Geology and Soil Mechanics
Prof. P. Ghosh
Department of Civil Engineering
Indian Institute of Technology Kanpur
Lecture - 14
Soil Compaction- D

Welcome back to the course Geology and Soil Mechanics. So, in the last lecture we have solved couple of problems on the compaction of soil and today we will be taking one more problem.

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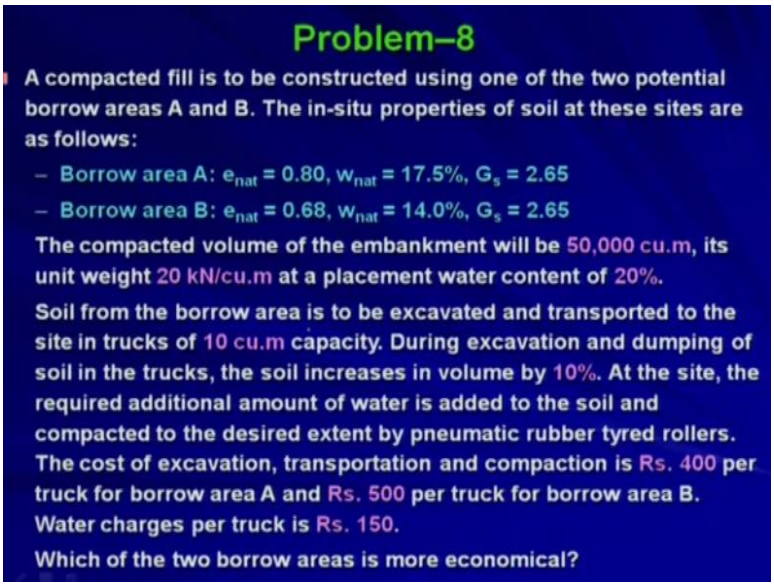

And the problem says that a compacted fill is to be constructed using one of the two potential borrow areas A and B okay. So, I mean borrow areas means from where you can collect the soil to construct the embankment. So, the in-situ properties of soil at these heights are as follows. So, borrow area A gives the e natural that is the natural void ratio is equal to 0.8 water content that is w natural is 17.5% and G s that is the specific gravity of soil solids equal to 2.65, but the borrow area B gives e natural equal to 0.68, w natural that is small w natural what is that is your water content is 14% and G s that is the specific gravity of soil solid is equal to 2.65.

Now the compacted volume of the embankment will be 50,000 cubic meter. Its unit weight 20 kilo newton per cubic meter at a placement water content of 20%. So, this is the requirement for the embankment which is to be constructed. Now soil from the borrow area is to be excavated and transported to the site in trucks of 10 cubic meter capacity. During the excavation and dumping of soil in the trucks, the soil increases in volume by 10% so that kind of I mean

allowance you have to consider. At the site the required additional amount of water is added to the soil and compacted to the desired extent by pneumatic rubber tyred rollers.

The cost of excavation, transportation, and compaction is Rs. 400 per truck for borrow area A and Rs. 500 per truck for borrow area B. Water charges per truck is Rs. 150. Which of the two borrow areas is more economical. So, this problem is basically the I mean based on some practical situation that means you want to construct one embankment and that embankment construction will take the soil or will borrow the soil from different locations or different sites.

Now you have to find out as an engineer, you have to find out which borrow area or which location will be economical for construction of this embankment. So, now let us start this problem. So, this problem is saying or is elaborating all the parameters. Now based on those parameters you have to find out which one will be the economical. That means which one will give you the less amount of cost to construct the embankment. So, let us solve this problem.

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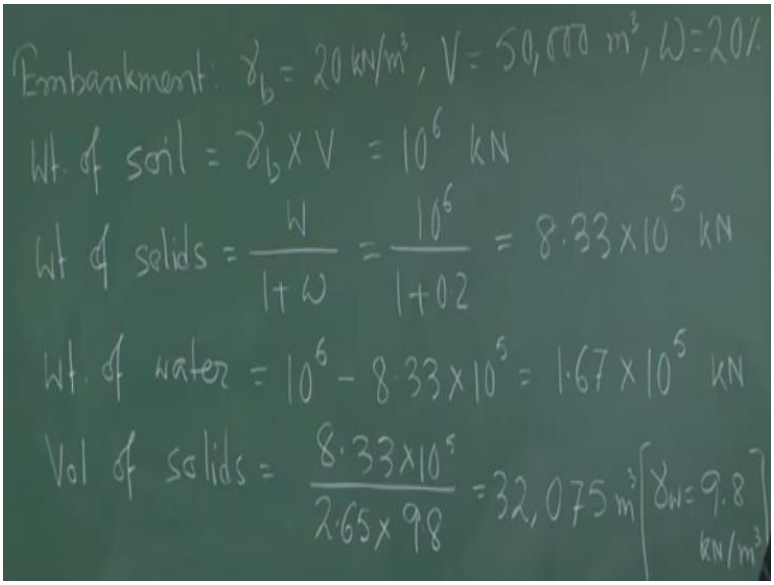

Now first we will write down what are the different properties available for the embankment. So, for embankment you know the bulk unit weight is given that is 20 kilo newton per meter cube that is cubic meter. The volume of the embankment or the soil of which is coming on the embankment is 50,000 cubic meter and the water content is 20% okay. So, these are the things are given for the embankment construction.

