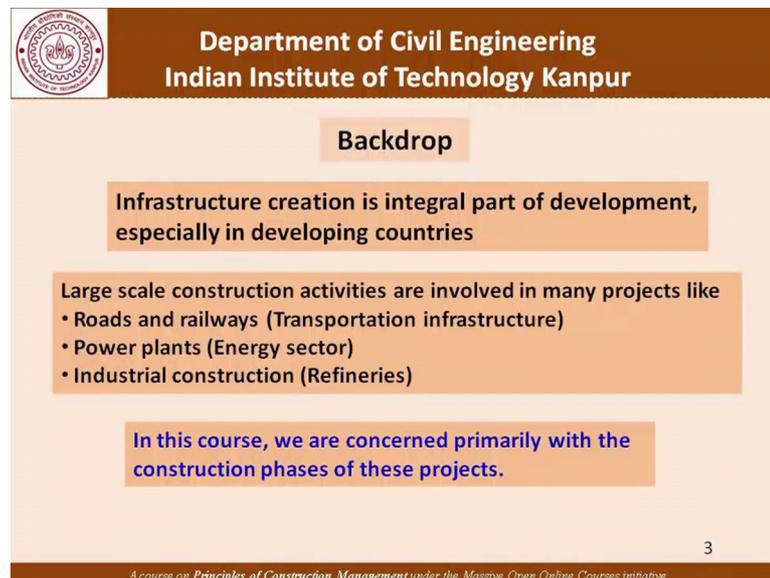


**Principles of Construction Management**  
**Prof. Sudhir Misra**  
**Department of Civil Engineering**  
**Indian Institute of Technology, Kanpur**

**Lecture – 01**  
**Introduction to the course**

[FL] and welcome to this series of lectures, in the massive open online course initiative titled Principles of Construction Management. Now this is the first lecture in this module and we will talk about the general overview in the course. What are the backdrop with which we are talking about construction management.

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**Backdrop**

**Infrastructure creation is integral part of development, especially in developing countries**

Large scale construction activities are involved in many projects like

- Roads and railways (Transportation infrastructure)
- Power plants (Energy sector)
- Industrial construction (Refineries)

**In this course, we are concerned primarily with the construction phases of these projects.**

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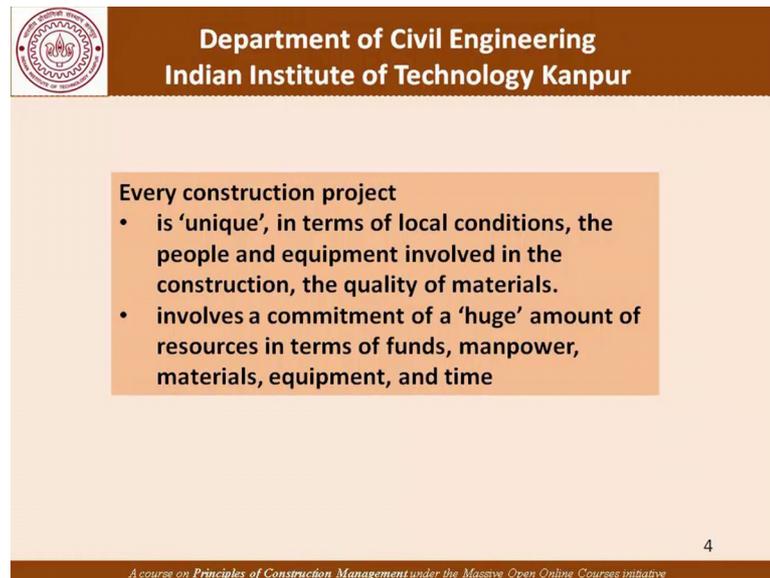
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We are looking at infrastructure management or infrastructure creation as an integral part of development; especially in developing countries, whether it is the design and construction of roads, airports, houses industry or whatever.

