Introduction to Civil Engineering Profession
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Lecture – 18
Sustainability

Today we are going to have talk on Suitability, looking at both what civil engineering can do for sustainability and also trying to think whether civil engineering itself is sustainable. How long will civil engineering as a profession as a career would last, ok? So we will we are coming to the end of the course; we looked at different disciplines, different aspects of civil engineering what these disciplines contribute to and what they are based on.

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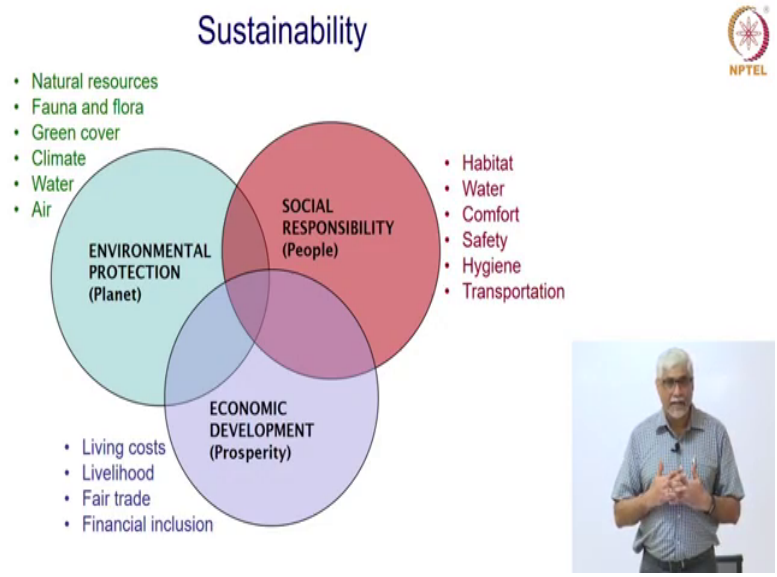

So, let us now try to answer the question of sustainability. Now, sustainability has these 3 pillars or what are also called the together called the triple bottom line; where, we look at social responsibility, that is sustainability something that helps people is accepted by people and will be for the benefit of people.

Then we have the environment or the planet. So, in addition to people being benefited we also want to protect the environment, we want to protect the planet and not use up all the resources so that future generations suffer or other species suffer as well.

Finally and very importantly, sustainability means that it does not harm when we have a technology or a product it does not harm the economy and prevent people from living well. So, the prosperity and economic development is also very much important.

So when we say that something is sustainable, when we want to look at sustainability we have to look at these 3 aspects or the 3 pillars of sustainability. We can go into more detail when we talk about sustainability, the part of sustainability which influences people or the social responsibility, we could look at the different aspects that will benefit people or can affect people.

What comes to mind right away, is that people should have a place to live, to work that is comfortable, should have water, food and so on. And comfort, hygiene these are things that people would require to live in a proper way.

Further then we look at transportation, how people can move about without wasting a lot of time without facing lot of difficulties, how can people be transported? So, this could be aspects of social responsibility that engineers particularly, civil engineers could be concerned about. About the environment, what is that we want to protect? What is that should be protected in the natural environment in the planet?

So that as I said before future generations are not affected and other species that we share the planet with are not affected. So, the natural resources is something that is of very grave

concern; we cannot use up all that there is on earth or satisfying the needs of us or the presented generation or just the next generation.

So, we have worried very much on conserving the natural resources. Other than that, as I said before, we share this planet we share the natural space with other species fauna and flora; animals, plants and so on.

Many have become extinct because of human intervention and we want to prevent this or at least slow this down as much as possible. So, we are worried about the green cover; the vegetation and what has been talked about a lot is climate change. We are now close to the 20th 2020 and recently there was a report saying that by 2030 or 2050, 300 million people are going to live in land which will be flooded at least once a year.

Why is this happening? Because, the climate has changed, we are facing more storms, facing more floods, temperatures are going up. So therefore, the level of seas will rise, we are going to face more rain, more floods in certain places; possibly drought in other places.

So, these studies are looking at how many people will be affected and it is staggering when we see millions of people who are going to be affected by this. So, there will be abundance of water in some places, there will be shortage of water in other places and we are also polluting the air.

So, our role in the sustainability aspect is to look at how we can slow down this influence or the negative influence that we are having on climate change and natural resource the pollution. And on the other hand, what do we do to counter these things which are happening? The level of the sea is going to raise. So, what are we going to do about it?.

So, there civil engineering becomes very important and people have to be protected. Now, we know that some places are going to flood more what can we do about it? So there are these 2 aspects with people and environment that civil engineering can play a role and does play a role; one is to slow down to mitigate to stop the changes that are negative.

Secondly, to adapt one is mitigation slow it, down stop it from happening secondly, is adaptation some things are changing will change. Now how do we make people's life safer in these circumstances?

Lastly, the economy; economy means that people should have a fair chance a good chance of making a living possible livelihood works job should be available for all and we want trade to be fair, we do not want something to harm the farmer and profit the final person who is selling.

So trade should be fair and they should be financial inclusion; that means, there should not be such a big difference between the richest and the poorest so that we have a fair chance for everybody in the world to live better, ok.

So this is the scenario where, civil engineering can play a role. As I said, in benefiting all this in terms of sustainability making, sustainability an issue all the time in our projects. So, we will take some projects some types of projects and see; how is that we can go about in the future?.

Two questions is what we have to ponder about; one is civil engineering doing enough? Can it do more to make sustainability better? Secondly, as we go along, we are seeing so many new fields of engineering coming up, so many changes happening.

Is civil engineering sustainable? Will we have civil engineers say after 2050? By the time this class retires will civil engineering become obsolete? Or will there be still jobs for civil engineer? So these are the questions I will try to answer during the course of this lecture by taking examples that are important have made a big mark on the world today.

