Principles of Construction Management
Prof. Sudhir Misra
Department of Civil Engineering
Indian Institute of Technology, Kanpur

Lecture - 08
Estimation of project cost

[FL] and welcome to this lecture under the Principles of Construction Management, and what we are talking about today is estimation of project cost, this is part of the module where we are talking of how to estimate the cost of a project. Now we have already discussed in the previous lectures that the estimates of project cost would depend on the quantities of the individual items involved, and these quantities are estimated using the measurements in the drawings.

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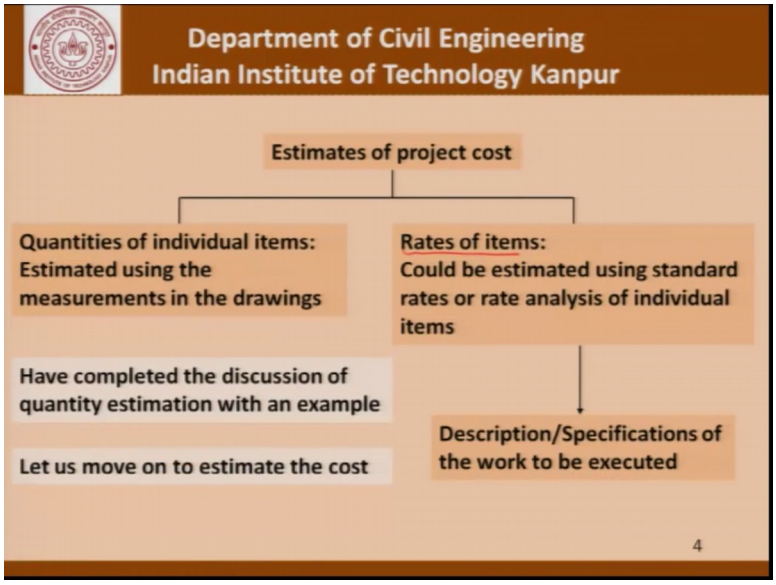

This we clearly saw with an example of a boundary wall, then the estimate would depend on the rate of those individual items. So, first we have to identify the items find their quantities and then talk of the unit rates of these different items, which could be estimated using standard rates or rate analysis of individual items, and this is also dependent on the description and the specifications of work to be executed.

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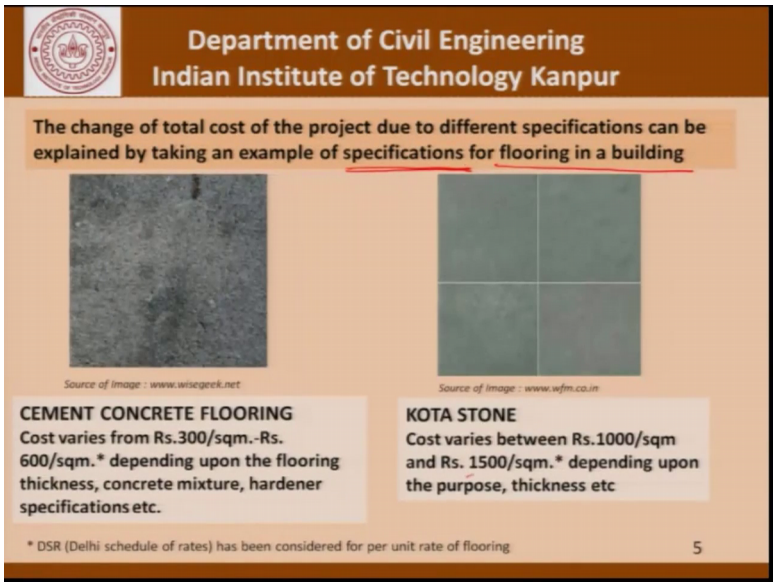

So, now having completed the discussion on the quantity estimation with an example, let us move on to the estimation of costs. So, the change of the total cost of a project or the cost of the project itself as a matter of fact, let us take the example of flooring of a building, and try to see how the is specifications, what kind of flooring you want, how that specification alters the cost or the unit cost of the flooring. Now we have all seen that there can be different kinds of flooring that we have this here is a cement concrete flooring and this cost could vary from 300 to 600 rupees per square meter depending upon the flooring thickness the concrete mixture the hardener and specifications and so on.

Similarly we could have what is called a kota stone flooring, and here the cost varies between let us say 1000 rupees to a square meter to 1500 and square meter, depending upon the purpose and thickness, and these estimates whether it is 1500 or a 1000 or 300 have been drawn from the Delhi schedule of rates, and these rates are published periodically.

In this case the example that I have taken is a government agency let us say, but it could be published by any professional organization and a client is free to identify and choose any published literature, which gives these kind of rates how these rates are arrived at we will discuss in a moment. So, let us carry on with our discussion on the different types of flooring for the time being.

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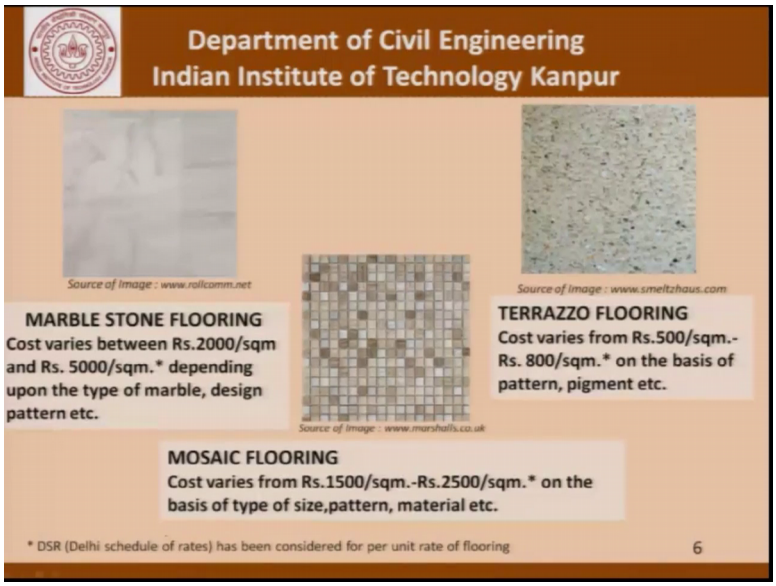

And we continue with marble stone flooring, which could cost between 2000 to 5000 rupees a square meter depending on the type of marble the design pattern and all that then we have what is called the terrazzo flooring, which could again cost 500 to 800 square meter on the basis of pattern and pigment and we have mosaic flooring which could cost between 1500 and 2500 rupees a square meter depending on the pattern and material.

So, what these two slides really show is give you a glimpse of some of the different types of flooring that we can use in a residential building and depending on the kind of flooring we want the specifications for the flooring we want the cost could vary between let us say 300, 500 rupees to even as much as 5000 rupees a square meter.

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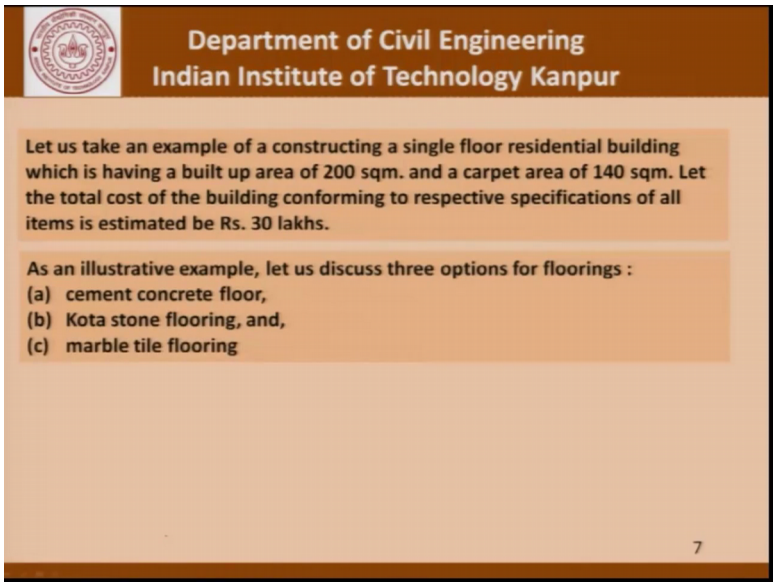

Now if we take an example of constructing a single floor residential building having a built up area of 200 square meters and a carpet area of 140 square meters, let us assume that the total cost of the building is 30 lakhs. Now as an illustrative example lets discuss three options for the flooring the cement concrete floor, the Kota stone floor, and the marble tile flooring.

