Concrete Engineering and Technology
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Lecture - 12
Principles of quality control in concrete construction

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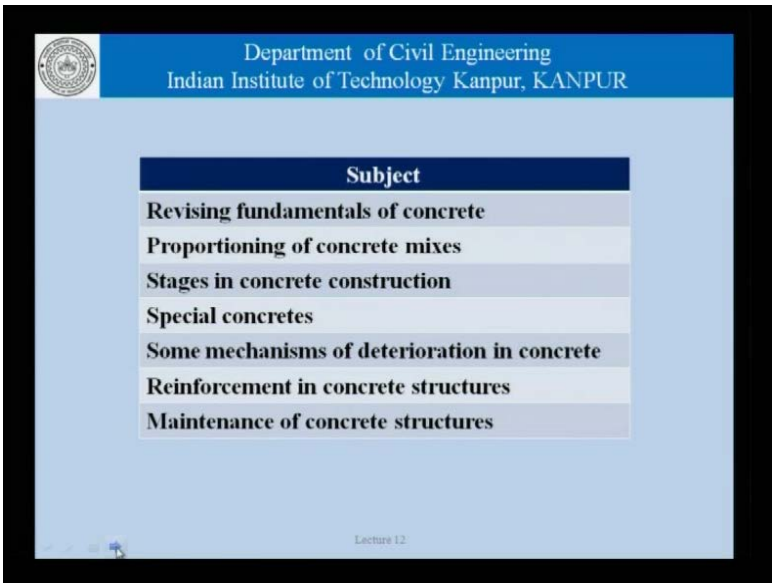

(( )) and welcome back to this discussion on concrete engineering and technology, in this course we have been trying to talk about fundamentals of concrete proportioning mixes different stages in concrete construction, special concretes, mechanisms of deterioration reinforcement and maintenance issues. Basically, the focus is on subjects, which have become important in the recent years on account of the development that has taken place in the different aspects relating to concrete engineering and technology, whether it is in the form of new materials, new methods, more challenging places of concrete application and so on.

So, in the discussion today, we will look at the aspect relating to stages in concrete construction, from the point of view of quality control and assurance. We should remember that quality is closely related to accidents and safety. Poor quality construction invites accidents, while construction is going on or even later on therefore, it is important that everyone involved with the concrete construction, leaves no stone unturned in ensuring quality construction.

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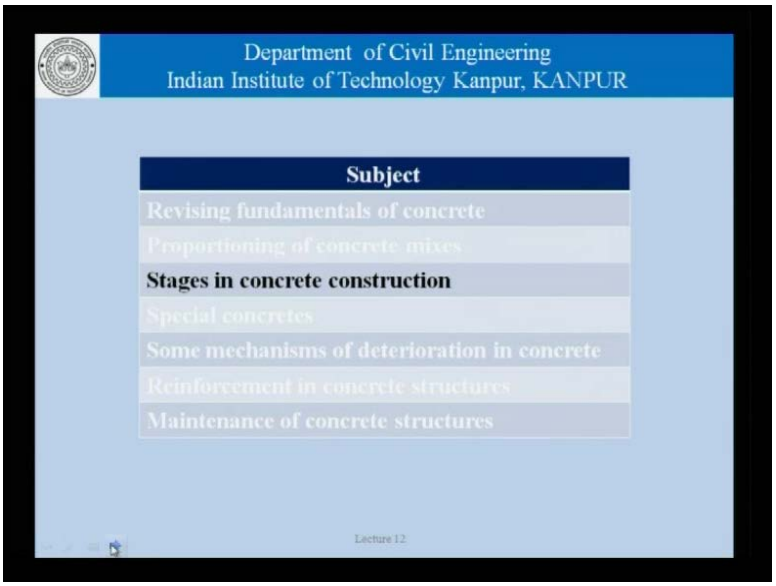

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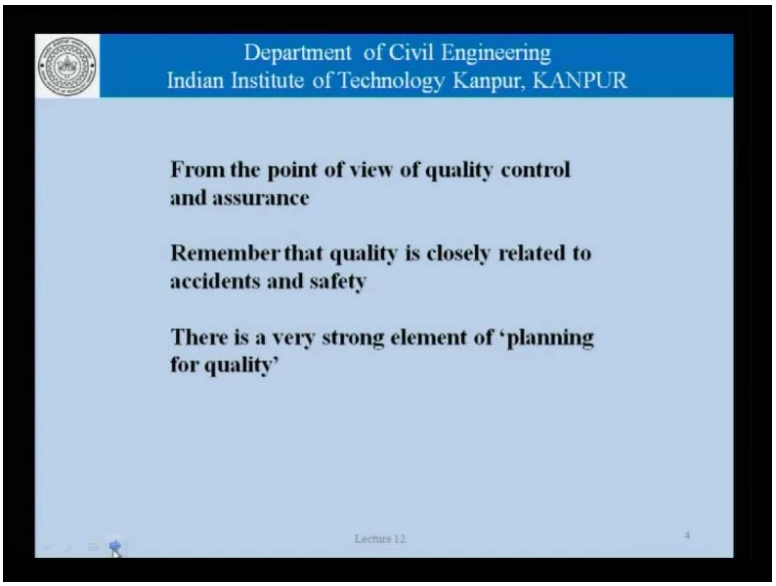

We will talk about today, different aspects which are related to and are very important to ensure quality construction of concrete structures. There is a very strong element of planning for quality, quality does not come on it is own engineers and technical people engaged in various activities related to concrete construction, whether it is material selection, batching at a concrete plant, placing, curing everyone has a role to play; in insuring quality and it can be planned. If we are systematic in our approach, no matter what we are doing, we would be contributing to quality.

Conversely speaking, any lax or any lack you know or laxity at any stage leads to poor quality construction; it has an implication on the quality. And it has an implication to the extent that no matter how hard the others try, the qualities impelled.

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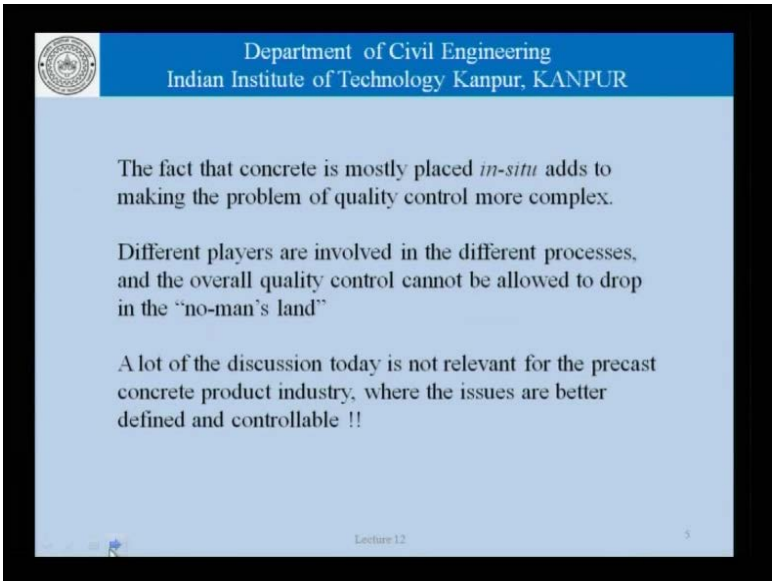

So, that is something which you would try to take a look today. The fact that concrete is mostly placed in-situ adds to the problem being made more complex. Factory by products are easier to handle, as far as quality control is concerned. There are different players involved in different processes as far as concrete construction is concerned, and the overall quality control cannot be allowed to drop in the no-man's land; it is it is important that not only the people involved in the different individual aspects, material, selection proportioning batching, transportation and so on. They do their job, but finally, the overall control of quality is also exercised and is not lost site off

A lot of discussion today is not relevant perhaps for the precast industry, where concrete products are made, and there because the products are made in a controlled environment in a factory. The rules of normal mechanical engineering or a production line quality control are applicable. Today, we are concerned primarily with concrete being placed in-situ in a construction project at site.

