

**Introduction to Civil Engineering**  
**Prof. Ravindra Gettu**  
**Department of Civil Engineering**  
**Indian Institute of Technology, Madras**

**Lecture – 02**  
**What is Civil Engineering?**

So, this is the second lecture on the Introduction of the Civil Engineering profession. In the first lecture we had discussed what civil engineering is all about, what civil engineers are expected to do and this lecture we are going to look at what are the different specializations within civil engineering and what they cover and what the scope would be in each of these cases.

(Refer Slide Time: 00:37)

### Civil Engineering Specializations



- Environmental Engineering
- Geotechnical Engineering
- Hydraulics and Water Resources Engineering
- Construction Materials and Technology \*
- Structural Engineering
- Transportation Engineering
- Construction Management
- Urban Planning



So, these are the different civil engineering specializations that you see here, starting from say the environment and looking at environmental engineering, how we interact with the

environment, how do how should we take care of the environment, the soil, the ground, geotechnical engineering covers that hydraulics and water resources deal with the flow of water and how we can control save and utilize water better.

Construction materials and technology we will look at how, what is used in construction, what are the technologies available and how do we efficiently have construction going on. Structural engineering deals with the design analysis of structures that we want to construct. Transportation engineering as the name implies deals with the planning, design and construction of all transportation facilities mainly roads, railways, ports, airports and so on.

Construction management is a very broad discipline which looks at, which takes care of the managing, using resources efficiently in whatever civil engineering project we take up. Finally, we have urban planning sometimes it probably comes first before anything else starts to look at where city should come up, how they should develop and even projecting how they will develop in future.

(Refer Slide Time: 02:09)

## Environmental Engineering



Wastewater treatment ([www.veolia.com](http://www.veolia.com))



Pollution monitoring and mitigation ([www.hindustantimes.com](http://www.hindustantimes.com))



We will start with environmental engineering; environmental engineering deals with providing water that is drinkable to people, taking care of waste water, treating it so that when it goes back into an environment, it does not harm the environment.

So, at the top you see a picture of a wastewater treatment plant, where there is water that is coming from sewage tree, sewage of households and industry, treated such that it can be put back into the environment.

In each case I am giving here, the reference where this image was taken and that could also be a reference for getting more information regarding these aspects of the different topics that I am talking about. Waste management is a very important area, as it is obvious human beings consume a lot of material and also produce a lot of waste, all this waste has to go somewhere, properly treated and hopefully recycle, brought back into the system. So, we have to analyze

what are the waste that are being generated, quantities, types, collected properly. Now, we are starting to segregate more and more in most places the waste is segregated at source and then we can decide what to do with the different types of waste.

So, it has to be transported and as much as possible, we would like to recover whatever we can from waste. Glass for example, is something that is readily recycle, then you have plastics and many other things and maybe some of the other material, which is biomass can also be used in some ways fuel or in some other purpose to create energy so that is just not dumped.

So, as much as possible see, if we can recycle reuse some of the material which is coming in waste and only finally, if we cannot do anything with it see, how to dispose and where to dispose. Another aspect of environmental engineering is pollution monitoring and mitigations. As urban environment comes up, as cities come up, we pollute air, we pollute water, we pollute groundwater.

So, monitoring of this and mitigating, mitigation is very-very important, because just knowing that this is happening is not enough. We have to see how to stop it and how to make sure that the pollution does not keep on increasing. Otherwise, our cities are going to get dirtier, the air that we breathe in is going to become more difficult to breathe and our groundwater will become contaminated and it will spread to their environment all around these cities as well.

(Refer Slide Time: 05:13)

## Environmental Engineering



### The protection and improvement of the natural environment.

Application of chemistry, biology and fluid mechanics in the design and operation of systems for providing drinking water, and for the treatment of municipal and industrial wastes.

Modelling and monitoring of the movement and behavior of pollutants in the environment.

Based on:

- Chemistry (for understanding reactions and effects)
- Biology (for knowing the impact on living things)
- Mathematics (for modelling the responses)
- Design of waste treatment systems
- Study of pollution and its mitigation
- Assessment of Environmental Impact



So, environmental engineering does all this aiming to protect and improve the natural environment, where we all have to co habit and work and live. It draws upon basic sciences like; chemistry, biology, fluid mechanics, because these are sciences that are required for designing, operating the systems that have to be built for providing drinking water and for treating waste, municipal as well as industrial waste, depending on where the waste comes from, the treatment may be different, we have to see what are the contaminants and how they can be treated or handled before the treated waste is sent back into the environment. This also brings up the very importance of a civil engineer knowing chemistry well. Lot of environmental engineering processes is draw on the draw on chemistry and the understanding of chemistry as much as we are concerned. The other aspect is monitoring and modeling of the environment. There are many processes that we have to say how they will evolve over time.

