

Introduction to Civil Engineering Profession
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Lecture - 10
Structural Engineering
L- 01

So, before we begin you have already been introduced to different specializations, different areas of Civil Engineering, you have already been you know that. So, what I would like you to do first is take out your notebook and write down in the next 30 seconds whatever you think is a structure is. So, what is a structure? Before we get into Structural Engineering, just write down. It does not matter you may not have even thought about it, but it is important to put down the first thought on the first day.

And all I will assure you is that over your next 4 years day here at IIT Madras, you will slowly improve upon that first definition and by the hopefully by the time you graduate, you will know what a structure is and particularly more importantly, what a modern day structure is all about. And therefore, what is expected of if you choose to become a structural engineer at the end of your stay here, what is expected of you right. So, please take 30 seconds write down whatever you think a structure should be defined as.

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Acknowledgements



- **Professionals**
 - Colleagues
 - Students
 - ...
- **Internet**
 - Organizations
 - Individuals
 - for information / images



In this class, I will be using lot of photographs beautiful photographs. So, which are obviously, not all taken by me, but I will take this opportunity to acknowledge all the contributors, individuals, organizations who have put up so beautiful images all over the internet and some of my colleagues who shared for us to learn a subject. And so, for this academic purpose, I will be using them and so, I will acknowledge their contributions.

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Why build structures?



- **Two Basic Needs**

- Movement
- Protection



If you have put down your thought on what a structure is will not get into that directly, but we will start with this idea of why do we build structures in the first place right. And, if I think of it the first thing that comes to my mind is you know one of these early cave paintings that we see. It is not just a painting, but it is it reflects the aspiration of human being as a race to do more to do beautiful things. Just look at the vitality in this pictures, the creativity, the aspiration to do more that gets reflected in this.

Human being as a race where confined in these natural caves and all and that is where they wanted to go out to go out and explore right and so, it is not surprising the theme as a human race, where we are we have achieved whatever we have achieved, it is not surprising. That urge was there long back and to fulfil that urge, what human being started doing is actually building structures, we will see. That only help them come out of those caves and build a wall

that we see today right. So, it is a very fascinating journey that is facilitated by building things as we moved along our history.

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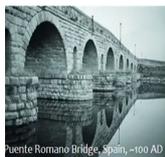
Why build structures?

- **Two Basic Needs**

- Movement
- Protection

- **Other needs**

- ...
- Power
- Simply,
make a mark!



And so, the first thing was for movement and protection, but then there were as we progressed as a race, there were other requirements also and we started building for different purposes. In sometimes it is it just boiled down to you create something so beautiful that it catches everybody's imagination and you just leave a mark right and that itself is a great achievement of human race.

And, we were able to do that by building, by constructing this beautiful structures; beautiful structures beautiful not only in terms of the architecture of it, but also in terms of the science behind it and we will this well see why is I say you know or people say structural engineering

is a combination of art and science. So, you just build one of these in your lifetime and you will be famous and known forever. The question is are you willing to do that?

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Why build structures?

- **Basic Needs**

- Movement

- Food gathering

- Conquering new lands

- Transporting

- » People

- » Resources



So, if you really look at it, it is very simple we have seen fallen logs branches and then we have used not only we, but even other animals have used it as simple bridges right. Taking inspiration from that today we have managed to build massive-massive bridges. This particular that you bridge that you see this length, any guess how much it can be? It is almost 2 kilo meters long and I want to keep this number in mind because it is important to understand the magnitude of it, the scale of it right. It is more than 1.9 kilo meters long.

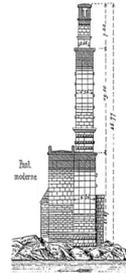
So, taking clue from nature, we managed to do such massive things, wonderful things and what was the whole purpose? The whole purpose is to come out and explore the world to be able to move around, to move people to move resources right. So, first obviously, the option

was to hunt to get food as slowly you know move to newer places looking for newer resources which eventually led to conquering new lands for resources and for men and then, move on and move on right. So, movement or transportation of people and resources was important for us.

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Why build structures?

- Basic Needs



I am sure in your other classes on civil engineering, particularly hydraulics and engineering you would have seen this or heard about this. This is transportation of water. Just look at this centuries old structures build standing beautiful, it if you just look at it and you feel good that yes, we as a race have done something beautiful in this world. That feeling is also important.

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Why build structures?



- Basic Needs



So, another example: of beautiful Roman architecture and construction.

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Why build structures?



- Basic Needs



And then, in modern days we took it one step forward and so, we make aqueducts; but now which can also support these ferries and all. It is not just a small one transporting water, but you actually transport people also ferries or people also. So, what it shows is that we are slowly expanding our domain, we are thinking bigger and bigger and bigger and as we do that, we are capable of actually executing such dreams and making such dreams reality right. That is important.

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Why build structures?



- Basic Needs



Well, any idea what this is. This is what is called Eco duct, where you have these animals. We are obviously, you know transgressing into their land and so, they are getting threatened. So, this bridge is not for humans, but for them to cross over safely across the highways that we have created for ourselves. This whole concept started in 70, you know 60s-70s in the Europe and now, it is very common in many parts of the world. So, again creating bridges.

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Why build structures?



- **Basic Needs**
 - Protection
 - **Hazards**
 - *Natural*
 - *Manmade*



Talking of protection obviously, the first thing that comes to our mind is we need we need protection from the natural, the nature's right, the natural hazards and today of course, we have natural as well as manmade hazards also. So, what are natural hazards? Things like floods, cyclones, earthquakes, right droughts. So, these are and then today we have lot of manmade hazards in terms of starting from you know pollution to even arsons and so on so forth.

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Why build structures?