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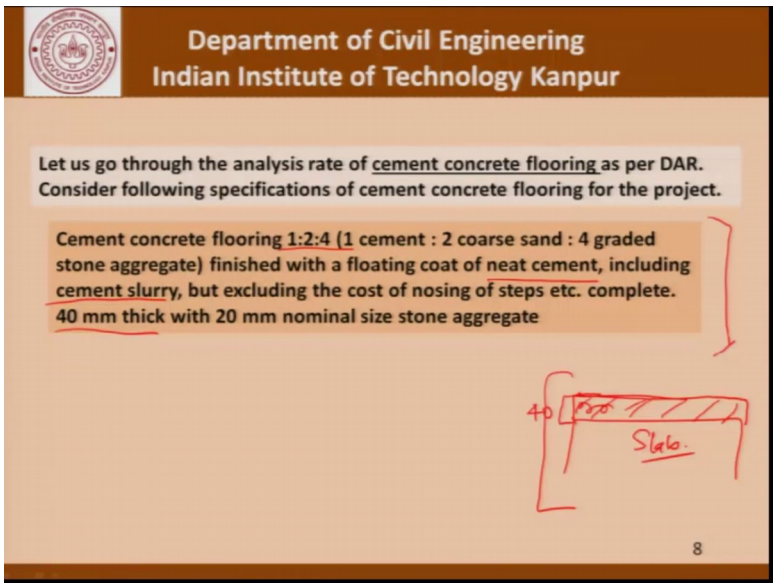

So, if we go through the rate analysis for the cement concrete flooring as per the Delhi analysis of rates, let us consider the specifications given in this slide the cement concrete

flooring 1 is to 2 is to 4, which means 1 cement, 2 coarse sand, and 4 graded stone aggregate, finished with a floating coat of neat cement including the cement slurry, but excluding the cost of nosing of steps complete 40 mm thick with 20 mm nominal size aggregate. What we really have is this is the slab of concrete and we are trying to provide a flooring on top of this.

So, in this particular case we are talking of 40 mm thick cement concrete floor, which is made with 1 is to 2 is to 4 mixture and this concrete is then finished with what is called a cement slurry, a floating coat of neat cement slurry.

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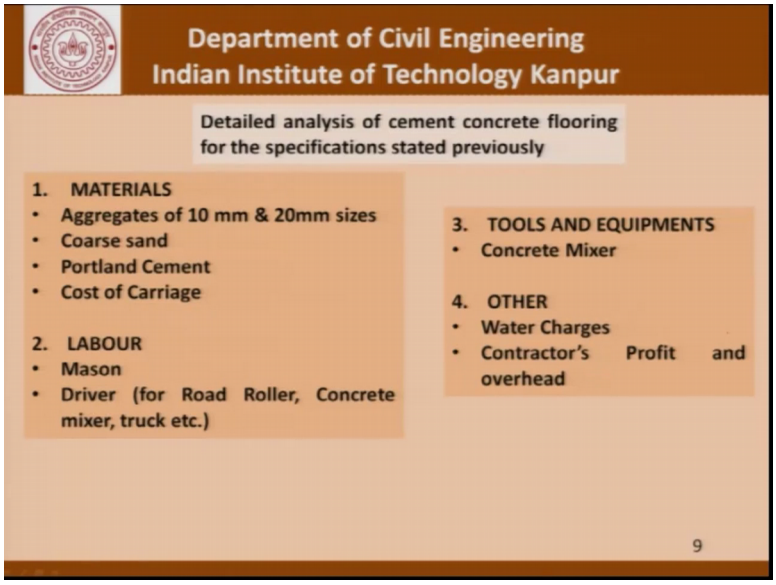

So, if this was the specification that we lay out in our tender document, then the detailed analysis for this would include the cost of materials, which could be aggregates, coarse sand, Portland cement, cost of carriage, labour it could be the mason involved, it could be the driver and operators for the concrete mixer and truck of course, the road roller does not come into picture as far as this particular example is concerned and apart from materials and labour there is cost associated with tools and equipment which could be the concrete mixer and other small tools which are used in the operation and then there are water charges contractors profits and overheads.

So, basically the cost has to reflect all these individual items depending on their availability, depending on the transport cost involved the quality of each of these materials and so on.

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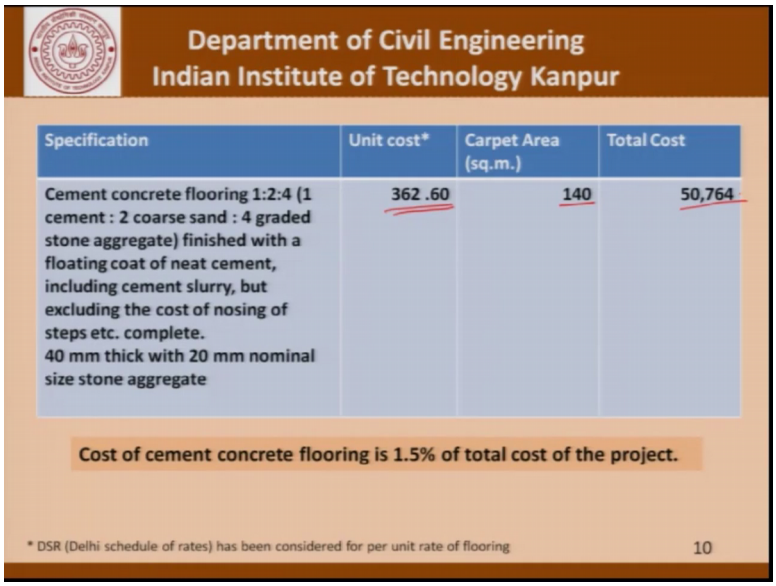

So, if we do that and go to a document like the Delhi schedule of freights, we would find that for a carpet area of a 140 square meters the unit cost is given as 360.6, which gives the total cost of the project for flooring as 50,764, what this shows is that the cost of the cement flooring or the cement concrete flooring is 1.5 percent of the total cost of the project because we started with the project cost of 30 lakhs.

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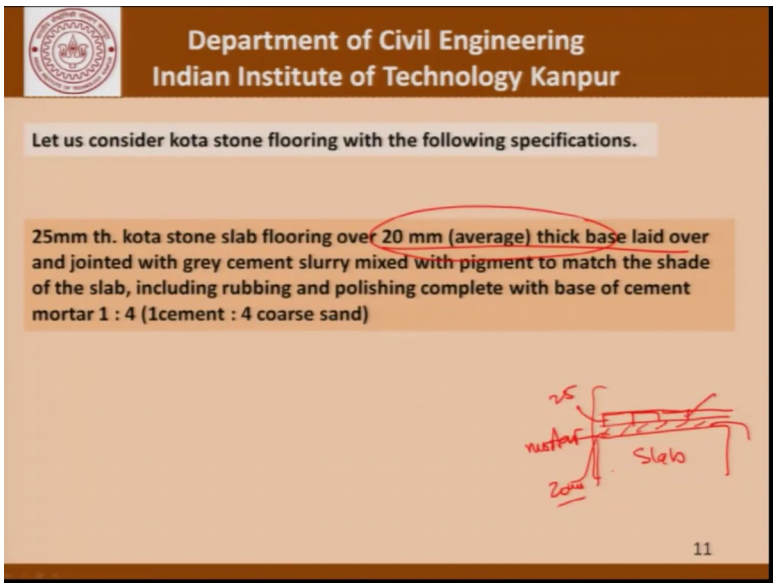

Now, if we move on to the kota stone flooring, which has these specifications given 25 mm thick kota stone slab flooring over 20 mm thick base laid over and jointed with grey

cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with the base cement mortar of 1 is to 4, that is 1 cement and coarse sand. So, in this case what is being done is that on top of this slab we first place this mortar and on the mortar we fixed Kota stone.

So, the thickness of this kota stone is given as 25 mm, and this thickness for the base slab is given as 20 mm, since the stone thickness will not be exactly 25 mm, in order to maintain the level ground we will have to make an adjustment as far as the mortar is concerned and therefore, we talk in terms of an average thickness of the base mortar.

