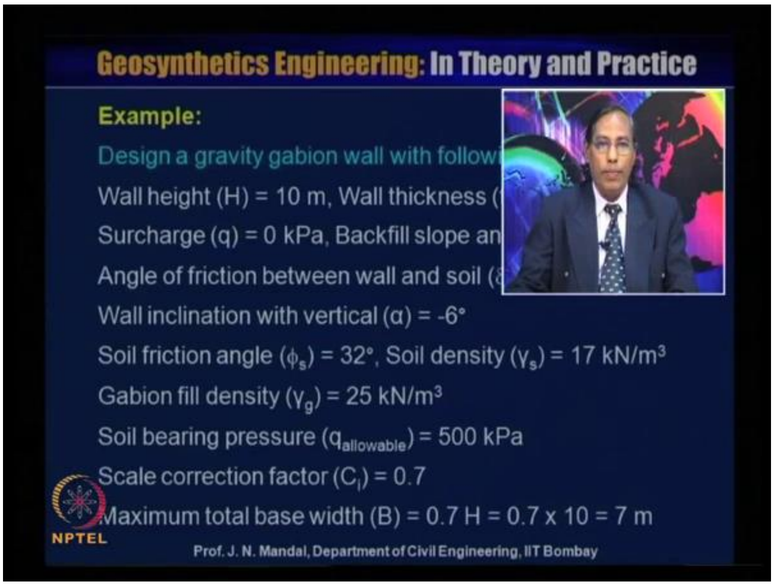

Now, I will present an example, design of gravity gabion wall with the following data. The wall height is about H is 10 meter, wall thickness tg is 1 meter, surcharge load q is 0 kilopascal, backfill slope angle i is 0, angle of friction between wall and soil delta is 0. Wall inclination with the vertical alpha is minus 6 degree, soil friction angle phi s is 32 degree, soil density gamma s is equal to 17 kilonewton per meter cube, gabion fill density gamma g is 25 kilonewton per meter cube.

Because, we use the stone, soil bearing pressure q allowable is 500 kilopascal and scale correction factor Ci is equal to 0.7. And maximum total base width B is equal to 0.7 H and as the height of the wall is 10, that means 0.7 into 10 is equal to 7 meter. So, base width will be about 7 meter so these are the data is given for the design of the gravity retaining wall.

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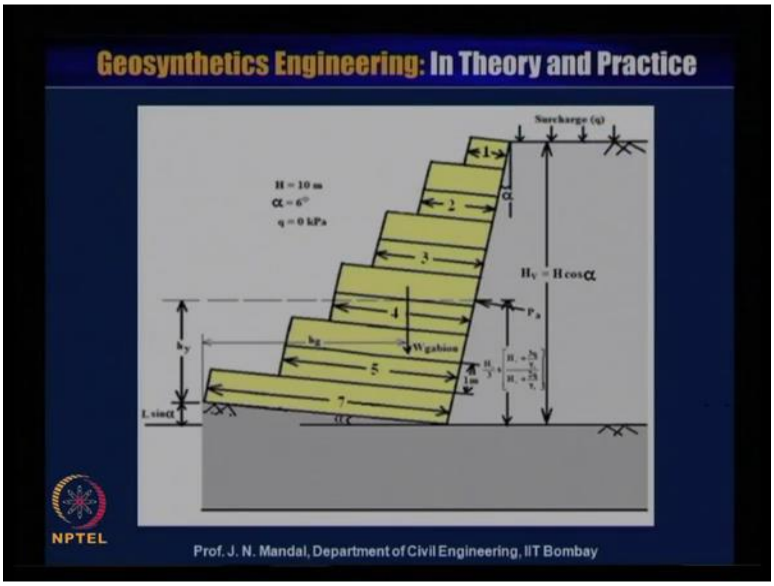

So, here you can see all the data and here also, base is the 7 then after that it is 5, 4, 3, 2,1 like this.

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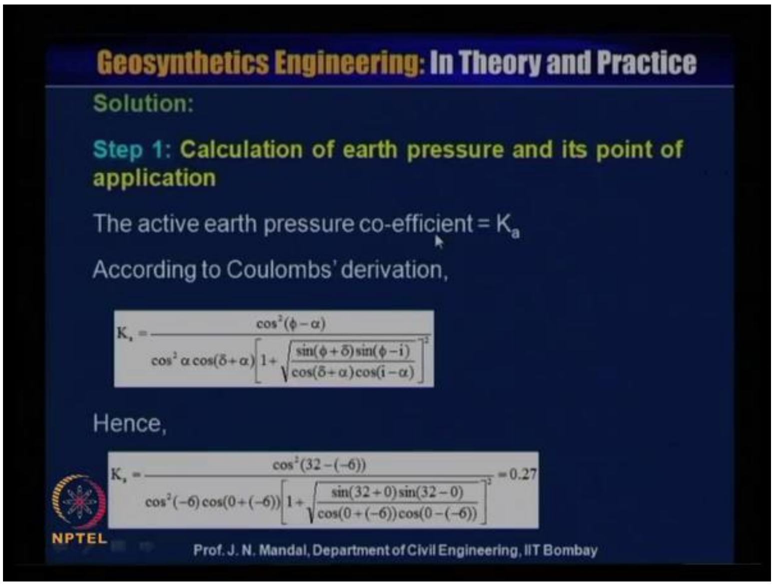

So, solution step 1, calculation of earth pressure and its point of application so active earth pressure coefficient is equal to Ka according to the coulombs' derivation. So, you can calculate Ka using this equation, so you know that phi is equal to 32 degree given, alpha is minus 6, that is why minus 6 and then cos square alpha, cos square alpha is minus 6 into cos delta value is 0 and alpha value is minus 6.

So, cos 0 plus minus 6 into 1 plus sin phi value is 32, delta value you know 0 and sin phi value again 32, i also is 0. This divided by cos delta, delta value is 0 alpha value is minus of 6 into cos i minus alpha, i is 0. So, 0 minus, minus, minus 6, so this will give that what will be the active earth pressure coefficient Ka is equal to 0.27.

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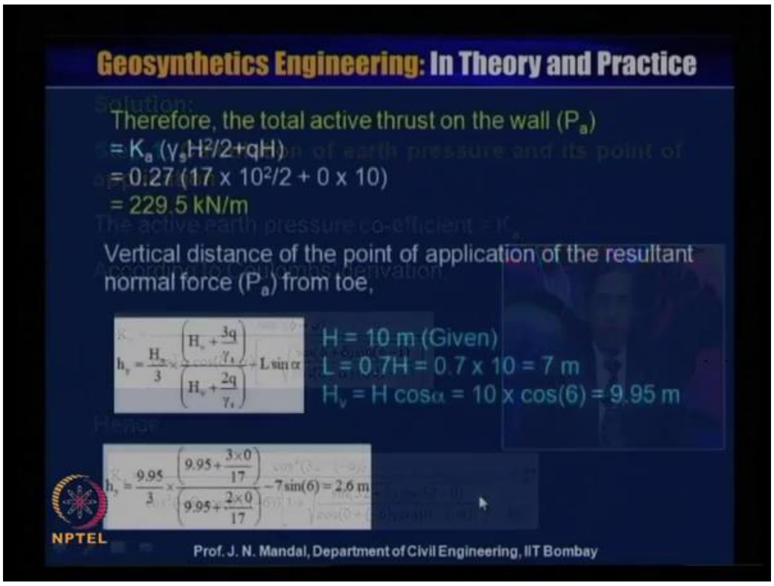

Therefore, the total active thrust on the wall Pa will be equal to Ka into gamma s into H square by 2 plus q H, that is due to surcharge. So, Ka you know that 0.27, gamma s is 17, H is equal to 10 meter height of the wall, that 10 square divided by 2 plus, this no surcharge we have considered so q is equal to 0 and H is equal to 10. So, you can calculate what will be the total active thrust on the wall Pa is 229.5 kilo Newton per meter.

Now, vertical distance of the point of application of the resultant normal force Pa, from the toe so this Pa from the toe, you can calculate from this equation, that means hy, you know this equation, I have also explained this earlier. So, here H value is given 10 meter given, length is 0.7 times the height when 0.7 into 10, 7 meter and Hv is equal to H cos alpha, that is 10 into cos is 6, that is 9.95.

So, if you substitute this value hy is equal to Hv is 9.95 divided by 3 into H is the, is 9.96 plus 3 into q surcharge is 0, divided by gamma s is 17, that divided by Hv is equal to 9.95 into 2 into q 0, this gamma s is 17 minus L is you know 7 meter, seven 7 into sin of alpha H 6. So, if you calculate you can obtain hy value, that is 2.6 meter, so hy is known to you.

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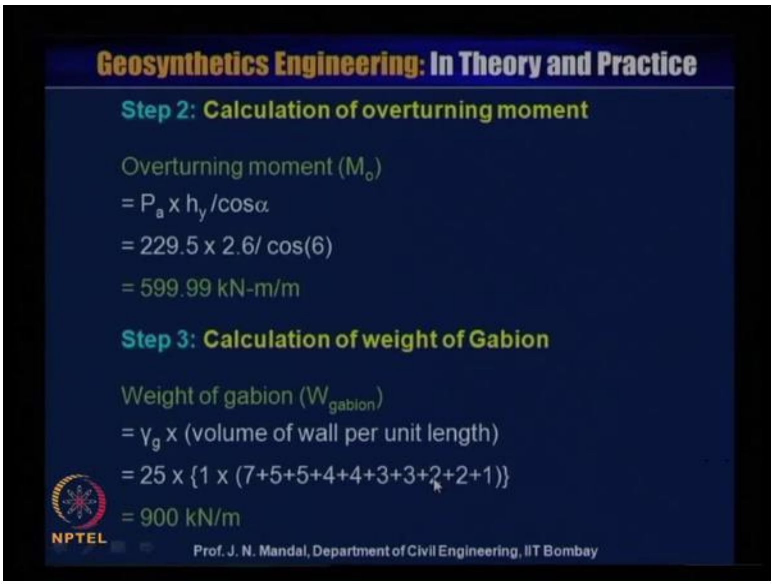

So then step 2, calculation of overturning moment, overturning moment Mo is equal to Pa into hy divided by cos alpha. So, Pa you know 229.5 into hy is 2.6, you calculated divided by cos alpha is 6 so you can have overturning moment Mo is equal to 599.99 kilonewton meter per meter. Step 3, calculation of the weight of the gabion so weight of the gabion that means, gamma g into volume of wall per unit length. So, we are considering unit length and gamma g is given 25, gamma g is given 25.

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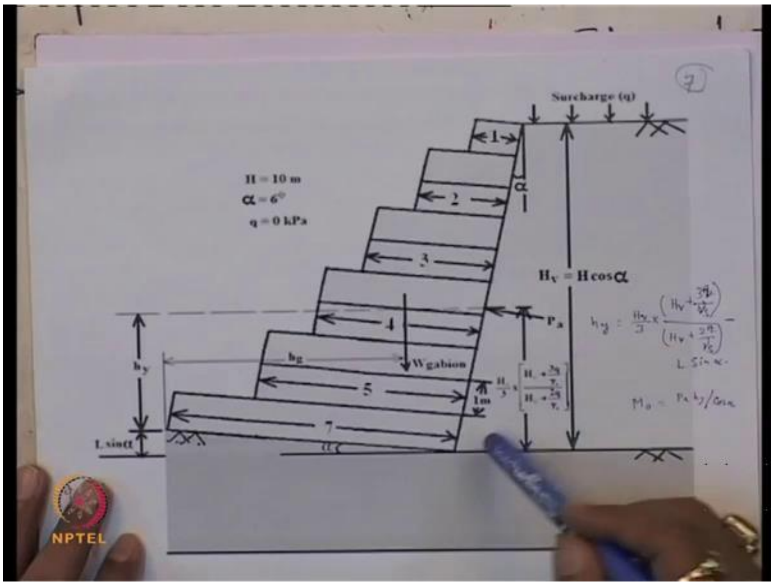

For example, that, this is you know hy etcetera. So, this base gamma g is 25 and volume of the wall per unit width. So, let us say 1 so this is the 7, next this is 5, this is 5, that means 7 plus 5 plus 5 plus this is 4, this is 4. So, plus 4 plus 4 then, this is 3, this is 3, plus 3, plus 3 then, this is 2, this is 2, plus 2, plus 2 and then, this is 1, plus 1. So, that means gamma g is 25 into 1 width 1 into this is 7 plus 5 plus 5 plus 4 plus 4 plus 3 plus 3 plus 2 plus 2 plus 1, which will give you the, what will be the weight of the gabion. That is about 900 kilo Newton meter so you can calculate that weight of the gabion.