So, the embankment, after construction of the embankment or whatever embankment you are considering so that basically takes those parameters that is the bulk unit weight is 20 kilo newton

per meter cube. The total volume of soil is 50,000 cubic meter whereas the water content is 20% okay. So, now we will find out the weight of soil. So, when I am talking about the weight of soil that means this is taking care of weight of soil solid plus water.

That means this is the weight of moist soil. So, weight of soil, how can I get the weight of soil? That means you know gamma bulk, that is the bulk unit weight multiplied by V, simple. So, the volume multiplied by the unit weight will give you the weight of soil. So, that is giving me 10 to the power 6 kilo newton okay. So, that is the weight of total moist soil required for the embankment construction.

Now you can find out weight of solids. How can you find out weight of solids? So, now this is the weight of soil. Now if you find out weight of solid, if you if you can manage to find out weight of solids then you can find out how much water that is the weight of water is present in the embankment soil okay. So, weight of solids is nothing but capital W that is the weight of total soil or the moist soil divide by 1 plus small w that is the water content okay. So, this is the expression. So, if you put the values here 10 to the power 6 by 1 plus 0.2 which will be giving me 8.33 into 10 to the power 5 kilo newton okay.

So, this is the weight of solids which will be remaining constant whatever you do I mean if you collect soil from borrow area A or if you collect from borrow area B the weight of soil solids will be remaining constant right. So, weight of I mean the volume may change right, the volume will be changing the total volume will be changing or whatever you are collecting based on the void ratio volume will be changing but weight of solids it will be remaining same. This much of weight of solids is required to construct the embankment that is all.

So, therefore weight of water which will come as 10 to the power 6 that is the total weight of the solid that is the moist weight of the (soi) I mean soil minus the weight of soil solid which will give me the value 1.67 into 10 to the power 5 kilo newton. So, this much of water is required to compact the soil to construct the embankment okay. Now coming to the volume of solids. How can I get volume of solids?

I know weight of solids divided by specific gravity into gamma w. So, I am considering gamma w is 9.8 kilo newton per meter cube okay. So, this is the consideration for this problem. You can consider gamma w equal to 10 or 9.8 that does not matter but anyway for this problem I am considering gamma equal to 9.8 okay. So, which will give me 32,075 meter cube okay. So, this much of volume of solid is required to construct the embankment. So, no matter whatever

borrow area you are considering this much of volume of solids you must bring okay from the respective borrow area that is all.

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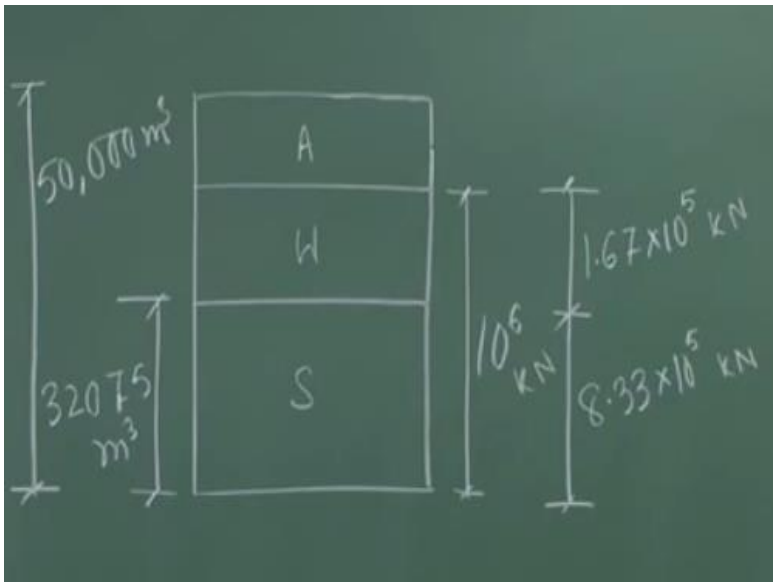

Now if you try to plot the 3-phase diagram or rather yes, the phase diagram for the this embankment soil then it will look like this. So, let us draw that. This is your air, this is your water, this is your soil solid. This side you have the wet axis. So, total weight of the moist soil was how much 10 to the power 6 or you have the separation for the water as well as for the soil solid. For water, it came 1.67 into 10 to the power 5, so all are in kilometer okay and this is coming as 10 to the power 5 so kilo newton, let us write down the okay.