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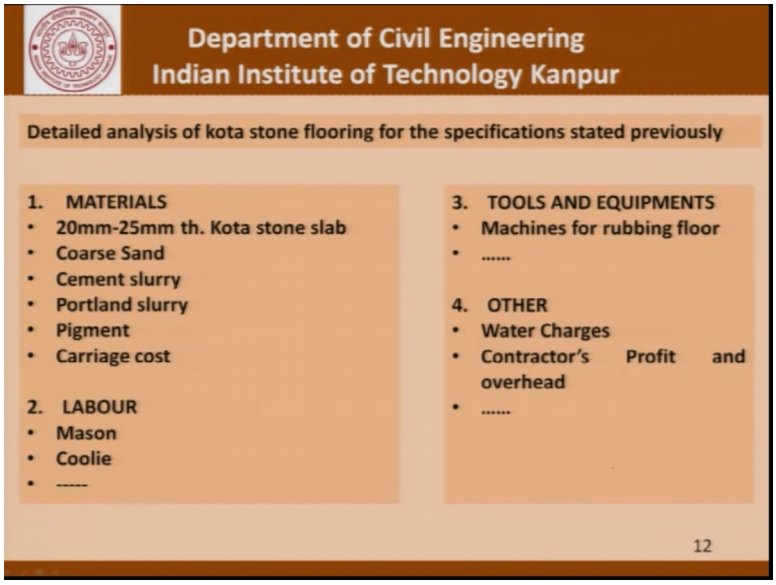

So, with this description of the kota stone flooring the kind of material cost the labour cost equipment and others have to be worked out.

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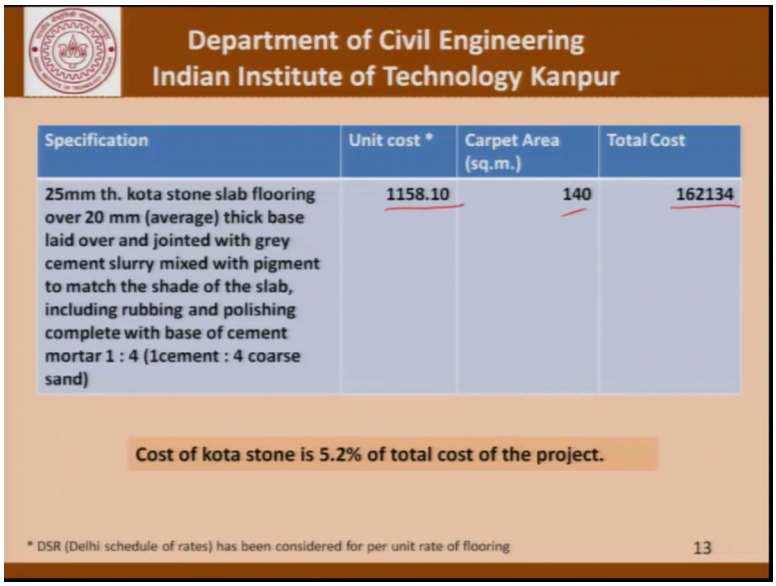

And what the Delhi schedule of rates gives us is that for the same carpet area the unit cost is 1158.1. So, this gives us a total cost of a 162134, which as we will see and which we can see is about 5 percent of the total cost of the project, recall that for the cement concrete flooring this percentage is about 1.5 or something like that.

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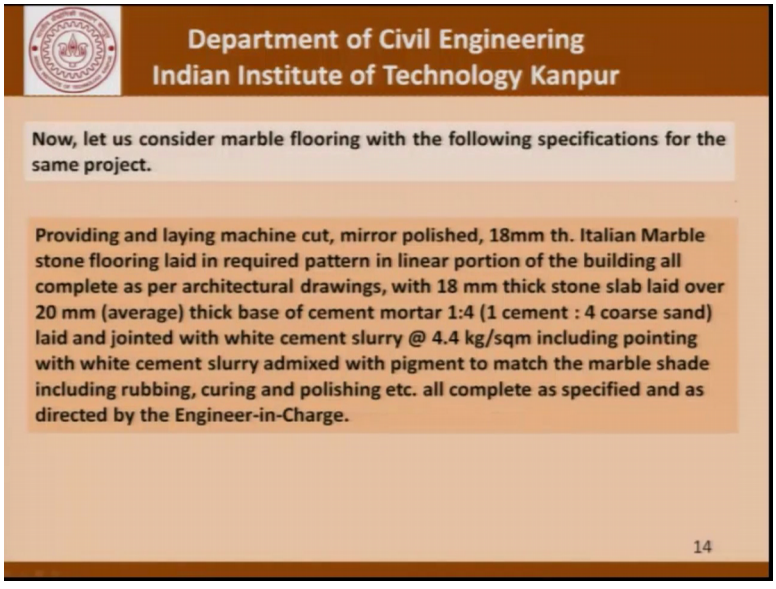

So, moving forward and taking up the third example that we promised to do that is marble flooring, if this was the specification given which is providing and laying machine cut mirror polished 18 mm thick Italian marble stone flooring laid in required

pattern in linear portion of the building all complete as per architectural drawings, with 18 mm thick stone slab laid over 20 mm thick base mortar of 1 is to 4 and jointed with cement slurry and so on.

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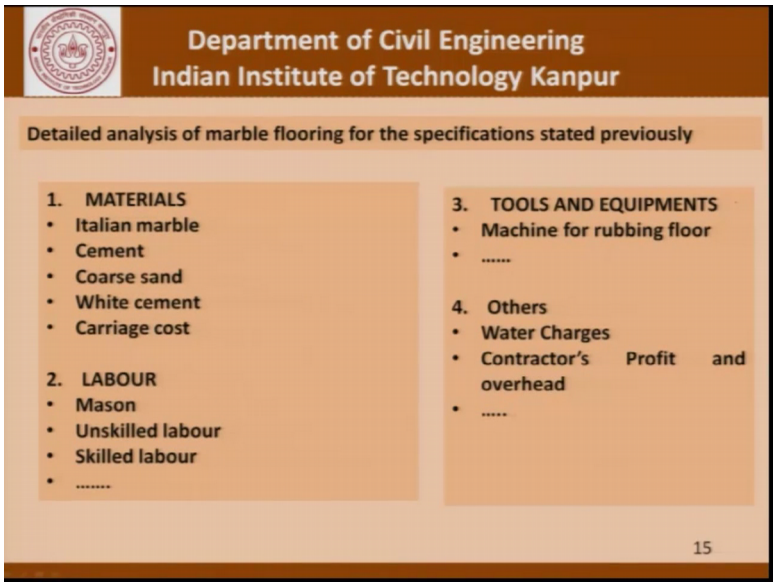

So, if that is the case then again basically that analysis of rates would be the same, we have look for the materials which could in this case include; obviously, the marble itself cement coarse sand white cement carriage cost and all that labour component the tools and tackles involved and other charges.

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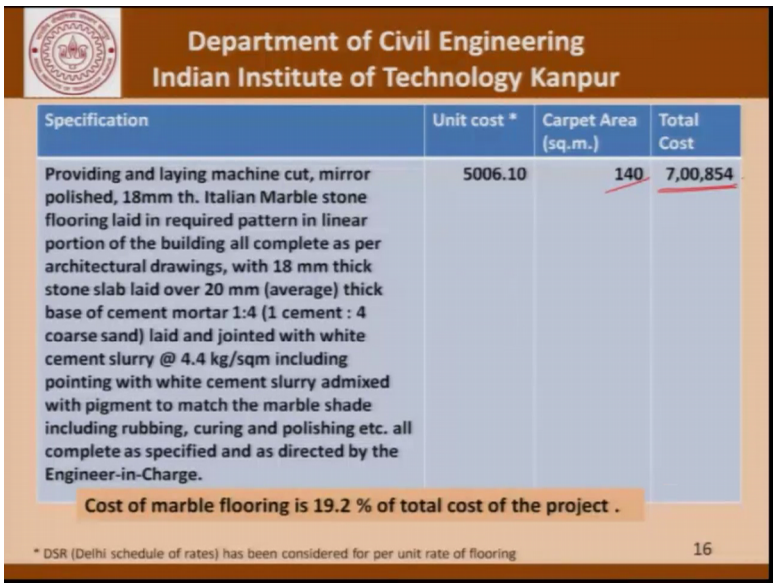

So, if we do this exercise the Delhi schedule of it guides us or tells us that the likely cost of this kind of flooring is 5006.1 rupees per square meter, and given that our carpet area is 140, we are looking at 700 1000 rupees of expense, if we choose to go for marble flooring in this particular house. So, this is about 19.2 percent of this total cost of the project.