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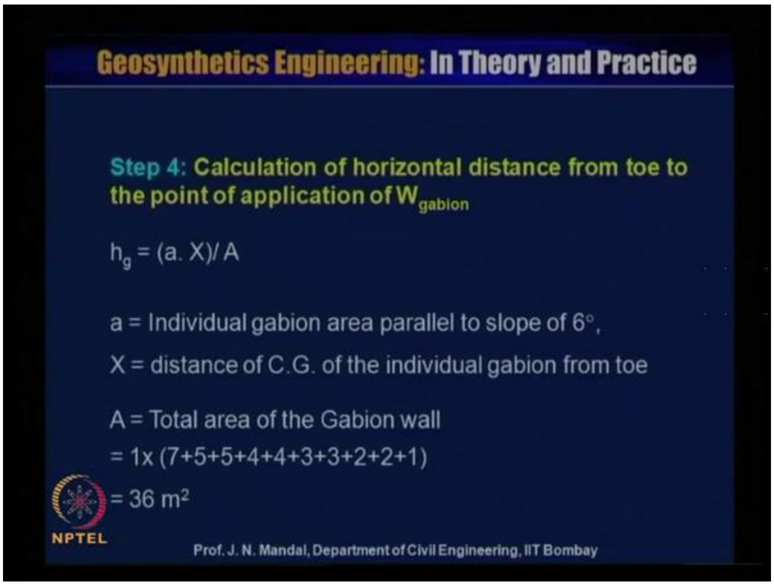

Now step 4, calculation of the horizontal distance from the toe, to the point of application W gabion also, we explained what is hg, a into X divided by capital A. A is equal to individual gabion area, parallel to the slope of 6 degree and X is equal to distance of the C G of the individual gabion from toe. So, here A total area means 1, into area I say initially 7 then, plus 5 plus 5 then, plus 4 plus 4, plus 3 plus 3, plus 2 plus 2 and plus 1. So, area will be equal to 36 meter square.

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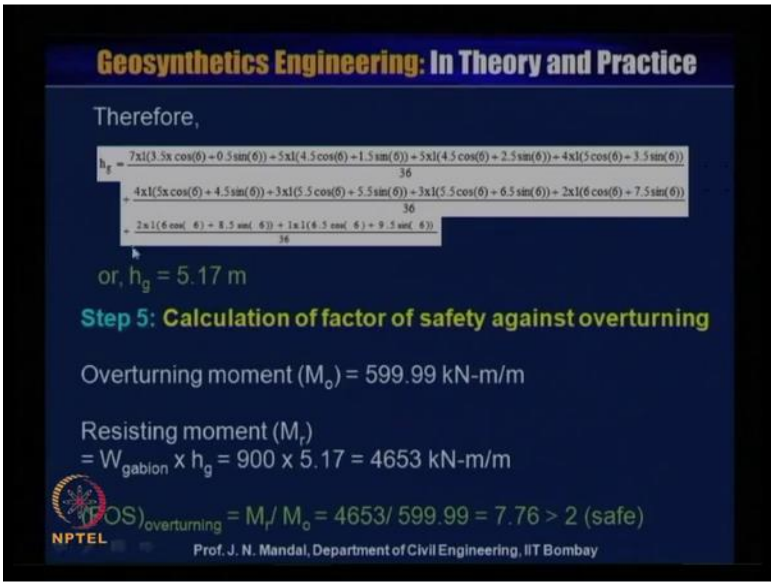

Now, with this equation so you have to calculate that h of g so this h of g you can see here for the 7, 1 this is for 5 and this is for 5, 2 then 4 and 4 this 2 then, after that 3 and 3 another 2 then, 2 and 2 another 2 and then, only 1. So, like this from the geometry of the gabion, you can calculate the hg and this hg value will be 5.17 meter. Step 5, calculation of factor of safety against overturning. So, you have calculated overturning moment Mo is 599.99 kilo Newton meter per meter.

And resisting moment Mr is the, what will be weight of the gabion into hg, that mean weight of the gabion you calculated, that is 900 this into hg you calculated here, 5.17. So, which will give you that resisting moment Mr is equal to 4653 kilo Newton meter per meter. So, factor of safety overturning is Mr by Mo that means 4653 divided by 599.99, that will give 7.76 which is greater than 2. So, it is safe so factor of safety against overturning is safe.

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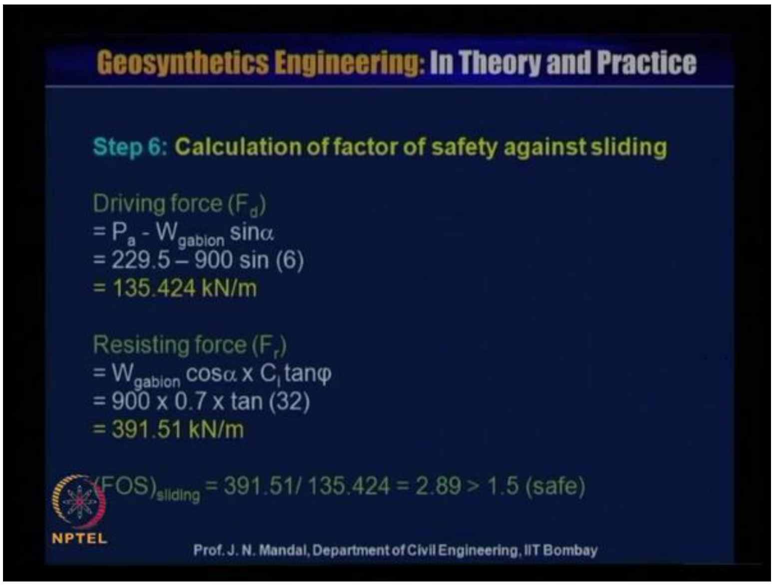

Step 6, calculation of the factor of safety against sliding. So, driving force Fd is equal to Pa minus W gabion into sin alpha so Pa we calculated 229.5, W gabion is 900 into alpha is equal to 6 so sine 6 degree. So, driving force Fd is equal to 135.424 kilo Newton per meter, resisting force Fr is equal to W gabion into cos alpha into Ci tan alpha, this is the resisting force, at the base.

So, this is W gabion is 900 into 0.7 into tan of 32 degree so this will give you 391.51 kilo Newton per meter. So, factor of safety against the sliding, will be equal to resisting force Fr divided by driving force Fd. So, this will give 391.51 divided by one 135.424 this is 2.89 and that is greater than 1.5, so it is safe.

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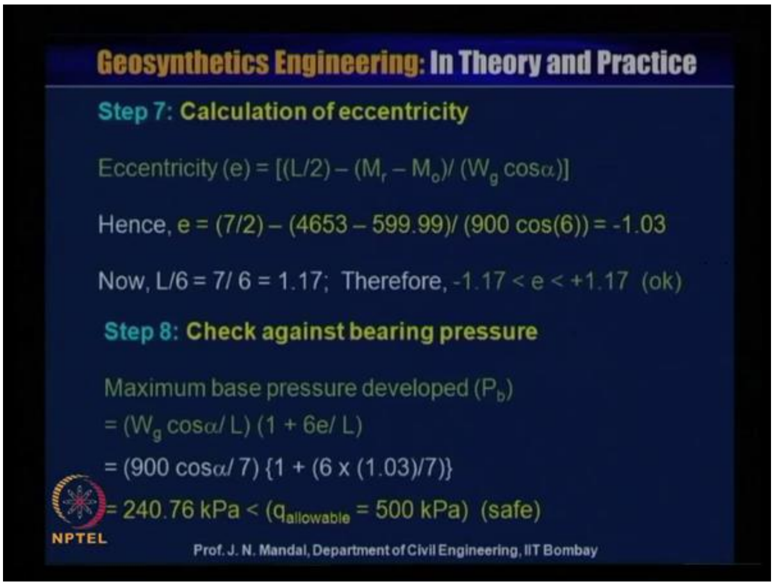

Step 7, calculation of eccentricity you know, eccentricity is equal to L by 2 minus Mr minus Mo divided by Wg cos alpha. So, hence e is equal to 7 by 2 minus 4653 minus 599.99, you know all Mr or Mo value this divided by Wg is 900 and cos of alpha, is cos 6. So, this will give the eccentricity e, value minus 1.03. So, now you look L by 6 value, 7 by 6 is equal to 1.17 therefore, the minus 1.17, that e should be greater than, minus 1.17 and less than plus 1.17 so that is why it is okay.

Now step 8, check against bearing pressure, maximum base pressure developed Pb is Wg cos alpha divided by L into 1 plus 6, e divided by L. So, Wg is 900 cos alpha divided by L is 7 and 1 plus 6 of e, e is 1.03 divided by L is 7. So, if you calculate you can have 240.76 kilo Pascal, which is less than, the q allowable which is given 500 kilo Pascal. So, it is safe so it is safe against the bearing pressure.

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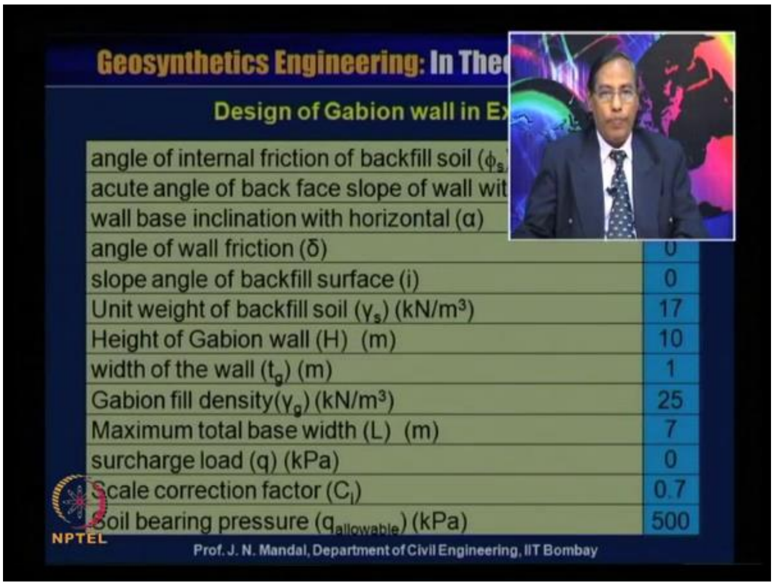

Now, here in the excel form is shown the design of the gabion wall, in excel if you know the angle of internal friction of the backfill soil, we can put phi s 32 degree. Acute angle of a back face slope wall, with vertical is minus 6, wall base inclined with the horizontal alpha is equal to minus 6, angle of wall friction delta is 0. Slope angle of backfill i is 0, unit weight of the backfill soil gamma s, 17 kilo Newton per meter cube and height of the gabion wall is 10 meter. And width of the wall tg is 1 meter and maximum total base L is 7 meter, surcharge load q is 0 and scale correction factor Ci is 0.7 and soil bearing pressure q allowable, that is 500 kilopascal.

