Engineering Graphics and Design
Indian Institute of Technology Delhi
Week 12
Lecture 3
Civil and Architectural Drawing

Welcome to Engineering Graphics and Design.

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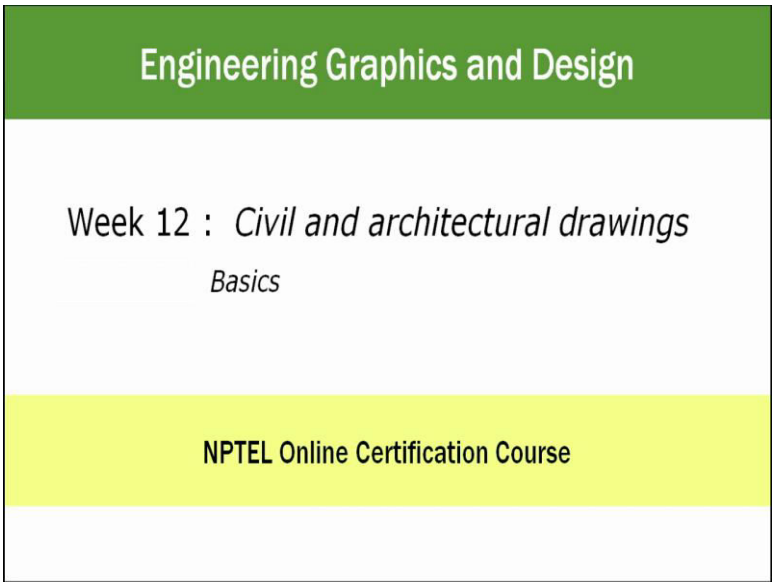

In this lecture, I will introduce the basics of civil and architectural drawings.

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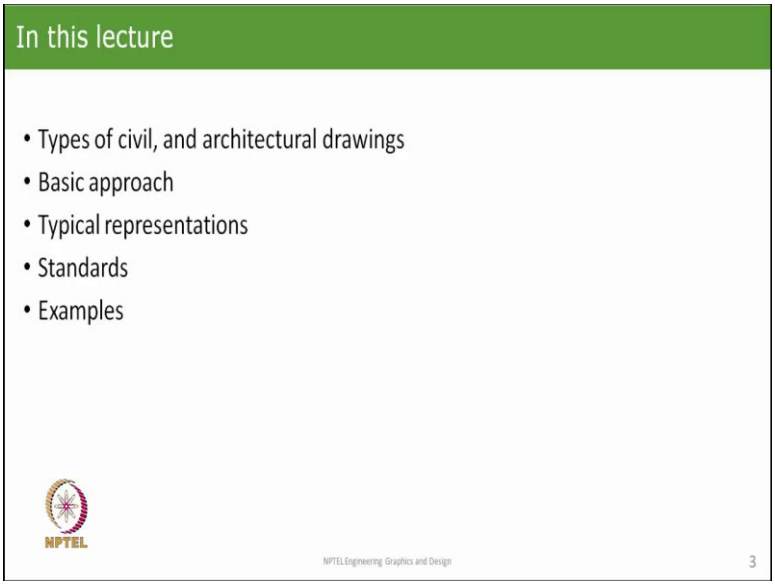

We will look at what types of drawings are there. What is the basic approach, we will look at some typical representations. On the way, we will look at some standards and also have some examples.

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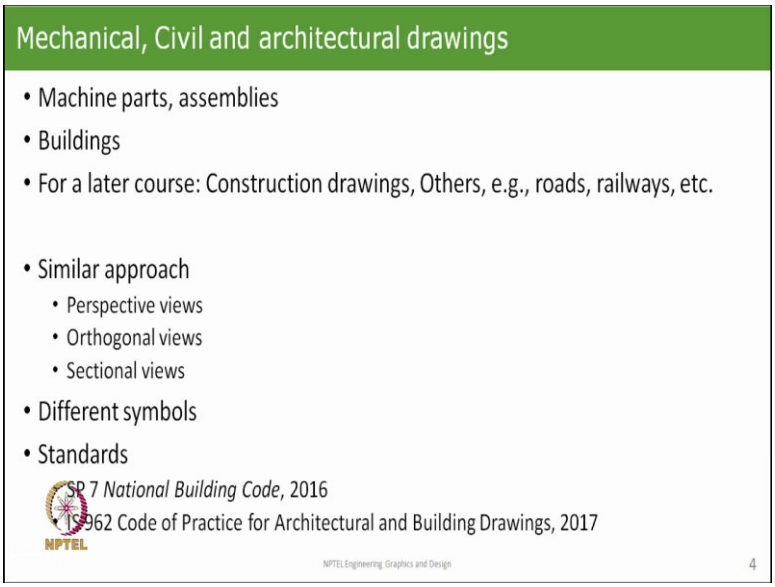

You have already studied mechanical machine drawings, where there were parts and assemblies. In civil and architectural drawings, we shall look at buildings. We are restricting ourselves just to this topic. And there are many other types of civil and architectural drawings which are left for our future course.

For example, drawings related to roads, bridges, highways, airports, railways, and industrial structures. The approach in civil and architectural drawings is very similar to that in mechanical drawings, that we have perspectives orthogonal and sectional views. Civil and architectural drawings use a very large variety of different types of symbols as we shall see later on in the course.

The important standards related to civil and architecture drawings are first is SP7, Special Publication seven by the Bureau of Indian Standards, which is the National Building Code 2016. This code is a very comprehensive compilation of all aspects related to the design and construction of buildings.

The other standard IS 962 which is code of practice for architectural and building drawings. We shall draw upon some of the information given in both of these standards. In today's lecture.