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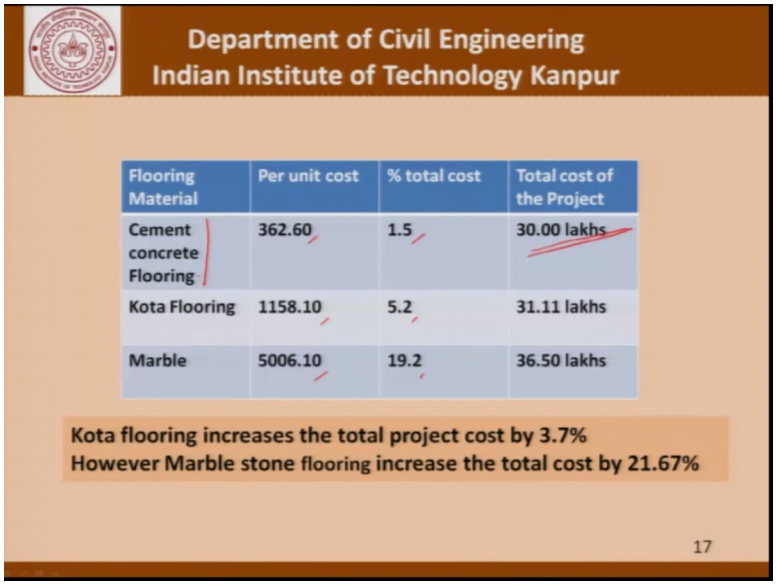

So, in summary if we look at the cement concrete flooring, the kota flooring and the marble flooring, the unit costs are 362, 1158 and 5006 and the total cost as far as the percentage of the cost is concerned is 1.5, 5.2 and 19.2. So, what we have done through this illustrative example is to say that well even though flooring is not a structural item it has only a certain amount of structural significance as for as the functional or aesthetic significance is concerned its fairly significant and depending on the specifications depending on the type of flooring that we want to go into the rates could be very different.

So, here we are talking of more than about 15 times difference and that difference; obviously, affects the cost of that project. So, now, we can see that the Kota flooring increases the total cost of about 3.7 percent, and the marble flooring increases it by 21.67 percent taking this to be the base price, which includes the cement concrete floor. So, what is often done is that we have a base number and depending on that base number or

as a variation from that base number we try to see how much is the increment or reduction in the cost if we change the specifications.

So, in this case of course, we went for more expensive flooring and therefore, the changes were all in the positive direction. So, there is; obviously, a possibility that if we take the bass specification is a higher specification and we want to reduce the cost of the project then we will have to try and see which are the areas where the specifications can be reduced. So, now, let us look at this business of estimation of rates of an item in a more detailed manner, the standard rate is given by the CPWD as the Delhi schedule of rates can be used.

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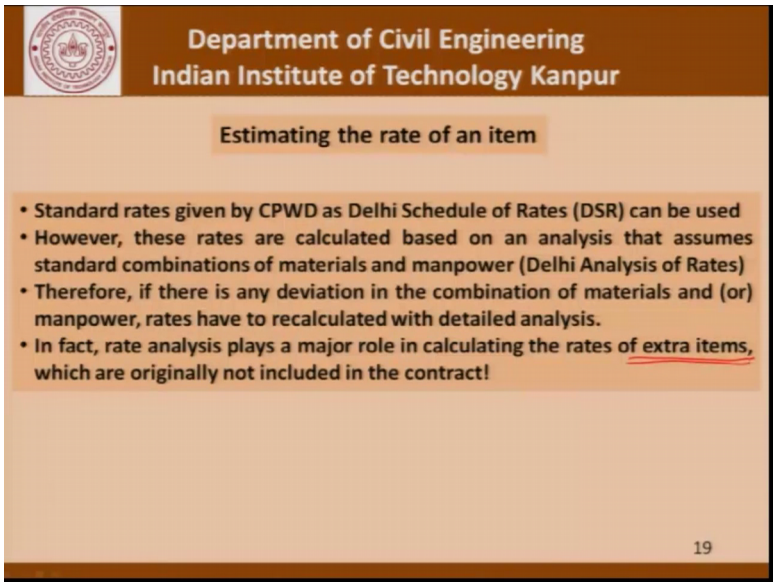

However, these rates are calculated based on an analysis that assumes, standard combinations of materials and manpower and that is what is given in let us say the Delhi analysis of rates therefore, if there is any deviation in the combination of the materials and or the manpower the rates will have to be recalculated with the detailed analysis, now this exercise is important and is often used in calculating rates of extra items.

Now, what these extra items are we will talk about separately in a subsequent lecture which are; obviously, not included in the contract.

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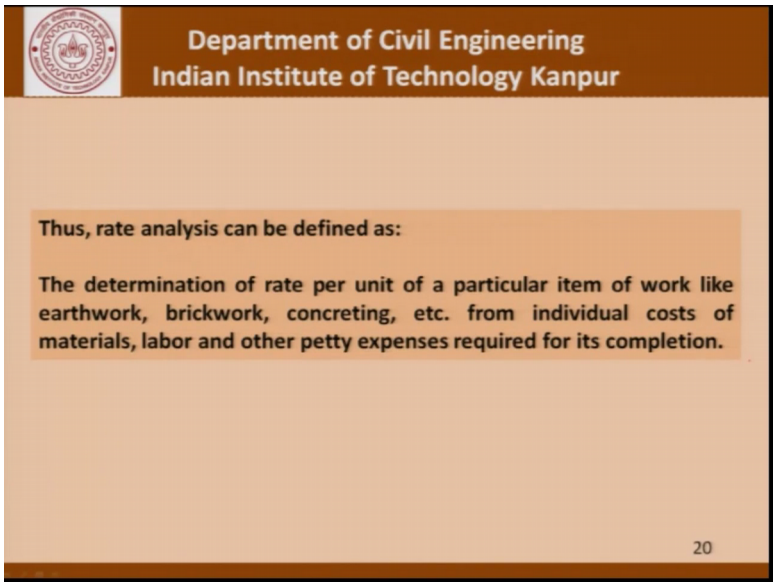

So, the rate analysis can be defined as the determination of rate per unit of a particular item of work like earthwork, brickwork, concreting, etcetera. From individual costs of labour, materials and other petty expenses required for its completion. So, even though we had alluded to the example of flooring and the kind of materials and so on, that we listed was more relevant from a floating point of view the same excise can be carried out for other items such as brickwork or earth work concreting as we will see in subsequent slides .

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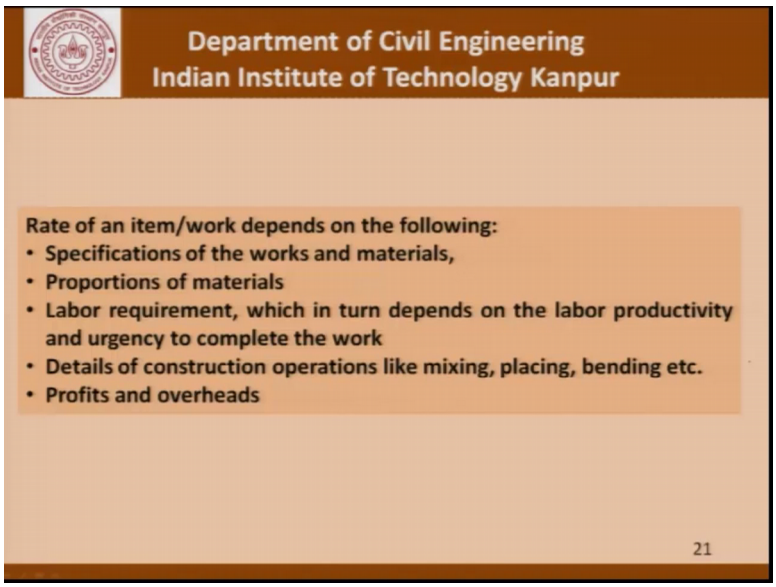

Now, the rate of an item of work depends on the specifications of the work and the materials, the proportion of those materials, the labour requirement, which in turn depends on the labour productivity and the urgency to complete the work besides details of construction operations like mixing, placing, bending and so on, profits and overheads. So, when a contractor tries to estimate as to what the cost of a unit quantity of any item is concerned he looks at some are in fact, all of these items.