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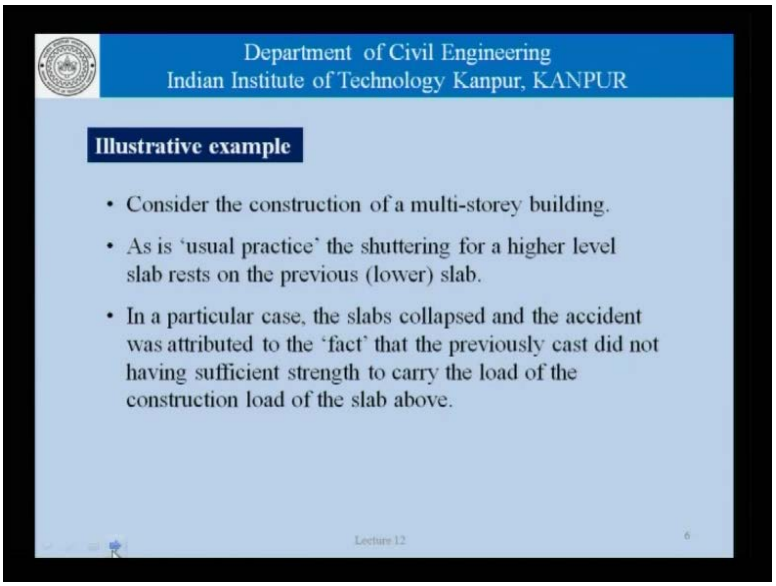

Let us take an illustrative example; consider the construction of a multi-storey building; and as the usual practice, if you have seen multi-storey constructions, the shuttering for a higher level slab rests on the previous or the lower slab. And in a particular case the slabs collapse and they accident is attributed to the fact, that previously casts slab did not have sufficient strength to carry the load, that came upon it during the construction of the upper slab.

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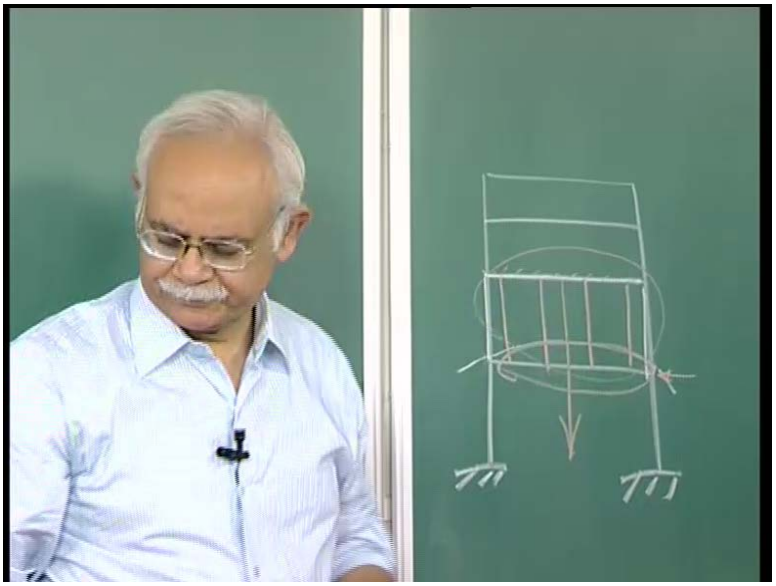

What we are saying is the following. If this is a multi-storey fringed construction, what we do is to cast the structure up to this point, and to cast the slab here, we have the shuttering for this slab resting on this, lower slab and while this slab is cast, the entire dead load of the concrete being cast the live load of people moving around on, it they kept when that is kept there and so on is transferred to this slab which may not be very old.

Now, it is not so difficult to believe or envisage the situation, where if this slab has not gained sufficient strength, the entire portion here will simply collapse, if the dead load being applied or the construction load being applied from the slab here, acts on this slab prematurely.

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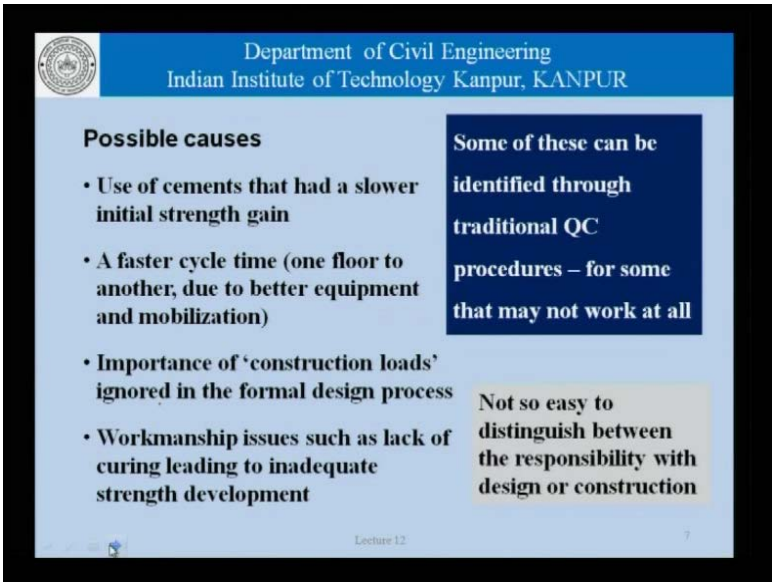

What could be the possible causes for this situation, it could be the use of cements that had a slower initial gain in strength; it could be a faster cycle time, one floor to another due to better equipment and mobilization, usually between one floor and the next floor, that is the time it takes to do the columns tie the scaffolding and shuttering for the next floor, that is the what is called the cycle time; that is from floor one slab to the next floor how much time it takes, and construction people, construction engineers, they try to maintain a certain schedule. That at least in a week 3 days, 7 days, 12 days that is how that cycle will be; that is how they plan their construction activity.

Now, account of mechanization better mobilization and so on, it is possible to cut the cycle time, but if we are not conscious of the fact that cement takes certain amount of time to hydrate to the extent that a certain amount of strength develops, we are really playing with fire.

The importance of construction loads could have been ignored in the formal design process. When we design a concrete structure these slabs for example, we design them for live loads, dead loads, wind loads earthquake loads and so on, but in case the construction load happens to be substantial, then one has to formally include that in the design process itself. There could be workmanship issues such as lack of curing leading to inadequate strength development at the bottom floor.

Now, there could be so many factors, and some of them can be identified through traditional Q C procedures, for others it may not work, traditional Q C procedure as far as concrete construction is concerned, let us say deals with strength gained in cubes.

Now, the strength gained in cubes is determined, while the cubes are cured in water at a certain temperature, the slabs need not be cured in those conditions they may not have been adequately vibrated and so on and so forth. The case of the illustrative example that we discussed just now briefly also brings out the fact that it is not easy sometimes to distinguish between the responsibility of a designer and a contracting agency, which is involved with the construction work.

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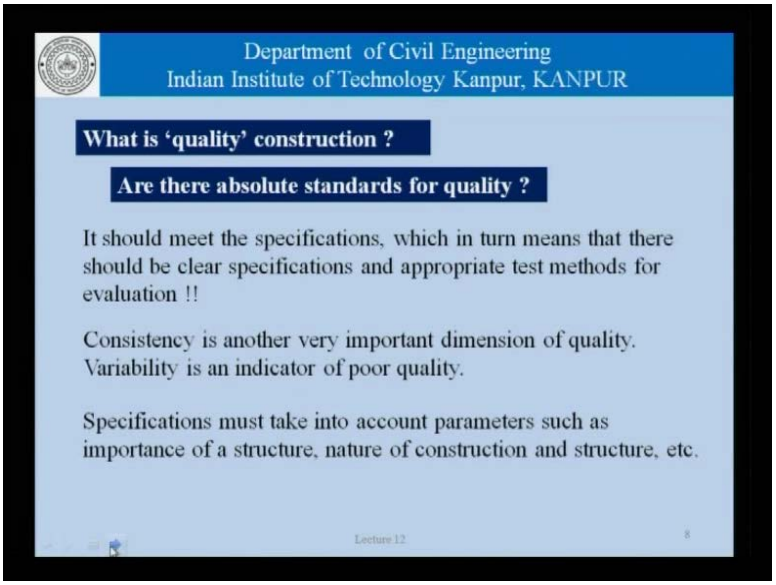

Indeed finally, it is the construction work that has collapsed, but what was responsible for it could have been a design flow; it could have been lack of guidance to the contracting agency to carry out the work in terms of determining the kind of strength that is required for the slab, before the slab above it could be cast and so on.

Now what is quality construction? are there any absolute standards for quality, this subject has been debated greatly in literature dealing with products, industrial engineering, management issues and so on, from our point of view quality would mean perhaps that the concrete construction, should meet the specifications which in turn means that there should be clear specifications an appropriate test method for evaluation. Also consistency is another very important dimension of quality variability is an indicator of poor quality, specifications that we write for quality must also take into account parameters, such as the importance of a structure nature of construction and structure and so on.