- **Basic Needs**
 - Protection
- **Hazards**
 - Natural

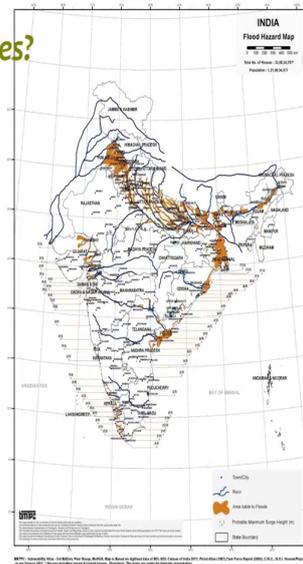


So, if you really look at it, I will just touch upon some of the very you know important ones which are cyclone; cyclonic occurrences. So, you see that the whole of the coastline of India is actually prone to cyclones and we have the eastern coast, more prone than the western coast and we will see some data. So, when we build structures, we have to ensure that whatever we build can take these natural events and protect ourselves.

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Why build structures?

- **Basic Needs**
 - Protection
- **Hazards**
 - *Natural*

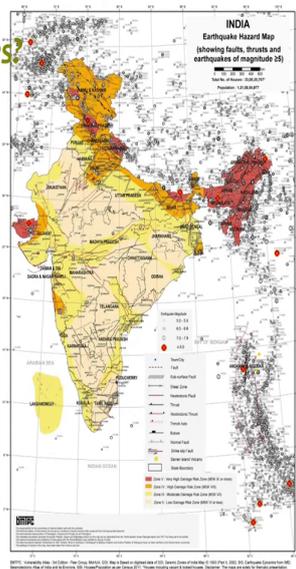


Flood is another natural hazard and every year, we see this reports of; on one side we see drought right and on one side we see flood going on.

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Why build structures?

- Basic Needs
 - Protection
- Hazards
 - Natural



And then, earthquakes. So, we have earthquakes occur occurring all over the India and particularly, the whole Himalayan belt if you see is very very prone to earthquakes.

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Why build structures?



- **NDMA**
 - 58.6 % of the landmass is prone to earthquakes of moderate to very high intensity
 - 12 % of land (40 million hectares) is prone to floods and river erosion
 - 75.8% of coastline (5,700 km) is prone to cyclones and tsunamis



So, just to summarize this if you visit the website of NDMA; what is NDMA? It is National Disaster Management Authority under government of India, they list out lot of natural and manmade hazards. Just to give you an idea India as a country has about 60 percent of landmass prone to earthquakes of moderate to high intensity, has about 12 percent of land prone to floods and river erosion and have about 76 percent of the coastline prone to cyclones and tsunamis.

So, what you see is we have to do more than natural and normal things as civil engineers, as structural engineers to ensure safety of ourselves and this you know the structures that we build in a country like India and so, we need good structural engineers. We need to understand all these things affects and then, build structures accordingly.

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Why build structures?



- Basic Needs



So, going back, we started you know housing ourselves in caves which were natural and then, we started building caves. This is a very interesting example. It is a very soft sand stone. So, they said that whoever could not afford a house would go and create a borough in this ridge and then, have a house for himself and his family right.

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Why build structures?



- Basic Needs



But then, look at this. This is a very interesting example almost 2000 year old a cave a manmade cave. So, we built such things for our protection from natural you know hazards and this was hidden, but then found recently; discovered very very recently.

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Why build structures?



- Basic Needs



So, in terms of protection in terms of building houses and all of course, we started with smaller things and then we aspired more and we built more; one of the very early you know fortresses or forts that you see.

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Why build structures?



- Basic Needs



Back here in India, we have a beautiful fort the Jaisalmer fort. Those who have visited will know and we created this very very massive structures beautiful structures.

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Why build structures?

- Other Needs
 - Societal



But then, that was not all. We aspired to do more and there came a social and cultural and you can add religious and so on so forth issues to it and we build structures like this. Not to talk about the great pyramids in Egypt, but also all over the world there are pyramids. But look at this picture, I like this picture for one simple reason. Look at the creativity. The creativity that we saw in that first cave painting is still evident here.

If you see here this is the face of a serpent and on the march equinox, the sun falls in such a way that it creates a shadow. So, starting from here you see the serpent effect and it happens on that particular day right. So, structural engineering is not just building something, but it is building something beautiful also.

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Why build structures?



- Other Needs



So, if that was built with stones; this famous temple is built by cutting away stones. It is one of the largest rock cut temples in India right. So, of course, it took lot of time, lot of patience; but then if you do things calmly peacefully all it tells us is that we can do great things.

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Why build structures?



- Other Needs



One of the tallest temples in India and when it was built it was definitely one of the tallest in at least this part of the world. But the beauty is that they had put a 80 ton or so; one single stone at the top. How did they do that right? And by the way, each of these structures that you know I am trying to show has a history of its own and you can actually spend your whole lifetime studying and understanding those, but that is not the point.

The point is to see and understand and appreciate that as builders as constructors as engineers people without even having these phrases or these degrees associated to with them, they did manage to build such beautiful things, massive things. So, if they could do, we can also do is the belief with which we have to start.

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Why build structures?



- Other Needs



With all this, came another dimension to our life which is power. This is the view of Rome from you guessed it right.

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Why build structures?



- Other Needs



But again, to have authority, to have authority you have to look powerful; you have to look bigger greater than the common and one of the best way is of doing that was to build something so beautiful, so exotic for yourself right.

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Why build structures?

- Other Needs



And that same thing went ahead and went ahead in time.

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Man, the Builder



All you know the story of this. Effectively, what it tells is that we wanted to come out of those caves, explore the world and that urge coupled with our inherent creativity and talent made us do all this. So, we as a race is very important and we are capable, only thing is we now need to take that forward.

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Structures: Early Trends



- **Types**

- Massive
- Long & Tall
- Slender (*Slim!*)



So, if you really look at all these things at the early trends, where we build structures which are massive. It is all inspiring right. But then, slowly we started building long structures, tall structures and today of course, the buzzword is slim and fit slender structures right. So, just compare bridges, this is what we used to build earlier and this is what we are building today.