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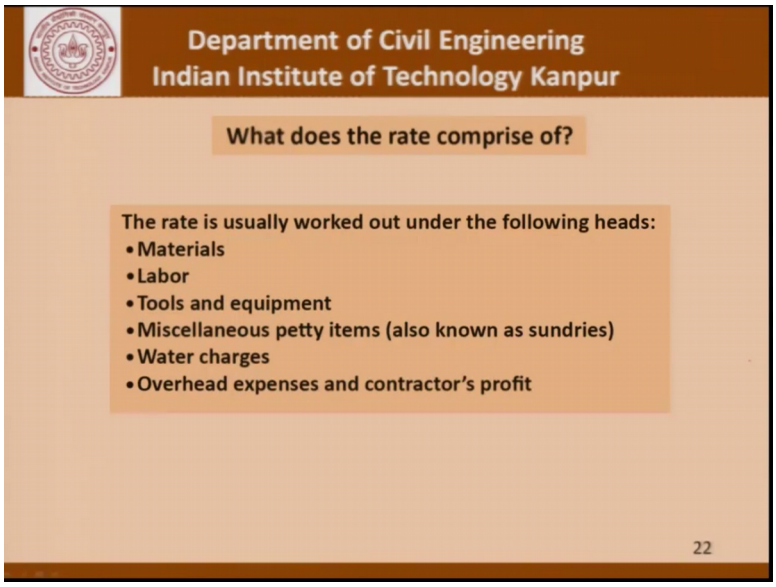

So, to reiterate the rate is usually worked out under the following heads materials, labour, tools and tackles, miscellaneous and petty items known as sundries, water charges, overheads expenses and contractors profit. So, moving on to materials the most common materials like cement, aggregate, sand, lime and etcetera.

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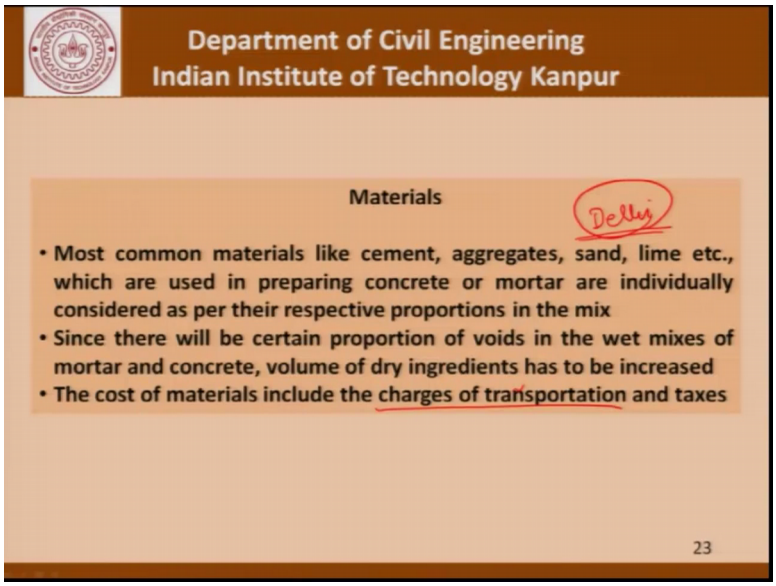

which are used in preparing concrete or mortar are individually considered as per their respective proportions in the mix, and since there will be a certain proportion of voids in the wet mixes of mortar and concrete, the volume of dry ingredients has to be increased, and the cost of these materials includes charges of transportations and taxes.

So, since the charges of transportation are supposed to be included, in this document that we are talking about and let us say that the document is a Delhi base document and we are trying to apply this to any other city, we are trying to estimate the cost of construction in any other city we must keep in mind that the charges of transportation could be different. So, once we keep these kinds of things in mind, we use the Delhi schedule of rates as a guide and try to arrive at our own numbers for individual estimations.

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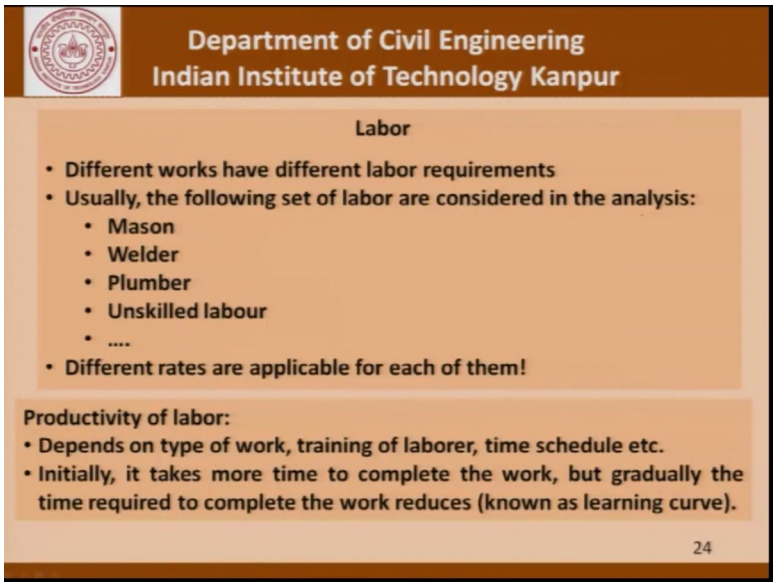

So, from materials if we go to labour different works have different labour requirements, and usually the following set of labour are considered in the analysis, it could be the mason, it could be a welder or a plumber or an unskilled labour electrician and so on, and different rates are applicable for each of them some of them are skilled unskilled semi-skilled and so on, and depending on market forces and at times governed by certain provisions in the law, the rates or the minimum wages for each of these labour is specified in the document ; obviously, the productivity of labour is also an important component when it comes to determining the cost.

So, what we really need to know is to complete a cubic meter of concrete or do a cubic meter of masonry work what is the amount of labour required this problem can be put forward in a different way. That given a mason and a helper and so on and so forth, how much of masonry works or how much of concrete work they can do. So, based on that data we turn the problem the way we want to understand it and say that for a cubic meter of work how much is the labour involved.

So, once it is said that brickwork involves one and a half mason it does not mean that one and half mason is working on it, but that number is coming from the fact that our mason cant complete a certain amount of brickwork and therefore, for a unit brickwork you need one and half times that mason.

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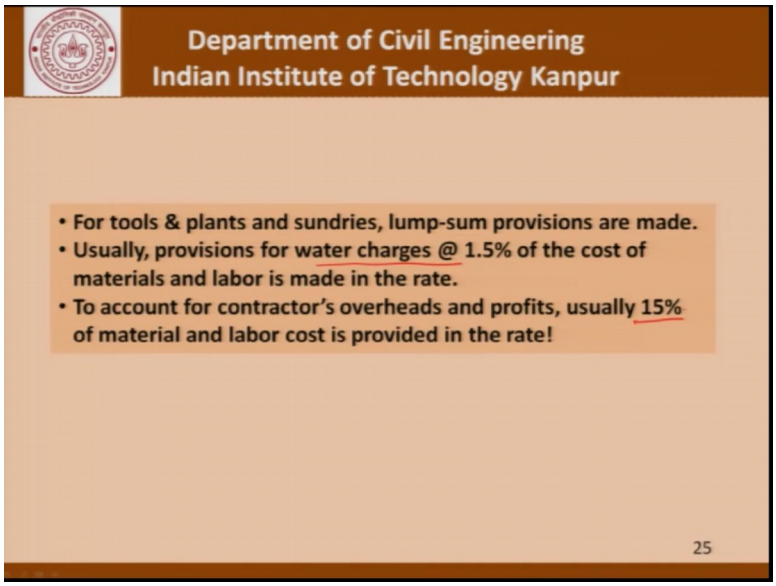

So, it is a very simple way of the good old principle of man month's kind of a calculation, moving on from material and labour for tools and plants and sundries a lump sum provision is usually made. So, we do not really try to break it down to individual equipment or the small equipment which is used and its cost what we provide for a lump sum figure as far as water charges are concerned, one may put it as 1.5percent, of the cost of material and labour and it could be 15 percent as for as the contractors profits and overheads is concerned and that is how we complete the cycle of carrying out an estimate of cost.