So, modeling is very-very important, we have to understand the phenomena and see how they will affect the world in future. How much will temperature increase? How much will the carbon dioxide in the air increase and if so, how are we going to stop it, how are we going to limit it and how are we going to mitigate. How did these pollutants move? See pollution in a city does not stay just in the air of the city, it can move, it can affect neighborhoods and sometimes we have large movements of contamination.

In Europe when there was the Chernobyl accident, the radioactive cloud moved towards large parts of Europe and affected areas that were very-very distant from where the accident occurred.

So, we have to understand how these pollutants will move and where will they reach and as I said the different areas that we have to understand is chemistry. There are reactions, effects of these reactions have to be understood Biology, because we are dealing with not only human beings, but many other living things that are on the earth along with us, Mathematics is needed for the modeling, we need sophisticated models sometimes which depend on many aspects as they could be in the environment to tell us how the pollutants will change, pollutants will spread and how pollution will change increase.

For example, and that will lead us to design, for example of this design of wastewater treatment plants for that we will have to know where it is going to be situated, what waste is coming in, how the population, which is producing this waste is going to change with time and therefore, see what would be the adequate design for the waste water treatment.

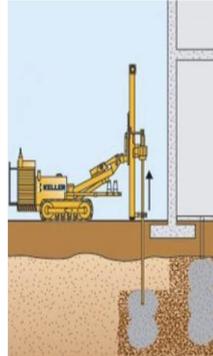
I have already talked about pollution and its mitigation and finally, an important aspect of design of almost everything that is large is the environmental impact assessment. When we have a large project say a new township coming up or a dam coming up or a canal. Now, it is almost necessary to have what is called an environmental impact assessment. How is this going to affect the environment in general? What are going to be the emissions? What are the resources that are going to be needed and how will this change the environment? Where this is coming up? Ok.

(Refer Slide Time: 09:13)

## Geotechnical Engineering



Chenani-Nashri tunnel  
([www.greaterkashmir.com](http://www.greaterkashmir.com))



Ground strengthening  
([www.kellerindia.com](http://www.kellerindia.com))



Foundation of high-rise building  
([www.shanghai.gov.cn](http://www.shanghai.gov.cn))



So, this is again something that environmental engineers do. Moving on, Geo technical engineering as the name implies is whatever that has to do with the earth, the soil, the ground. So, suppose we have to make a tunnel for example, I have the image here of the Chenani-Nashri tunnel in Jammu and Kashmir, where you have a large tunnel network being built. These tunnels have to go through a mountain. go through rock, go through soil, we have to understand the soil, we have to understand the rock, we have to see how to make this tunnel safe when you are drilling, boring and also during the life it has to be safe enough and it will withstand the pressure of the earth around it and the movements and so on.

Whenever we have a large building, a high rise building, you need a strong foundation, because everything that you see above the ground is transferring the load into the ground. So, you have to make sure that that is going to be stable. So, we have to understand how to make a foundation of these structures. So, that they will last a long time and keep the building safe.

Also, we have to understand that the earth itself can move, the ground can move when there is an earthquake, when there is settlement the ground can move.

So, we want to make sure that it stay stable. So, there are techniques where you can strengthen the ground. So, there are ground strengthening techniques, if the ground is not strong enough what you are going to put on top of it can de strengthen the ground. You may not have a choice to say that I cannot build here, I can move elsewhere. So, we have to see how to make the ground strong enough for whatever we are constructing on top or within it.

(Refer Slide Time: 11:07)

## Geotechnical Engineering



### **Understanding of earth materials and the design of safe foundations for structures.**

Analysis of soil and rock behavior to design structures, pavements, underground facilities, and containment structures for solid and liquid wastes.

Design of foundations, retaining walls, tunnels, etc.

#### Based on:

- Mathematics (for modelling the response)
- Physics (for providing the fundamentals for soil mechanics, and behavioural and failure theories)
- Foundation design (for providing safe bases for structures)
- Slope stability assessment
- Seismic engineering
- Design of underground structures



So, geo technical engineers understand earth materials whatever is in the ground and see how to design safe foundations for structures that we are going to place on them or within them. So, they analyze the behavior of soil and rock. So, that they can design these structures safely, the structures could be high rise buildings, could be pavements, underground facilities, we

talked about tunnels. In India, almost all the major cities are having metro tunnels and surely we will have these projects running for several decades in India and other parts of the world.