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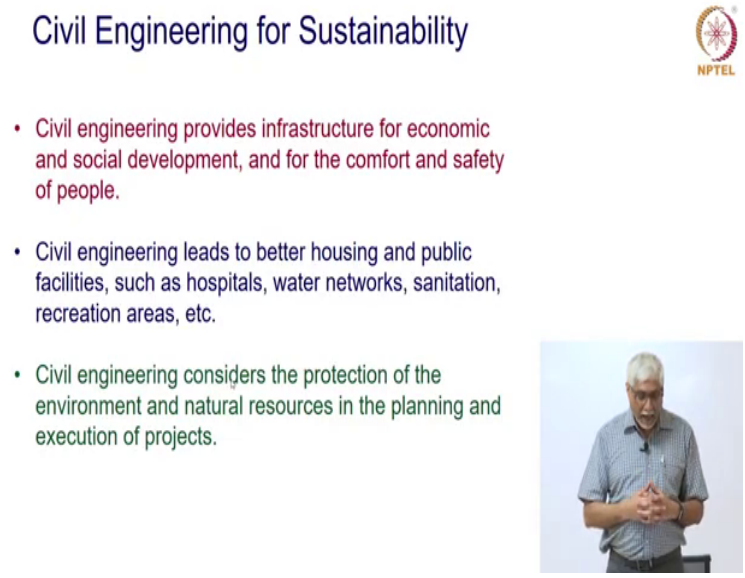

So to summarize on what I think civil engineering does for sustainability, for making sustainability better for improving sustainability. Civil engineers and civil engineering provides infrastructure, which is very important for economic and social development; for commerce to happen, for industry to grow and for people to be happier and more comfortable; we need civil engineering infrastructure like bridges, transportation systems, water networks, sanitation and so on.

Civil engineering also provides or tends to provide housing, better workplaces, more comfort and safety. We also deal with infrastructure which is for public use, such as hospitals, water supply, networks, sanitation systems and so on. So these obviously, are beneficial to people, to commerce, to the industry.

Further, civil engineering in most large projects and probably more and more in every project plans or tends to protect the environment and the natural resources within the planning and execution. We do not want to have a project that will use up all the resources which will create harm for the environment, ok.

So let us look at specific examples and see how different disciplines of civil engineering contribute to making something that is useful in these different context. The first thing that comes to mind in our country and many parts of the world are railway systems.

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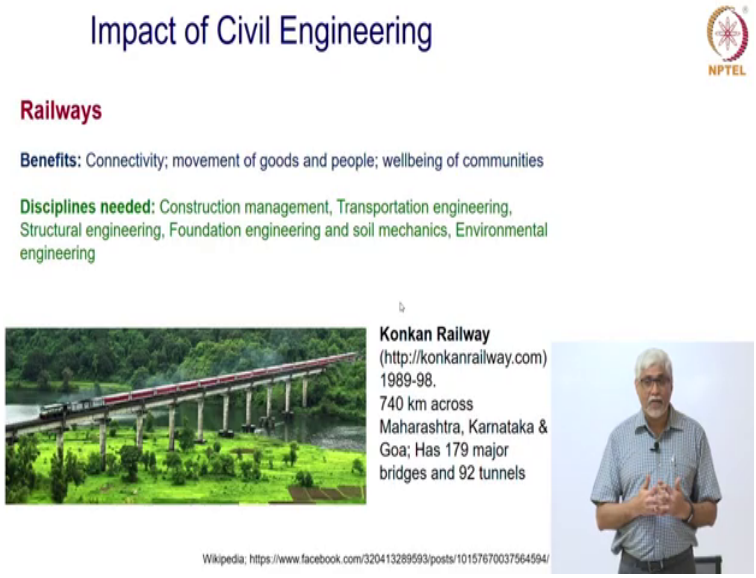

So I think all of us who are here or listening to this lecture have used the railways at some point in time. It provides connectivity, it provides for movement of goods as well as people

and communities are connected; isolation of communities ends. So, these are very clear benefits of having railways.

So to make a railway system like the one here in the image this is the Konkan railway. The Konkan railway was a massive project, a landmark project for our country. It took from 1989 to 1998 to complete, it was a very big exercise because they had to simply in terms of land acquisition 40,000 people had to give up some part of their own land for this project to happen. About 2000 streams and rivers had to be crossed, ok.

So, this meant that a railway was made 740 kilometers from Maharashtra through Karnataka to Goa; having about 179 major bridges and 92 tunnels, ok. It is set in a beautiful setting, but it was a major challenge in terms of engineering.

So this means that construction management had to become very important and here is and here is where one of the very important engineers of our time Mr. E Sreedharan became famous. Because he was in charge of this project and made it successful then went on to lead the Delhi metro.

So, construction management is becoming very important, is very important in a project like this, together with transportation engineers deciding where the rail railway should be, ok. How it should be connecting? What it should be connecting? What cities should be connected? Then the structures this goes over terrain which is very very different.

So, structural engineering plays a very important role. In this image, you see a bridge with several spans. Now, the soil conditions also will change; it will be in swampy land sometimes it will be on rocks of foundations have to be taken care of. Soil mechanics becomes important to understand how this works. We do not want during the life of this railway for the beams to settle for the pears to settle or the foundation to settle.

So, we have to understand different conditions over 700 kilometers which will be very very different, ok. And finally environment engineering; we do not want a massive project like this

to disturb the environment especially when its running along the coast. So, we want to protect the coastal environment as such.

So this is an example where for the benefit of people, for connectivity, there is a large project which is undertaken brings together these different disciplines of civil engineering. So, if we were to ask you, give you an example of a project you should be able to think which are different disciplines of civil engineering which would have contributed.

So in the following slides, I will tell you different projects and how different disciplines have contributed. Similar to railways, we have airports becoming very important. Our community is said to have developed a city or a town is said to have developed when it has an airport.