But it is not just a change of test, but actually there is a engineering involved in this and this is what we will be understanding over next your you know couple of days or I would rather say over your stay here at IIT. Why is it that we are able to build these kinds of structures that you see on the right today which we did not build earlier? It is because of our understanding, because of materials, our understanding of how structures behave, our capability of analysing structures and designing structures and so on. So, when those are the items we will be discussing later.

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Tall Structures

- 56.6 m
- 186 ft

a Torre di Pisa, Italy, 1173-1372



But just to give you a idea of what how we have moved forward, let us take the example of tall structures. Just as an example. All of us know this structure very famous. So, if you really look at it is just about 56 to about 60 meters tall and in those days, it was a marvel. I mean even today it is, no doubt about it right.

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Tall Structures

- 73 m
- 240 ft



Qutub Minar, Delhi, India, 1193-1368



And then, in our own country, we have this structure which is more than 70 meters tall.

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Tall Structures

- 324 m
- 1,063 ft

Eiffel Tower, Paris, France, 1887-1889



And then, suddenly you see a quantum jump. Now, if you follow the construction, the material, you see that there is a certain change now right. It is possible it was possible to build this because of something that happened in between and we will discuss that later right. So, suddenly we have moved up to this and this whole thing gave that idea of it is not just we want to create a structure where once in a while we can go up and then see.

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Tall Structures

- 282 m
- 925 ft

Chrysler Building, New York, USA, 1930



But actually, we want to build buildings which will be tall and so, we want to live up there. So, very famous building less than 300 meters tall. And in those days just imagine it was all built, I mean you did not have today you carry a smart phone which is a super computer right and we will see in structural engineering, we will need physics, we will need mathematics and so on and so forth.

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Tall Structures

- 381.0 m
– 1,250 ft

Empire State Building, New York, USA, 1931



They managed to build this structure and that actually created a race. So, everybody had to build a taller structure than the previous one and so, suddenly, we started we got into this, we had this empire state building.

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Tall Structures

- 417 m & 415.1 m
– 1,368 & 1,362 ft

World Trade Center Towers, New York, USA, 1972 & 1973



And then we had these two right, but still 400, about 400, still about 400, 450, 500.

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Tall Structures

- 442.1 m
- 1,450 ft

ears Tower, Chicago, USA, 1973



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Tall Structures

- 451.9 m
- 1,483 ft

Petronas Twin Towers, Kuala Lumpur, Malaysia, 1998



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Tall Structures

- 509.2 m
- 1,671 ft

Taipei 101 Tower, Taiwan, 2004



So, what do you see is that it was simple to move to a certain level and then, it is becoming difficult and difficult and difficult to go up right. But each one of these structural that buildings that we saw actually has beautiful, but simple structural engineering concept behind it and we will discuss those later.

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Tall Structures

- 828 m
- 2,717 ft

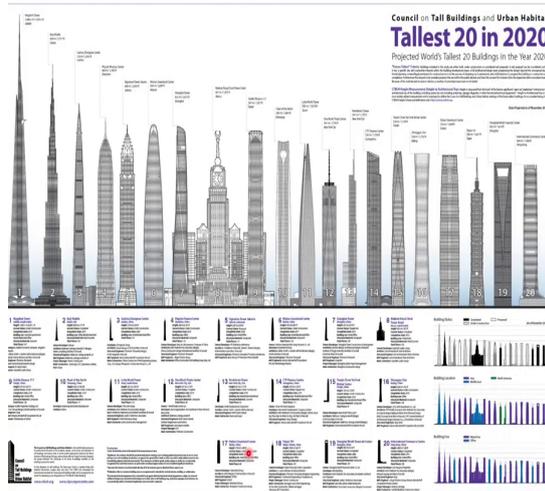
urj Khalifa, Dubai, 2010



But we have reached here and then of course, this is again a quantum jump. This is again a very very quantum jump, but we are not satisfied, we are not satisfied. What is it that we are building? We realize that we have still not been able to bridge the 1 kilo meter mark right, you saw that bridge span nearly 2 kilo meter. Now, we are trying to go up you are struggling to go up 1 kilo meter.

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Tall Structures



So, the original idea was to have a 1 mile tall building, but then it came down to 1 kilo meter and that is what we are targeting. Of course, within this time frame, there are many more buildings tall buildings, super sky high skyscrapers have been built; particularly china is going very very aggressively in towards building these super tall buildings and they have developed the capability and so, they are doing it others are also trying to do it. But, so, this is the forecast that the by 20-20, this is what we are trying to achieve right. So, the point is imagine you are able to build a structure 1 kilo meter tall.

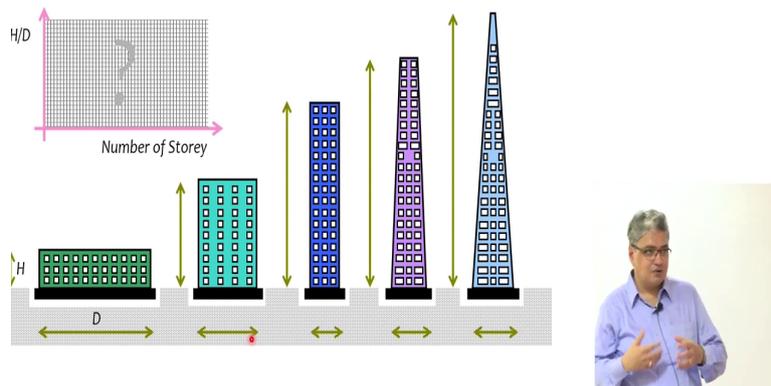
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Slender Structures



- Maximum slenderness?