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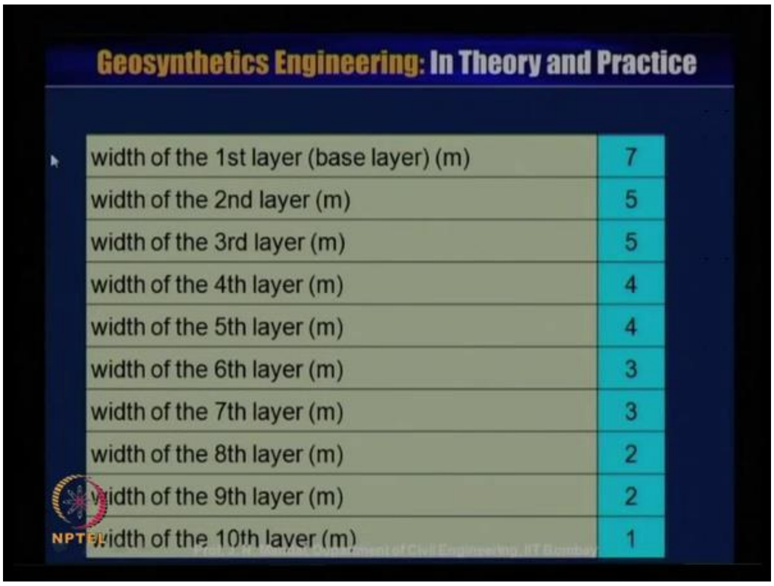

So, that width of the first layer of the base layer is 7 then, width of the second layer is 5 meter, width of the third layer is 5 meter, width of the fourth layer is 4 meter, width of the fifth layer is 4 meter. Width of the sixth layer is 3 meter, width of the seventh layer is 3 meter, width of the eighth layer is 2 meter and width of the ninth layer is 2 meter and the width of the tenth layer is 1 meter. So, this way it has been adding.

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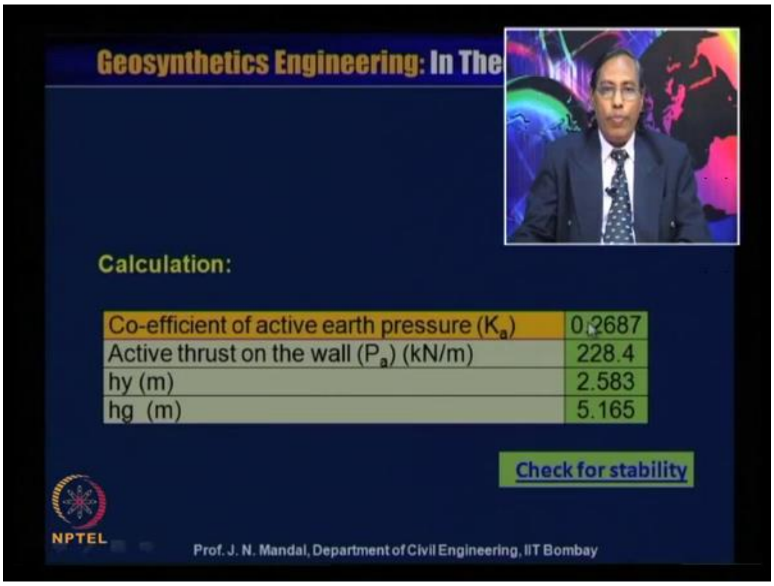

So, then ultimately if you calculate, you can obtain that coefficient of active earth pressure coefficient Ka, is 0.2687, this is almost 0.27. And active thrust on the wall Pa, that is 228.4 kilo Newton per meter, you can also calculate the hy that is 2.583 and also you calculate, hg is 5.165 and then, you can check the stability.

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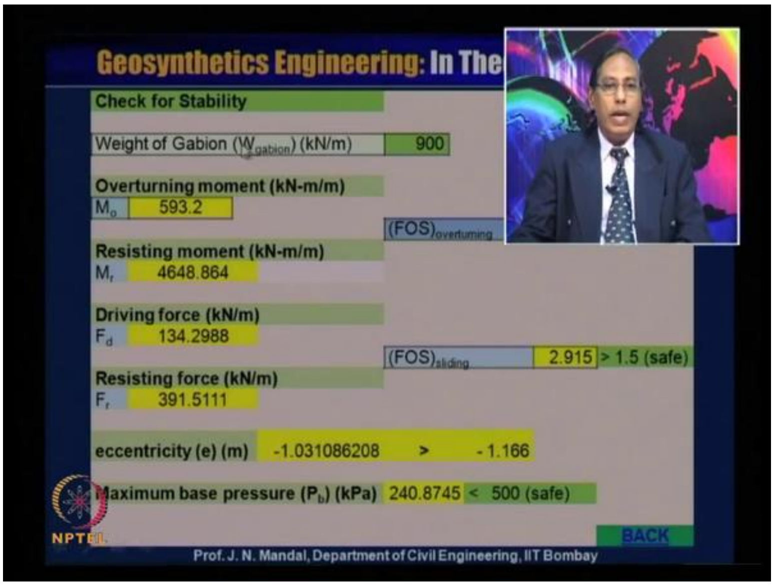

So, you can check the stability you know the weight of the gabion W, k g is 900, overturning moment, that is M of o is 593.2. So, you check that, what will be also the resisting moment that is Mr is 4648.864, so you check that what will be the factor of safety against overturning. You know this is the ratio, of this so this is 7.837, it is greater than 2 is safe.

Now, also check their driving force that is Fd 134.2988 and the resisting force Fr is 391.5111. So, you check that factor of safety against sliding so this will give you that 2.915, which is greater than 1.5 also safe. And eccentricity e, is minus 1.03 which is greater than, minus 1.166 and maximum base pressure Pb, that is 240.8745 kilopascal, which is less than 500 so it is safe. So, you can check the, all the stability that is, you can check that what will be factor of safety against overturning, factor of safety against the sliding. And also you have to check that, what will be the bearing capacity so you can design a wall, gravity wall like this.

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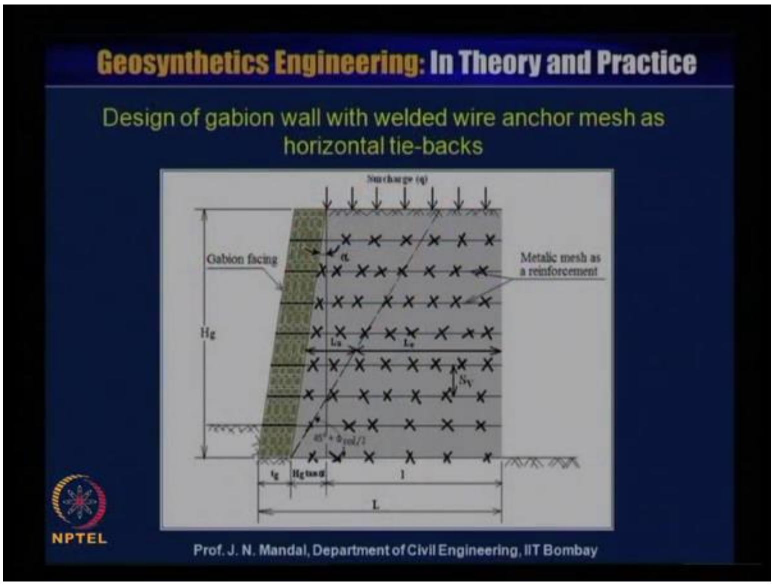

Now, design of gabion wall with welded wire anchor mesh as a horizontal tie-back now, here you can see that.

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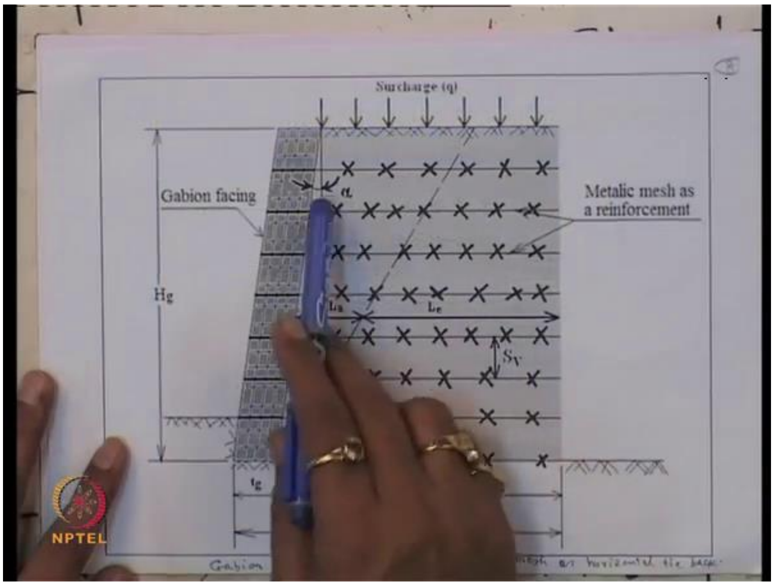

This is the gabion wall with welded wire anchor mesh, as a horizontal tie-back. So, this is fixed with the gabion, this is gabion as a facing and there is a surcharge and this is metallic mesh as a reinforcement. This is the failure line so we will design this structure and also, this is the failure surface which is making at an angle 45 degree plus phi s by 2.

And this is the t of g and this is the height of the wall hg and because this angle is alpha so this is hg into tan of, tan of alpha. So, here that wall height hg is given.

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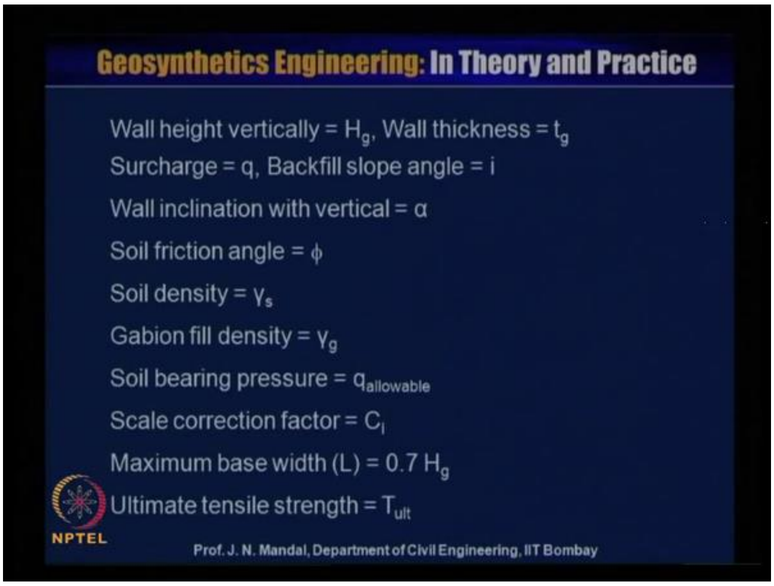

Wall height hg and wall thickness is the tg and surcharge is q and backfill slope angle is i, wall inclined with the vertical is alpha, soil friction angle phi, soil density gamma s. Gabion fill density gamma g, soil bearing pressure q allowable, scale correction factor Ci and maximum base width L is equal to 0.7 into hg and ultimate tensile strength is t of ultimate.