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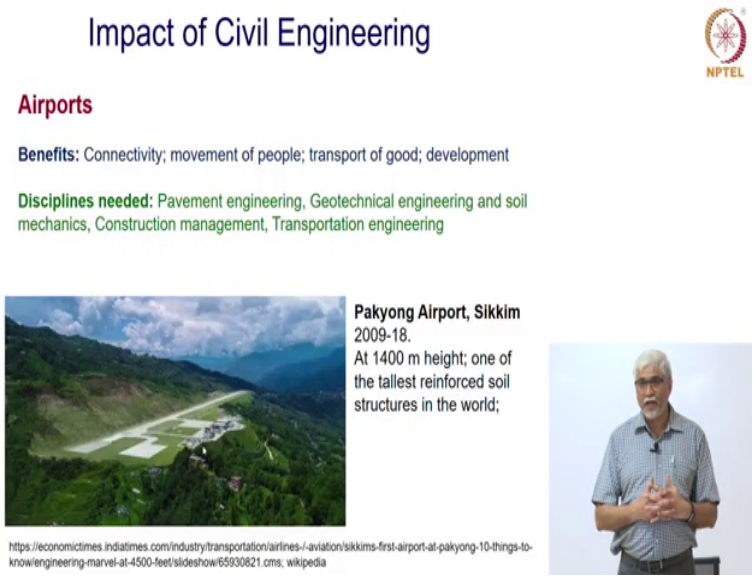

So, its always a landmark when a city claims that we have an airport some cities claim to have more than one airport. So this means that these regions are very developed; it is a sign of development other than connectivity and goods.

The image here is from one of our newest airports in India called the Pakyong airport in Sikkim, built at the height of 1400 meters; and very importantly, this came about because they have they could cut a part of the mountain almost hundred meters of mountain was cut for this runway and airport to come up.

So, all this soil had to be, has to be, will continue to be protected so that it does not slide down. So, major geotechnical engineering had to be done to hold this part of the mountain in place so that it does not slide down.

So pavement engineering, what kind of pavement will be stable? Will not move? Will not deform over time? How do we ensure that the slope is stable and does not slide down? How do we reinforce it? How do we design the reinforcement? Geotechnical engineering and soil mechanics again plays an important role.

Construction management at this remote area; how can we make technologies available for fast construction, ok? And transportation engineering; obviously, to plan the systems how to control traffic? How to make sure that planes can land safely and take off safely ok?

So, this is also an example where again connectivity has been broken. Sikkim did not have an airport for a long time, and people had traveled by car or bus to reach Sikkim, now there is an airport so, tourism will improve, trade will improve, commerce will improve and connectivity is better. Within cities also people have to be moved and we find that in India almost all the major cities have a metro rail project.

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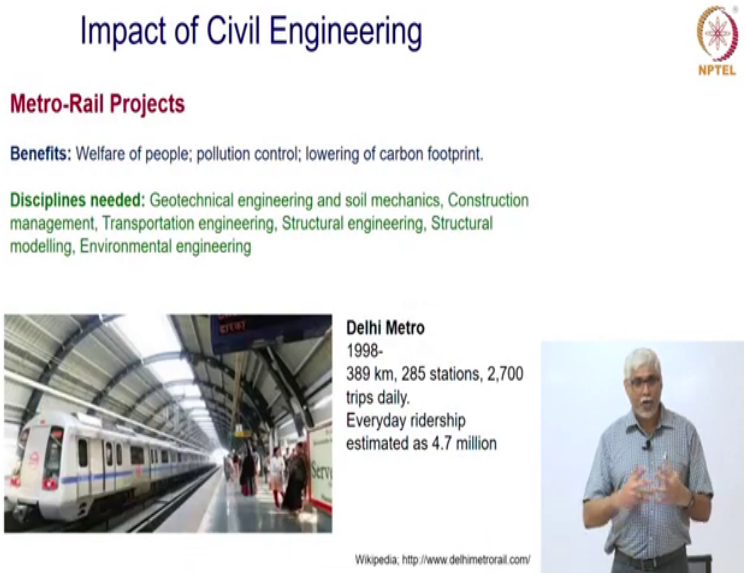

And it is also almost guaranteed that the class of today until you retire there will be at least 1 or if not more metro rail projects happening. Why are these very so important? Because we can decrease the traffic conjunction, we can have people reach their office from work, go from one place of commerce or entertainment to another quickly without causing so much of a carbon footprint when they have to use their own vehicle.

So, the welfare of people is very very important, people if they are able to move around efficiently and economically, will promote the society. Pollution is better if you imagine that everybody who is using public transport instead of their own transport they are having a scooter or a car. There is a lot of pollution and the whole carbon footprint decreases.

What do we mean by carbon footprint? It is the carbon dioxide emissions, coming from burning of fuel, from using machinery, from making machinery and so on. All these will decrease if we have better metro projects, more metro projects.

So, again lot of these metros utilize tunnels. For example, the Delhi metro started construction in 1998 and still going on, they are adding more and more. Right now, it stands about 400 kilometers, 285 stations and 2700 trips daily; which can take about 5 million people every day through Delhi, ok.

So, you can imagine 5 million people are benefited if they had to travel by themselves, without this metro. You can imagine the congestion, the difficulties, the pollution and the carbon footprint. So, this is reduced when you have an efficient metro system.

But this also requires different disciplines to come in. You have tunnels, you have bridges, geotechnical engineering becomes very very important. Where do these tunnel go? Tunnels are sort of a blind construction, you hope you are going through good soil or rock but you do not know.

So, lot of times unfortunate things happen and there are beliefs. So, geotechnical engineering becomes something forth front, construction management again these are massive projects, very expensive, involve different teams which have to be brought together.

Multi-cultural teams, multi-disciplinary teams, transportation engineering; obviously, is very important to calculate as simply what should be the frequency of the trains. How many trains should there be? How many people could travel by each train, ok?

Structural engineering we have to hold up the soil, we have to make all these bridges; in all the cities that we have metros, you see these elevated tracks which are on very slender columns and then you have the elevated section running above. Or you have the train running underground.