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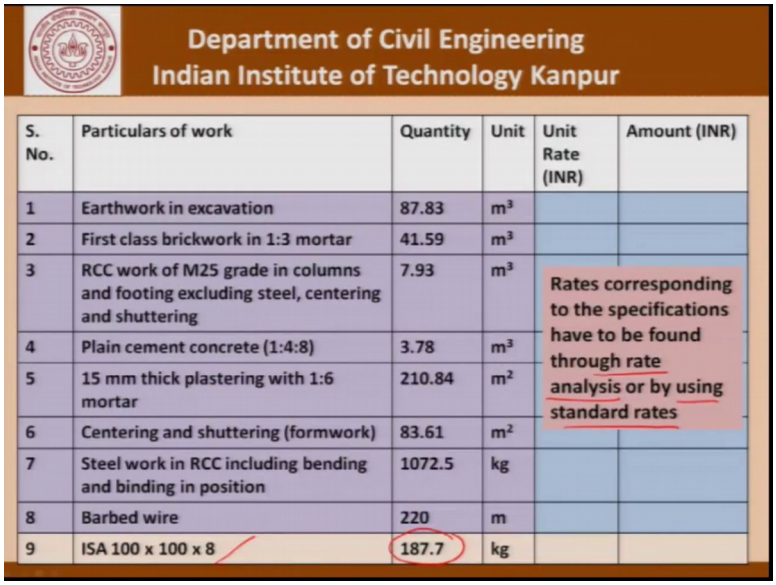

Now, let us go back to our example where we had worked out the quantities involved in the boundary wall. So, here is the list of those 9 items, beginning with earth work in excavation first class brickwork in 1 is to 3 mortar and so on and so forth, I had left this provision of ISA 100 100 8 angle to you to work out. So, what I am doing is, is just giving this figure of a 187.7 kgs is what is my estimate of the amount of angles involved now if we know that quantities involved, in order to get the total cost of this project what we need is the unit rates and these rates corresponding to their specifications have to be found through either rate analysis or using standard rates.

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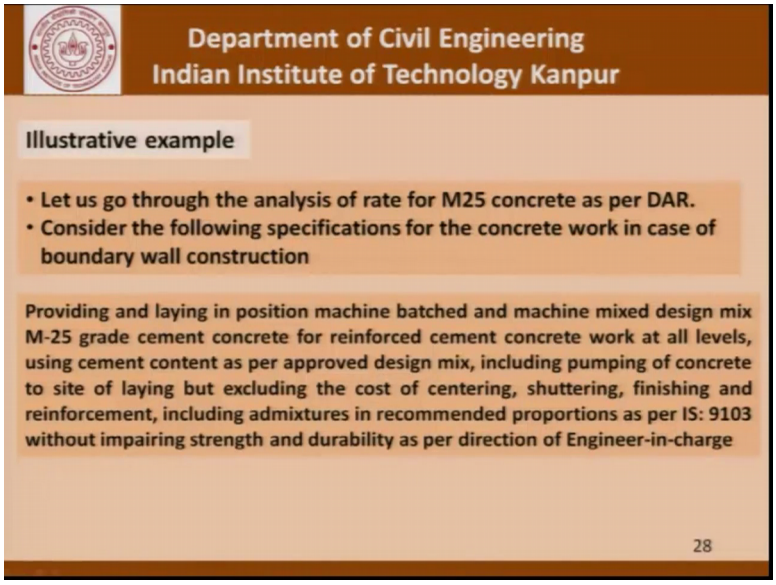

So, we both these options are open to us, and let us see if we want to do the rate analysis for concrete, if we consider this specifications given here providing and laying in position machine batched and machine mixed design mix m 25 grade cement concrete for reinforced concrete cement work at all levels using cement content as per approved design mix including pumping of concrete if required, including transportation of concrete to the site flaying, but excluding the cost of centering, shuttering, finishing and reinforcement.

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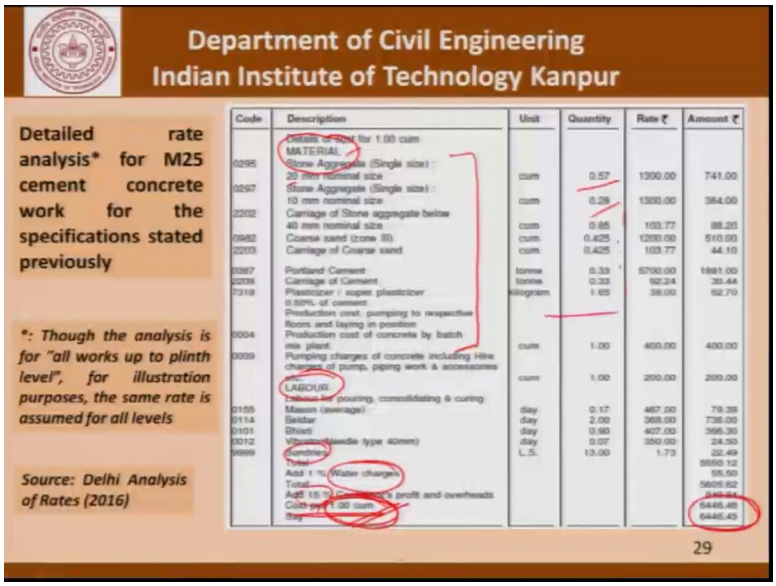

But, including the cost of admixtures in the recommended proportions without impairing strength and durability as per the directions of the engineer in charge, if this was my specification then if we look at the detailed analysis of rates, we will find the same old friends material, labour, water charges, sundries and contractors profits. So, now once we look at materials there is a whole lot of detail which is given here and all these is supposed to be contributing to one cubic meter of concrete.

So, we see that for one cubic meter of concrete, it would require a certain amount of stone aggregate of 20 mm or a certain amount of 10 mm and so on and so forth, and if you are careful to observe this table you will realize that the total volume is more than a cubic meter and that is precisely, because that is more a matter of measurement of these quantities, if they are measured in the dry state in bulk then the volume will be more simply because there are lot of voids in these material. So, without getting into those kinds of details we have a final number, which simply says that the cubic meter cost of concrete of this grade is 6446.6.

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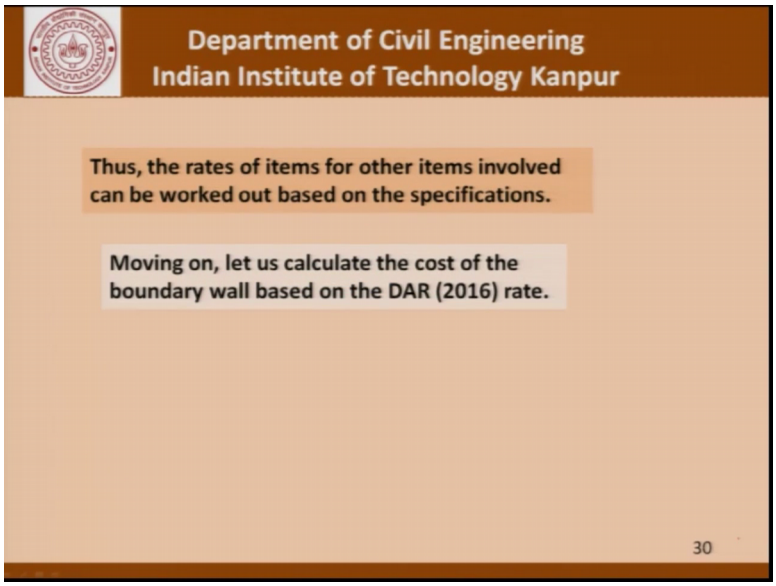

Now, similarly if we work out the cost of other items involved in our work let us calculate, what is the cost of the project?

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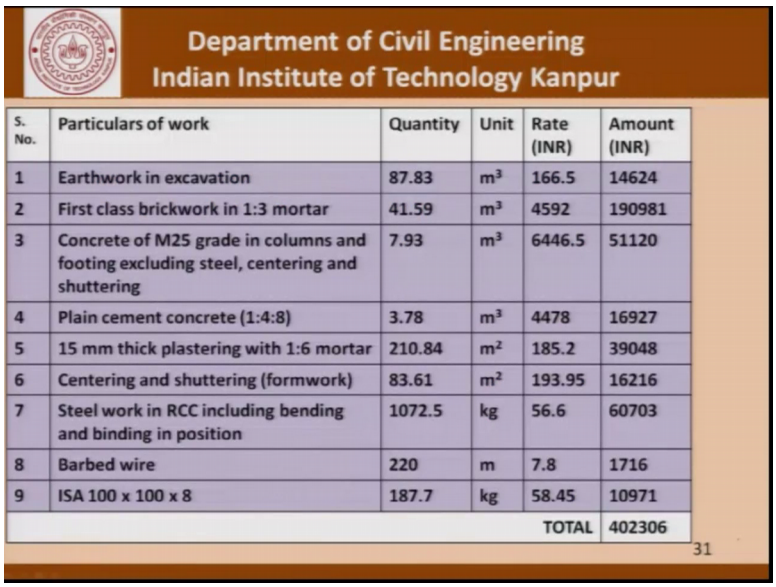

So, for the concrete we have taken the cost as we determined in the previous slides, and these numbers have been taken from the Delhi schedule of rates in a similar manner and we find that the total cost of the project involved is 40230 rupees.