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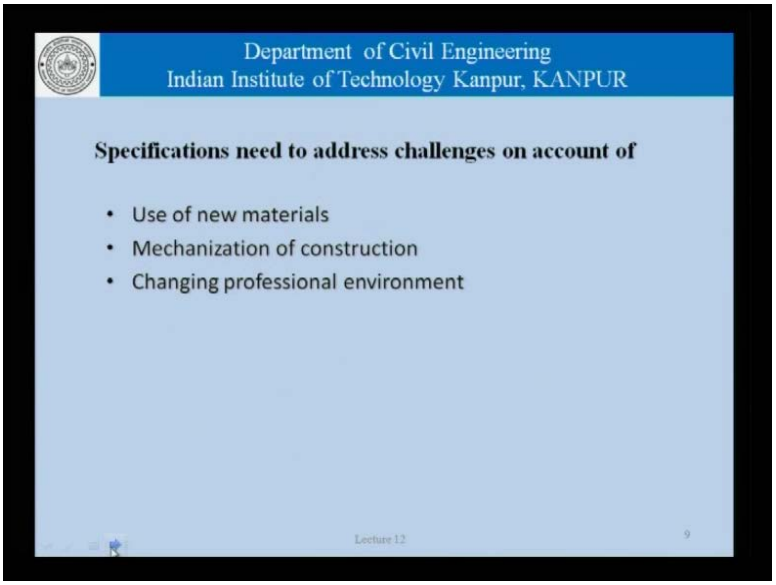

Their specifications that we write need to aggress challenges on account of use of new materials mechanization of construction, changing professional environment, basically quality means compliance with standards, if the standards are such that a medium performances expected; that is all right in which case the product should be of a medium quality.

If high performance is expected then indeed the product should clear those higher standards. We must set the standards clearly and ensure, that the construction meets that benchmark therefore, we must write the specifications very very clearly very very unambiguously. So, that it is easier to ensure compliance from that point of view these three points will elaborate a little more.

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We are using lots of new materials in construction; we are using blast furnace slag we are using silica fume, we are using flyash, we could be using chemical admixtures, which could be air entrainers, water reducers, set regulators and so on. We could be using short fibers in fiber reinforced concrete; we could be suing different kinds of reinforcing bars, epoxy coated bars, fiber reinforced plastics and so on.

We could be using curing of sealing compounds; we could use any of these materials in the construction process. But we must assure that the construction product that is the structure that we build, whether it is a building or a bridge or a dam, the quality of that is not compromised. So long as we ensure that the quality is not compromised we can more or less use any material we want. For that, we need to have standards, which will test these materials, which will test the compatibility of the use of these materials with concrete.

For example, certain fibers which are not so durable in an alkaline environment would not be suitable for concrete construction, because concrete is a very alkaline medium

therefore, designers and engineers must understand the concrete environment, the concrete properties and then try to choose the materials, they want to use to enhance properties of concrete, whether it is fresh concrete or it is hardened concrete durability of concrete and so on and so forth.

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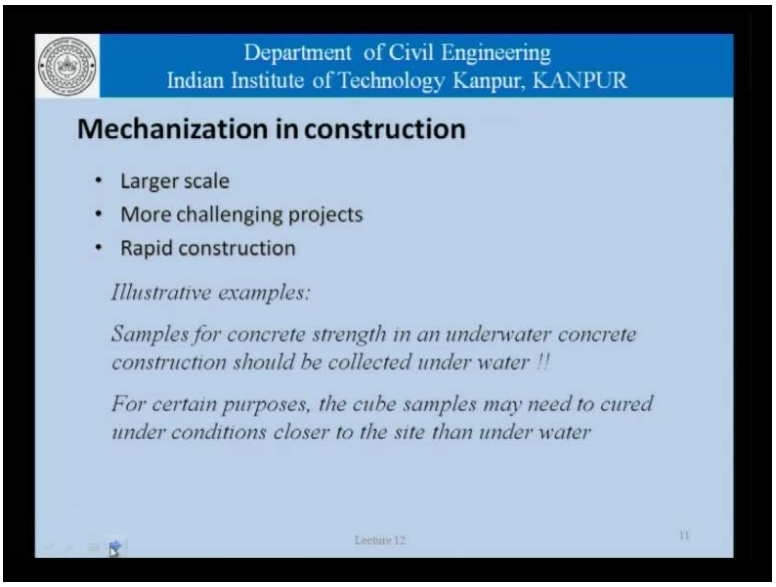

As far as mechanization is concerned that gain needs to be taken into account, when we are writing specifications, because the specifications that were valid or that can be true for small scale construction, using non mechanized methods, would not be sufficient when we are dealing with using mechanical equipment in construction.

Concrete is being poured into more challenging environments, more challenging product are very very challenging projects are being executed with concrete, and throw the challenge to the clients, to the end users to be able to write as specification. One must remember also, that in concrete construction, people from different companies work together, these engineers who come from different companies have different objective functions they are not therefore, charity they are for making a certain amount of profit a certain amount of money for their company.

Therefore, we cannot ensure quality at the cost, at zero cost we can try for that we can try for quality at low cost without allowing the cost to increase beyond the certain level, but at times an economic decision has to be made, where we say that if quality versus cost, has a certain relationship then fine for this cost, this is a best quality, that we can get and

therefore, that is and therefore, let us leave it that; so the distinction to accept a certain quality is often governed by economics, and that is something which we must keep in mind.

Rapid construction kind of example, that we discussed where a slab collapses, if it is prematurely loaded with construction loads, these are examples which we need to keep in mind, when we write the specifications. Let us take an example for example, concrete is being cast under water now of course,, it is important that the sample for concrete strength in such cases are also collected under water ,they cannot be collected in air. Similarly, in certain cases the cube samples may need to be cured under conditions closer to the side, than under water under water curing is standard curing, but if we are interested exactly in the strength development, that is happening at site, then we need to have cubes cured under those conditions.

The reason why we do not do, that as a matter of standard practice is these conditions vary widely from one place to another from one time to another, and so on therefore, we say that let us have a standard condition of curing water or concrete placed or concrete cubes placed in water in a certain temperature.

However in a project specific situation indeed, there is a case that cubes, there is a case the cubes are cured, along with the structure, that has been cast, so that we can compare the or we can estimate the actual strength of the structure. Sampling for concrete from a roller compacted concrete is better with cores than with cubes.

Roller compacted concrete is not vibrated using ordinary needle vibrators, or internal vibrators; it makes no sense to cast the concrete in cubes, using needle vibrators, where the concrete is being vibrated at site using vibratory rollers, accept that we cannot create a cube using vibratory rollers, one may argue that we can create cubes using surface vibration. That perhaps is a better way of getting cubes, which are more representative of the concrete cast in the roller compacted pavement or dam, than a concrete cast and a cube using needle vibrators.

These things though they may sound trivial, but need to be written down in specifications or methods to be followed for quality control, at a site specific document. We must remember that standards in specifications generally are guidelines, they should guide the engineer to write down, and enforce. The specifications at a particular site to deviate

from that is nothing wrong accept, that the deviation should be conscious and with full knowledge of the consequences.

If we decide to take coarse from the roller compacted pavement, we should know that this is not standard concrete; this is not the concrete which has been prepared under standard conditions, this is not the concrete which has been cured under standard conditions and therefore, the results need not be cannot be compared with concrete prepared or cast or cured under standard conditions.