So, something has to hold up the track in air or hold the soil so that it does not collapse into the tunnel. So, this means that structural engineering is important modeling; modeling of the soil and the structures around. So, modeling concepts competitional science's becomes very important, as well as engineer environmental engineering. We do not want to mess up the environment again through these projects.

These are projects all the 3 types that I have talked about; railways, airport and metro are meant to last for a long time. Now, we build them at least to last 100 years if not 200 years. So this means that they have a lasting influence on everything people, economy and the environment. So this is another type of project which has a major impact and could be positive for sustainability. We also contaminate, we have also messed up a lot.

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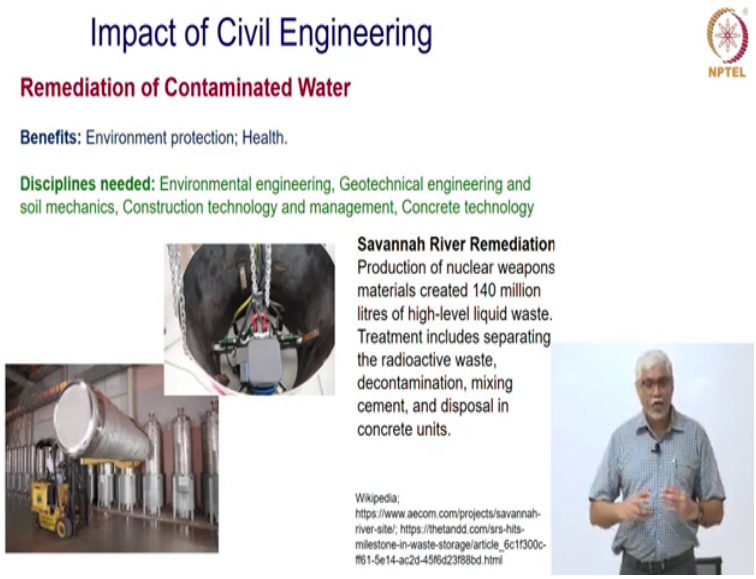

So, civil engineering also comes in remediation; not only to make change new things, but also correct mistakes of the past. So contaminated water is available in many many places. So, remediation or cleaning up is a very important thing.

And the example I have here is from the United States which is called the Savannah river remediation scheme, where there was a site where nuclear weapons were being made and this created 140 million liters of very high toxic waste, ok. So, this waste was there; liquid waste and something had to be done.

So, major effort was taken to make clean up this water, separate the more toxic from the cleaner water, take this toxic water, mix it with cement to solidify and put it in these containers of concrete so that this can never escape, ok. So this was a major project.

In each of the slide I give you some references that you can get more information on. So, here, environment protection was very very important in health. Because if you have these toxic water or waste lying around, eventually it reaches the ground water and ground water is what we eventually will drink. Other things get affected animals, plants, the environment itself changes and gets affected if you do not clean up.

So this means environmental engineering has to take a major role, decide how to clean up, how to make sure that what we cleaned up is not causing a bigger mess or bigger problems. Geotechnical engineering is important because we have to know bury this such that the waste does not escape and cause problems.

Construction technology how are we going to make these containers? How are we going to make these containers that for 1000's of years nothing will leak? What type of concrete will be used to store all these is in one place ok?

So, the first 3 sets of projects I talked to you about something new. Here, we are correcting the mistakes of the past. So, remediation and cleaning up becomes very important and this is again where civil engineering has a very important role.

We talked about projects, we can also talk about smaller projects systems of civil engineering or even elements. Bridges which form part of many of the projects that we have talked about, connect people.

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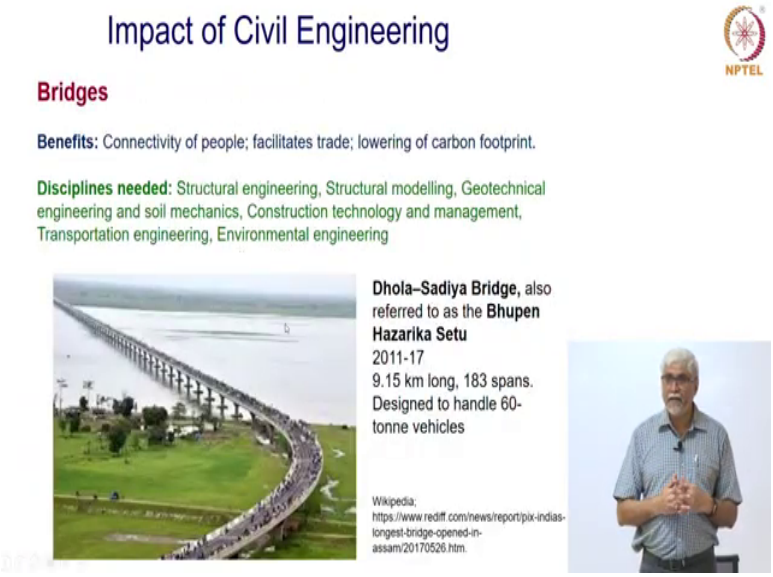

We have seen you might have experienced by yourself that when a bridge is built, new commerce comes up. Small populations rise around a project at the beginning at the end of the; end of the bridge, and shops show up and commerce increases, connectivity is better.

Instead of going around the bay, they can cross the bay faster ok. So, carbon footprint decreases, pollution is less. So, again structural engineering is important, modeling is important because we want to know that the bridge will be stable for many many years; that it will not settle down, it will not break, it will not crack. Geotechnical engineering for the foundations, construction management, ok, transportation, environmental engineering and so on.

The example I have here is currently what is the longest bridge in India? Which is the Dhola-Sadiya bridge, also called as the Bhupen Hazarika Setu built from 2011 to 17, it is about 9 plus kilometers long, 183 spans ok. Each span is what is between 2 columns or 2 pillars of the bridges.