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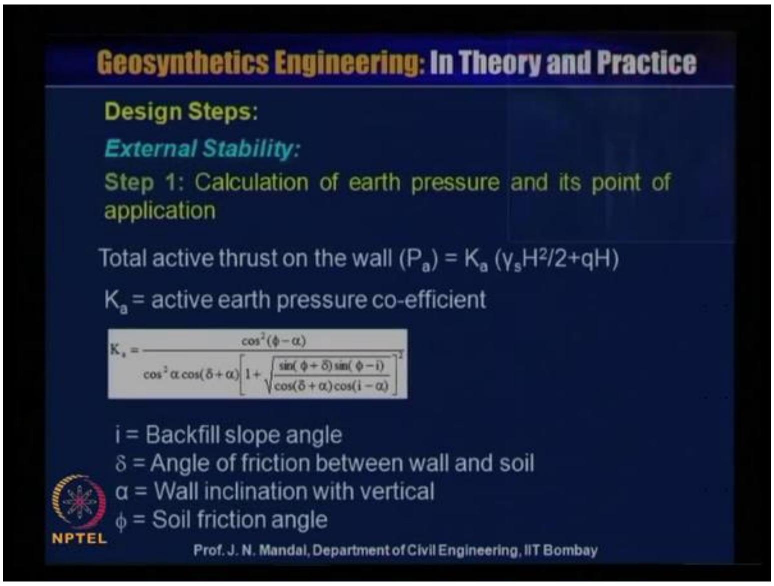

Now, how will you design this, I will show you that design step and then we will solve one example. Now in design step, you have to go for external stability. So step 1, calculation of the earth pressure and its point of application so you know that total active earth thrust on the wall Pa, is equal to Ka into gamma s into H square by 2 plus q into H, that is due to surcharge. And Ka you know, what will be the active earth pressure coefficient, this you know, you know that what is the I, that backfill of the slope angle, delta angle of friction between wall and soil. Alpha is equal to wall inclination, with the vertical and pi is equal to soil friction angle so all values is known, you can calculate that Ka value.

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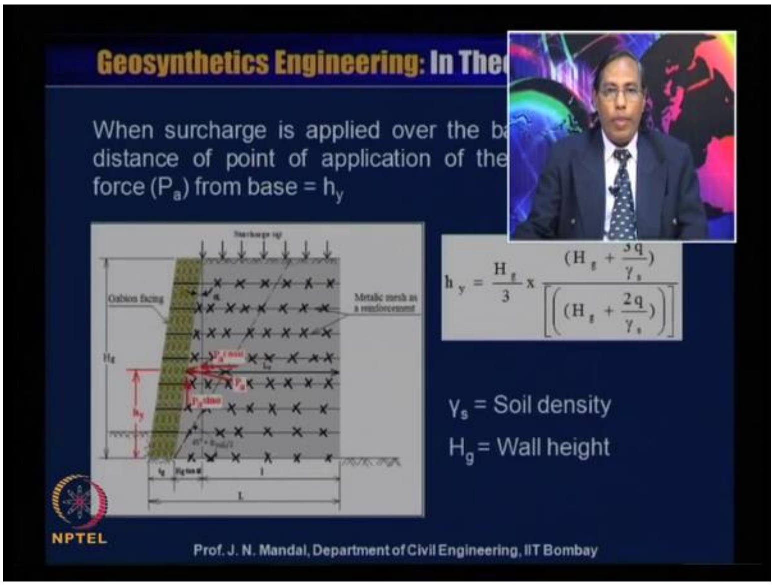

Now, when the surcharge is applied over the backfill, the vertical distance of the point of application of the resultant normal force that is, P of a. This, P of a from the base, this from the base is h of, h of y so here is the h of y, here hy. So, this h of y can be calculated with this equation, that is Hg by 3 into Hs plus 3 q by gamma s divided by Hg plus 2 q by gamma s, where gamma s is equal to soil density, Hg is equal to wall of height.

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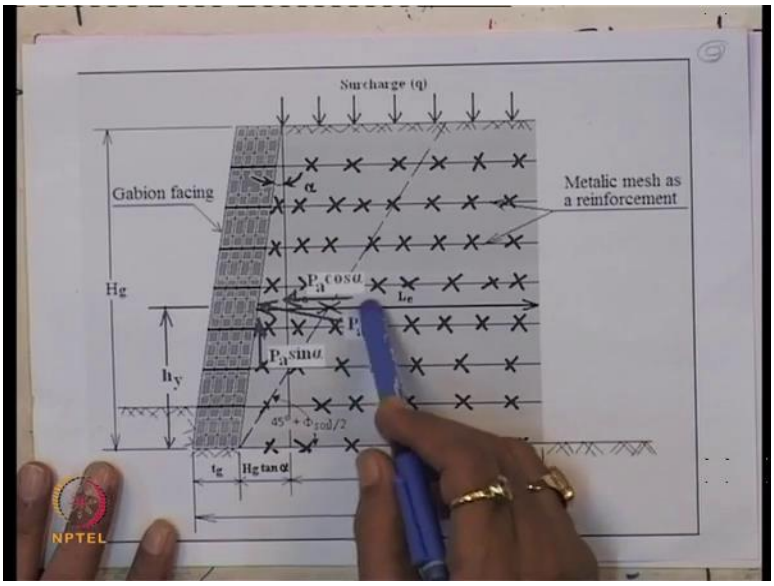

So, this is like, like this what I say that this is the P of a which is, this distance is hy and this is h of d and also Pa has the component of Pa cos alpha and also, the Pa sin alpha. So, we are interested to determine that the value of hy, so this value of hy can be calculated using this equation.

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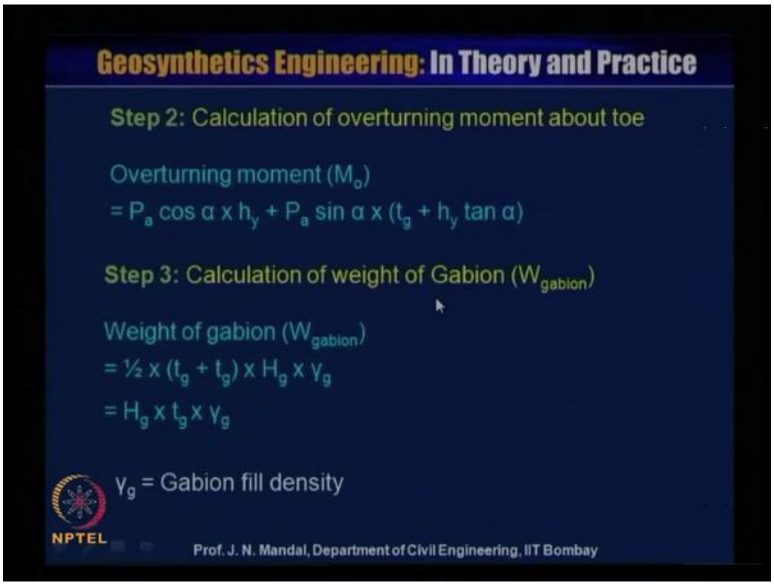

Now step 2, calculation of overturning moment about toe so overturning moment Mo again is equal to Pa cos alpha because horizontal force is acting Pa cos alpha, I show Pa.

And this is angle Pa cos alpha, that means this is the Pa, this is Pa cos alpha, Pa cos alpha into hy, this is the moment.

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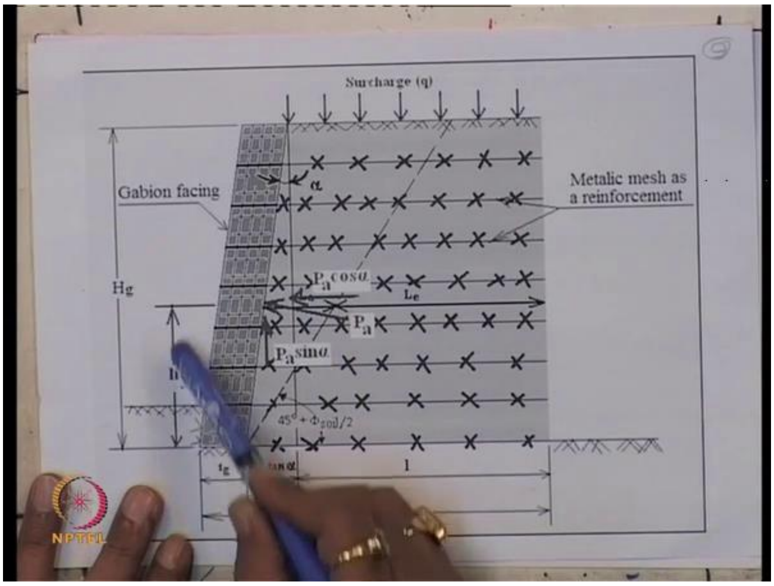

So, Pa cos alpha into hy plus, this is the vertical component Pa sin alpha, this Pa sin alpha is equal to this, is tg and plus hy, this is tan of alpha. So, this will give the overturning moment and step 3, you have to calculation of the weight of the gabion, W of gabion, that means this W of gabion, this is the tg and this also tg. So, it is like a trapezoid so that means half into tg plus, tg and this height is equal to Hg and this gamma g, unit weight of the stone or aggregate. So, that means weight of the gabion will be equal to Hg into tg into gamma g, so you can have ultimately this equation that, W of gabion is equal to Hg, tg into gamma g.

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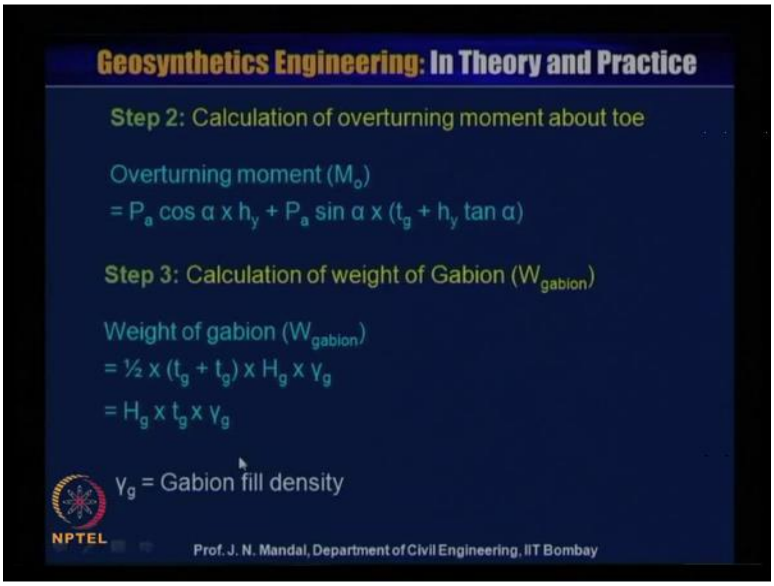

Where, this gamma g is the gabion fill density because this gabion is fill up with the stone. So, we know the, what is the gabion fill density, you can calculate the weight of the gabion.