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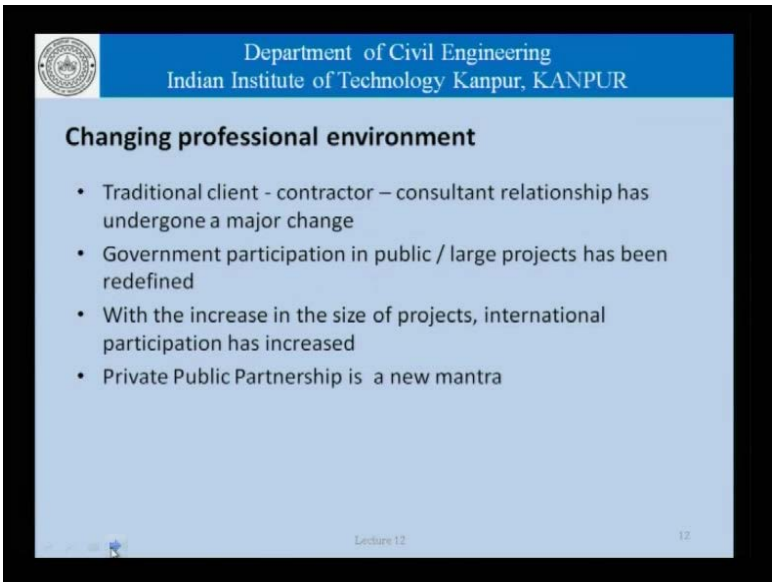

Continuing with our discussion, coming to the changing professional environment the traditional client contractor consultant relationship has undergone a major change in most major construction projects. The government or the regulators participation in public, and large projects has been redefined with increase in the size of projects international participation is increased and with that we have engineers from different backgrounds, who have been educated in different standards in specifications, capers an engineer who has been trained in India work with Indian standards, an engineer who has been trained in, England. For example, would be familiar with British standards or European standards and so on and so forth.

All these standards have different viewpoints have different methods, and in fact the stand point from which they have been written is different when private public

partnership, becomes a new mantra then quality control has to be defined very differently.

In a traditional situation, where there is a client, and the funds are being provided by the client the client, has a lot more power to enforce certain standards, but in certain cases when the funds are not being provided by the client, the contractor or the contracting agencies the builders, they have a little more leeway in defining quality. There is a lot more responsibility on them in terms of ensuring quality, because at the end of it as far as accidents are concerned as far as the safety of the structure is concerned; it is absolutely everybody is concerned.

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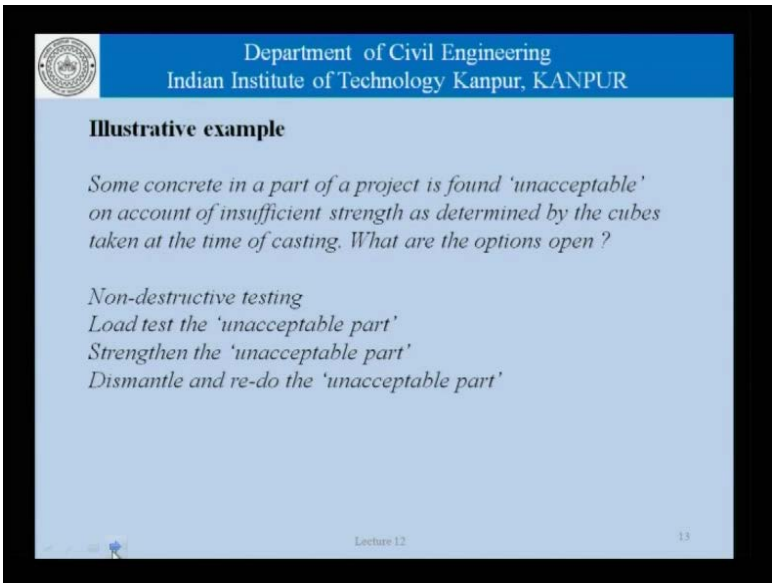

Let us take an again, let us take another example let us say that some concrete in a part of our project is found unacceptable, on account of insufficient strength as determined by the cubes taken at the time of casting; it is a situation, that is not uncommon it happens sometimes that the cubes taken at the time of a casting, do not meet the standards.

What do standards are we will probably talk about it a little latter, but they do not need the standards and therefore, the concrete is deemed unacceptable. Now, what are the options open we must remember, once again that concrete construction projects, are large projects involving a lot of effort, in terms of time materials, energy, money, equipment and therefore, for various reasons, all effort needs to be made to ensure. That

that effort does not go wasted, it does not mean at all that we should compromise on quality.

But, while maintaining quality, while maintaining the standards is there a possibility, that the results that we got from the cubes are something, which are in error it should not happen, that because of that error a lot of effort gets wasted, and there are different implications of that in terms of time, in terms of reputations, in terms of the energy and the money and so on.

So, what are the options that are available as far as the Indian standards. For example, is concerned it gives you an option in terms of non-destructive testing; it gives an option in terms of carrying out a load test for the unacceptable part. There could be an option of strengthening the unacceptable part and of course, the option of dismantling and re-do the unacceptable part.

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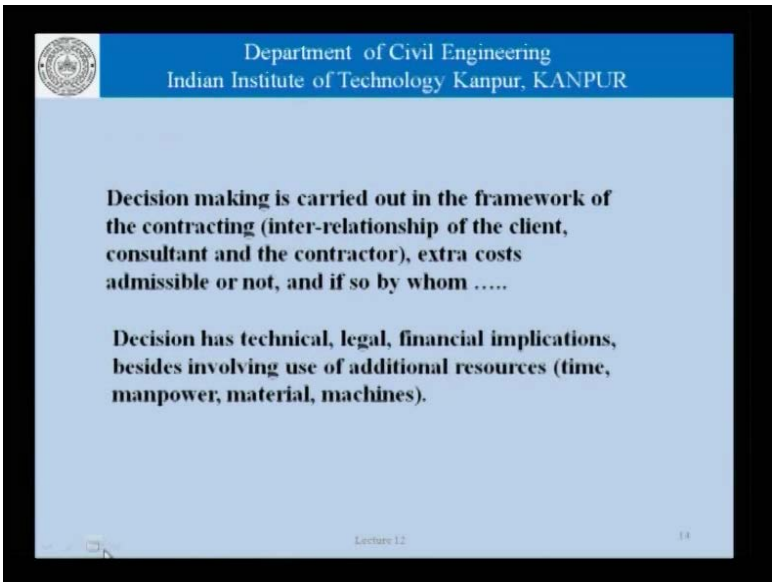

The decision making in this kind of cases is carried out in the framework of contracting, these things have to be laid out in the specifications, that if certain things happen then how will the situation be dealt with, discretion at the end of it has to be given to someone. There can be a discretionary clause, which says that fine, there is this issue of extra costs, whether that will be admissible or not, and if so who will pay for it, there are implications in terms of delaying the project, because that dismantling will take time, and

again we have to go back and refurbish, the whole thing create, the new construction so there is a time delay involved.

The decision thus has technical, legal, financial, implications, besides involving the use of additional resources, in terms of time, man power, material machines and so on. Engineers as professionals must be conscious of this very important role, where quality has to be looked upon, within this larger framework. Quality should not be compromised, but at the same time the specifications, should be clear in terms of what is really required, if that is being met we need not be worried, but if that is not being met, then we need to take the extreme steps.

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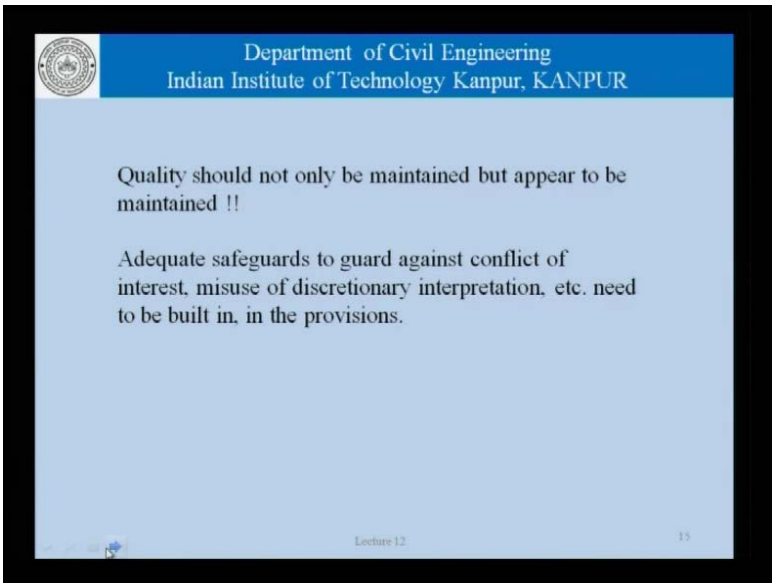

One must remember, that quality should not only be maintained, but also appeared to be maintained, it should not look as if quality has been compromised, even though there may be a technical reason for doing, so there should be provisions, which unable the engineer and the builder to actually be able to figure out the situation, where there is a problem.