So, its like 183 small small bridges make up this complete bridge of 9 kilometers and it is designed to handle loads of up to 60 tonnes. So you can have a tank, you can have a tanker of 60 tonnes crossing this bridge and it will be safe.

So that means, we have to understand the mechanics and we have to model it such that it is as elegant as it looks in the picture, but also safe and to last for a long time. The environment could be aggressive, you would have water all the time and that could attack the concrete attack the steel, so we have to also protect it from such as that. So this is an example again where different disciplines are brought together. Another such type of project are pipelines for oil.

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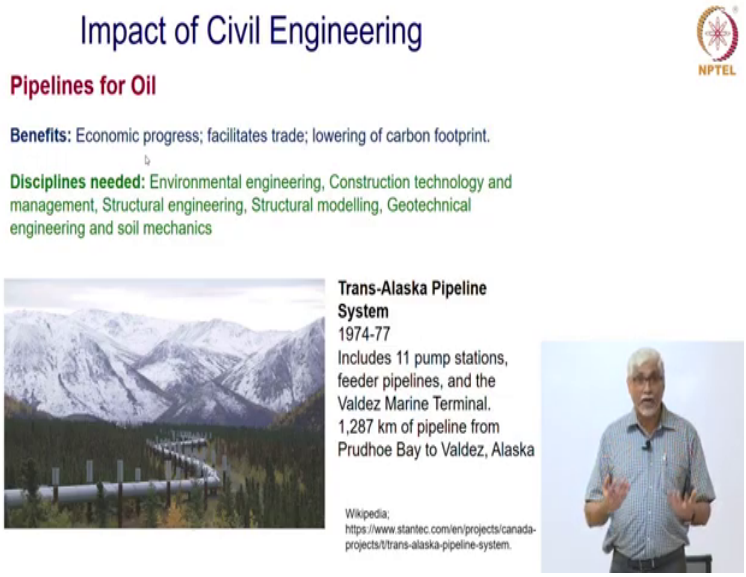

In the news sometimes you will hear that India has reached an agreement with Iran for transportation of oil and so on. So, there are lot of pipelines the example I have here is the Trans-Alaska pipeline system built from 1974 to 77 which covers about 1300 kilometers and you can see the environment is very harsh it is crossing Alaska, that is why its called Trans-Alaska pipeline from Prudhoe Bay to Valdez has 11 pump stations and several pipe lines.

Why do we need oil? We need energy, for progress we need energy for economic progress this becomes very very important to transport oil with the least carbon footprint messing up the environment the least. Instead of having trucks and tankers can we have about pipeline? But you can imagine a pipe running 1300 kilometers.

There has to be a lot of modeling done because, the pressure should not drop, there should not be leakage; if there is a leakage we should be able to detect, so lot of sophistication comes in,

to modeling it, constructing this, what are the type of structures that are required to keep this pipeline above ground?.

What sort of modeling is required and the geotechnical engineering what will happen if when there is freezing and thawing of the ground? When there are colder temperatures how will things change? So these are major projects very unique this is not something that you hear of everyday, but a project like this can last for a long time and will require major management to make it work.

Just like the tunnels that we have for metros we can have other tunnels; tunnels and underground spaces are becoming very important.

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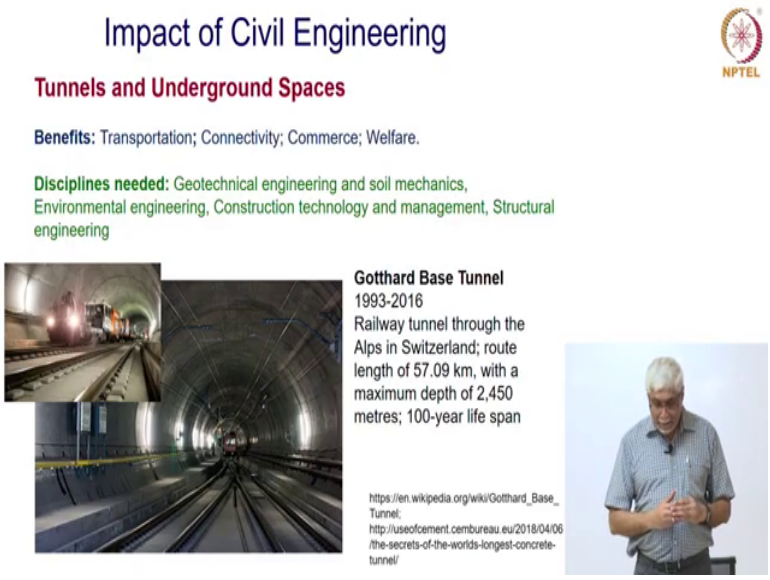

In many cases we are running out of space above ground. So, we have to start constructing below ground, tunnels are very good example. This example, I have here is the Gotthard Base Tunnel a very important tunnel system that is running through the Alps sometimes at a depth of 2.4 kilometers under the ground.

You can imagine that a tunnel is being made 2.4 kilometers under the ground, so you have to understand what this tunnel has to go through, how to make it happen and make sure that all the alignment is correct.

If you see images of this construction happening, there was lots of excitement when 2 sides of the tunnel construction met because there was also some hesitation, there was also some doubt whether they will be aligned when they meet. They started from 2 sides and they were so accurate that there was no misalign.

So this means that the geotechnical engineering has to be good. We have to understand soil mechanics well, we have to model it well and again environment and construction become very very important. And if we do a good job, you can have the proper connectivity, commerce this particular tunnel is basically for railway, you can see the tracks here.

So this is for railway to run and this has been designed for at least 100 years of life. So, all these major infrastructure now has to last for a long time; so they will benefit people for a long time, but also they will effect everything around it for a long. So, that is why we have to think about it more and be careful. Talking about waddling of an engineering and planning of traffic, the modeling of traffic in cities between cities is becoming more and more complicated.