This kind of infrastructure is absolutely required to achieve any kind of development. Now large scale construction activities are involved in many of these projects which could include roads and railways like I said in the transport infrastructure, power plants in the energy sector or industrial construction; for example, refineries. In this course we are concerned primarily with the construction phase of these projects as we will see in this lecture and as well as, as we go along in the other lectures of the course.

There are different stages or phases that we have in any of these large projects beginning with conceiving the project, doing a planning and then a detailed planning, construction finally, operation and so on. So, in this course as I said here, we are primarily concerned with the issues that are of importance during the construction of these projects.

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**Every construction project**

- is 'unique', in terms of local conditions, the people and equipment involved in the construction, the quality of materials.
- involves a commitment of a 'huge' amount of resources in terms of funds, manpower, materials, equipment, and time

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Now we must remember that every construction project is unique in terms of local conditions, the people involved in the construction process, the design of the facility whatever it is, the equipment involved in the construction and the quality of materials.

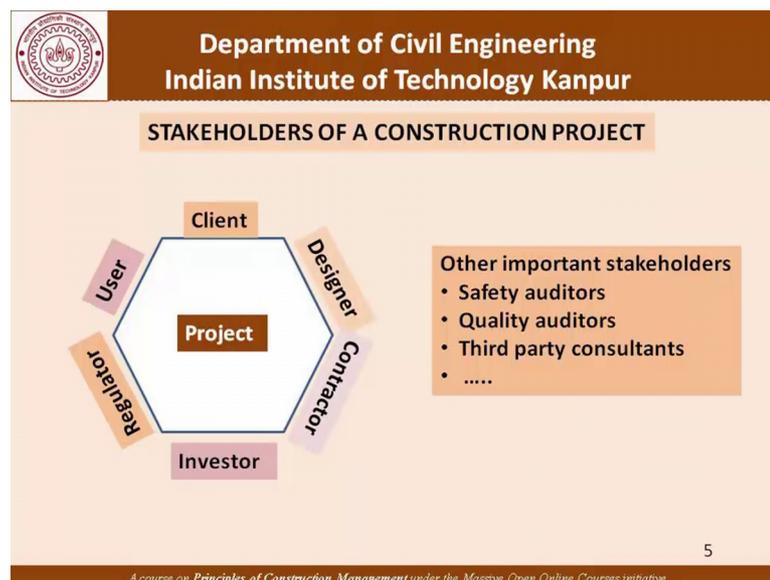
For example, even if you are talking of metro construction in different cities, in different countries even though the technology is the same, but the project in city 1 and the city 2 is unique because of the people involved in constructing it, the equipment that they use, to implement the same technology, the quality or the characteristics of the materials that are being used and so on. Also every construction project involves a commitment of a huge amount of resources in terms of funds, manpower, material, equipment and time.

Any of these infrastructure projects can easily span over several months and sometimes several years. Now what happens as a result of this is that at different stages right from the word- go somebody has to plan, what kind of resources? What kind of equipment for example, will be needed at different points in time as the project progresses? What kind of manpower will be required at different points in time of the project as it moves through completion?

Similarly, very important is the issue of what is called cash flow. Now cash flow essentially refers to the flow of funds there will be a total cost associated with any project, but that amount of money or that fund is not required immediately as we start the project. As different activities get completed different amounts of money or different amount of funds is required.

So, this requires a planning, a foresight into how the project will move and this kind of a thought process is an absolutely integral part of a construction management plan. Now let us look at who the stakeholders in a large construction project are? Please remember that as I have said we are not talking of in this course a small project even though bits and pieces of whatever we talk about will be applicable to even the smallest of projects, but its perhaps easier if we are able to visualize a large construction project and keep that in mind when we talk of some of these things.

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So, coming to the stakeholders, in the construction project there are at least these six entities which are involved. Now let us look at the client, now the client is essentially the owner of the facility. If it is a road project in India for example, it could be the NHAI or the State Government; they become the clients. Now the person who owns this facility does not necessarily have to have the expertise to design the project or design roadways or the bridges that will come in a road project and so on and therefore, the client has to have a designer who will actually carry out the design.