Adequate safeguards to guard against conflict of interest, misuse of discretionary interpretation etcetera, need to be built in in the provisions itself. This is becoming more and more important, when we are dealing with international projects larger projects, with engineers from different organizations, different background, different professional

qualifications, trying to work together, to the completion or the successful completion of a quality mega project.

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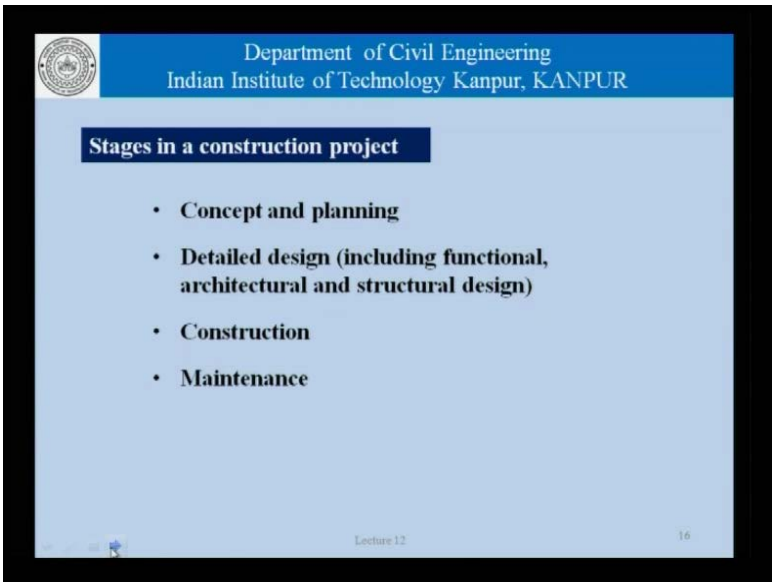

Now, let us look at the stages in construction project, basically a concrete construction project there is a concept in planning, where the project is conceived and a plan is drawn up. This is generally followed by detailed design including functional architectural and structural design, followed by the construction of the project and finally, operation and maintenance.

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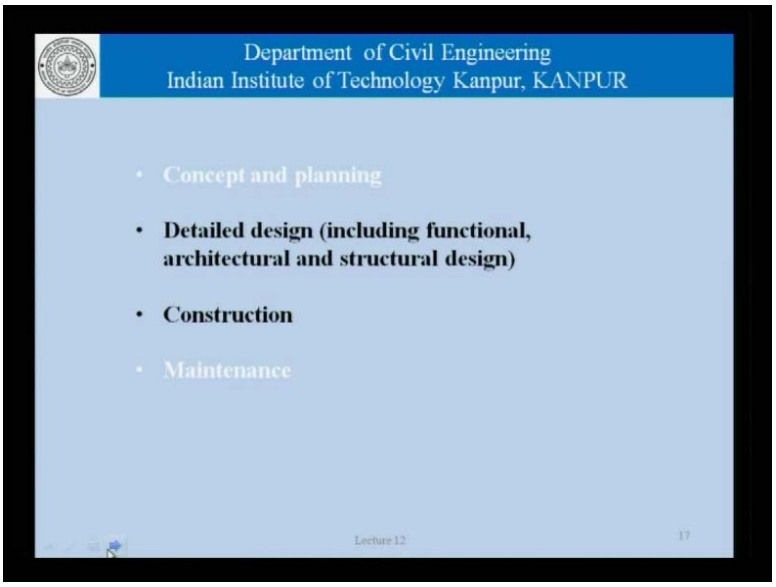

Now, if we leave up a concept in planning and maintenance, there are quality issues related to design and construction , which we must be aware of which we need to address, then we are taking a view of overall quality of a construction project.

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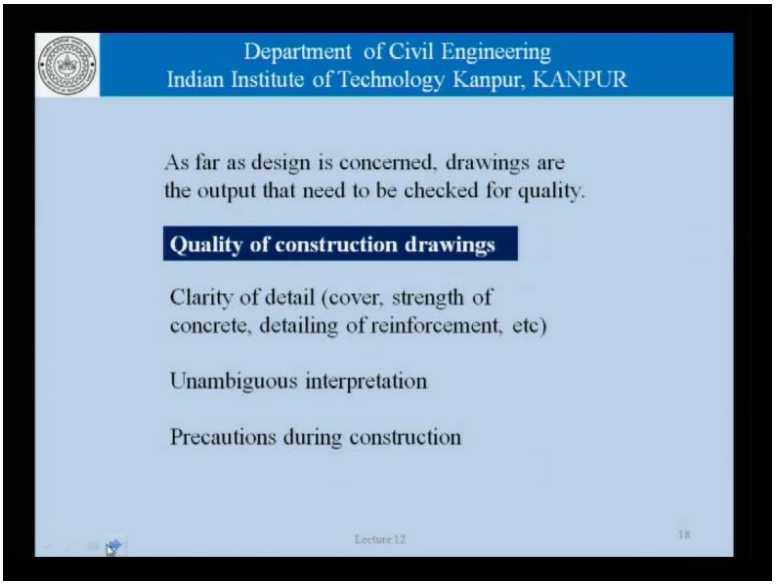

As far as design is concerned drawings are the output, that need to be checked for quality do drawings have quality of course,, they have quality. The quality of construction drawings can be measured in terms of clarity of detail, the cover the strength of concrete to be provided in the different members, sometimes the beams, the slabs, the columns, they may have different rates of concrete to be provided that should be specifically noted on the drawing.

The detailing of reinforcement is a very very important aspect as far as concrete construction is concerned, and that as far as possible, should not be left to the site engineer. Who has so many other things to bother about, and is very likely to leave it to a bar bender, who may want to go home at a particular evening, and leave out some details, or take a short cut as far as placing certain amount of reinforcement is concerned, and that may have far reaching implications as far as the overall quality of that particular portion is concerned.

There should be unambiguous interpretation. The drawings and the design detail should provide for precautions to be taken during construction, if possible they should ,actually help the construction engineer, with the construction methodology, the construction

engineers at site need to interact with designers to develop in appropriate construction methodology, which is in line with the design philosophy or the design process that has been followed.

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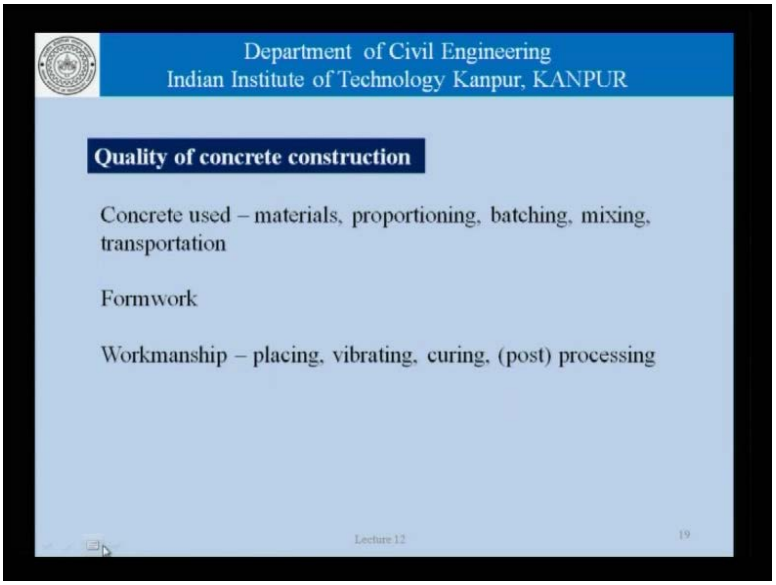

Coming to the construction itself or the construction phase itself, we have the concrete used and its properties or its quality, which is governed by materials proportioning batching mixing and transportation. We have the formwork, which play such an important role in determining the quality of the concrete construction. We have issues related to workmanship in terms of placing, vibration, curing and post processing.

Now, what is post processing of concrete construction, other than curing in certain cases for example, highway construction; there is a process called texturing which basically means or involves creating some roughness on the surface of concrete that has been cast. Now, when should texturing be done, what is the nature of texting to be done and so on is purely and simply a matter of workmanship at site. Whereas, some of these things we will talk about great a detail in a discussion later on.