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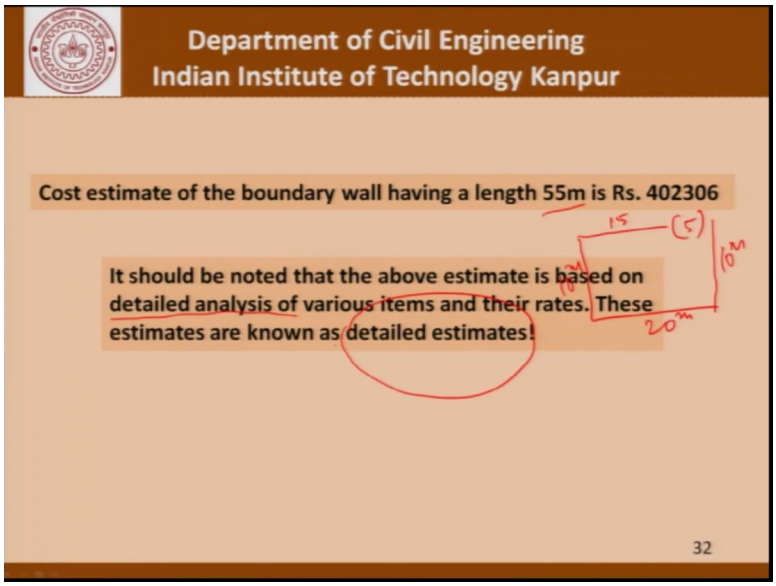

So, what we have estimated now is that the cost of a 55 meter boundary wall is 402306 rupees, now you will recall that this 55 is coming from the fact that we are talking of a boundary wall which looks something like this 10 meters here, 10 meters here, 20 meters here, and 15 meters here, with a 5 meter opening now this analysis or this estimation is based on the detailed analysis that we have carried out of the various items and their rates and therefore, what we have done is a detailed estimation.

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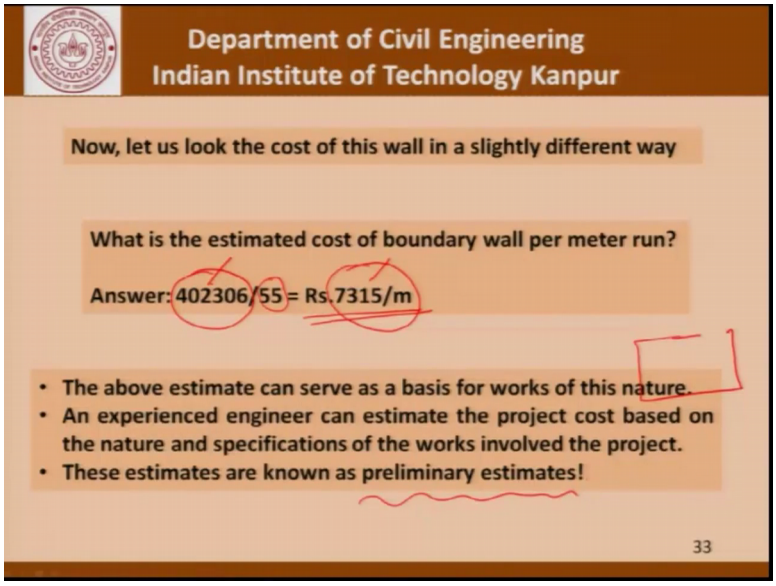

Now, there is a slightly different way of looking at things, what did we estimate, we estimated that this is the cost of the total project and this is the length of the boundary wall and therefore, if we divide it we will get something like 7315, which is the cost of the boundary wall per meter, now without going through this entire exercise that we did in the last classes, where we were required to have the drawings for the boundary wall we calculated with a lot of precision, the amount of earth work involved length width height we calculated the barbed wire length and so on and so forth, if somebody could just tell us that well here is a 55 meter long boundary wall what would be the approximate cost.

So, with a certain amount of experience an engineer should be able to give you a number which is not very different from 7315 and this is exactly what is done when we are trying to do preliminary estimation and this estimate of 7315, serves as a basis for the works of this nature.

So, this kind of discussion where we are talking of the total cost of project per meter could be used for other projects as well for example, pipelines and an experienced engineer as I said can estimate the project cost based on the nature and specifications of the work involved. So, this particular project for example, had about 1.8 meter high boundary wall. So, if this boundary wall was to increase to 2.5 meters there will be changes, there will be changes because it will not be possible to do the brickwork without having to erect the scaffolding. So, this part will also change and this part will also change, if we increase or decrease the spacing of the concrete pillars then again the cost will change. So, these are the kind of things which should be borne in mind when we are trying to do the estimates known as preliminary estimates preliminary estimates are drawn up not necessarily with the help of drawings, but based on experience and a certain understanding of the specifications and like we said in the previous example that once.

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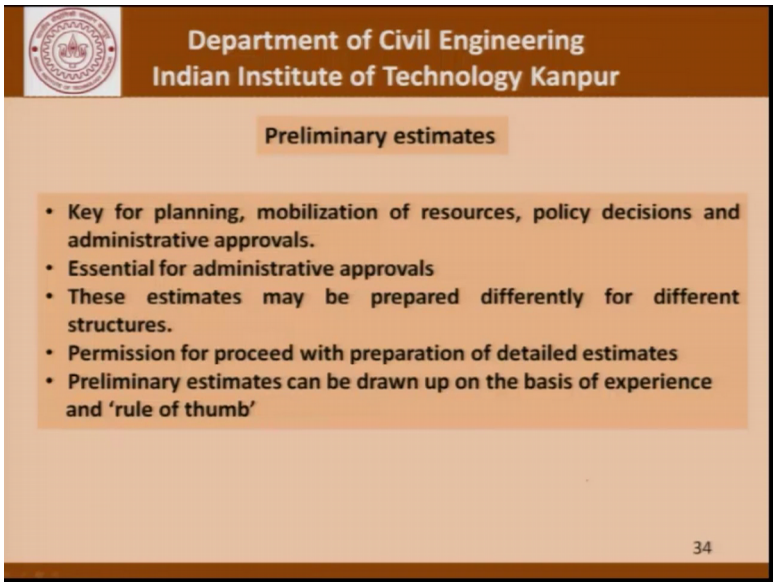

We have a base understanding then we can alter the specifications depending upon the kind of funds that are available to us. So, preliminary estimates are key, for planning mobilization of resources, policy decisions and administrative approvals, we have talked about this in the first module of this course and they are essential for administrative approvals as I said.

These estimates may be prepared differently for different structures; obviously, in the example that we shared with you just now. So, what we did was a per meter estimates of the boundary wall that will not help us if we were trying to do the estimation of a house, these estimates are required to obtain permissions to proceed with the preparation of detailed estimates and are drawn up based on experience and rule of thumb.

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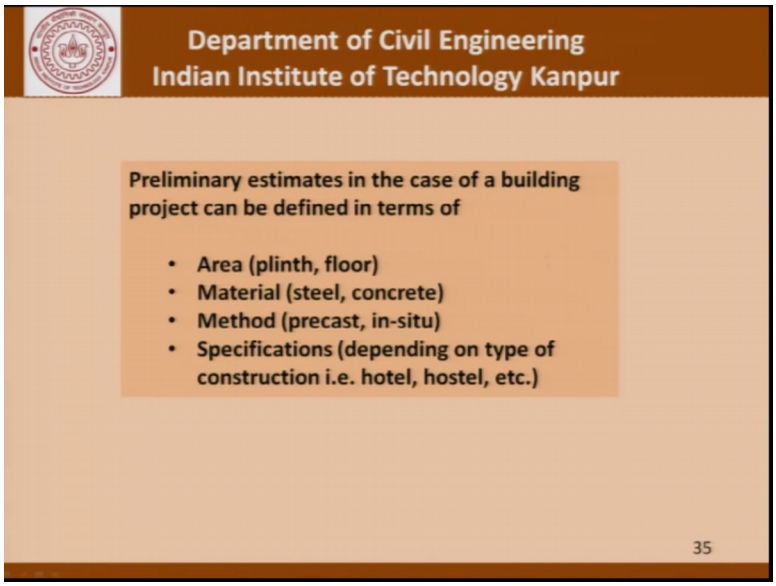

So, now preliminary estimates in the case of a building project can be defined in terms of area, it could be the area of the plot, the plinth area, the total floor area and so on, the material that is going to be used whether we are going for a steel frame building or a concrete frame building, the method that we use whether we are going to do precast construction whether it will be all in situ what is the kind of wall panels, we will use and so, other specifications for example, we are trying to do a hotel, a hostel or a simple residential building. So, these are the kind of questions and there will be many other questions, what is the kind of plumbing that we will use what is the kind of electrical fittings that we will use, these are the kind of questions, if we have a rough answer to them.