Now, this design could be functional, it could be aesthetic, it could be structural. So, depending on what kind of design we are looking at we need to have the services of a company or a set of people who can be clubbed as designers. Then there is a contractor; now the contractor is the agency which actually carries out the work. They do the execution of the project, they construct the project. Off late investors have also become very important players in this whole game.

We often hear of the PPP model that is the public, private, partnership model where the funds for these projects are not being provided by the government; traditionally the client used to provide the funds especially for large infrastructure projects. It was the government which was the owner of projects, but off late it has been realized that we can and we perhaps should have the involvement of investors in the project.

So, then we come in with investors that could be banking institutions, it could be the contractor who takes a loan and so on and so forth all kinds of models are being talked about, so different models are being implemented in India, in other countries in the world and so on. Then there is the regulator; now government now and government agencies largely play the role of a regulator.

That is they are the people who are charged with the responsibility of ensuring that the design, the construction and the operation is done as per an existing or in a greed guideline or a specification. So, there are regulatory agencies like the standardization agencies, the people who write tests methods and so on.

So, there will be a regulatory agency, which will lay down the methods for testing concrete for example, what kind of concrete is acceptable or not these are the rules of the game that have to be decided before the project actually starts. Sometimes of course, there is a need to change those specifications as we go along as we become wiser with the execution of the project, but there is this regulatory agency and the documents that are issued from time to time by the regulatory agencies.

Then at the end of it and in fact, it should have been perhaps in the beginning of it there is the user. Now the user is often not necessarily involved in all phases of the project. For example, if it is a road project the user is the guy who is actually driving the car or the person who is driving the truck, but those people are not directly involved in the

planning of the project, the construction of the project and so on, but they are very much part of the in fact, the whole project is being built for them.

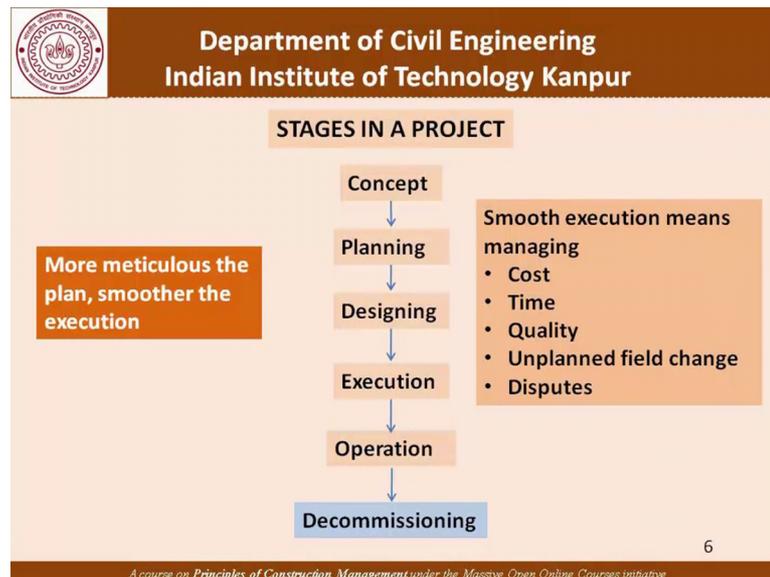
Their needs and requirements should therefore, should always be kept at the back of our mind when we actually do the design and that is what is normally ensured in the design process and that is why we have design guidelines. So, those are the kind of technical details which we are already familiar with. So, we in this course are looking at the entire issue of a project its design, its construction and so on from a management perspective and we are trying to figure out what are the roles and responsibilities the importance of the different stakeholders because at the end of it these different stakeholders will play a very important role as far as management of the project is concerned.

Apart from these there are other stakeholders for example, there could be safety auditors which in one sense of the word can be a part of the regulatory agency, there could be quality auditors which again is not necessarily a part of the regulatory mechanism, but there could be outside agencies which are involved in the safety and quality audits of projects.