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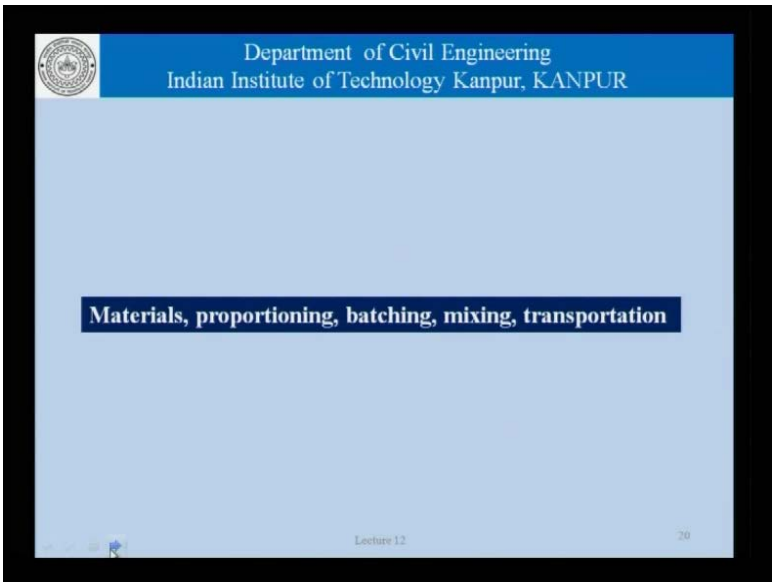

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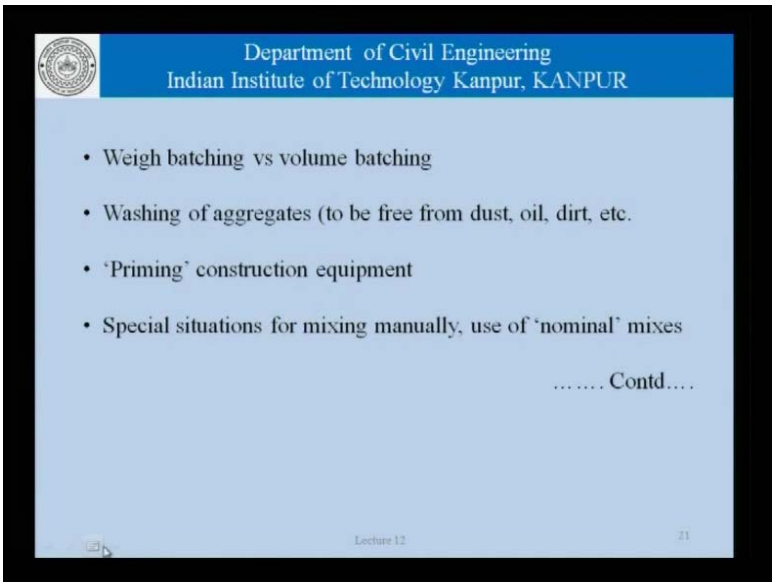

Let us focus for the time being on materials, proportioning, batching, mixing and transportation, which enough way comprises of the basic construction process. There are issues, related to way batching versus volume batching way. Batching means, we take the material by weight the concrete, proportion is given in terms of k g s per cubic meter and we way that material and mix it.

Volume batching means, that we measured the aggregate and sand by volume, we use the specific gravity or the bulk density as a matter of fact, and determine a certain

volume. Now, if we are using volume batching and bulk density by definition, then the amount of aggregate or sand being taken by weight could vary depending on the level of compaction and the actual geometry of the box, which we use; it is not a good idea to use volume batching.

But at the same time in certain cases, it is impractical to insist, and ensure that ready mix concrete, which meets a certain standard or concrete, which has been way batched the contractor may not have, or the builder may not have facilities to way batch a concrete mix. In those cases, it is not fair perhaps to insist on way batching, but at the same time one must not hesitate to insist on way batching, if it needs to be done in a certain project.

Similarly, washing of aggregates which need to be free from dust, oil, dirt and so on, it must be ensured, that the aggregates are clean, it must be insisted for example, that the coarse aggregate, and the final aggregate are s s d, that is surface saturated dry if not the correction, that is required for the mixing water should be at least in corporate. Priming of construction equipment, now once the any equipment, whether it is the batching plant or the agitator trucks or it is the slump cone, and so on, whatever is used in order to take the concrete from the batching plant to the actual site of placement the pipelines the pumps and so on.

All these equipment, when they are used for the first time a certain amount of layer, a certain amount of concrete is deposited on the surface, and the properties of the first batch of concrete are somewhat different from the subsequent batches. Looking at another way if the equipment has been used for a certain type of concrete, and then another concrete is mixed in the same mixer, some remnence of the previous mix whether they contain fibers, whether they contain silica, fume or flyash and so on. They will adulterate, the first mix or may be the first few mixes of the new concrete.

Therefore, if we are very careful about quality, if we want to be very careful about quality, then we must prime the construction equipment with the kind of concrete. That we are going to use that is we will have a few batches or some amount of concrete, which is allowed to go waste, just to make sure that a steady state as far as the effect of properties of the mixing equipment on the properties of concrete is concerned, that part is taken out of our equation, when we are talking of the quality of concrete.

There are special situations for example, for mixing manually, the use of nominal mixes. Nominal mixes is another very special kind of mix, where we say that in order to get m 20 concrete or a 15, kind of concrete basically not very high strength concretes or not even medium strength concretes, we do not need to design a concrete mix. Because, that process is very involved, it takes more time and in certain cases that luxury is not available with us and we say that fine.

If concrete is mixed in a particular proportion that is a prescriptive thing for 50 k g of cement. So much of sand so much of aggregates so much of water, if it is mixed properly and placed it may be considered equivalent to m 15 or m 20 that provision. If it is there it should be used very sparingly because, that is not the way we would like large construction projects to be executed, but at the same time for smaller construction projects, that kind of a provision needs to be there.

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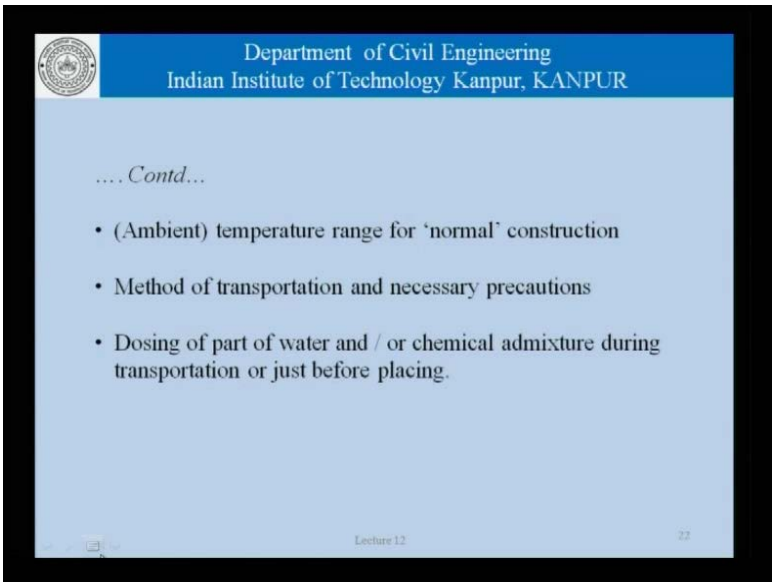

Defining in ambient temperature range for normal construction when concrete is been placed at site the temperature could vary for example, in a country like, India from anywhere between minus 3 minus 4 degree centigrade to may be as higher 45, 47 degree centigrade.

Now, what is the normal range in which construction activity will be allowed in other times, we will need to bring in the special considerations which are involved for cold,

weather or hot weather concrete, what is the normal range, where we would allow construction activities without taking those measures.

Then we talk of methods of transportation, and the necessary precautions. These have to be spelt out in the specifications specially, if you are using something like, conveyer belt or even if you are using agitator trucks or agitator mixes is there a need to ensure cooling of the surface of these trucks, when is that cooling required. What is the performance criteria that is to be used, these are things which we need to clearly write down in our specifications, and only then we can ensure compliance, which will in turn ensure quality.

There could be issues for example, for dosing part of water or a chemical admixture during transportation or just before placing, this has to be specifically studied on a case to case basis, and a decision taken without adversely affecting the total quality of concrete construction.