- H/D



It is a massive you know achievement as in terms of building, but having a tall is one of part of it. As engineers, we would like to look at it in a slightly different way right. So, we want to look at it in terms of a ratio slenderness. So, what is it? Height to width ratio or depth or whatever you call it length right. So, if you look at this, what is that ratio and if we have to build draw a graph of all these tall buildings that their height divided by their width, how does that graph look like ok? Take this up as a nice cute exercise and try to come up with this.

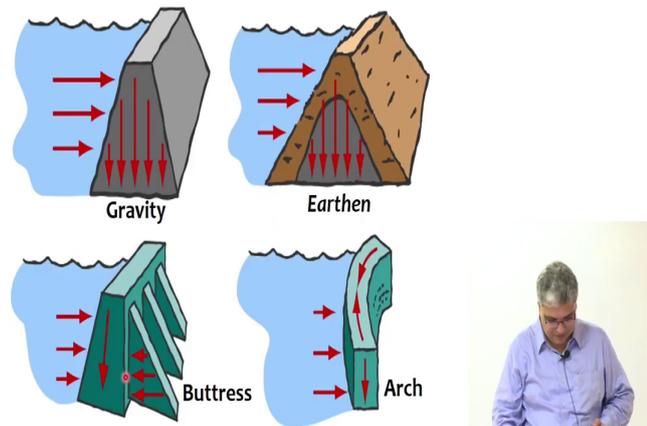
So, as the number of stories increase, typically if you take these buildings as examples you have got the heights when find the widths base dimensions and see how does that change vary. Is it a linear variation; is it at this variation or is it this variation; what is it? When figure out? It is very interesting thing. You will realize that as you know in terms of structural engineering, we are reaching somewhere and what is that?

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Civil Structures



- Dams



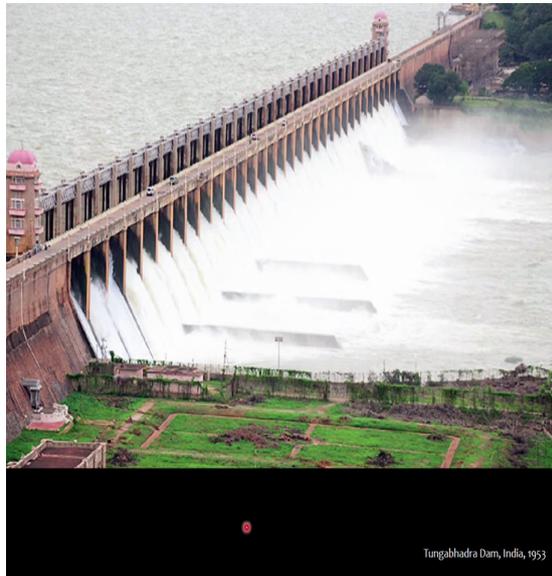
Talking of tall buildings, we then created we also created massive structures in the form of dams and I am sure you would have discussed this different types of dams.

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One of the engineering landmarks is this over dam building 1930s in the US right. It is a concrete H dam and remember almost like what, 90 years back the construction of concrete and of this scale was humongous and so, this is considered to be a landmark construction in this.

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Back here, we'll look at this beautiful dam Tungbhadra. Please do visit these dams. They are beautiful structures and by the way in modern India dams are known as, yes.

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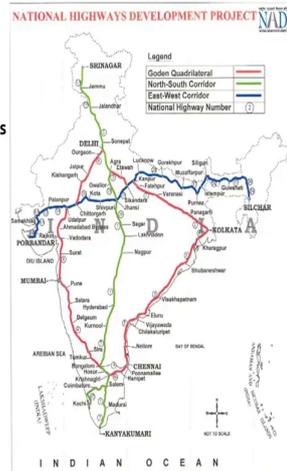
Look at this how beautifully. So, again if you there are these hills and within which this whole structure is built in such a way that it blends with the natural system that you have right and then, you create this.

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Civil Structures

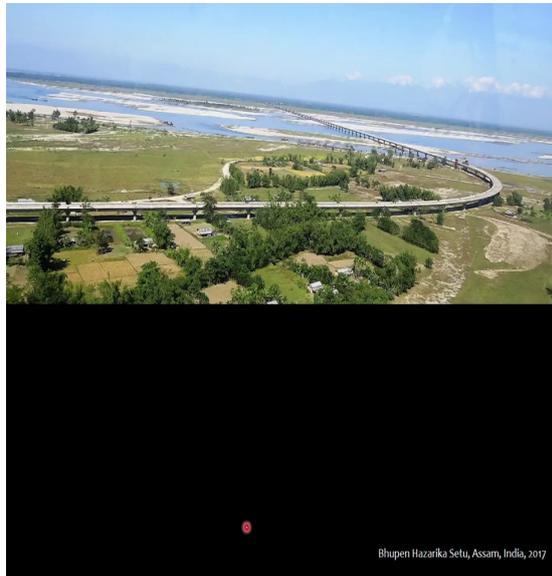


- IMBS
 - Indian Bridge Management System
 - 1,72,000 bridges & culverts



Then, of course, in terms of transportation another important field of civil engineering if you see, we had this golden quadrilateral, then we had this north south corridor, we have the east west corridor and now of course, we are taking it one step forward and moving and so, two things that are happening we need to create lot of bridges and at the same time, we realize that we have lot of old bridges. They are very old. So, we need to preserve them. So, we have work on two fronts; create new bridges, new structures and preserve old structures and for both of these task we need very trained qualified civil engineers right.

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Just to give you one example under hundreds and thousands of this, but just to give you one example, how beautiful this bridge is. Going back concrete, steel, a landmark bridge and even modern way bridges.