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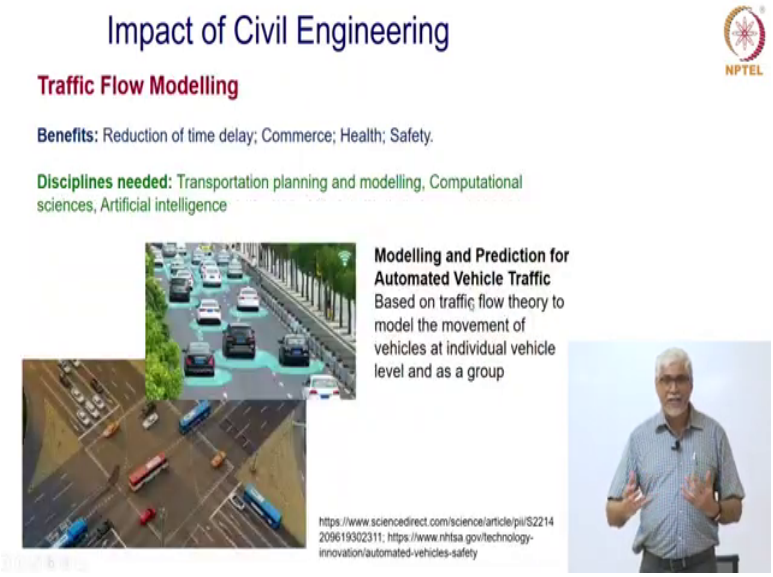

And in a country like India, you have all sorts of traffic what they call multimodal traffic on the road. You have an auto-rickshaw, you have a cycle you have a bike, a big bus, a car and so on.

Further, what people are looking at is automated vehicle traffic. You must be hearing on the news that there are driverless cars; where instead of driving your own car you are just enjoying the ride or being transported. So, there is a lot of traffic flow modeling which is happening. In all these cases of possible traffic being only of automated vehicles, and driver less vehicle, groups of vehicles how are they going to travel in the roads, through the roads and into the cities.

Why would we do it? We want to decrease time delays, we want to decrease congestion we want to improve the health and safety and facilitate commerce. So transportation, planning and

modeling becomes very very important. All of you who have been in cities most of you have will know the chaos that happens when there is rush hour and this can happen in many major cities.

Now, imagine that all the vehicles are driven by themselves. In current circumstances, it would be chaos the cars may never move. So, we have to know how to model the flow and control the flow such that everything will happen well. So, traffic flow theory is important to model such movement and work on it on the individual vehicle and a groups of vehicle.

How can you make groups of vehicle moves over? How can they interact with each other? So, artificial intelligence is becoming very important. Deep learning is becoming important to understand how cars can drive by themselves.

We have research projects which are trying to understand how the brain of a driver behaves; can be mimic, can be understand and use that knowledge to show how a car should drive by itself ok, to make things efficient, to make sure there are no accidents and there is a efficiency required.

So traffic flow modeling again is something that is something becoming more and more important especially when we are talking about automated connected vehicles that are going to come up in a bigger way. In construction again, we have lot of automation we have robotics and construction which is becoming very very important more and more usage, why?.

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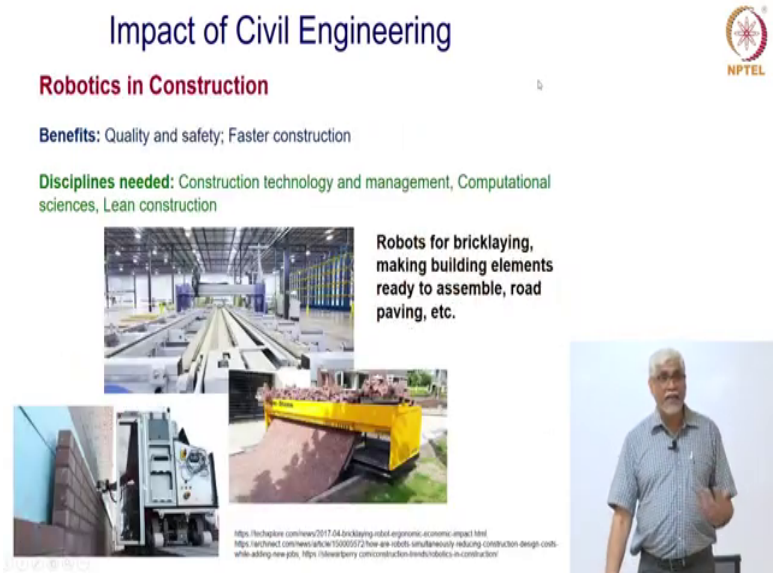

Again for quality and safety instead of an unskilled worker being involved, suppose we have a robot that is properly designed we can ensure quality, safety especially in difficult environments, faster construction. Construction speed dictates the cost and also how fast we can deliver comfort, safety and facilities to be.

So this means that construction technology becomes very important, computational sciences because different machines have to interact with each other. Machines have to talk to each other, artificial intelligence becomes important.

And what is coming up more and more is what is called lean construction. Lean construction is where you have less wastage, you have faster construction and less errors creeping in. So, there are already robots that can make brick walls like in the bottom left and then you have other robots which are making elements to make a house or a building.

In factories, robots are constructing these elements which can then be taken to the site and assemble. This is a robot that you see here which is paving an entire road, there are a pile of bricks and this robot is now putting these bricks together and just laying out a road as if it is unrolling a carpet.

So, this means that we have to design properly, the material that system and understand what the road is going to go on ok. So, this is again these are things like the automated vehicles that are new technologies which are coming up. We are looking forward and this is where I am trying to answer the question of is civil engineering sustainable.

As long as we do our job of making sure sustainability is there and as long as we are bringing in new things all the time in civil engineering, there will never be a possibility that civil engineering goes out of fashion or out of requirement. These are the things which will keep civil engineering sustainable.