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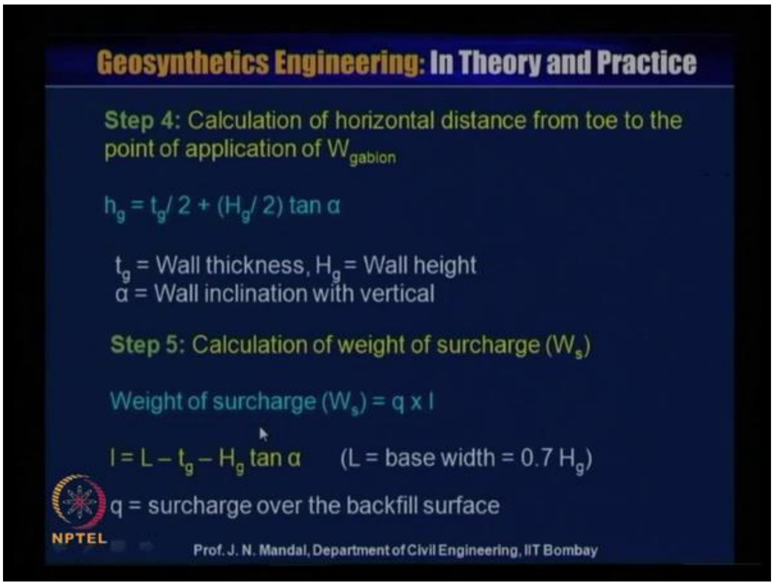

Step 4, calculation of horizontal distance from the toe to the point of application W gabion. So, here again you can see that, what should be the h of g that means, this is t of g.

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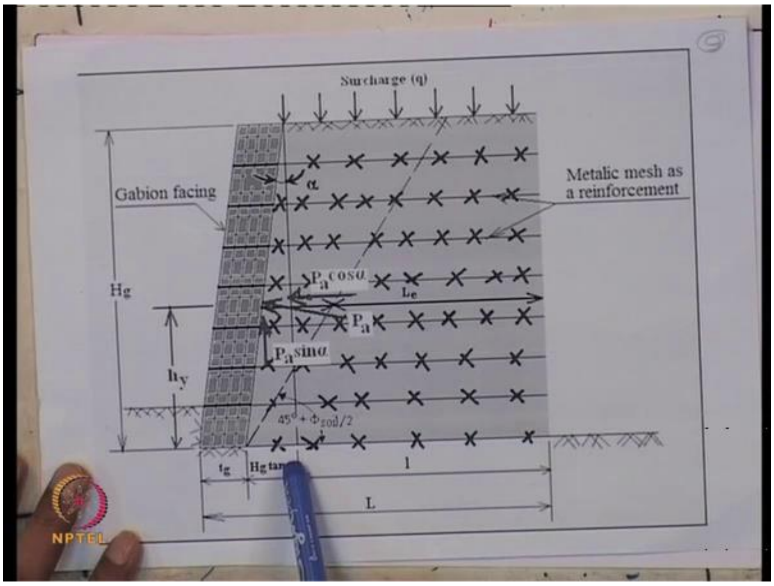

So, this will be the middle tg by 2 plus this is Hg tan alpha, that means Hg by 2 into tan alpha because tg is equal to wall thickness, Hg is equal to wall height and alpha is the wall inclination, with the vertical. So, you can calculate what is the Hg, Hg means this half of tg by 2 plus, half of Hg into tan alpha. Now step 5, calculation of weight of the surcharge.

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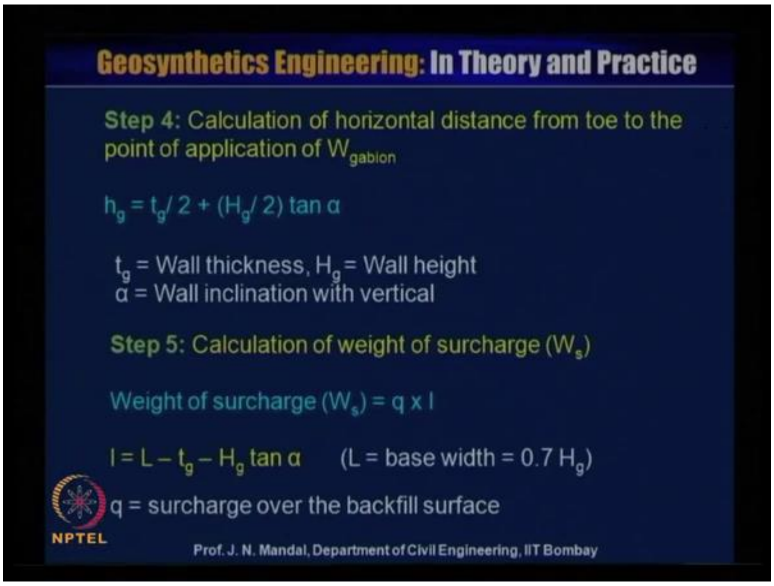

So, there will be a surcharge and that surcharge is q so weight of the surcharge Ws will be q into L. So, L is this distance, L is this distance because surcharge is q and this distance is equal to L. So, weight of the surcharge Ws is equal to q into L, that means this L. Now how to calculate this L, this L so this L is equal to you know the total, this is length L minus this is tg minus Hg tan alpha. So, where L is equal to base width, that is 0.7 times the height of the wall, that is Hg. So, you know this, you know this value, you know this value so you can calculate L so weight of the surcharge is q by L, q is given, L you have calculated. So, you can calculate what is that weight of the surcharge.

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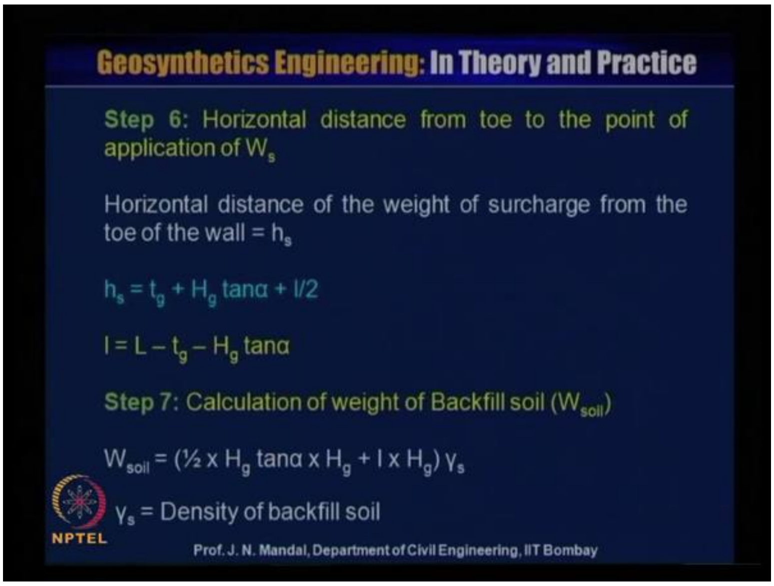

Now step 6, horizontal distance from the toe to the point of application of Ws. Now, horizontal distance of the weight of the surcharge from the toe of the wall is hs so hs will be equal to, that means you know tg plus Hg tan alpha plus L by 2. So, it is like this, this is tg plus Hg tan alpha and this is half of this L by 2 so this will give that, what will be the horizontal distance of the weight, of the what you call surcharge from the toe of the wall. So, this will give that value, that means you can calculate what should be the L value, that means L, you know the capital L minus tg minus Hg tan alpha.

Now step 7, calculation of weight of the backfill soil, that is W soil, that means W soil will be equal to half into Hg tan alpha, into Hg plus 1, L into Hg into gamma of s. Because, you know that gamma s is equal to density of the backfill soil so you can calculate what will be the weight of the soil here. Because, you can see here this is Hg of tan alpha, so this is like a triangle half of Hg tan alpha into this, height is equal to the H so this plus this, that means this is L and this is that height is equal to Hg. And the unit weight of the density of the backfill soil is gamma s so this into gamma s into this, into gamma s. So, you can calculate what will be the weight of the backfill soil.

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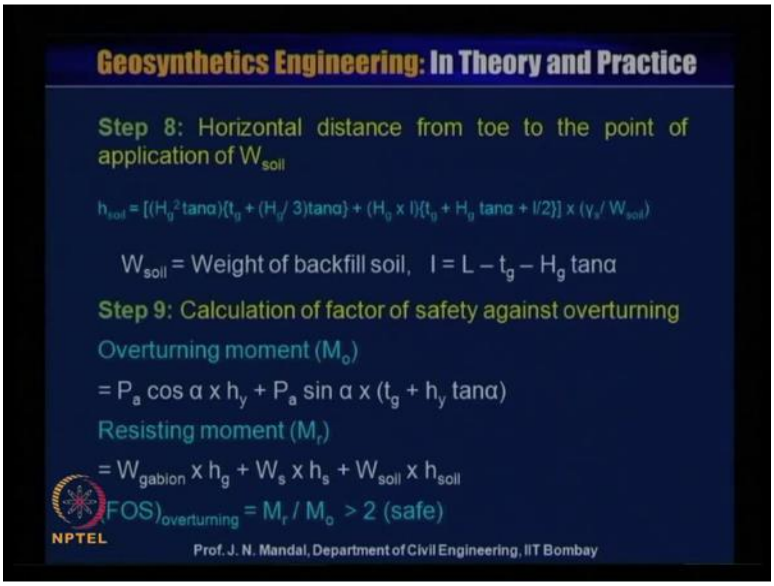

Step 8, horizontal distance from the toe to the point of application of W soil. So, here that again h soil is equal to you know Hg square into tan alpha into t of g plus Hg by 3 into tan alpha plus, Hg into L into tg plus Hg tan alpha plus, L by 2 into gamma s by W of soil. Where you know W soil is equal to weight of the backfill soil and L is equal to L minus tg minus Hg tan alpha. So, you can calculate here, the horizontal distance from the toe to the point of application of W soil, where it is the acting.

Step 9, calculation of factor of safety against overturning so overturning moment Mo is equal to Pa cos alpha into hy plus Pa sin alpha into tg plus hy tan of alpha. So, you are taking the moment at the toe you know, what is that Pa cos alpha and you know that like this is a Pa cos alpha, you know this is the hy. So, Pa cos alpha into hy, you know this is the Pa sin alpha and this also you can check where, also it is acting, this is sin alpha into tg plus H tan of alpha.

So, resisting moment Mr is W of gabion into H of g plus W of s into H of s plus W of soil into H of soil, that means resisting moment that due to the gabion. And what is the Hg you know, due to the soil W s you know what is distance Hs also, W soil you can also into H of soil, you know. So, then you check that what will be the factor of safety against overturning, that is Mr by Mo and it should be greater than 2, then it is safe.

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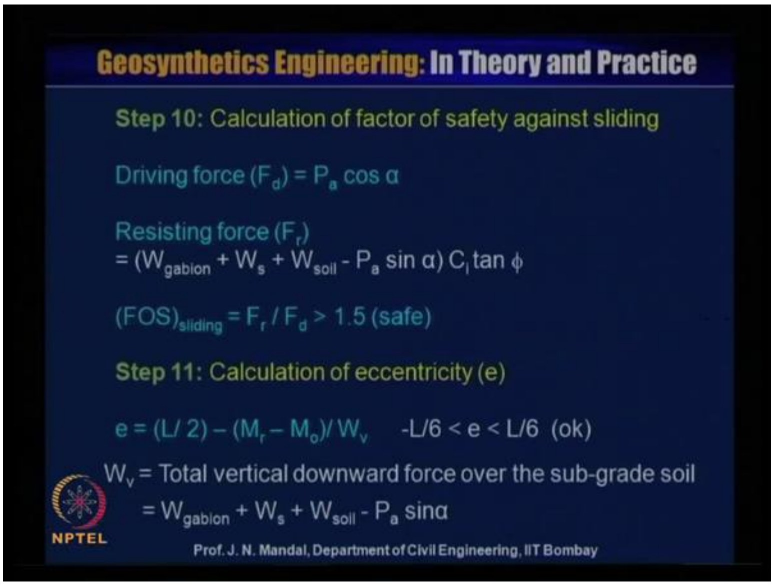

Step 10, calculation of factor of safety against sliding so driving force Fd is equal to Pa cos alpha. So, resisting force Fr is equal to W of gabion plus W of s plus W of soil minus Pa sin alpha into Ci tan phi, that is at the base. So, factor of safety against sliding is equal to Fr by Fd that is greater than 1.5, that means safe. Step 11, calculation of eccentricity e so e is equal to L by 2 minus Mr by minus Mo divided by W of v, that means e should be greater than minus L by 6 or less than L by 6. Then, it is okay where, Wv is equal to total vertical downward force over the subgrade soil. So, this will be equal to W of gabion plus W of s plus W of soil minus Pa sin of alpha.