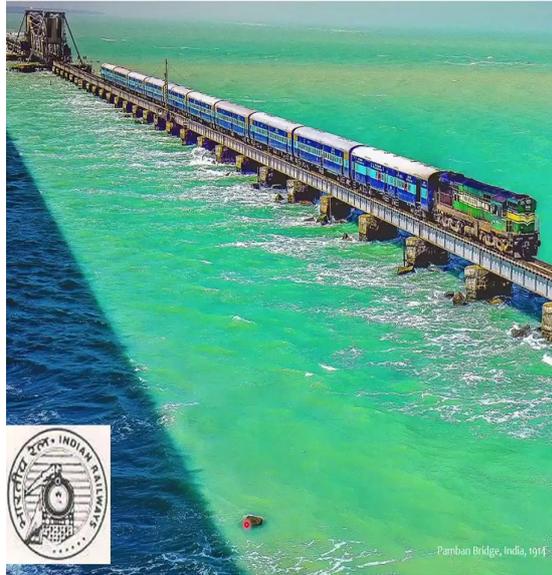
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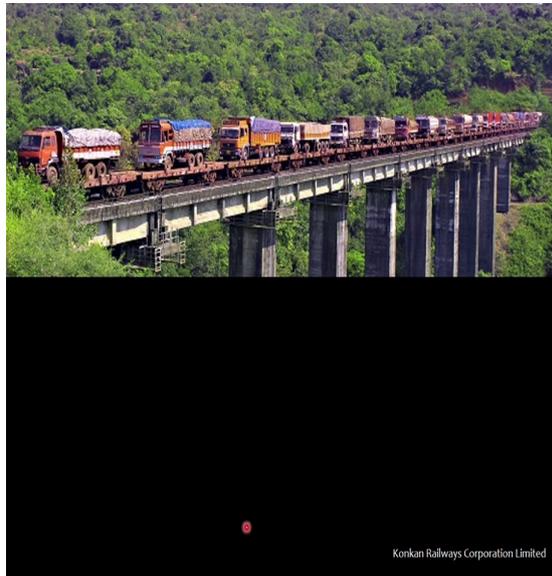
If you just look at it this is a very recent bridge completed last year. Talking of bridge is actually if you look at Indian railways has will it is breath-taking to look at the bridges that they have been. Not just road bridges, but we also have rail bridges right., This is the famous Pamban bridge that you see here.

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The tallest pier that we will find in India is this. Just look at that height of that those concrete pier right; it is breaths taking.

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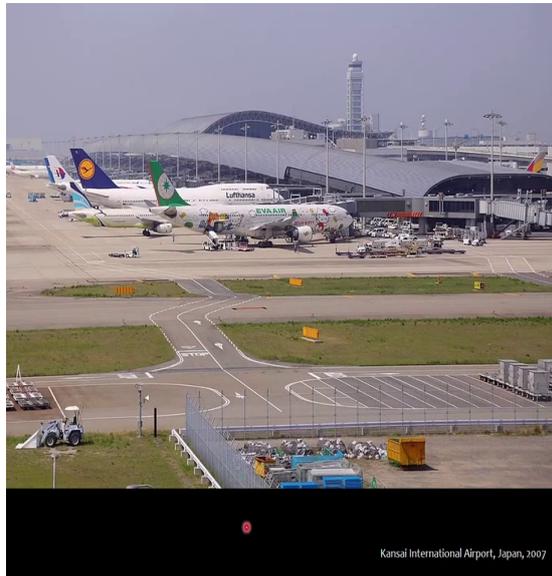
And this is part of Konkan railway project and in and you will find such beautiful structures there.

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We aspire to do more that is the only thing that I can keep on repeating. So, what we decided was land is not enough. We created an entire airport in the middle of nowhere in on sea right. So, beautiful project, there are a lot of information available, do go and look at this, the whole airport is on the middle of a sea.

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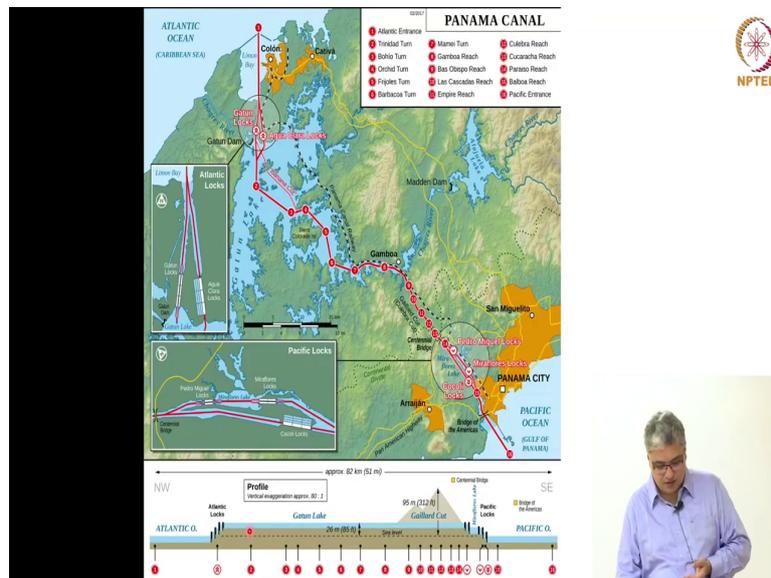
And so, you can imagine we had structural engineers, geo technical engineers, oceanographic engineers, hydraulic engineers, everybody working together, all civil engineers working together to create such a massive project; make it successful.

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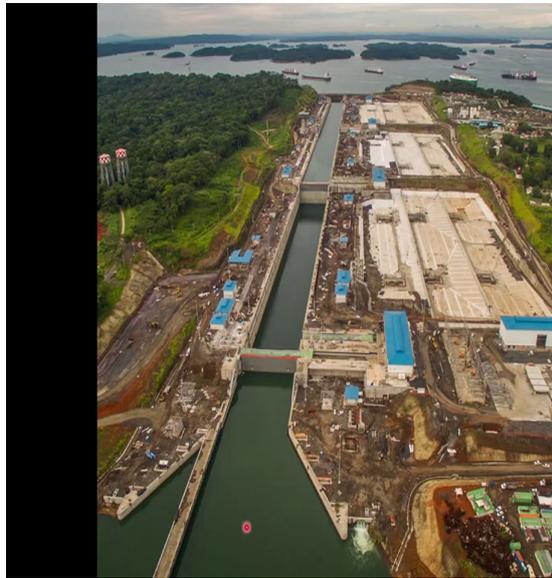
One of the landmarks of 19th century civil engineering, the Panama and the Suez Canals right.