So, these are structures which are mostly or at least partially under the ground and we have to make sure that the drilling process, the excavation is done safely, economically and the structure once it is constructed is safe enough for transportation to occur through it.

So, underground structures are becoming more and more important. We also need underground structures for containment of waste. Suppose, we have radioactive waste, we have to store it safely, we cannot have leakages. We cannot afford to have this waste escape into the environment. So, we need containment vessels, we need containment structures that will keep contaminated waste or waste that could contaminate in a protected place. I have already talked about foundations. So, foundations are the substructure, which holds the structure superstructure that we see about the ground. Retaining walls are those that prevent soil from moving say, if you have a slope, you have an excavation, you do not want collapse of the soil to occur. So, there we have retaining walls, tunnels, I have already discussed.

So, anything that is on the ground, under the ground needs Geo technical engineers to study the situation and tell us how to go about it and for this the Geo technical engineer has to understand Mathematics well, because there is a lot of modeling of the response required. Physics of course, they have to understand soil, mechanics, how the soil will deform, move, shift. There are a lot of theories which tell, tell us how the soil will behave, how rock will behave and how will they fail. We also need to know how failure will occur so that we can prevent it and we can design for loads that will not cause failure.

Foundation design as already discussed is very much required for any type of structure now, because the ground has to withstand the loads, should not deform too much and it should be safe enough for the structure to sit on it. Slope stability is very important, because we have areas where you have to cut through mountains, hilly areas and when you make a cut you leave a slope that could become unstable and collapse and we certainly do not want that to happen.

So, we will have to understand how to cut a slope so that it does not collapse and if it has a potential for collapse what should we do to maintain the stability of a slope. Seismic engineering is everything to do with earthquakes. Earthquakes as we all know involves the shaking of the earth, it can be vertical, horizontal and combination. So, if you have a structure sitting on the earth and the earth is moving, the structure could fail, the soil could become loose, liquefy, settle crack and so on.

So, we have to anticipate what could happen in a certain region. With more and more knowledge in seismic engineering, we are designing better as structures for such type of actions that come from earthquakes. I have already talked about now, underground structures, the best example that is closest to most of us is metros. We use subways and we want them to be safe, because we cannot make transportation within a city without metros nowadays. So, everywhere we have metro construction happening and we want to understand, the best way to construct and keep these structures safe.

(Refer Slide Time: 15:51)

## Hydraulics and Water Resources Engineering



Bhakra Nangal Dam  
([www.nativeplanet.com](http://www.nativeplanet.com))



Canal in desert ([water.rajasthan.gov.in](http://water.rajasthan.gov.in))



Flood mitigation  
([www.thehindu.com/sci-tech/science](http://www.thehindu.com/sci-tech/science))



Another aspect which deals with the ground is how water flows on the ground; hydraulics and water resource engineering.

So, there are large structures like dams that have that have been built over the course of history. We still build large projects which involve dams, where water is stored for irrigation, drinking water purposes and also to generate electricity. It is one of the cleanest ways to generate electricity. So, we have a large, we have several large projects which are hydroelectric projects, which provide this pressure due to the buildup of water that can be used to generate electricity. These are all massive projects, because they involve making a huge reservoir that can collect the water and the impact on the environment on people is tremendous.

So, they have to be done properly and safely. This water is often transferred to the places that we require them. This is an example of a canal in Rajasthan, where a desert land can be converted to a livable place, where you can have irrigation by having proper canals. So, this will require us to understand where to store the water and how to move the water, the water has to flow by gravity.

So, we have to understand how to make it flow in the direction that we want to and it should reach the place that we want and sometimes disasters happen say floods, this is an image from a recent Chennai flood and we find that sometimes there is too much rain, there is too much of flow of rainwater and that could flood unintentionally; obviously, a city that is inhabited by a lot of people.

So, here again our hydraulics engineers will have to estimate when this could happen; using statistics, using the knowledge of historical data, they have to guess, what would be the maximum rainfall that is reasonable to use in design and if this rain falls how is it going to be handled such that it does not become unsafe for the city, for the people and for the businesses in the city. So, there is a lot involved in storing and conveying water. On the other hand also, we are worried on protecting too much water from coming into the city and destroying the city and its people.