Similarly, there could be third party consultants; a consultant and a designer sometimes may be the same sometimes may be different. The designers are basically general purpose design companies or firms whereas, consultants are more specialized in their jobs. So, even designers or contractors often that matter even the client may sometimes hire a consultant or request a consultant to help in a certain process whether it is the design of the construction or whatever it may be and of course, this list is not exhaustive and there are other people who could be also stakeholders in a project.

So, now coming to the stages in a project, we have the concept that is somebody thinks or puts together a proposal that we need a road to connect point A and point B.

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This concept is now put into a planning stage where the routing for example, for that road is decided because to connect point A and point B, there could be multiple routes which will have individual difficulties.

So, for example, if we go by route 1 there could be a river to be crossed at one place, in route 2 the river could may need to be crossed at another point which will have its own local geographical conditions and so on. So, this is the stage where this kind of routes are examined and we come up with different options. Followed by planning we go into design, where more specific details or more information is gathered and based on that information the actual design exercise starts.

Once the design is completed we go into the execution phase where, the project is taken out of the drawing board and is implemented at site. Now we must remember that as far as construction projects are concerned and that is the project that is our target in this course they have to be implemented in the field. And the project which does not get implemented on the field there are projects which do not see the light of the day and are not implemented, but that is not what is offer concerned right now.

So, once the project goes to the field then the construction activities start. After the project has been completed, the project is put into operation; once the road is completed it is open to traffic. Most of the time we think that the cycle ends there, but sooner or

later we will have to be concerned with this stage called decommissioning where we say that this road or this bridge has served its purpose and now needs to be replaced.

Now, once we are replacing a bridge, we have to be careful we have to plan as to what we will do with that bridge which has been built and has served its purpose. We must remember that this total cost including the design, execution, operation and decommissioning is what constitutes the lifecycle cost of the project. So now, the concept of life cycle costing of a project is coming into our thinking in a big way. And we are bothered about the cost of a project not only up to the execution stage, but also to include how much is the cost while the project is being operated? And finally, what it will cost to decommission that particular project or that particular road or a bridge or whatever it is?

It goes without saying, that more meticulous the plan smoother is the execution. It depends on us if we are able to foresee the kind of difficulties that will arise as the project goes through different stages, the execution in the project will be smooth. If we have not foreseen difficulties that may arise then it will be a stop and go situation and that is extremely detrimental to any project from the point of view of time over runs, cost over runs and so on and so forth.

Smooth execution, what does that mean? It means management of time, cost, quality, unplanned, changes on the field and disputes. So, if we are able to do a meticulous plan we will be able to ensure that we are able to complete the project in time, we are able to implement the project with good quality at the cost that it was expected to be completed without having too many unplanned changes on account of field conditions and without any disputes.

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**MODULES IN THE COURSE**

- General overview and introduction
- Estimation of project cost
- Construction economics
- Planning and scheduling (Parts 1 & 2)
- Quality management
- Safety management
- Legal aspects of a construction project

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So, now coming to this course, this discussion of hours for about 40 lectures or 40 sessions has been divided into different modules. The first module is a general overview and introduction to the course and that is what we are starting to do today. The next one is estimation of a project cost followed by some amount of construction economics, planning and scheduling in projects that is actually divided into two parts. We have quality management, safety management, and finally, legal aspects of a construction project.

So, this course as you can see is not really a depth course that is we will probably not have the time. It is not intended that we go very deep into any of these aspects, but it is a width course where, the effort will be to expose you different aspects of management of a construction project. So, that you are better prepared to handle a construction project from a management point of view and also you appreciate the kind of information or the kind of skills that a project manager should have in most colleges in our education system.

We have courses related to project management or construction management as part of the civil engineering curriculum, but most of the time they concentrate on the planning and scheduling part. So, we of course, do some planning and scheduling, but we will try to cover some other aspects as well; now, coming to the first module on the general overview and project organization.