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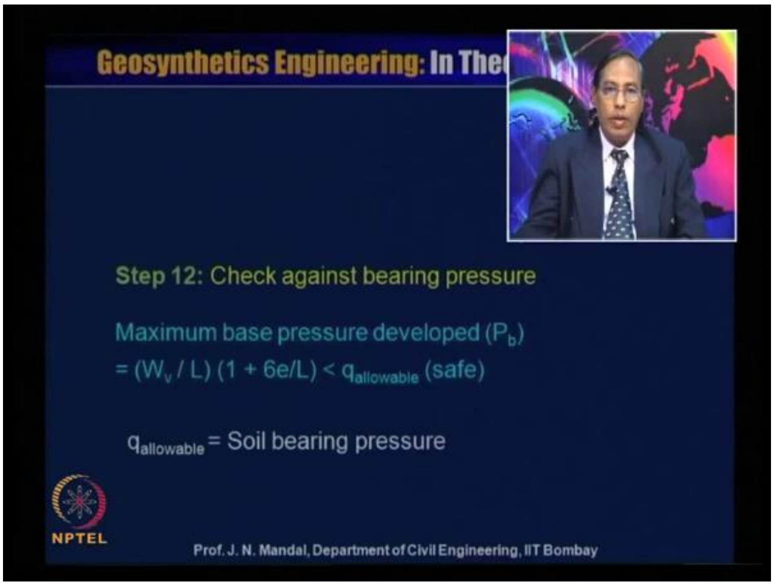

Step 12, you have to check against the bearing pressure so maximum base pressure developed Pb will be equal to Wv divided by L into 1 plus 6 e by L, that should be less than q allowable then, it is safe. So, q allowable where you can say soil bearing pressure.

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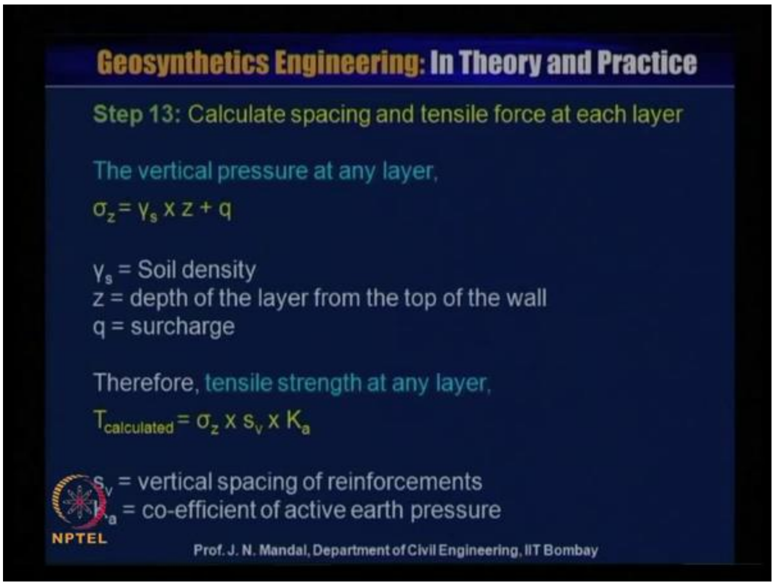

Step 13, you have to calculate the spacing and the tensile force at each layer, the vertical pressure at any layer that is sigma z, you know gamma into s into z plus q. Where, gamma s is equal to soil density, z is equal to depth of the layer from the top of the wall and q is the surcharge. Therefore, tensile strength at any layer that means, T calculated will be equal to sigma z into s v into Ka so this you know. So, where s v is the vertical spacing between the reinforcement, Ka is equal to coefficient of active earth pressure.

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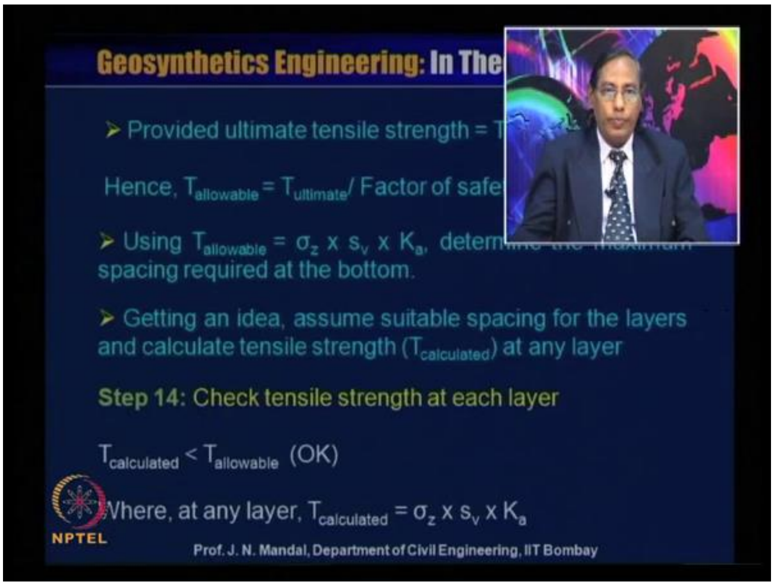

Now, provided ultimate tensile strength is equal to T ultimate hence T allowable should be equal to T ultimate divided by factor of safety. Now, using T allowable is equal to sigma z into s v into Ka, determine the maximum spacing required at the bottom. Getting an idea, assume the suitable spacing of the layer and calculate tensile strength, that is T calculated at any layer. Step 14, check tensile strength at each layer that means, T calculated will be less than T allowable then, it is ok, where at any layer, T calculated will be sigma z into s v into Ka, this will be more clear when I will solve one example on this type of wall.

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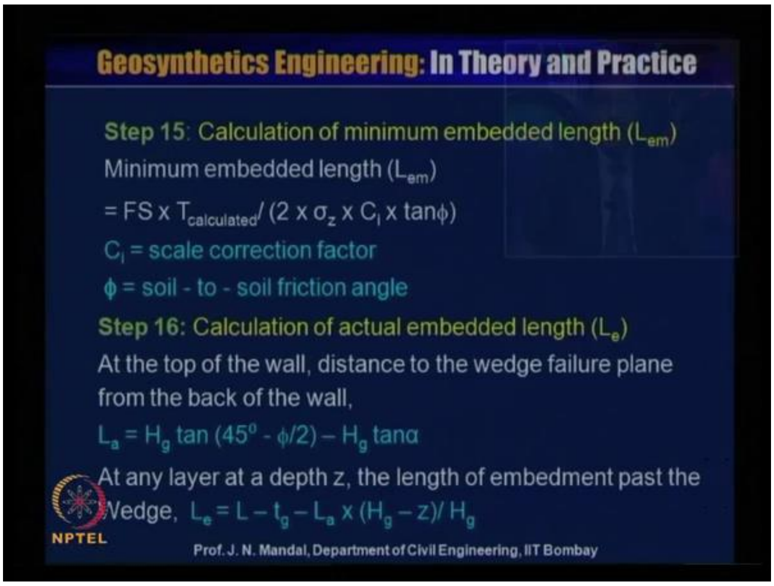

Step 15, calculation of minimum embedment length that is L em, what you call minimum embedment length. So, that L em is equal to FS into T calculated divided by 2 into sigma z into Ci into tan phi where, Ci is equal to scale correction factor and pi is equal to soil to soil friction angle. So, if you know Ci, if you know phi, you know sigma z so you can calculate what is Le minimum, from this equation. Step 16, calculation of actual embedment length that is L of e, that at the top of the wall the distance to the wedge failure plane from the back of the wall, that means La will be equal to Hg tan 45 degree minus phi by 2 minus Hg tan alpha.

So, it is like this suppose if this is the reinforcement, this is the L of e and this part is the L of a, this is L of a. So, if this is the L a, if this is L a, you know this is Hg into tan of, tan of alpha. So, this L of a will be equal to, this is Hg tan of 45 degree minus phi by 2 minus Hg tan of alpha. So, this will give you, what will be the value of L of e so for at any layer at the depth, any depth z the length of the embedment past the wedge ,that is L of e this will be equal to this total length, L minus this is tg minus we calculated L of a. This into Hg minus z at any depth, if it is h z at any depth so this will be Hg minus z divided by H of g. So, you can calculate what will be the embedment length from this step.

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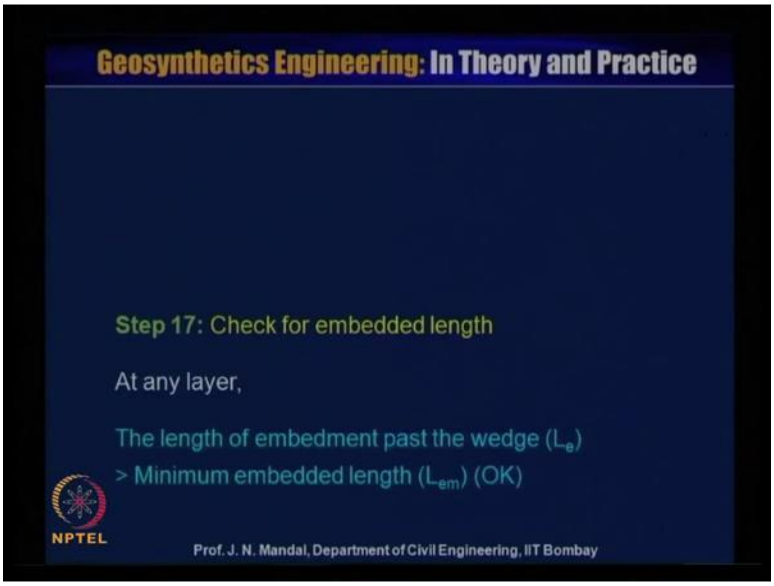

Step 17, check for embedment length, at any layer the length of the embedment past the wedge is Le. So, it should be minimum embedment length L em then it is okay. So, you have to check.

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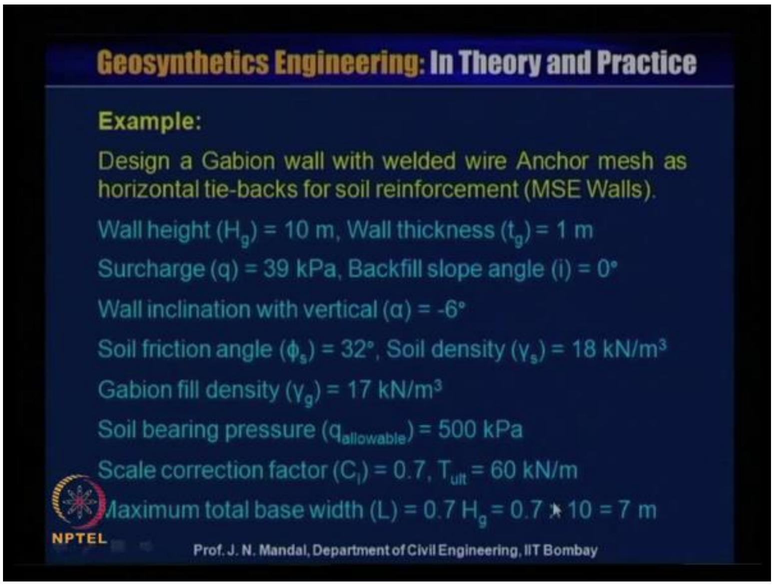

Now this is example design, a gabion wall with welded wire anchor mesh as horizontal tie-back for soil reinforcement. Like you say mechanically stabilized earth wall now, in this example wall height Hg is equal to 10 meter, wall thickness that is tg is equal to 1 meter surcharge q is 39 kilopascal. Backfill slope angle i is equal to 0 degree, wall inclination with the vertical alpha is minus 6 degree, soil friction angle phi s is 32 degree and soil density gamma s is 18 kilo Newton per meter cube.