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Connecting the Atlantic Ocean for the for the an with the Pacific Ocean, Panama and then, we had the Suez Canal thing.

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So, all of these projects require lot of multi-disciplinary in the sense that civil engineering in itself is a huge multidisciplinary area right. You have geotechnical engineering, water resources engineering, hydraulics engineering, structural engineering, transportation engineering; all of them come together to create things like this which serves.

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Once again, look at the size. This is a cooling tower. Just look at the sheer size of it.

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We have built such things. Today, new for clean energy, we are going to build lot of nuclear structures power plants. So, we are going to build lot of these structures.

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Energy sufficiency is an important thing today and what you see here is a very very interesting project. This is what is called the Trans Alaska Pipeline project to transport oil, fuel.

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And for this, engineers had to do a very unique innovation. So, here is a pipeline and if you see the pipeline, it is all bent, crooked and all you must be wondering why is it like that right. And here, if you see it is supported on something which is sitting on some rails. This is because it is crossing an active seismic fault and so, the earth moves when there is earthquake and if you create one stiff pipeline across it that pipeline will break ok. So, you create this segmented pipeline with flexible joints supported on rails like this so that no matter how the earth moves, shakes the pipeline stays intact.

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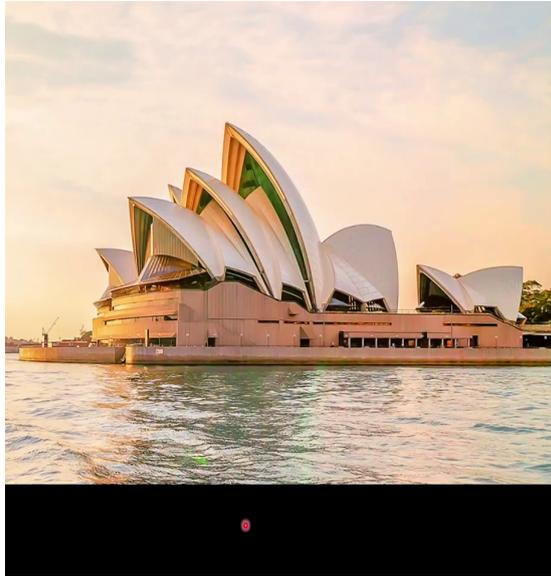
So, it is innovation or if you go to and you want to take a ride, you need a structural engineer to build that.

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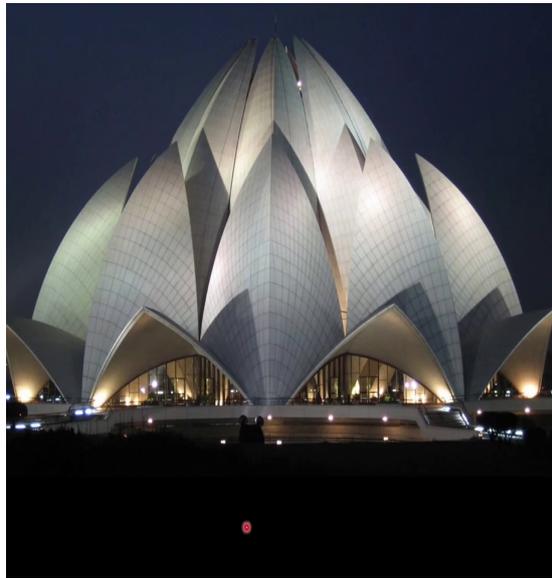
Trust me, so every time you go and enjoy, thank a structural engineer who have designed it for you.

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Or you just go and build something so is which is so refreshing, breathtakingly beautiful that you go sit there peacefully and enjoy cultural living.

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Well, we have our own also. So, please do visit and see and stand there and now that you are a civil engineering student, do not just go and visit this structures; but go there and take pride in the fact that yes, we have built it right. You as a civil engineer should start taking pride in all this.

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Structural Engineering

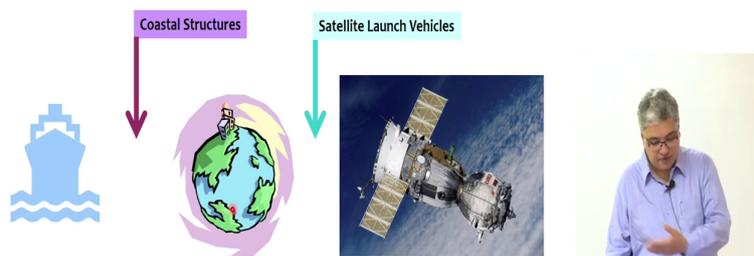


- Three types of structures

- On Water :: Ocean Structures

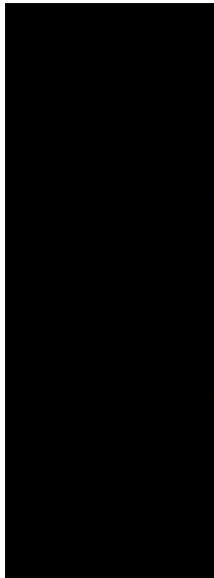
- On Land :: Civil Structures

- On Air :: Aerospace Structures



But that is not all. You will find Structural engineering basically to put it in a very short way, anything that you build is build based on some science and some mathematics and some physics behind it and the discipline of engineering which looks at all of this and make something stand or float is basically engineering. So, we have structures which are on water, on land, on air and we generally as civil engineers talk of those structures which are on land and then, we have the ocean engineering structures and then we have these.