We will basically talk about stakeholders, phases and features of a construction project, a typical organizational structure, the role of a project manager and very importantly the multi discipline nature of construction projects. We will talk about the resources that are required in a construction project and introduced the concept of the S curve. Now the S curve is a very interesting idea which helps us understand the extent of progress of a project.

We must remember that, if we think of a road project there are different activities involved, any project will have completely different activities involved. There could be land acquisition, there could be excavation, there could be some amount of design going on and so on. So now, at a given point in time how do we say what percentage of the project is complete? Is the project 10 percent complete or is a 20 percent complete?

So, how do we answer this question? The S curve provides one of the options. So in fact, I must share with you, that this course is not really a very objective discussion. There is a certain amount of subjectivity. There is a certain amount of openness, that there is no unique solution. It is only a matter of a thought process, it is more tough information that you have and how you interpret it is left more or less to the practice the person who is actually taking decisions.

So, as far as a second module is concerned which will deal with estimation of project costs, we must remember that the cost of a project has at least two sides to it; one is the cost that the client is willing to pay for a certain project. If the client thinks of a project as an owner that I want to build a road from point 1 to point 2, what is the estimated cost of that project?

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Module 2: Estimation of project cost

Cost estimates, client's estimate, preliminary estimate, detailed estimate, Item description, construction equipment, depreciation, overheads, introduction to contracts and bidding process, contractor's estimate, mark up

So, we will look at cost estimates, the clients estimate, preliminary estimates, detailed estimates, item description, construction equipment, depreciation, overheads, introduction to contracts and bidding processes, contract as estimates and concepts of markup. So, at the outset that client makes an estimate that for this project this will be the total cost.

A client goes to the market invites tenders and different people express their willingness; different people mean different contractors. They express their willingness they submit their bids to complete that project in a certain amount of money. This amount obviously, need not completely match the estimate from the client side. Of course, if the client has done a thorough job the differences are likely to be small if that job is not very thorough the differences are likely to be large and those are the kind of things which we will talk about as we go along in this course.

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**Module 3: Construction economics**

**Cash flow, Time value of money, Payback period, ROI,  
Evaluating alternatives based on cash flows, NPV, IRR,  
Discounted payback period, Evaluating projects of unequal  
lives, capital rationing, Taxation, Inflation, Benefit-cost ratio**

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We will talk about construction economics in module 3. Now what we will talk about here is concepts like cash flow, the time value of money, payback period, return on investment, evaluating alternatives based on cash flows, concepts of NPV, IRR, discounted payback period, evaluating projects of unequal lives, capital rationing, taxation inflation and cost benefit ratio.

So, you can imagine that there is a whole lot of things to be done and in fact, as we go along you will realize that sometimes I will just make a definition and then leave it for you to do some homework and understand on your own using literature and the kind of text books or papers which are available.

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**Modules 4 and 5: Planning and Scheduling: Parts-1 and 2**

**Introduction to construction planning, project plans, Work  
Breakdown Structure (WBS), Network diagrams, precedence  
rules, AOA, AON, Bar charts, CPM, PERT**

**Resource allocation, resource leveling, network crashing,  
cost of crashing, cost-time trade-off**

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Modules 4 and 5 will deal primarily with planning and scheduling of activities.

Here in module 4, we will talk about introduction to construction planning, project plans, work breakdown structure network, diagrams, precedence rules, AOA, AON, bar charts, CPM, PERT and so on. At the bottom of it the thought process is that different activities in a project cannot be all started at the same time. Certain activities have to be completed before certain other activities can be taken up.

So, we cannot do for example, the superstructure of a bridge unless we have done the foundations. So, in that sense the foundations precede the superstructure; civil engineers are often the last to complete their design because a lot of input for civil design comes from mechanical and electrical engineers. But the civil engineers are the first to be at site to start the project to start the construction in the project.