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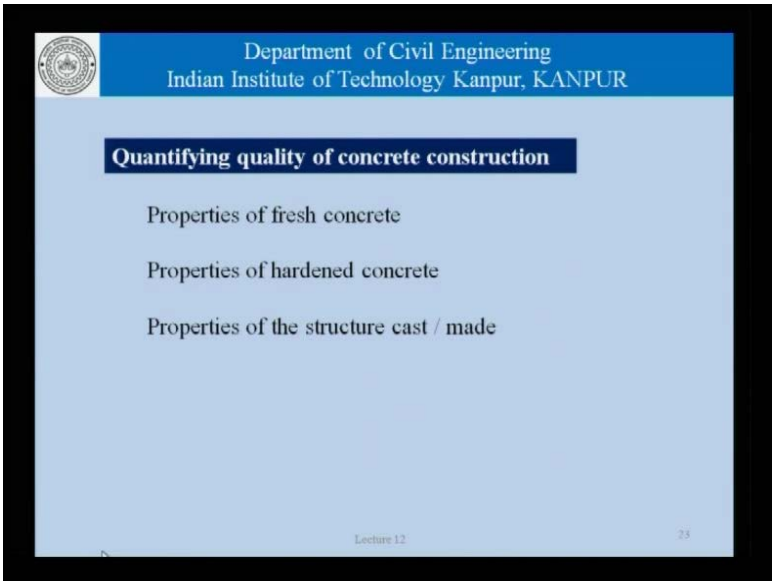

Now, coming to quantifying quality of concrete construction, at the end of it the quality needs to be reduced to certain parameters, which are measurable and by measuring them we quantify the quality of concrete construction, and that happens for properties of fresh concrete; the properties of hardened concrete, and also the properties of the structure which has been cast or made.

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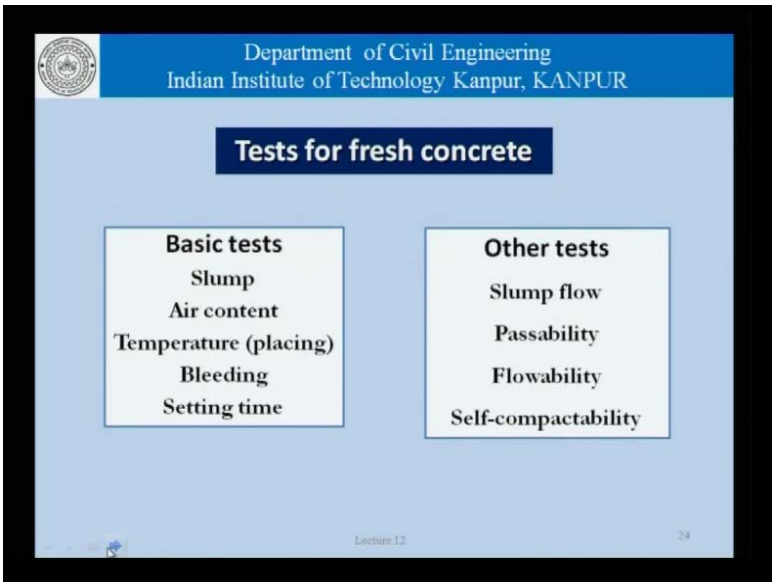

Now, as far as the properties of fresh concrete are concerned, we have talked about it earlier it could be basic test like slump air content temperature, time of placing bleeding setting time, whatever the engineers choose to use, there could be other specific tests or special test for slump flow passability, flowability and so on.

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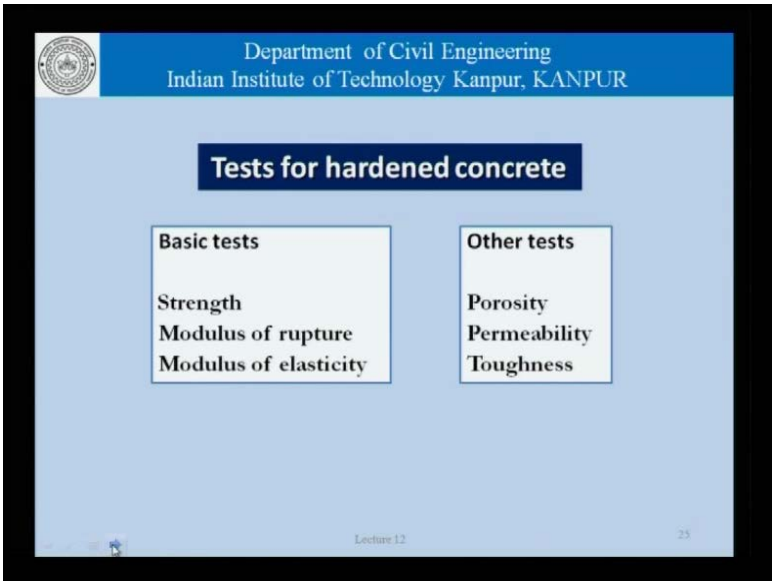

Similarly ,for the hardened concrete the basic test could be strength, modulus of rupture, modulus of elasticity, and so on other test could be porosity permeability, toughness these tests help us quantitatively, understand the quality of hardened concrete.

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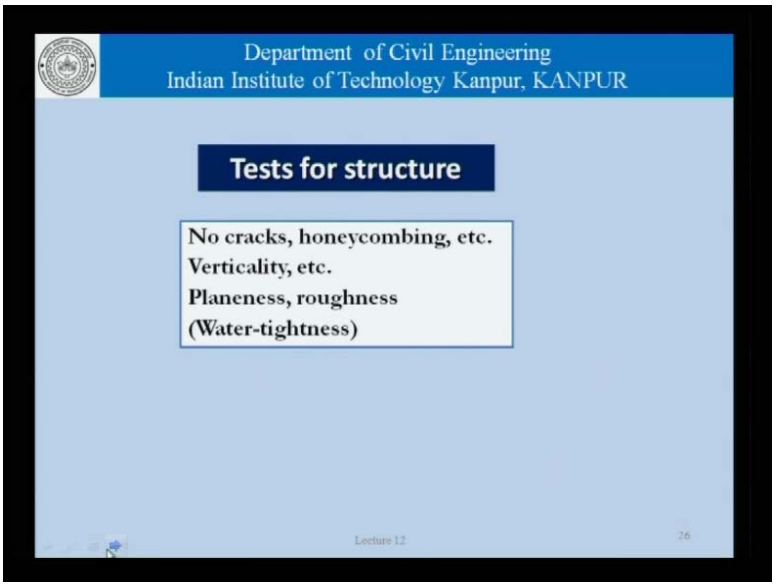

As far as the structure is concerned, that is the final product; it is not the concrete ;it is not the cement. So for the test for structure, we need to make sure that there are no cracks no honeycombing, there is a verticality in the vertical structure, the structure is not wavering, there is a certain amount of planeness or roughness and this is governed by the type of formwork used, the quality of formwork used, and the workmanship. Issues like water tightness, if it is a water retaining structure like, a water tank then there are performance tests, which specifically test water tightness.

Similarly for structures which are supposed to be vertical, that be vertical wall it should not be out of plumb by more than a certain amount, that amount need to be clearly specified and that is the way we ensure finally, the quality of the structure.

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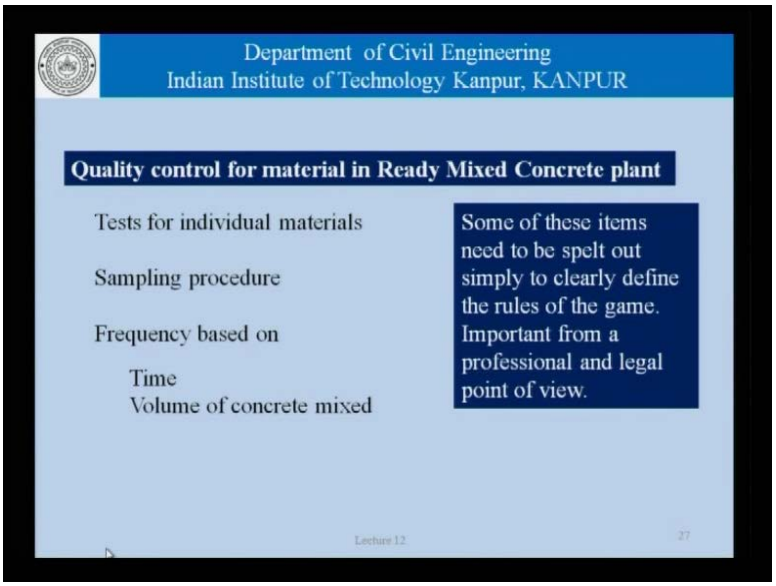

As far as the ready mixed concrete, plant is concerned. There are tests for individual materials ,it is important to have a specified sampling procedures, with the frequency; this frequency of test can be based on time, that is the sampling, will be done every day every week, every three days, twice a day and so on, it could be specified in terms to the volume of concrete being mixed. Because of batching plant need not produce the same amount of concrete every day, there can be a scheme of thought, which says that well for every cubic meter, every ten cubic meters, every fifty cubic meters, the material being used will be tested.