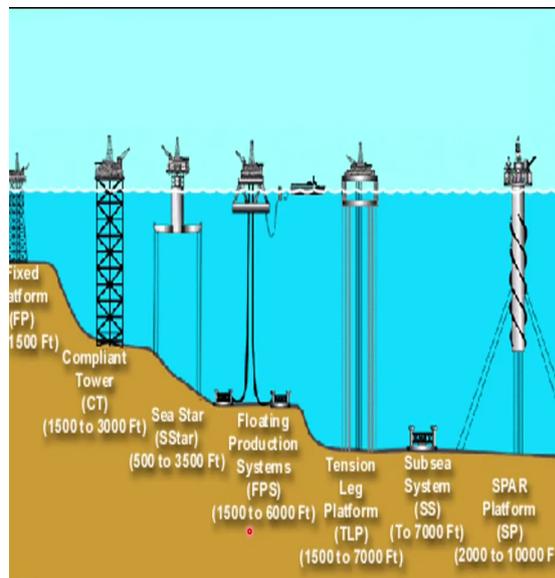
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And then, we have systems which are in between where also the principles of structural engineering, hydraulics engineering, geotechnical engineering; all of it is required to make things work right.

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Just look at this, it has to withstand strong wind, it has to withstand ocean current, it has to support people working there and so on and so forth and do its function.

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Well, we have our version also to take tremendous pride in is the launch of Chandrayaan-II by the way. So, if you see this, you have this huge amount of structures supporting structures right. First of all, they have to stand to make the rocket stand and then, as it goes you cannot let these structures fall apart and injure people. So, they have to be designed. They have to be produced built in such a way that it performs the intended purpose.

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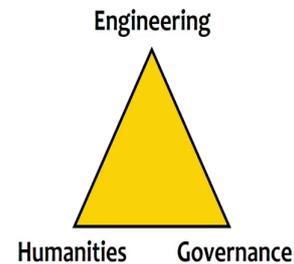
And even here, you will be able to use the principles of structural engineering mechanics and so on so forth that you will be studying over your stay here, you know to understand how these behave.

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Built Environment

- Engineering

- ...
- Aerospace
- Ocean
- Electrical & Electronics
- Chemical
- Mechanical
- Metallurgy
- Mining
- Civil



Geology
Hazards & Loads
Materials and Construction
Survey & Remote Sensing
Hydraulic & Water Resources Engineering
Environmental Engineering
Transportation Engineering
• Structural Engineering



But back on earth what if I start I said this word built environment whatever you see here works on these 3 pillars. So, you have engineering of course, you have to have good governance and so on and so forth. And then, you have a social humanities related thing. But if you look at engineering as such it all started with civil engineering in some form or other right. If you go and look at all the old universities around the world, you will see civil engineering was there right from the beginning. In fact, civil engineering was there right from the beginning of mankind as I said and tried to you know impress upon.

Then of course, mining was another important discipline of engineering which helped us, helped human race to progress; metallurgy, mechanical, chemical, electronics, electrical, ocean, aerospace and today, we are in at a stage where we can specialize and super specialize on small areas. But civil engineering still remains one of those very very broad you know

discipline of engineering where as a civil engineer, you will be learning, you will be discussing so many variety of things like starting with geology. Why is it important?

You cannot build anything on earth which standing or not without knowing what is below right. Without a geotechnical engineer friend, you cannot build a structure. You have to know that. It is so and before that you start with hydrology, you want to understand hazards, what are the things loads that are going to act. Materials and construction techniques, I am sure you have heard about it.

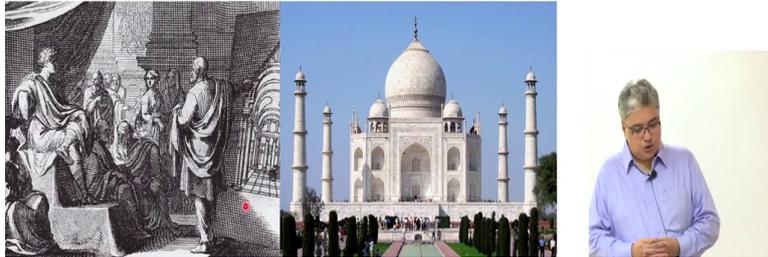
Survey and remote sensing, when you saw that beautiful curve, how do you plan it; what is what is the best way to plan that bridge right or the railway track that goes around. So, very very important Hydraulic, water resource engineering, environmental engineering transport and so, structural engineering is one of those parts of civil engineering; but civil engineering as a discipline of engineering is everywhere is very much required for our own existence.

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Structural Engineering



- **De Architectura** [Marcus Vitruvius Pollio, c 31B.C.]
 - Structures should exemplify
 - "firmitas, utilitas and venustas"
 - .. i.e., they should be
 - Safe, useful, & beautiful



So, talking of structural engineering, one of the earliest things that was said is that a structure I asked you to write down what you think a structure is right at the beginning and it has to get improved over time. But what they say is you must build something; a structure must be something that is safe very important, useful and beautiful. So, if you now think back of all the photographs and structures that you have seen.

First of all, they have to be safe that means, they are thousands of years old, they are still standing, they have not fallen on somebody right and they served a purpose, whatever that purposes; whether it is for movement for protection for social reasons, for political reason does not matter; it is served its purpose and most important the fall. I mean in a way they are all beautiful.

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Structural Engineering

- 5 Tenets

- Modern Day

- Safety
- Functionality
- Aesthetics
- Durability
- Economy



But today, we safety functionality, aesthetics are important, but we are dealing with a situation where we have to explicitly talk about durability. What we see is that those structures which has thousands of years old are still standing, but some of our recent structures are not really stand, continuing to stand. So, there must be some reason something that on our way, on our journey, we are probably beginning to not do right. And so, we need to understand that and then, pay attention to this aspect also and most important thing that has, that is happening today is that today none of us are Pharos or emperors and you know having unlimited land, unlimited resources and all.