So, this is the phase diagram as air is not having any weight okay. So, this is the wet axis. Now if you plot that thing for the volume so this is 32,075 meter cube so that is the volume of solids, it has come like that. Now the total volume which will include the volume of air now so that already has been given in the problem that is 50,000 meter cube.

So, this is the phase diagram. So, you can find out the volume of water also from this these values because you know the weight of water, so from this you can find out the volume of water, so that is not a problem. So, this is your phase diagram for the embankment, for the embankment soil. Now let us talk about or let us analyse the different borrow area, like first we will consider borrow area A.

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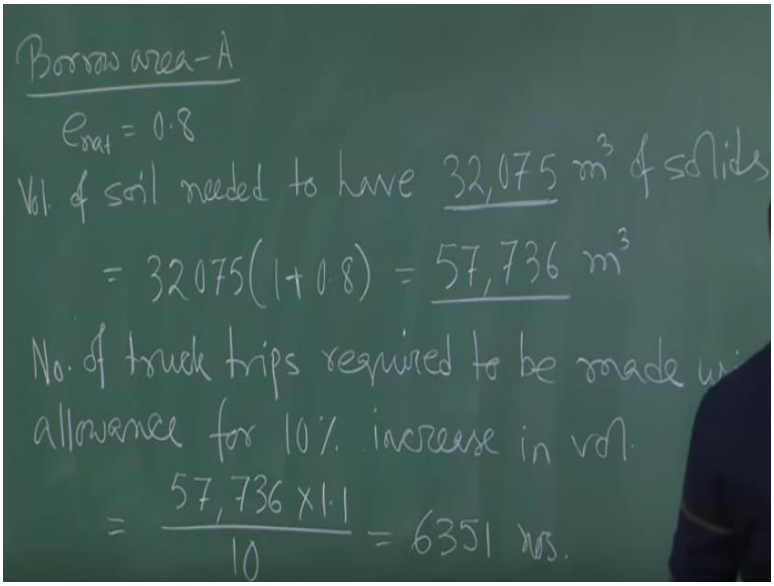

So, first we consider borrow area A. So, what is the natural void ratio in borrow area A? e natural is given as 0.8. So, volume of soil needed to have cubic meter of solids so as I told you that the volume of solids will be remaining same or the it will remain unchanged for whatever borrow area you consider, right? So, your volume of soil need to have this volume of solids will be 32075 into 1 plus e natural that is the e available for that particular borrow area that is 0.8, as simple as that. So, that comes around 57, 736 cubic meter.

So, this is the total volume required to be excavated from borrow area A okay. Now find out the number of truck trips required to be made using allowance for 10% increase in volume. So, what does it mean? I need this much of soil basically you have to transport okay by using the trucks. Now when we are talking about number of truck trips when we are calculating required to be made making or using the allowance for 10% increase in volume that means basically this much this is the total volume which needs to be transported through the by the truck plus some 10% increase in volume must be incorporated as given in the problem.

So, total volume is required, why this 10 is coming into the picture? Because it is given in the problem per truck can carry only 10 cubic meter of soil okay. So, this 10 is coming here. So, that gives me 6351 number of trips okay. So, you need 6351 number of trips to transport this much of soil which will be having this volume of soil solids which is actually required for the embankment.

So, that means you are taking or you are keeping all the allowance and you are transporting this much of volume, this much of total volume. This is the total volume required for the

embankment plus multiplied by some allowance you are considering and that gives you a total volume which is getting transported by the trucks. So, how many number of truck trips you need, 6351 okay.

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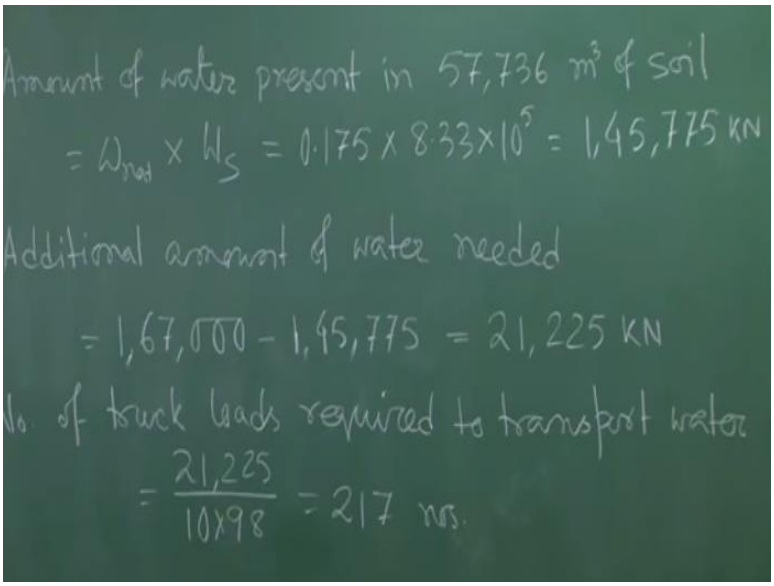