The rational could be that after a certain amount of time, the batches of the material being used could change, the time that has elapsed might be different and so on. We must remember that some of these items, need to be spelt out simply to clearly define, the rules of the game, and it is important from a professional and a legal point of view. These provisions have legal implications, there are financial implications and therefore, unless they are returned down, in that form it is difficult to ensure compliance.

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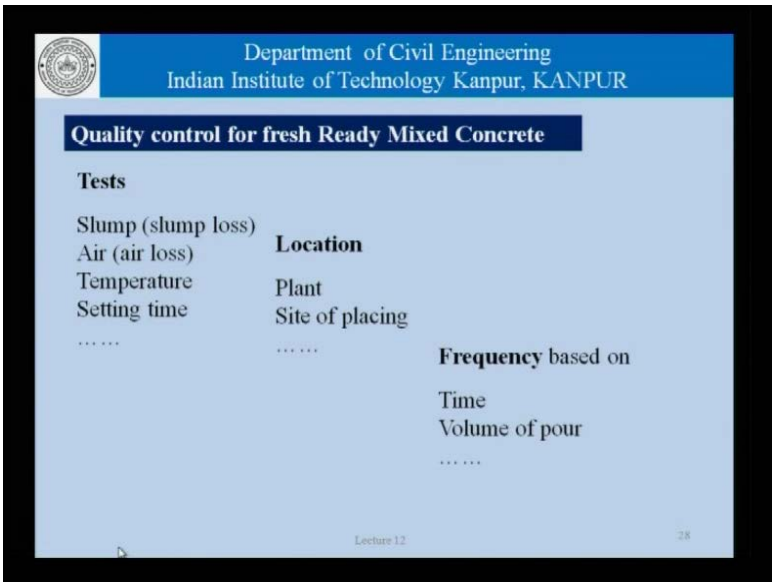

As far as the testing of concrete itself is concerned, it could be the same test, slump air temperature setting time and so on, but the important point is where should these test be carried out, as far as quality control procedures are concerned. They can be carried out at the plant, they can be carried out at the site of placing or both these places. Finally, concrete is going to be placed at a certain location, and that is where the concrete must satisfy certain criteria. But it stands to reason to believe that there is no point in taking a concrete which is unacceptable to begin with all the way to the site of placement and then reject it therefore, there needs to be tests at the plant itself.

These tests at plant and at site, should account for differences that might occurred during transportation for example, slump loss, air loss, evaporation of water and so on. These are the kind of considerations, which would give rise to a procedure by which some water or chemical admixture may be added at site, and not at the batching plant this especially true for example, for an accelerator, there is no way an accelerator can be used in a concrete at the batching plant, and the concrete has to be transported.

So, there is a case where someone will say that well let me use everything else in the concrete, at the plant have certain properties, take the concrete to the batch, take the concrete to the site of placing, add the accelerator and then do the casting. In this case obviously we need to have quality control parameters, the acceptability of concrete in

terms of the concrete at the plant, and at the and for the concrete at the site there is this issue of frequency of sampling.

Again, the frequency could be based on time twice a day once a day, once in 3 days or it could be based on the volume of pour since testing involves use of resources. If it is not specified it may not be carried out and therefore, it must be specified.

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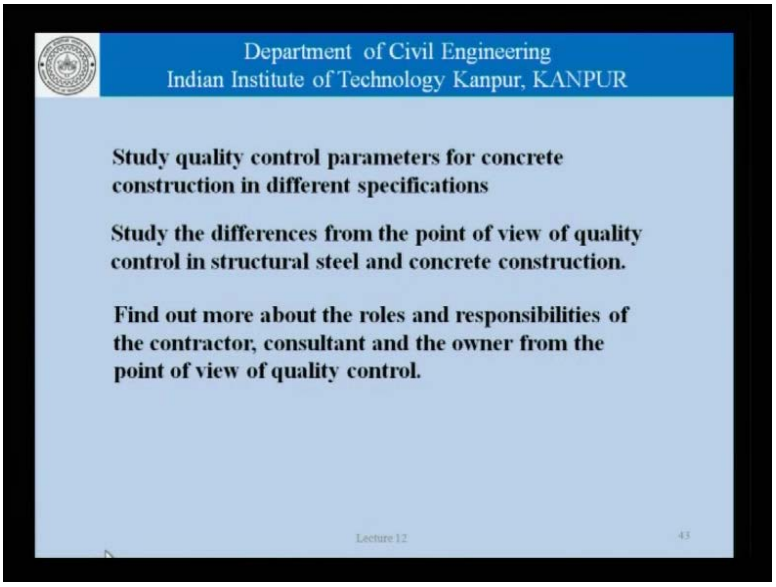

Here too the issue of frequency of testing is very important, how often should the sampling be done, for properties, of fresh concrete properties, of hardened concrete whether it is at site or at say plant, whether it should be governed by time, that is twice a day once a day once in 3 days, once a week whatever or should it be on the volume of the pour for every 10 cubic meters, every 50 cubic meters, everyday regardless of the volume and so on. This needs to be laid down its needs to be laid down because testing involves consumption of resources, and somebody may like to cut corners, if a minimum of sampling frequency or a minimum amount of sampling is not specified.

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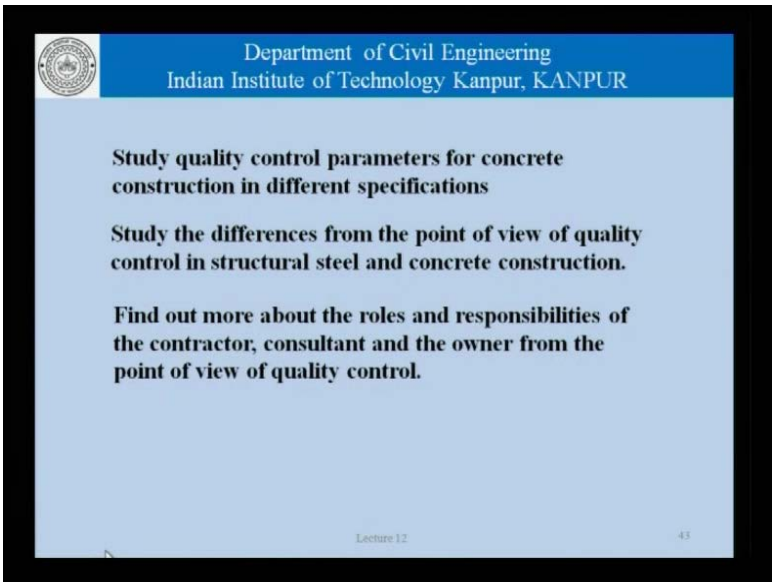

Now, having discussed the different aspects relating to quality, now let us try to conclude the discussion for today, with some homework as, we usually do. We could study the quality control parameters for concrete construction, in different specifications we have been talking about today of different specifications being written for different kinds of concrete construction in different countries.

Specifications could be different for dams, they could be different from for bridges, they could be different for priestess concrete, they could be different from India to the United States or Singapore or Japan. We could study the quality control parameters, in these different conditions, and different countries. It will be interesting also to study the differences from the point of view of quality, control in structural steel, and concrete construction. Structural steel construction is not something which we have at all talked about in this course nor do we intend to, but the principle is that steel is a factory made product, roll sections are made in factories, built up sections are made at site fabricated at site and the whole range of issues, as far as quality control is concerned is quite different, the fabrication drawings for steel structures are often made at site, not so the detailing of reinforcement. Seldom is detailing of reinforcement formally done and recorded at site.

The same is true with the design of formwork that is something, which we will probably talk about briefly in some other context enabling structures, temporary structures, these are all very different. As far as steel structure is concerned and concrete is concerned, so

from the point of view of quality control, it would be an interesting study to understand these things a little bit better. We could find out more about the roles and responsibilities the contractor, the consultant and the owner from the point of view of quality control. At the end of it, the quality of the product the structure is of importance is something sacrosanct to everyone. But how everyone approaches these problems, how the different agencies involve approach their problem, there could be very interesting differences and that is something, which we could study a little bit more.

Thank you.