(Refer Slide Time: 18:29)

## Hydraulics and Water Resources Engineering



**The application of computational techniques and fluid mechanics to the flow, control, collection and supply of water and other liquids.**

Design of hydraulic structures and machinery

Study of rainfall, and its flow and collection

Prediction of storms and floods, and mitigation of their impact

Based on:

- Mathematics (for modelling the responses)
- Physics (for providing the fundamentals)
- Fluid Mechanics
- Hydrology
- Design of Water Supply Networks
- Design of Hydraulic Structures



So, the hydraulics and water resources engineers apply methods; analytical methods, computers, fluid mechanics to the study of flow of water and controlling this water. So, that we need we use it when we need it and it is not going to harm us during its flow. So, flow and control is important and we collect like dams as I said is a way of collecting water, we can have tanks and we can have other facilities and then supply this water where it is required and the same can be extended to other liquids, there are civil engineers who work on the flow of blood in the body, because it is also a fluid.

So, there are many fluids other than water where these principles of hydraulics can be used and civil engineers also work on in these areas. They mainly do the design of hydraulic structures and machinery that is required for controlling water and moving water, they spend a lot of time studying rainfall especially, in a country like India where we have a lot of areas,

where we do not have water readily available. So, we have to study when will we get rain, how much rain and how are we going to store and use it properly.

So, that we can control its flow, decide the flow and collect it. Disasters happen and lot of it is, because of storms and floods and there are many hydraulics engineers who study storms, see how they move and even predict and warn people that there is a storm approaching, that there could be a flood. So, that even though we have designed well, there could be something that is beyond our control. So, we can warn people that a storm is coming, we have to evacuate, we have to be safe we have to move to higher ground. So, that they are not affected by floods.

So, they base a lot of the work on Mathematics, lot of analytical work is needed, Physics; obviously, fluid mechanics is this special area of mechanics of Physics that deal with flow of water, flow of different fluids, pressures it creates during its flow, hydrology is the study of flow of water on the earth and they end up designing a lot of water supply networks, our cities are growing, new cities are coming up we need to provide water. So, the water supplying networks also have to be designed properly and hydraulic structures like dams and canals. So, these are the different areas that hydraulics engineers work on.

(Refer Slide Time: 21:18)

## Construction Materials and Technology



Large construction site  
([www.guinnessworldrecords.com](http://www.guinnessworldrecords.com))



Crane at tower project  
([www.nbmcw.com](http://www.nbmcw.com))



3D printing of concrete  
([manmonthly.com.au](http://manmonthly.com.au))



Next, we would come to the area of construction. Construction involves resources and materials and processes. So, the people who are involved with construction materials have to decide what material to use, how much to use and how to use it.

So, here we have an image of a huge construction site and these green lines that you see here, each of them is a pump delivering concrete. So, you have a bunch of them and then there are concrete trucks here, you see the concrete trucks here and this is now going to go into this huge construction site, where probably the foundation of a very tall building or set of buildings is coming up. So, construction materials expert has to know which concrete to use, how much should be delivered, how it should be delivered and that the construction technologist has to see what are the equipments required so that this material will be delivered correctly and on time, we see here some cranes.

So, material has to be lifted during construction, how many cranes do we require, what is the type of crane required has to be decided by somebody who is going to tell us what type of technology is best suitable. Here, actually you have a tower and as the tower is building up the crane is going up by itself. So, the crane is also sitting on this tower itself, you see here the crane is attached to the tower.

So, as the tower is growing the crane sort of moves itself up. So, it is always above the tower. So, that it can lift things and put on top of a tower. Concrete might seem a very mundane material everybody thinks that they know everything about concrete, but there are people like me for example, who do a lot of research on concrete and now, the new thing which is the buzz is 3D printing and if we 3D printing everything why not concrete. So, this is an image of 3D printing of a wall with concrete. So, you do not need to have a mold or a formwork, you can just pour concrete and it stands up. This is being done in polymers, it is being done with metals, and many other materials.

(Refer Slide Time: 23:47)

## Construction Materials and Technology



**Utilization of material and equipment to implement the design of structures and other civil engineering projects, and take care of their maintenance**

Design of new materials and construction methods

Improvement of the performance of materials

Improvement of the quality of construction

Based on:

- Physics and Chemistry (for providing the fundamentals for the Behaviour of Materials)
- Understanding of the market and practice
- Architecture and building physics
- Building drawing
- Surveying
- Maintenance of facilities



So, the construction materials and technologists will look at what are the materials resources required for the construction to be done properly and efficiently. So, the engineer who works on construction materials at technology looks at the utilization of the material and equipment to implement the design. The design is given now, how best to implement it and make it happen. These could be structures or any other civil engineering project.

They also have to take care of the maintenance, structures become old, facilities become old. How do we make sure that they are in running condition and usable condition, when do we have to repair and how do we repair these structures? Design of new materials is very-very important just like our demands, our requirements keep changing, we have to supply, we have to come up with new materials.