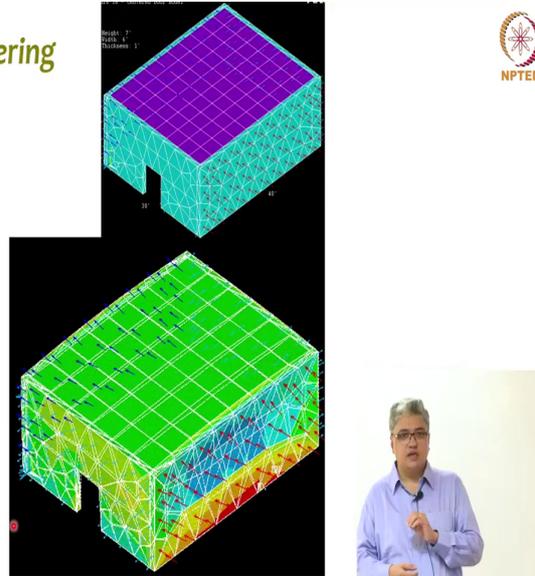
So, economy is an important aspect of modern day civil engineering, you have to build structures within a constraint budget and more importantly, within a constraint timeline. You cannot take one century to build a structure; although there are structures which are even you know going like that. So, durability and economy are also going to be important facets, tenets

of structural engineering that as a student of structural engineering or civil engineering, you will have to understand and appreciate and then act accordingly.

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Structural Engineering

- **Structural Safety**
 - Equilibrium
 - Compatibility
 - Constitutive Law



But safety is of paramount importance. If the structure is not safe, it is going to collapse, it is going to fall down, it is going to kill people, not acceptable right and this is where this is where your science, your physics, your mathematics all comes into picture right. We need to understand how forces act on the structure and how a set of force is say to be in equilibrium for a structure to be safe.

We need to understand compatibility of deformations and we need to understand how materials behave, how members behave, how structures behave. So, these are the scientific part of structural engineering that you will be learning as we as you move along. Only then,

you will be able to ensure that you have built a structure which is not only beautiful, not only useful; but safe.

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If we do not, things can be bad.

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And we will see things of which we will not be very proud. I hope you understand the end part of the picture right. A whole express way is has fallen of course, due to earthquake, due to earthquakes. But, I said anyway you our job is to build structures to protect them and us against those natural hazards right. So, we have to do that we have to learn.

But then as they say it is its ok, we should learn from our mistake and that is another very very important aspect of engineering. We have never done it first you know right the first time, but we have learnt from it and then moved forward and that is why we have been able to progress, we have been able to you know do what we have done.

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So, the important thing is to let go of your ego and say ok, you have done something wrong and we will do it right the next time around.

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Structural Engineering



- **Understanding**
 - Behaviour of Structures
 - Materials
 - Structural Systems
 - Analysis & Design



This is where comes the an important part which is as structural engineer, you will have to feel, you have to understand how structures behave and this is like almost like psychiatry that you understand how a person is going behaving; you go inside the mind of a structure and understand how it is going to.

Now, this may sound very weird to you today that is absolutely fine, that is absolutely fine. But this is precisely what a good structural engineer will do, he will look at a structure and understand what is happening in the structure. Just like a good doctor will look at the patient and say ok, I understand I know what you are going through right; diagnosis.

Same thing a good structural engineer will do and the whole training is about to train you to see a structure and understand how it is behaving, what is going on within the structure and that is why you are here for the next few years right and that is the whole thing and so, to be

able to understand how structures behave, we will understand how materials behave. We saw different materials. We will see how each one of them behaves.

We will understand structural systems; you saw different systems without I explicitly telling or pointing out you saw different structural systems which we will discuss again next time around and then, we will learn we will have to learn two very important traits which is to be able to analyse a structure and to be able to design a structure and what are these we will also see next time around.

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Engineering



- **Needs**

- Creative mind
- Scientific temperament
- Motivation
- Discipline



But for all of that to be done or for you to be able to do, you need to start of with a very creative mind. Trust me, it is not some question is given you do that. Civil engineering is very creative as you have already seen. So, you need to keep that alive in you. But at the same time you need to have a very very scientific mind, you need to be I know all of you are good you

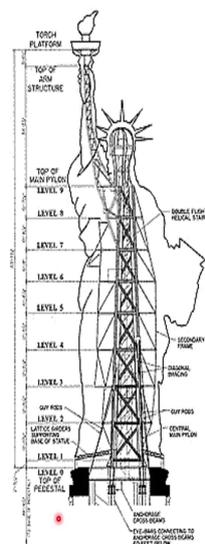
loved your physics, you loved your mathematics, you loved your chemistry; continue to love physics, chemistry, mathematics, all that and you will be a good engineer. But you will need to continue to love them ok.

So, first year all the courses that you are doing you need to come you know continue to love them, but the important thing is to be motivated and to be disciplined right. All forms of engineering, I am not talking about structural engineering here it is important that you continue to be motivated and motivation, the first motivation has to come from within. If you find it lacking there, come across; there are enough people in this institute who will help you. But you have to come across and say we need motivation, you will get motivation.

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Engineering

- Plan
 - Creating one...
 - Executing



But you have to be discipline, that is something that you have to work on. Nobody else can do that and if you are able to do manage all that, you need to dream first right and then, make

that dream happen and that is what engineering is all about. And you have to first create a plan and then, find ways to execute that plan and I show this picture because I also taught engineering drawing and I am I do not know if you as a batch is doing engineering drawing or not.

Take that very very seriously ok. Take it very very seriously because that is where your creativity starts and then, if you get that right, you will be able to do many beautiful things ok.