Now amount of water present in 57,736 meter cube of soil is equal to small w natural that is natural water content at borrow area A multiplied by the weight of solid right. So, that is given in the problem 17.5% which is nothing but 0.175 into what is the weight of solid, 8.33 already we have derived that 10 to the power 5, that is not going to change right. That will be remaining same. So, it is coming around 1,45,775 kilo newton.

So, this much weight of water is present in this volume which is getting transported from borrow area A okay. So, now in the embankment okay what was the water present in the embankment? So, that already we have calculated. So, additional amount of water needed is equal to, this much is the requirement in the embankment. This much water is present in the soil which you are transporting. So, additional amount of water basically you need to transport by using trucks and you have to mix in the embankment site and then you have to compact right.

So, that comes around 21,225 kilo newton. So, this is your additional amount of water which needs to be transported by trucks okay and which will be mixed later on to compact the soil in the embankment site. So, number of truck loads required to transport water is equal to 21,225 by 10 into 9.8. So, this is total weight and this is the volume okay which will be carried by the truck.

So, truck capacity is 10 cubic meter multiplied by the unit weight of water which will give me the weight per truck. So, that gives me 217 number of trips.

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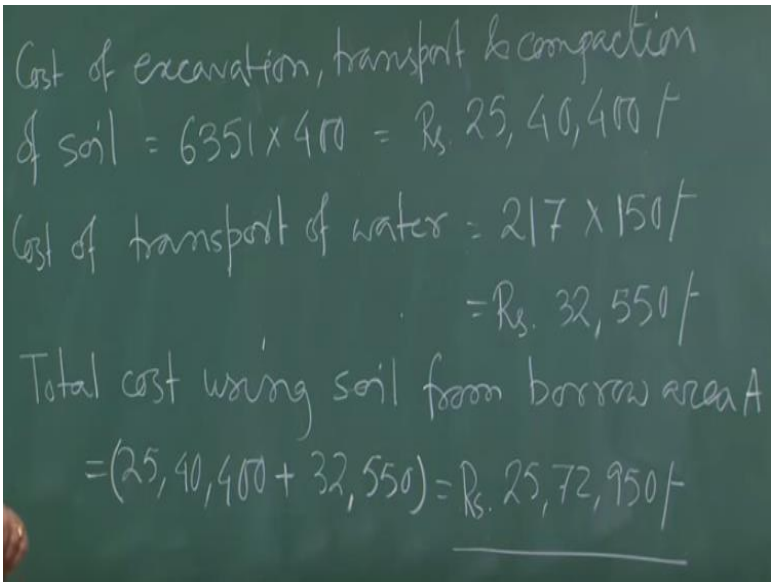

So, for borrow area A cost of excavation, transport, and compaction of soil is equal to so total number of trips which is coming as 6351 multiplied by 400. So, per trip will be costing you 400 Rs. So, that comes around Rs. Twenty five lakhs forty thousand four hundred okay. So, that is for excavation, transportation, and all those things which is included for borrow area A that is total number of trips is 6351 and the per trip will be costing you 400, so that comes around twenty five lakhs forty thousand four hundred.

Now cost of transport of water is, how many number of trips okay are required to transport the water, 217, already we have seen multiplied by the cost per trip is 150 which will be coming as Rs.32,550 okay. So, your total cost using soil from borrow area A is coming as 25,40,400 + 32,550 which will be total as Rs. 25,72,950. So, that is the total cost required if you collect the soil from borrow area A. So, it includes the cost for transportation, compaction, and excavation for soil and for transporting of water.

So, these 2 things are combined and the total cost is coming as twenty five lakhs seventy two thousand nine fifty. Now in a similar way we will analyse borrow area B. So, in the next lecture we will just look at this problem again and we will see that if we analyse the borrow area B and if we try to calculate the amount required to collect the soil from borrow area B and then we can

compare that which borrow area will be suitable for construction and which borrow area actually will be economical. Thank you.

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