So, these engineers will look at new materials construction methods, how to improve the performance of the material, if we know that something is going wrong with certain type of material how can we make that better. Quality of construction we always hear a lot of complaints about construction not being good quality. So, there are people who are supposed to work on that and make sure that this quality is improved.

So, they draw on the physics and chemistry to understand the behavior of materials, they understand what is there in the market, because you cannot in civil engineering use something that is very-very expensive has to be brought from a long distance, because it makes the construction not feasible. Architecture building Physics is important.

We want to design structures that are comfortable that we should have enough ventilation, we should have enough lighting and we should feel nice using the environment that is created for us for these drawings have to be built made and building drawing is something that is drawn upon at the construction site, where you put the ideas on paper and this is what is taken to the site and used. Surveying is a science where you have to take measurements accurately of the land area and also keep track of what is coming up to see if it is of the right side, it is at the right location and so on.

So, surveying uses principles and equipment which can tell us where something has to come up where something is constructed if it is right or wrong and what is the elevation and height that it is at, maintenance as I said is very important. All the facilities that civil engineers create most of them at least have to last for tens, if not hundreds of years. So, how to make sure that these are maintained well, but that is also very important and has to have a scientific basis.

(Refer Slide Time: 26:39)

## Structural Engineering



High-rise building, Mumbai  
(lodhaworldtowers.in)



Cable stayed bridge, across  
the Yamuna (in.c.mi.com)



Howrah  
bridge,  
Kolkata



Then we come to the structure, we have looked at the people who take care of the foundation, the people who have taken care of the material and the process. Now, we have to design a structure, a structure like this high rise building in Mumbai or this bridge across the Yamuna River. This is a cable stayed bridge, where you have a deck over which the traffic is flowing, but the deck has to be kept across the river and you have cables which are holding it up.

These cables are tied to these huge tower which is above the bridge. You can have a steel bridge as well this is a very elegant, Howrah bridge in Kolkata which shows the entire steel bridge and its skeleton or the structure of steel that is holding it up. So, these are things which are very impressive. They could be tens of, if not hundreds of meters tall or long and they have to be designed in a safe way and to last for a long time.

(Refer Slide Time: 27:43)

## Structural Engineering



**The analysis and design of structures to resist loads and other actions, and to ensure their functionality.**

Considerations of economics, aesthetics and social implications.

Based on:

- Mathematics (for modelling the response)
- Physics (for providing the fundamentals for mechanics, and behavioural and failure theories)
- Structural analysis (for obtaining deformations and stresses)
- Structural design (for providing safe and usable structures)



So, this is what the structural engineer does. The structural engineer analyzes, analyzes the forces, stresses and deformations and designs the structure. So, that it will resist the loads and any other action, the loads that are coming, because of the people using the weight of the materials, movements due to wind or seismic action and still last for a long time and when they last we want to make sure it is functional.

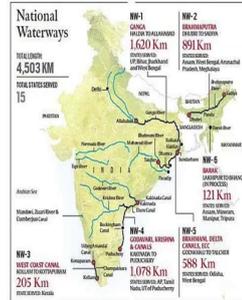
What do we mean by functional? It should be fit for use if there is a bridge, but the bridge has deflected a lot or as the car is moving across it, it moves 1 meter it may not break, but it is not functional. Similarly, if you sit in a building and for the least wind that you can have it moves a lot, nobody is going to use the building. It may not feel it will be safe, but it is not functional ok.

So, functionality is very important and later on when you study more courses in civil engineering you will hear this concept of serviceability, that it should be good for service, good for use. Obviously, all this has to be done within certain constraints of cost, it should look good like the pictures I have showed you, show the elegance that can be brought out in a well designed structure and the social implications like ease of use, comfort, people should feel nice that of the structures that they live in and work in ok.

So, this again depends on the knowledge of Mathematics to model the response of these structures, Physics very important for understanding the fundamentals, fundamentals for mechanics and the theories of failure and behavior, this leads on to structural analysis which looks at deformation and stresses for given loads and this is followed by structural design, where the concept is taken, the idea is taken, functionality is built in and translated to something that will go to the construction, for the construction manager to start executing.

(Refer Slide Time: 29:57)

## Transportation Engineering



National waterways of India (ipfs.io)



Mumbai airport  
(www.deccanherald.com)



Transportation as we all know is very important, we use different modes of transport.