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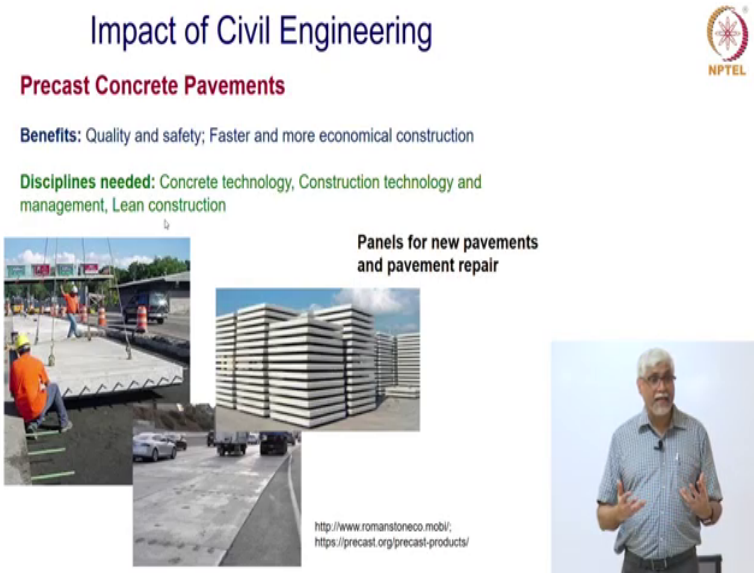

Talking about roads again, there is a new technology which is looking at precast concrete pavements where instead of the long process that all of you have experienced of laying as far laying concrete to make a road; can you make the concrete like Lego bricks somewhere in the factory, have them piled up and when it is needed bring these panels put them together and you have traffic in a few hours crossing.

So, this could be used for new pavements and for pavement repair, ok. What do we get? Quality and safety instead of the potholes, can we have a new road fast? Can we have a road repaired fast enough? It will be more economical in the long run to get it done.

So this means we have to understand how the concrete will behave, how the technology will be; can we bring in robotics? Can we bring in automation? How do we make sure that all the pieces stay together and for a long time? Again lean construction, no wastage can we make it

faster less wastage and more economical?. So, this is also some new technology which is coming in. Talking about concrete can we make concrete more specific to what we want?

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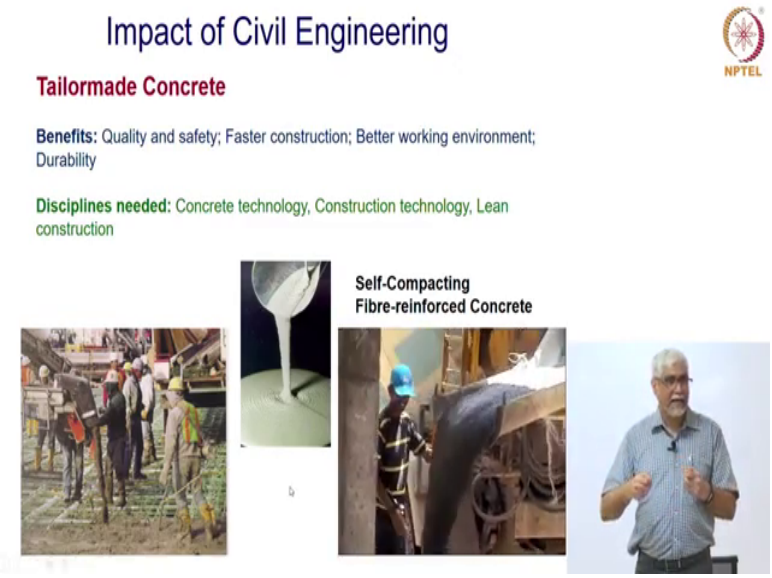

Concrete traditionally which was also discussed in this course was a mixture of cement water and stone pieces what we call aggregates. But now new chemicals are being put in to go from a site which is like this, with a lot of people, lot of energy you would have seen in every construction site there are so many people; some pouring the concrete, some leveling the concrete, somebody vibrating the concrete and again leveling supervising and so on.

Can we go for a concrete that just pours itself? Even can we avoid a concrete which needs a reinforcement? Can the concrete come along with the reinforcement? Will not require anybody to pour the concrete?.

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So I will show you a video, this is from one of the works that we have done here; where we have a self-compacting concrete does not need much help being poured, and vibrated and compacted. It sort of pours itself.

Further, what does it do? It brings its own reinforcement the reinforcement is mixed into the concrete itself. So, you do not have to put these bars all the time and make sure that they are in place. So, these are concrete which is mixed such that it can flow over a long distance, you do not have to have lot of people, you have to have some people to level it off to check everything, but not too many people around.

So, what is the benefits? Quality, safety, faster construction, better working environment. You do not have to have these so many laborers all the time working hard. We just have to have somebody leveling things on. This means that we have to understand concrete technology, we

have to understand construction technology and this will lead to concepts of less wastage or leaner construction.

We talked about remediation in terms of water. What do we do with all the waste from construction? We have buildings that have been built over a long period of time.

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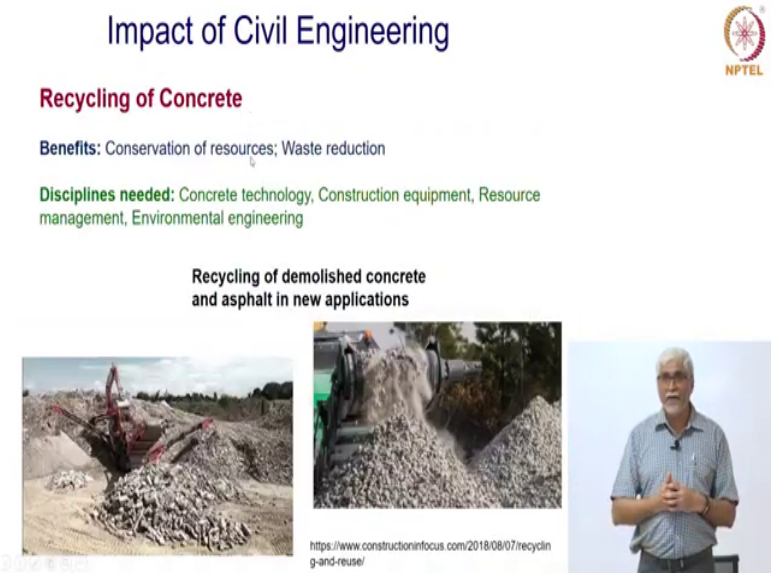

When we want new buildings, we are going to demolish these. When bridges are old, we have to demolish. Where does all these waste go? So, if you have seen if you have experienced, they go into landfills legal and sometimes illegal landfills people just dump whatever they have from the construction or old construction somewhere. And this is piling up and creating a mess, creating lot of empty space that is being filled up by this.