For example, if there is an industry or an industrial construction and you want to put a cooling tower. So, the construction of the cooling tower is indeed a civil engineers job, but the capacity of the cooling tower the technology to be used and so on is definitely not a civil engineers cup of tea. So, somebody else will decide those things and finally, give that input to the civil engineer who has to start his design.

Even to take another example, even in building construction; suppose you have a multi story building where you want to install a lift. So, somebody has to first tell you the specifications which are required for the lift and only then you can design your lift well and unless you design your lift well you cannot actually complete the design of the building. So, that is what I mean to say when I say that the civil engineers get the input the last, but they are the first to actually start the work. You cannot have the lift installed unless the building has been completed.

So, anyway that is what we will talk about when we talk about planning and scheduling. In the second part we look at this planning and scheduling discussion from a slightly different perspective and talk about resource allocation, resource leveling, network crashing, the cost of crashing and the cost time trade off.

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The slide features the IIT Kanpur logo in the top left corner. The main header reads "Department of Civil Engineering Indian Institute of Technology Kanpur". Below this, a box contains the text "Module 6: Quality Management". A larger central box lists the topics: "Quality control, Quality assurance, Total quality management, Quality audits, Cost of quality, ISO standards, Inspection". The slide number "12" is in the bottom right, and a footer at the very bottom reads "A course on Principles of Construction Management under the Massive Open Online Courses initiative".

Now module 6 would deal with some principles of quality management where we will talk about quality control, quality assurance, total quality management, quality audits, the cost of quality, ISO Standards and inspection. The discussion in this module would largely be related to construction projects. We must keep in mind and I am going to reiterate that when we come to this. As far as industrial systems are concerned, as far as production industry is concerned where we are talking about manufacturing of cars, we are talking of any industrial product which is manufactured in the industry; the concepts of quality and quality control are reasonably well developed.

The issue is whether those systems are applicable to construction activities which are unique; that is they are non repeatable? They are done at site under completely open conditions where we do not have controlled environment, when we are constructing a bridge is not a factory condition it could start raining sometimes, it could become very hot sometimes, it could become windy and so on.

So, the issue will be that how do we ensure quality of construction under these conditions? Of course, we have a lot of information available from our friends in mechanical engineering, from our friends in industrial management, what we have to actually adapt those prescriptions or those specifications in our systems as far as construction projects are concerned. Of course, it does not mean that we do not have any

methods or any protocols to ensure quality as far as construction is concerned, but we will try to evaluate those issues as we go along in this module of quality management.

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**Module 7: Safety Management**

**Unsafe acts and conditions, injuries, accidents, PPE, Safety audits, Role of site-engineer, Principles of safety, safety manual, safety plan, incentives, OSHA**

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Now, module 7 would be safety management; we will talk about unsafe acts and conditions, injuries, accidents, personal protective equipment, safety audits, role of a site engineer. the principles of safety, safety manual, safety plan incentives and OSHA. I am not explaining to you, what OSHA is? Try to figure out if you can otherwise of course, when we come to it well talk about it.

The thought process that I have in including this module in this course on principles of construction management is that we must as civil engineers or as engineers with any kind of affiliation, we must ensure that the construction activity is safe, it is accident free. It does not cause injury or any kind of harm to the people involved in the project or people who are not involved in the project, but happened to be passing by or at the end of it even the people who will use the project at the end of the execution.

Now, it is very unfortunate that we often hear that a certain building under construction or certain bridge under construction collapses, there are reasons for that and those are exactly the kind of reasons which we must investigate, we must be aware of what could cause an accident and try to make sure that accidents do not happen. Accidents are accidents sometimes they will happen they are unforeseen, they are unplanned. Nobody

plans for an accident, but there has to be a method in which we will or we can control accidents. Make sure that accidents do not happen.

There have to be methods by which we can evaluate one company or another in terms of its accident record, in terms of its safety record. So, these are the kind of things which we talk about when you go through this module on safety management.