Here, we have some networks that I have shown. This is the expected national highway network of India, where several thousands of kilometers still have to be built to create this grid that connects different corners of India. Similar, to roads providing modes of transport, waterways can also provide ways of transport and now, in India we are looking more seriously as water, canals, waterways as mode of transportation, because we can transport goods very easily. This is done in many other countries, but in India. Now, we have to work seriously on creating waterways where goods can be transported very cheaply without competing with the transport of people. This could be a mode that is dedicated to transport of goods.

Other aspects of transport are also important, this is the Mumbai airport more and more airports are coming up. Airports are coming up at remote areas, hilly areas, difficult to do construction in, but all this is important for providing the network for moving people, moving goods and keeping businesses and life going as we want them to.

(Refer Slide Time: 31:25)

## Transportation Engineering



**Planning, design and management of systems used for the movement of people and goods.**

Analysis of the movement of persons and goods.

Design of traffic management systems.

Based on:

- Mathematics (for modelling the traffic flow)
- Physics and Chemistry (for understanding the behaviour of the materials in pavements, etc.)
- Computational skills
- Sociology (for cultural aspects)
- Management Principles



So, the transportation engineer takes charge of planning, designing, managing of all the systems used for moving of people and goods. So, they complete the cycle of taking care of planning, constructing, designing and managing. So, they analyze the movement of people and goods, make projections for the future, because we know that population is increasing, we know cities are going to become denser. So, how should our system also evolve they designed traffic management systems and anyone in India would appreciate how complicated their life is to be able to design, plan something for an Indian city on how to manage traffic properly. So, they again trust their Mathematics skills for modeling the traffic flow, they have

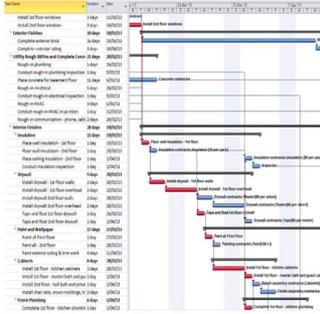
to understand Physics and Chemistry to understand the behavior of materials used, which material to use where, should a pavement be of asphalt or should it be of cement concrete.

So, these are questions which come up and they have to understand the Physics and Chemistry, their computational skills are very-very important. We have transportation engineers, who are all the time looking at computational models to see how to predict, how traffic will change and how it will evolve and how to manage it efficiently so that people do not waste time in transport.

Social aspects are important, will people use one mode of transport or not, when will stop people stop using bikes and when will they use a car, will they use an auto rickshaw or will they go by bus, how can we make them go more to mass transport, public transport instead of using their own car.

(Refer Slide Time: 33:33)

## Construction Management



Gantt chart  
(www.successfulprojects.com.au)




Public Private Partnership Models for Affordable Housing

September, 2017

Ministry of Housing and Urban Affairs  
Government of India

Public Private Partnerships – PPP  
(mohua.gov.in)



So, these are sociological aspects that they have to study and management principles, because a lots of these projects are huge, you have to manage money, you have to plan properly and see what is the policy and priority for these for the construction of such systems. Construction management puts all this together. Here, we have some charts. So, this is what is called a Gantt chart where different processes or stages of construction are given here and this is the timeline.

So, its projects can run for several months if not years and we have to know how to plan for the resources, the money and the time. There are new modes of construction management for example, what is called Public Private Partnership, where if you have a public facility, not all the money is coming from the government alone. So, the government is partnering with a private group, the private group is also putting some money, charging the users and that way they are financing the project ok.

So, these are called P P P or Public Private Partnerships. You must have seen many cases, you have highways which have a toll booth. So, they collect money from you for using the road, that money is paying back what money went into the construction and possibly once, they have collected all the money then it becomes free for the other users. So, there are several models, but which again construction managers look into and decide which is the best model to use and how to manage such projects.

Contracts are very important, a contract is an agreement between the different parts parties in a construction project between the owner, the contractor and the bodies that are administering.

So, there is an agreement saying that for so much money given, they will do the work in a certain way, comply with the rules and comply with the specifications. So, how to write contracts? How to deal with contracts that go wrong, there will always be problems, there will always be something that went wrong how do you deal with it? So, these are things that the construction manager does, they plan, coordinate and control all civil engineering projects,

they look at equipment requirement, also they design formwork formwork is where you pour concrete in so that it takes the shape that you want in the structure.

(Refer Slide Time: 35:27)

## Construction Management



### Planning, coordination and control of civil engineering projects

Design and allocate formwork, scaffolding, construction equipment, etc.

Management of resources: labor, materials, equipment, money and time.