So, there is a lot of research, there is a lot of energy being put into recycling of this concrete. Old concrete is being used to make new concrete. So, there are systems which are used to crush the concrete up, sometimes even at the same site.

Suppose you have a old road, there are some machines which will chew up, remove the old concrete, at the same time make it into new concrete and put it back. You can have cases where its accumulated from demolition sites or you can even have cases where at the same site you use the old concrete, break it up, mix it back to make new concrete.

Obviously, this leads to conservation of resources and waste products. We are we cannot keep chewing up mountains, we cannot keep excavating mountains to make new buildings and new bridges or new roads.

So the thrust, the pressure is on the society is putting pressure on construction experts to come up with ways of recycling concrete, to make old concrete, recycling of construction materials to make new materials and new (Refer Time: 36:45). So, in this case concrete we have to understand well, we have to understand the chemistry well, we have to know what equipment to use? Can we come up with equipment?

We have to know how to manage the resources, we keep it economic enough that this happens. And then the environment; is there going to be lots of dust? Is there going to be a lot of contamination if we do this? So, these are questions which have to be answered. So to summarize, we have looked at how civil engineering can promote sustainability can help sustainability.

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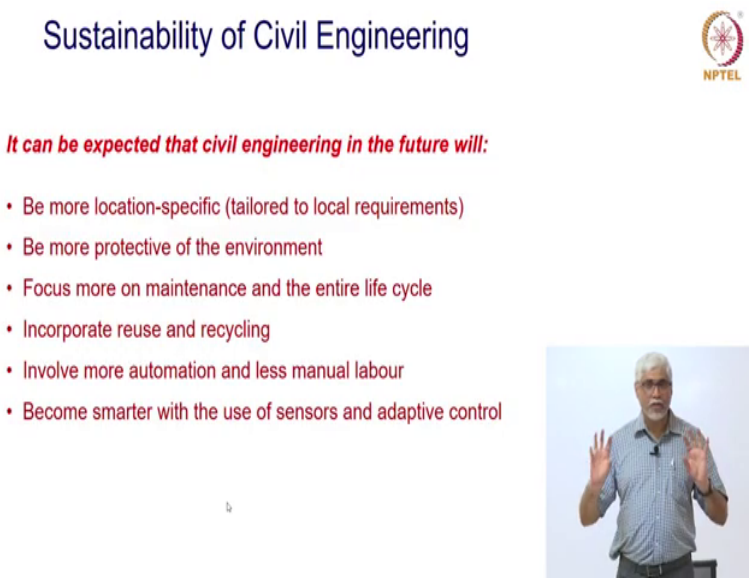

I have also tried to answer whether civil engineering will be in hope? Will we need civil engineering in the future? Or will civil engineering be sustainable for long enough? If we have to do this, the future of civil engineering has to be different, has to incorporate new things it cannot be business as usual. So, we can expect that civil engineering in the future will have certain characteristics.

First of all, it should become more location-specific, it should be tailor-made. One solution does not work for the whole world. Even within a same country it will not be the same technology. We will have to understand enough that just copying a technology will not work. We will have to bring up new technologies, adapt technology. So, technology in the future, civil engineering in future will be more location-specific, will be tailor-made just like the word tailor, right.

When you want clothes, you choose what you want. All of us do not wear the same clothes right. All of us will not like wear the same clothes, may not fit into the same clothes. So the technology also has to be like that. We have to see what fits us, we cannot use something developed elsewhere blindly without adapting. We will be we are we will should continue to be more protective about the environment.

Many aspects using of resources, using of water, contamination, destroying our natural resources this will happen less and less and this is what we are seeing elsewhere we will focus more on maintenance and the entire life not just the first just the initial part of the project. Traditionally or historically we have been very concerned about making the project happen, but not much on how it will be maintained, is it more maintainable? How long will the life of a structure be?

So, that is not traditionally it has not been our concern as civil engineer, but this will change it will be more of maintainability, more of life cycle. So this is one more change that I believe will happen. We will instead of using all new materials we will use more of older material and we will recycle more and more just like many things; like plastics are being recycled. We can have more construction done with old construction materials. We could even make it compulsory that when you demolish something, you should use all that material back in the new construction.

We will involve more automation, less manual labor. Labor is always been a fundamental part of construction, we have used unskilled laborers, lot of laborers for construction. This means that there are some people who are always working very hard who are not working getting paid a lot and having limitations in what they can earn and have as livelihood.

So, this will keep changing we have seen like I mentioned robotics and so on there will be more and more automation happening. We will also have construction that is smarter, buildings that are smarter we will have sensors built in just like we talked about automated cars; there could be buildings also which could incorporate sensors tell us how we have to adapt if something is not comfortable how can we change.

If before collapsing can it warn us that something is wrong in the structure? So that we can control. So, these are different aspects that I believe will make sure that civil engineering is sustainable and going to go on for long time. So, this is what if I had to predict changes in civil engineering these are things that will possibly happen to make civil engineering continue to be relevant and useful for society ok.

So, with that I finish and as I said, the idea was to discuss focus on two; aspects how civil engineering helps in sustainability and to also think ahead and say that how will civil engineering change, evolve adapt to continue to be relevant to our society, ok.