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**Module 8: Legal aspects of a construction project**

**Claims, Disputes, Arbitration, Project closure,  
Role of Third-party, Legal cell in construction  
companies, Labor laws**

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When it comes to legal aspects of construction, what will you talk about? There are different agencies involved in the project. It could be the client, it is the designer, it is the contractor, it is the investor, it is a regulator and so on and so forth.

Now, if there are multiple agencies involved in the project, what should be the kind of documentation which will define the roles and responsibilities of each of them? And that is, what is basically a contract? We must remember that these are large projects spanning over several months or years involving hundreds of people, sometimes thousands of people and therefore, unless there are written documents which define the roles and responsibilities, which define the kind of work they will do it is very very difficult to manage a construction project; that is one part of it.

The second part of it is that, there is a large amount of money being used and we have to make sure that the money is being used in the best possible way, in the most effective way. There is no wastage of funds and if there is any waste of resources by any of the

stakeholders, there have to be ways and means of penalizing that particular agency. So, all that part is laid down in contracts and that constitutes the legal aspects of construction and what we will be talking about is claims, disputes, arbitration, project closure, role of third parties, legal cell in a construction company and labor laws.

Now, labor laws are also a very important part of a construction managers job. As a construction manager one must be aware of the rules that governed employment of labor in terms of the facilities that they need to be provided, the kind of protection they need to be provided the kind of facilities and so on.

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**ASSIGNMENTS IN THE COURSE**

There will be two types of home assignments in this course

TYPE - 1	TYPE - 2 (Food for thought)
<ul style="list-style-type: none"><li>• Normal assignments for submission</li><li>• Grading will be done</li><li>• Solutions will be provided</li></ul>	<ul style="list-style-type: none"><li>• Reading and self-learning questions</li><li>• Questions will be posed, but grading will not be done</li><li>• Solutions will not be provided</li></ul>

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So, this is what the course will contain as far as assignments in this course are concerned there will be lots of assignments because; obviously, being a width course we will not be able to cover many of the keywords that we talked about in any detail.

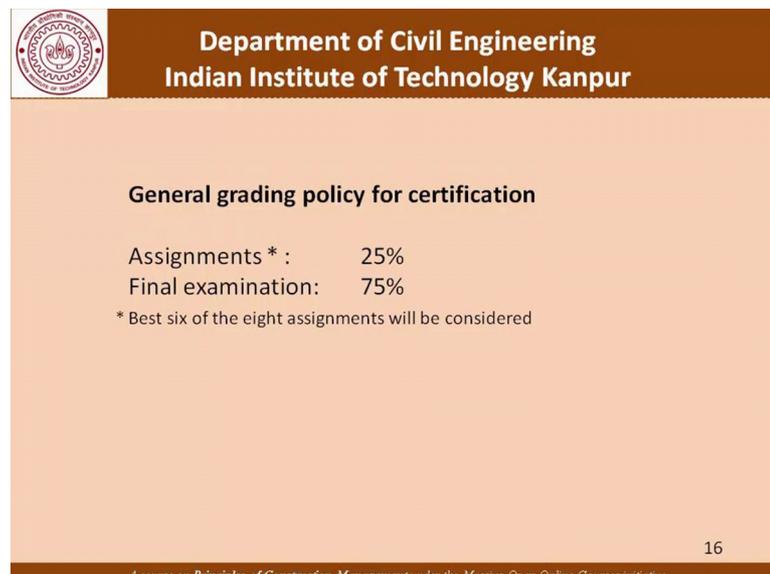
So, there will be just the definition given in this lecture and then it maybe will ask you to develop it on your own. So, basically what I have thought is that we will divide the assignments in this course into two parts; one would be normal assignments for submission where they will be grading and solutions would be provided and we will probably have a discussion in the discussion forum and so on and so forth. But apart from these assignments there will be what I call type 2 assignments which are basically food for thought and do it yourself kind of assignments where they would be reading and self learning questions.