#### Based on:

- Mathematics (for providing the fundamentals analysis and modelling)
- Estimation, economics and finance
- Management principles
- Sociology and personnel management
- Quality and safety assurance
- Contracts
- Risk Assessment



Scaffolding is all the supporting part like if you have gone to a construction site you will see that there are a lot of poles which are holding up some wooden elements where the concrete is going to be poured and we will keep the concrete in place until it becomes strong enough. So, scaffolding is anything that supports something and also can support people who are working at a construction site. All other construction equipment; we talked about cranes, they could be excavators.

So, a lot of equipment are now required in a construction site robotics are becoming very important, you can automate, you do not have to need people all the time to construct, you can have sophisticated equipment that can be controlled remotely, controlled by few people

and not to have many laborers at the construction site. Very importantly, a good construction manager should be able to manage time, money, other resources and deliver a construction site without delay and safety issues. They should make sure it is a safe site. So, they have to be able to manage all this, labor requirement, money and time, deliver good quality without safety problems.

So, again modeling is very important Math's is important finance comes in, they have to be good at managing money and time as well. So, they have to estimate resources required, money required, they have to understand management, management of people, management of processes and management of money sociology.

Again, they deal with people, quality and safety assurance is very-very important we do not want a construction site to be dangerous; we want to make sure that the laborers are safe and they do not get hurt or hurt anybody else. I mentioned contracts. Contracts are legal agreements, which have to be written well.

So, sometimes we find that in a construction project, the project runs into problems and when the contract is looked at, it has not been written well, who has to do? What is not clear? If somebody does not do something, what will happen is not clear. What is the compensation if there is a delay; if you finish in advance will you get some incentive? So, all of these are taken care of in contracts and a risk has to be assessed. Suppose, there is an exceptionally heavy rainfall will the project get delayed and if so, what do we do? If there is a strike, what do we do? So, there are many risks associated with construction management, which again a construction manager has to take into account.

(Refer Slide Time: 38:29)

## Urban Planning



### Coordinate the development of the built environment

Projection of road networks, location of green and recreation areas.

Zoning of residential, commercial and industrial areas.

#### Based on:

- Architecture
- Transportation
- Services
- Balance between open and built-up spaces
- Study of growth and usage patterns



The last specialization, I want to talk about is Urban planning. So, urban planners decide sort of how a city will grow. So, they coordinate how a built environment will develop, how new cities will develop, how cities will transform with time.

So, they look at road, networks where green area should be, where should we have parks, recreation areas where should be and how should be the combination of residential, commercial and industrial spaces here. I hope you recognize this as this the IIT Madras campus. So, we have the entrance here and we have a green area, all around right. We have a green area running here, which has been set aside for animals and for greenery, then we have a residential area, then we have an academic area and a student area. So, this is how the master plan was done in the 1960s and the growth of the campus has sort of followed this.

So, this gives the main arteries. So, you have a road, roads running through the campus and there is a place where the hostel sector has grown instead of randomly putting one hostel here, here and here there is a certain plan, there is a certain concept that student facilities should be grouped together so that students can approach easily. Student should be able to reach the academic zone easily otherwise, they will be late for class.

Sometimes even putting it close they will be late for class, but at least we try to put them as close together, they do not have to cross from one end to the campus to the other the people who are here with families, they are put close to the gates so that they can go to the children schools, they can go out without having to cross the whole campus. So, there are plans, there are concepts, there are needs why these things are done.

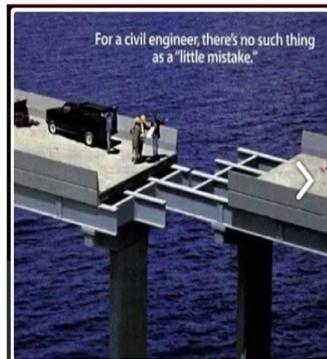
So, these are based on architecture transportation services where to put the substation for electricity, where to put this waste treatment plant, where to put these water tanks, that we have in different parts of the campus balance between how much should be the open space and how much should we build space, how would this campus grow.

So, when this campus started we would have had a few hundred students. This became a few thousands even as recently as about 10 years back. Now, we have we are getting ready for 12000 students, but if the space is the same. So, we need a plan to understand how a campus or a township will grow and how to make it grow properly instead of randomly.

So, these are the different specializations of civil engineering and it gives you a flavor of all the different aspects we need. Also very importantly, I have tried to highlight what do you have to know to become a specialist why we have to understand Math's, Physics, Chemistry, Biology and other sciences, because they form the basis for what we are going to do later, if you have to analyze, you have to know certain things before you do it. So, that is why you start off with revision of basic strengthening, the basics in many aspects before you go into deep, go deeply into civil engineering.