We would be able to make what would be called a preliminary estimate for that building similarly for the road.

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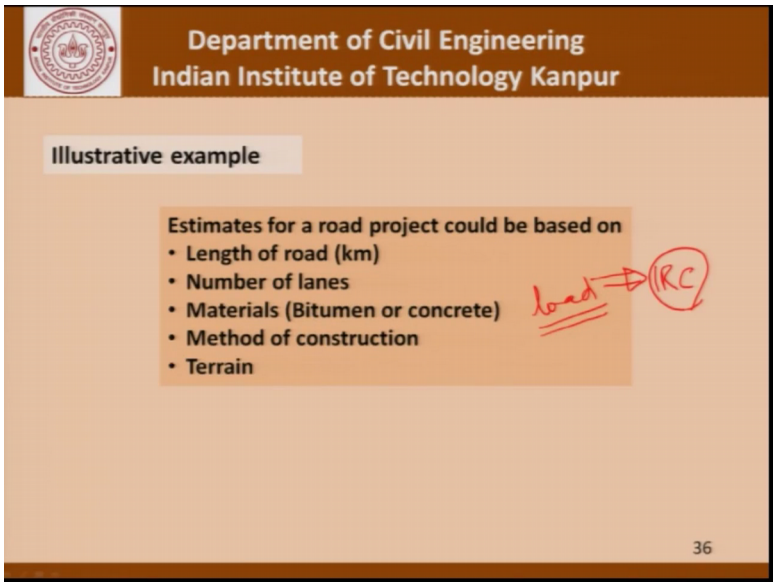

This estimate could be based on the total length, it would include the number of lanes whether we are talking of a 2 lane or a 4 lane or an 8 lane road, the material whether it is a concrete road or a bitumen road, what is the method of construction what is the terrain and what is the load that we are talked about as far as the road is concerned is it expected to carry only pedestrian traffic or light vehicular traffic or heavy vehicular traffic or very heavy vehicle traffic and for that we need to go to a standard documents like the Indian road congress kind of codes, or any other such document which tells us how to design roads for different kinds of loading .

So, like in the case of buildings, if we have the answer to these questions we will be able to make what can be called a preliminary estimate for the road construction.

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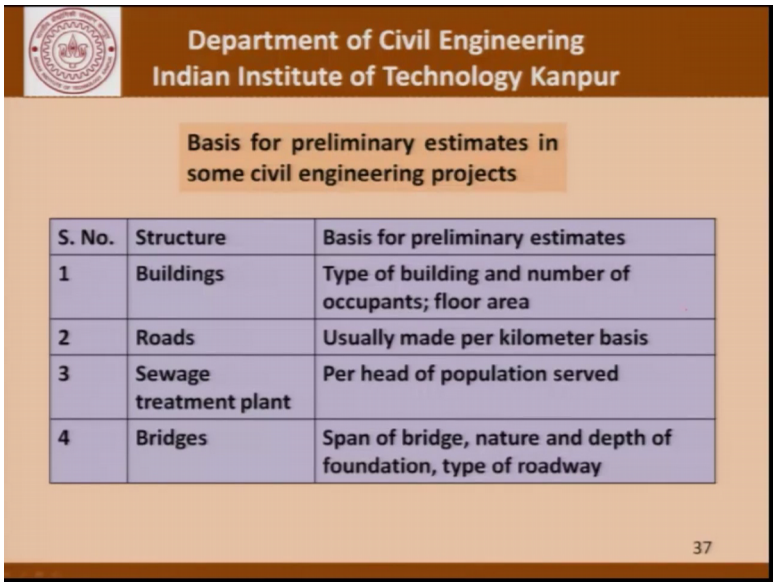

Now, for others like the sewage treatment plant it could be the per head of population which is served or in the case of bridges it could be the span of the bridge the nature and depth of foundation type of roadway and so on and so forth.

So, what we are trying to do is to arrive at the basis for preliminary estimates of civil engineering projects. So, once we understand the principles involved what are the kind of questions that one needs to answer, in order to be able to get a preliminary estimate then of course, we can move forward and determine or get the preliminary estimate and then we move on to make the detailed estimate as we have already seen in the previous discussion.

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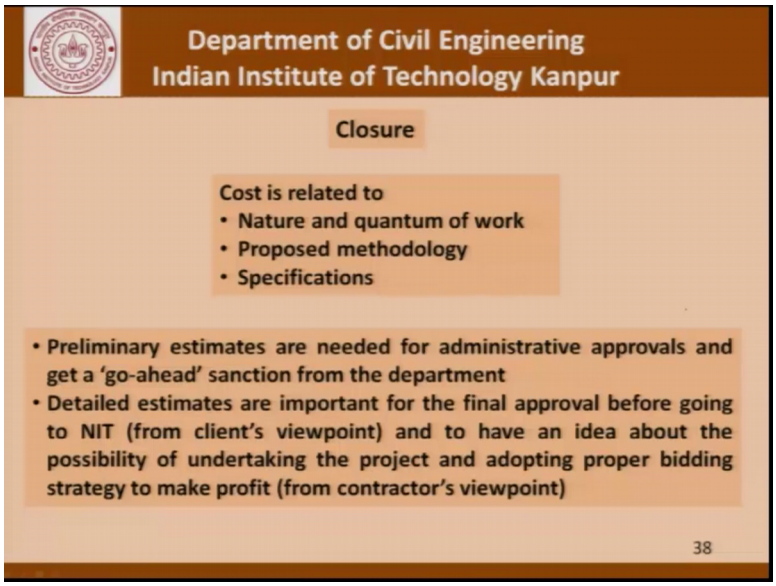

So, closing our discussion for today, we talked about the cost in relation to the nature and quantum of work the proposed methodology and specifications and we highlighted the importance of specifications taking the example of flooring and we discussed the issue of preliminary estimates, that are needed for administrative approvals and obtaining a go ahead and we talked about the detailed estimates are important for the final approval before going to the notice inviting tender from a client's point of view and to have an idea about the possibility of undertaking the project and adopting proper building strategy to make profit and that is from the contractors point of view.

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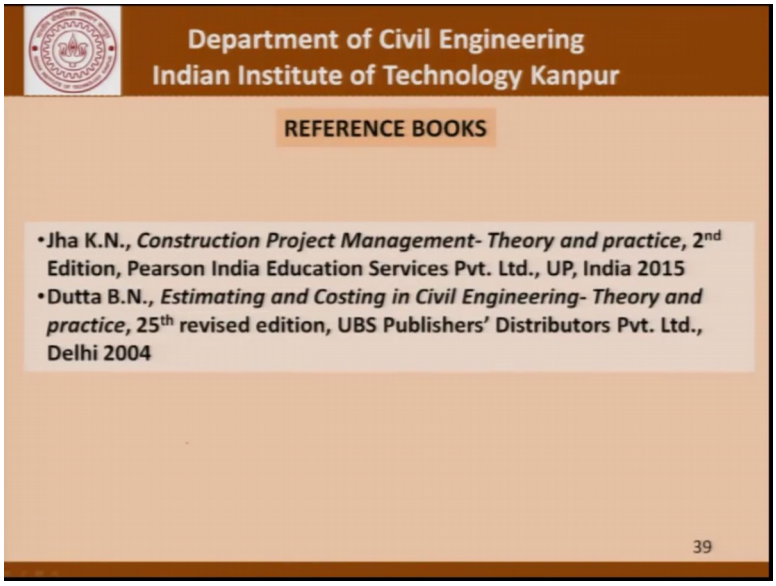

So, this discussion we come to an end of our discussion today and also the module on cost estimation of projects these are some of the references which you might find useful when you are trying to follow that material presented here. So, in the next module we will talk about different facets of construction economics with this we come to close of discussion today.

Thank you.