So, gabion fill density gamma g is 17 kilo Newton per meter cube, soil bearing pressure q allowable is equal to 500 kilopascal and scale correction factor Ci is equal to 0.7. And T ultimate is equal to 60 kilo Newton per meter so maximum total base width L is equal 0.7 times Hg, that is 0.7 into 10 is, 7 meter. So this, in this example, this all, this data are given so you have to design a gabion wall with welded wire mesh, anchor mesh as a horizontal tie-back for reinforcement soil wall.

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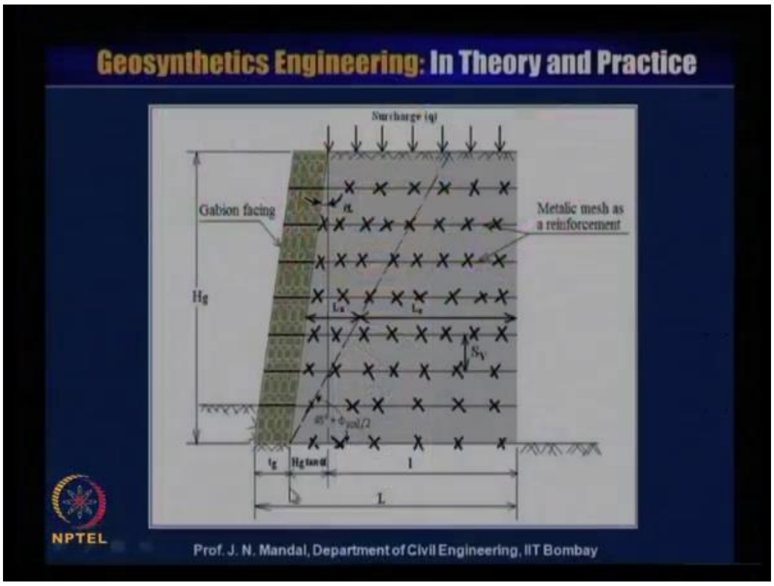

Now, this is a kind of the wall as I say, this is the gabion facing and this is the metallic mesh as a reinforcement and this is the spacing Sv, spacing between the two reinforcement. And this is the surcharge load, this is the Hg this you know what is L, this is L, this is Le, this is L of a and this is the failure line, which is making at an angle 45 degree plus phi by 2 and this is tg and this is Hg into tan of alpha.

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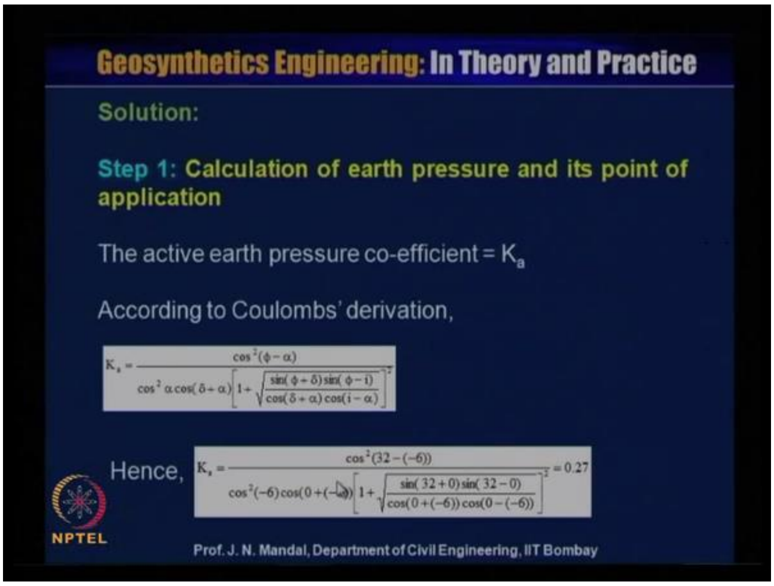

Now, for the solution so step 1, what we have already theory we have explained and step 1 here, calculation of earth pressure and its point of application. So, active earth pressure coefficient is Ka, according to the coulomb's derivation so this is the Ka, this is the equation. So, from this you substitute these value phi 32, this is alpha minus 6 degree so you know all these value, you have substituted and then, you find that Ka value 0.27. So, you know what is earth pressure Ka.

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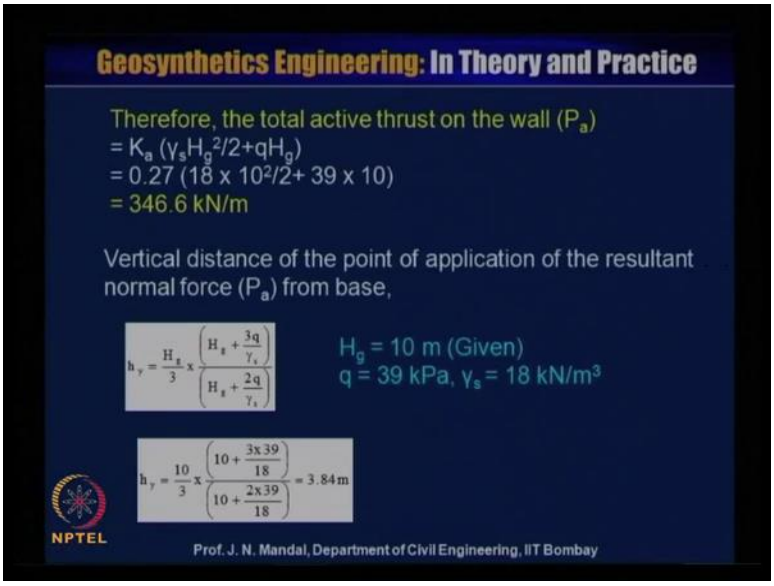

Therefore, total active thrust on the wall Pa will be equal to Ka gamma Hg square by 2 plus q into Hg, Ka you know 0.27, 0.27, gamma s value is given 18 and Hg is 10 square divided by 2 plus q is the surcharge load, is 39. And Hg is equal to 10 so you can calculate that, what will be the total active thrust on the wall Pa is 346.6 kilo Newton per meter.

Now, vertical distance of the point of application of the resultant normal force Pa from the base. So, you know this equation hy so here H of g is 10, this is 10 and this Hg 10 divided by 3 into Hg 10 plus 3 of q is, you know 30 surcharge and gamma s is 18, this is 18 divided by H is 10 plus 1 into q 1 into 39 by gamma s 18. So, this will give hy is equal to 3.84 meter so you have calculated what is hy that is 3.84 meter.

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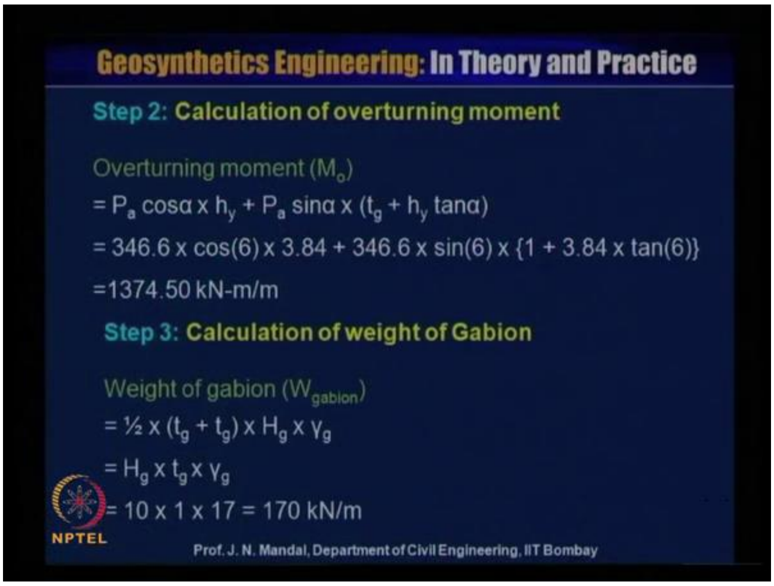

Now step 2, calculation of overturning moment, so overturning moment this equation already we have shown earlier Pa cos alpha into hy plus Pa sine alpha into tg plus hy into tan alpha Pa. You just calculated here, you calculated what is Pa 346.6 so this is Pa is 346.6 into alpha is equal to 6 cos 6, h this y you calculated here hy is 3.84. So, hy is 3.84 plus Pa again 346.6 into sin alpha is sin 6, tg is 1 is given hy you calculated t3.84 into tan of 6 alpha is 6. So, if we calculate, then you can calculate the, what will be the overturning moment Mo is 1374.50 kilo Newton meter per meter. Step 3, calculation of weight of the gabion so weight of the gabion W gabion you know that, we have shown that, earlier this equation that is half of into tg plus tg into Hg into gamma g, that is Hg into tg into gamma g. So, Hg is 10, tg is 1 and gamma g is the 17 so this will give the weight of the gabion is 170 kilo Newton per meter.

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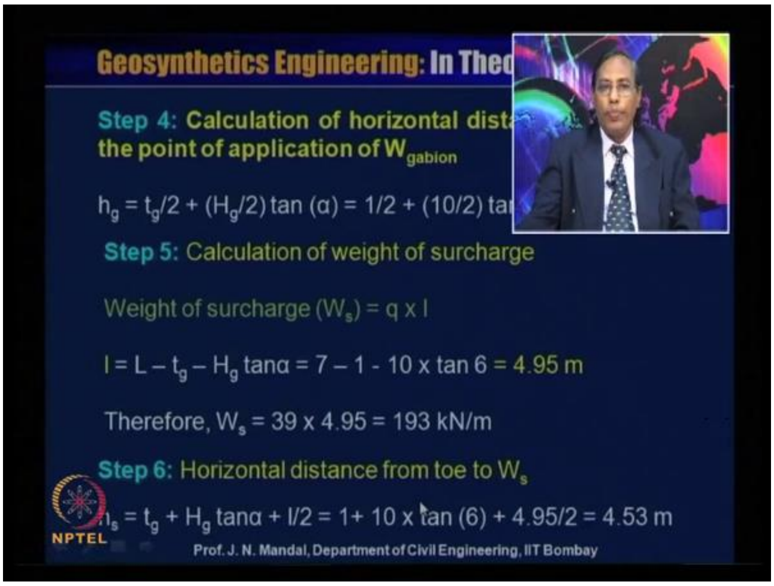

Now step 4, calculation of horizontal distance from toe to the point of application of W gabion so Hg is equal to tg by 2 plus Hg by 2 into tan alpha. So, this equation also shown so this is tg is 1 divided by 2 plus Hg is 10 divided by 2 plus tan alpha 6. So, this will give Hg is 1.026 meter. Step 5, calculation of weight of the surcharge so weight of the surcharge Ws is equal to q into l, l we defined so l is equal to L minus tg minus Hg tan alpha, that means this is 7, this tg is 1, Hg is 10 tan alpha is 6.