(Refer Slide Time: 42:01)

## Jokes about Civil Engineering



**Responsibility is high!**

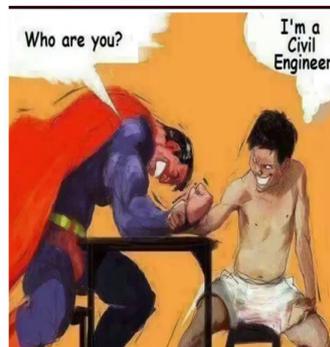
<http://imgarcade.com/1/funny-civil-engineering-cartoons/>



So to end this lecture, I thought on a lighter note we will see some things, which are put up as jokes about us civil engineers. This is one diagram if you can see, they started building a bridge, on one side they started building, another side they started building and then when they reached the middle, they find that they are slightly off. So, as the civil engineering comes with a lot of responsibility, there is nothing like a small mistake whatever mistakes you do have a huge impact ok. So, the responsibility of the civil engineer is very high so that is why we are always very careful as a civil engineer, because if you make a mistake it could have a huge impact and there is no getting back.

(Refer Slide Time: 42:45)

## Jokes about Civil Engineering



**Impact is strong!**

<http://imgarcade.com/1/funny-civil-engineering-cartoons/>



So, the impact is very strong. So, here you have you have superman trying to arm wrestle a civil engineer who does not look very strong, but he has so much in him that he has that impact which is possible know.

So, civil engineers have controlled so many things, if they do something it has an impact on a lot of things. So, the strength is inside, it is inherent to the civil engineer, this is a wedding procession.

(Refer Slide Time: 43:17)

## Jokes about Civil Engineering



### The Wedding of a Civil Engineer!

Commitment!



<http://imgur.com/gallery/XSvVDs4>



This is a wedding procession of two civil engineers getting married and you can see here that they are standing on the excavator and followed by a procession with all their friends in the excavator.

So, the commitment is there if you are a civil engineer, you are set all your life that to civil engineering and you cannot get out of the mode of civil engineering. Further civil engineering is everywhere, a lot of you would have seen Harry Potter right.

(Refer Slide Time: 43:45)

## Civil Engineering is Everywhere!



Harry Potter: The Prisoner of Azkaban



**Glenfinnan Viaduct  
Scotland  
1897**

380 m long & has 21 spans;  
Constructed with mass concrete.



This is a short from the Prisoner of Azkaban, where you have a Harry and his friend Ron flying with his car and below them, they see this very nice bridge. You might have noticed the car, but you may not have noticed the bridge right. This is that bridge, this is a real bridge in Scotland build more than a 100 years back 380 meters long. This is the Glenfinnan viaduct 21 spans and constructed with mass concrete no steel just by the form we will talk later about architecture and structural analysis just the form was such that it needed no steel and just the concrete could take all the loads and last for more than 100 years.

So, you can imagine this was the Hogwarts express and it needed this bridge to take Harry Potter and his friends to school.

(Refer Slide Time: 44:47)

## Civil Engineering is a Lot of Fun

Concrete Canoe Competitions  
in USA since 1970s



So, civil engineering is everywhere civil engineering can also be a lot of fun. We think of civil engineering structures as massive structures, which are always heavy, we can make light structures as well concrete; we think is so heavy that it will sink, but these are boats canoes made out of concrete.

Concretes was use quite a lot to make ships in the early part of the previous century, because during the wars they did not have enough metal to make ships. So, they made boats out of concrete, some are even still floating, but more recently since, the seventies there is a competition, which is called the concrete canoe competition where a canoe a small boat is made with concrete and people race with them and see who wins.

So, in India we started IIT Madras was the first to start this competition in 2010 and this is one of our first canoes. So, I am hoping that those of you who are at IIT Madras or want to

come to IIT Madras will participate and make sure that you make a nice canoe that does not sink and it will make you go faster with the water.

So, these type of things challenge you, because it is not normal to think of a concrete that will float, concretes supposed to be massive that will hold a lot of weight, but here on the contrary it has to be strong enough that it cannot collapse on water it should not leak water and it should be safe for people to travel ok. So, the concrete and civil engineering construction can be a lot of fun.

So, I will stop with that. Thank you very much. The idea was in these two lectures to introduce civil engineering before we get to the different disciplines and talk about each of them in detail. So, in the following lectures we will have different faculty members of IIT Madras talking about their specialization so that you would no more about these specializations, what they concern and see illustrative examples.

Thank you.