Questions which I will give you and not answer them and of course, there will be no grading. So, there is no submission of these assignments, there is no grading, but it will be interesting and important for you to go through these questions, try to have your own answers.

We will try to see if we can discuss them in the forum sometime, but they will not be part of the grading and evaluation schemes. And obviously, we will not be able to provide any solutions because we must remember that as I mentioned earlier there are no closed form solutions to several problems. As we go along in this course you will realize that there are different options and the whole idea basically would be for us to develop those options.

We think of those options we foresee the kind of difficulties that will arise, the steps through which we will have to go through if we choose a particular option and so forth. So, it is one option versus the other; sometimes there are closed form solutions where we can evaluate those options sometimes there are not. So, the type 2 assignments will be basically the self learning types and type 1 assignments will be those where we will try to guide you through the learning process.

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**General grading policy for certification**

Assignments * :	25%
Final examination:	75%

\* Best six of the eight assignments will be considered

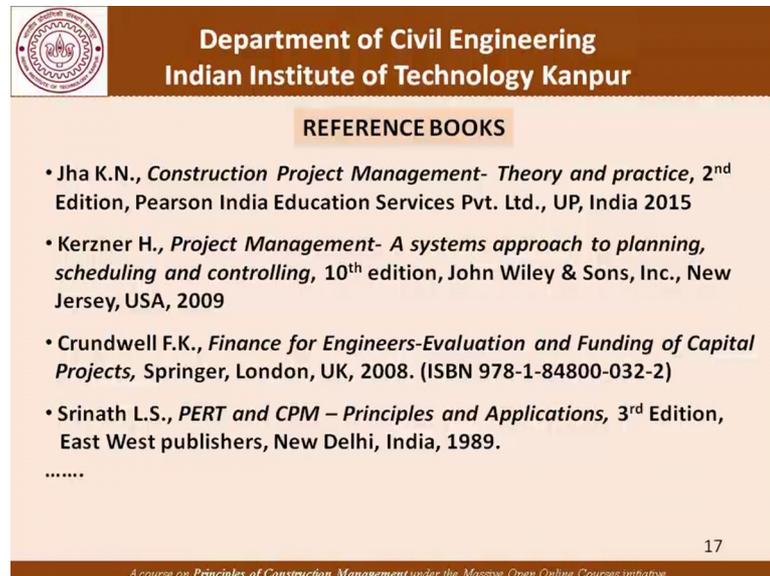
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As far as the grading policy for certification in this course is concerned we will follow the policy which is laid down centrally as far as the MOOCS initiative is concerned. The assignments will carry 25 percent, best six of the eight assignments being considered and

the final examination will be 75 percent. So now, as far as reference books is concerned this is just a list of four of the several several texts which are available in this area.

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The slide features the IIT Kanpur logo in the top left corner. The title 'Department of Civil Engineering Indian Institute of Technology Kanpur' is centered at the top in a dark blue box. Below the title, the section 'REFERENCE BOOKS' is highlighted in a light blue box. The list of books includes:

- Jha K.N., *Construction Project Management- Theory and practice*, 2<sup>nd</sup> Edition, Pearson India Education Services Pvt. Ltd., UP, India 2015
- Kerzner H., *Project Management- A systems approach to planning, scheduling and controlling*, 10<sup>th</sup> edition, John Wiley & Sons, Inc., New Jersey, USA, 2009
- Crundwell F.K., *Finance for Engineers-Evaluation and Funding of Capital Projects*, Springer, London, UK, 2008. (ISBN 978-1-84800-032-2)
- Srinath L.S., *PERT and CPM – Principles and Applications*, 3<sup>rd</sup> Edition, East West publishers, New Delhi, India, 1989.

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So, depending on the kind of topic we are talking about and the kind of interest that you have you may be able to find a lot more material on any of the subjects that we are going to deal with. But here I have listed only four of the books which could be of some interest to all of us with this we come to a end of this discussion.

Thank you and I look forward to seeing you in the subsequent lectures of the course.

Thank you.