So, this l will give 4.95 meter therefore, Ws is equal to q into l so q is 39 surcharge into this l, 4.95 this will give 193 kilo Newton per meter. Step 6, horizontal distance from the toe to Ws so hs is equal to tg plus Hg tan alpha plus l by 2, this we have discussed earlier. So, this is tg is 1 plus Hg is equal to 10 into tan alpha is equal to tan 6 and l value is this 4.95, 4.95 this divided by 2. So, this will give hs is equal to 4.53 meter.

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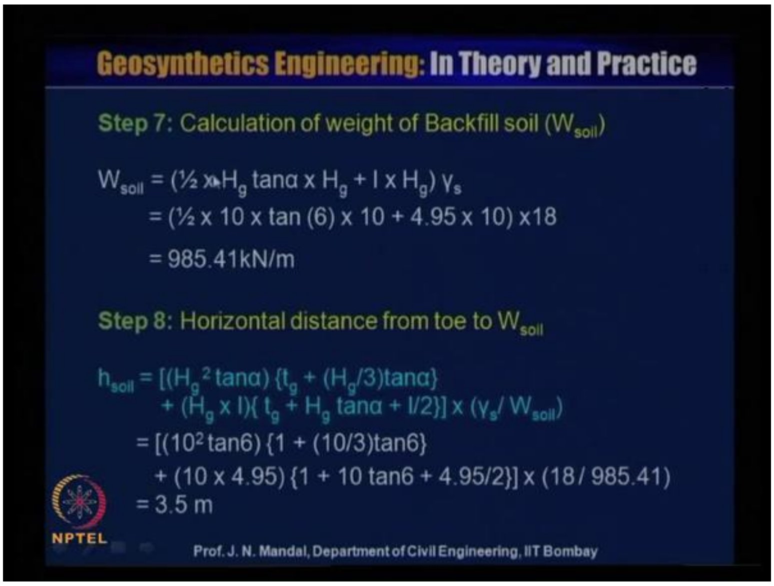

Now step 7, calculation of weight of the backfill soil that is, W of soil that means W soil is equal to half into Hg tan alpha into Hg plus l into Hg into gamma s. So, half Hg is 10 tan alpha is tan 6, Hg again 10 plus l we calculated 4.95 into Hg is 10 and gamma s is 18. So, this W soil 985.41 kilo Newton per meter. Step 8, the horizontal distance from the toe to W soil so that means h soil is equal to this equation, Hg square by tan alpha into tg plus Hg by 3 into tan alpha plus Hg into l into tg plus Hg tan alpha plus l by 2 into gamma s by W soil. Here Hg is 10 square tan alpha is tan 6, tan 6 plus tg is 1 plus Hg is 10 by 3 into alpha is 6 tan 6 plus this is Hg is 10 into l is 4.95, we calculated plus tg is 1 Hg is equal to 10, tan alpha is equal to 6. And this is l is 4.95 by 2 plus gamma s is equal to 18 divided by this W, soil we calculated 985.41. So, this h soil we will obtain 3.5 meter.

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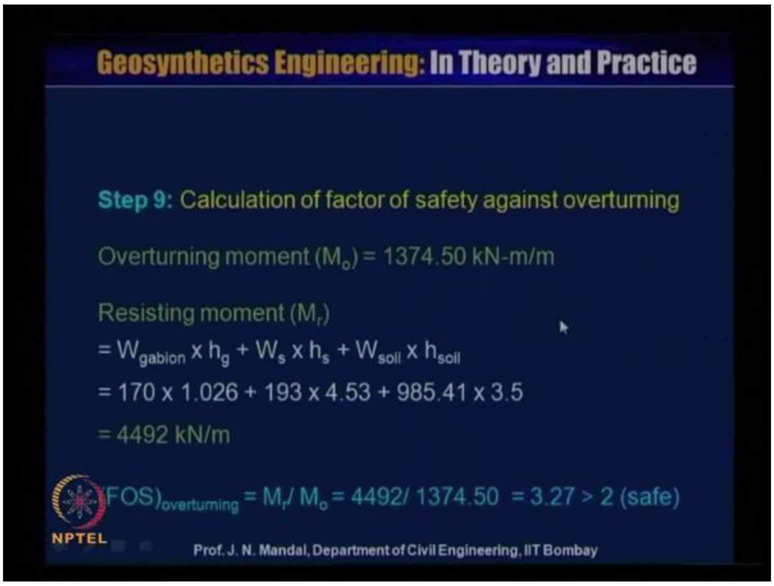

So step 9, calculation of factor of safety against overturning so overturning moment we calculated Mo is equal to 1374.50 kilo Newton meter per, meter resisting moment Mr is equal to W gabion into Hg plus Ws into hs plus W soil into h soil. That means we know that, W gabion 170 into Hg is 1, we calculated Hg is 1.026 plus Ws is 193 plus hs we calculated 4.53 and W soil is 985.4 one and h soil we calculated 3.5.

So, it will give the resistive moment Mr is equal to 4492 kilo Newton per meter so we can check that what will be the factor of safety against this overturning. That is Mr by Mo, that is 4492 divided by 1374.50 is equal to 3.27 so this is greater than 2 then, it is the safe. So, this we cover the partly with that, how to calculate the factor of safety against the overturning when, this gabion itself is a facing. And facing with the, number of the horizontal layer of the metallic reinforcement.

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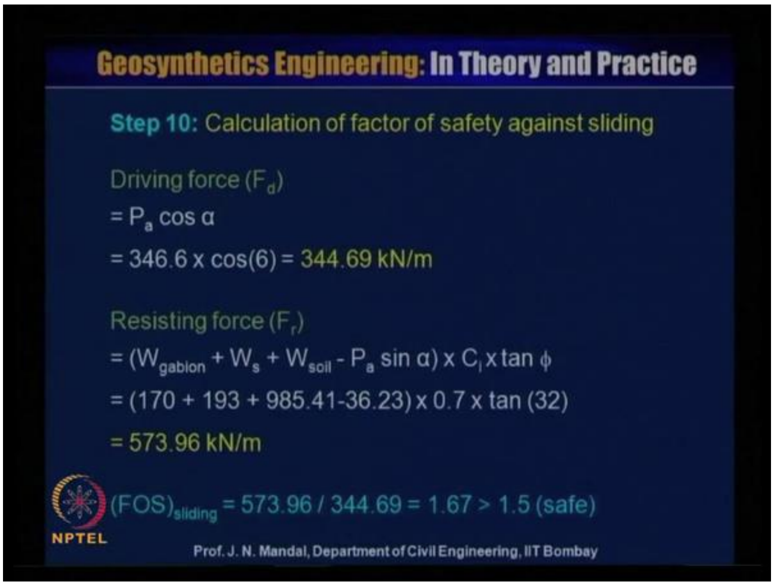

Step 10, calculation of factor of safety against sliding driving force Fd is equal to Pa cos alpha, Pa you calculated 346.6 into cos of 6. So, Fd is equal to 344.69 kilo Newton per meter now, resisting force Fr is equal to W of gabion plus Ws plus W soil minus Pa sin alpha into Ci tan alpha. So, W gabion is 170, Ws is 193, W soil 985.41 minus Pa is 36.23 into sine alpha is 0.7, Ci is, Ci is 0.7 and then, the tan of alpha is tan of 32. So, this will give that resisting force Fr is 573.96 kilo Newton per meter. So, we can calculate factor of safety against sliding is equal to, what will be the resisting force divided by driving force, that is 573.96 divided by 344.69 that is equal to 1.67, which is greater than 1.5 so it is safe. So, factor of safety against sliding is safe.

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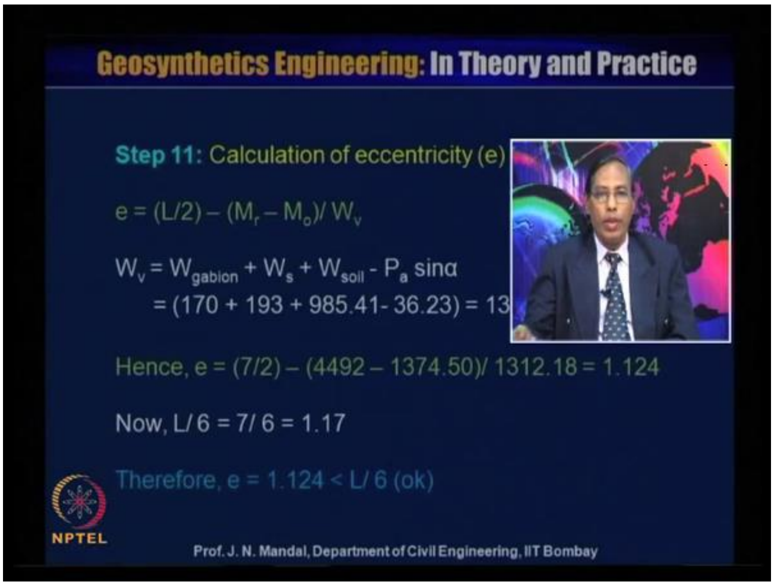

Step 11, the calculation of eccentricity e so you know the e is equal to L by 2 minus Mr minus Mo divided by W of v so W of v is equal to W of gabion plus W of s plus W of soil minus Pa sin alpha. So, W gabion is equal to 170, Ws 193, W soil 985.41 and Pa sin alpha is 36.23. So, this will give that W of v is 1312.18 kilo Newton per meter. Hence, eccentricity e is L by 2 that means, 7 by 2 minus M of r we calculated, 4492 minus M of o you calculated, 1374.50 this divided by W of v, this W of v is 1312.18. So, this will give eccentricity, 1.124. So, now L by 6 is equal to 1.17 therefore, eccentricity e 1.124 which is less than L by 6 then it is ok.

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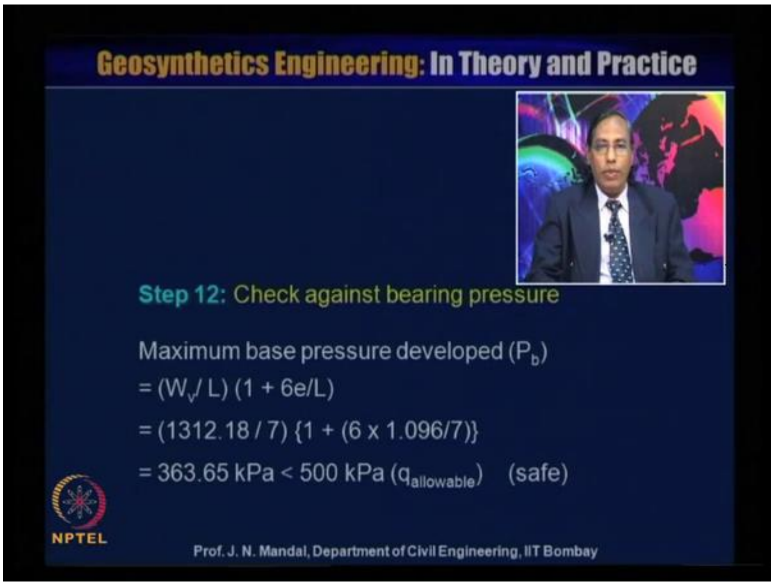

Step 12, check against bearing pressure, maximum base pressure developed Pb is equal to Wv by L into 1 plus 6 e divided by L, that means Wv is given 1312.18 divided by L 7 into 1 plus 6 into e 1.096 divided by L 7 so this is 363.65 kilopascal, which is less than 500 kilopascal that q allowable so this is the check against bearing pressure and it is the safe. So, we check against the sliding, we check against the overturning, we check also the bearing pressure. So, this wall is so far safe. So, with this I finish my lecture today, any question let me hear, from you.

Thanks for listening.