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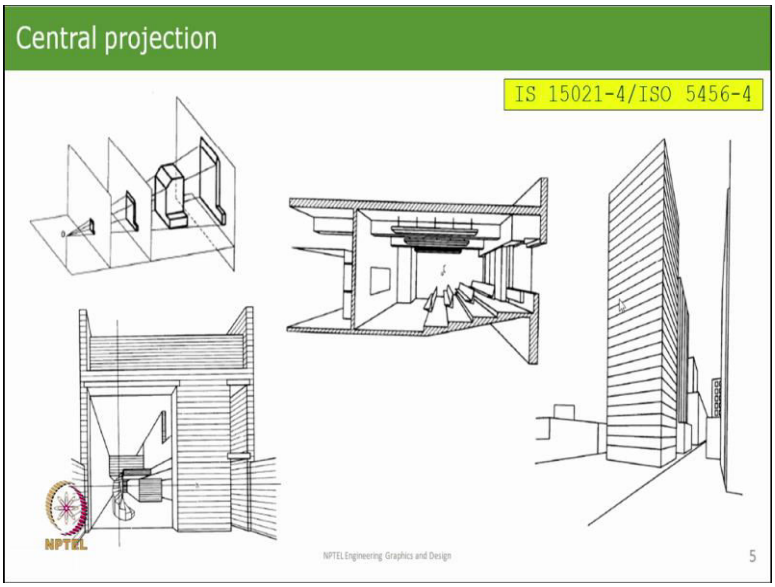

To revise what we had seen earlier in mechanical drawings, we had looked at Central projection, which is the way the human eye sees the surroundings. This picture on the top left is of a machine component. And it shows that depending on where the viewing plane is, we see the object in different sizes.

This is a one-point perspective of the cross-section of a classroom. And the bottom left is a one-point perspective of an entrance to a building of what you would see through the front part which is a transparent glass door. On the right side is a two-point perspective of a street view. But this is what one would see for standing on the road where structures around us are much bigger.

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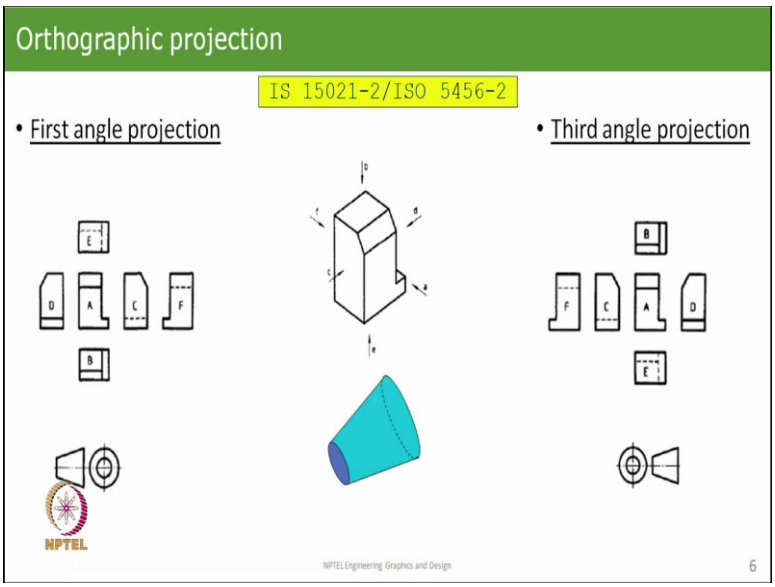

So, while these drawings are interesting, they do not meet the requirements that is there for design and construction which is where we go to true views which is orthographic projection, first angle projection, and third angle projection. In similar and architectural drawings, we follow largely similar ideas, but slight modifications.

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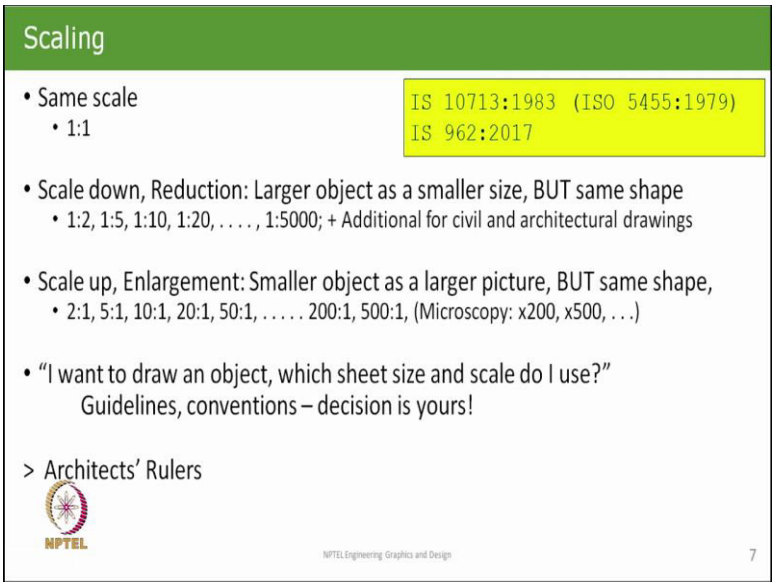

An important thing about these drawings is that most of these structures are much bigger than the sheets on which we make drawings. Consequently, when we make the drawing, we have to scale it down. So scalings, like 1 : 5000, 1 : 10000, 1 : 1000, these are common. And to ease the interpretation of drawings. There is a special ruler on which there are six scales each scale corresponding to different scale downs, which sheet size to use, it is our decision depending on what we are drawing and whether we get the best clarity or not.

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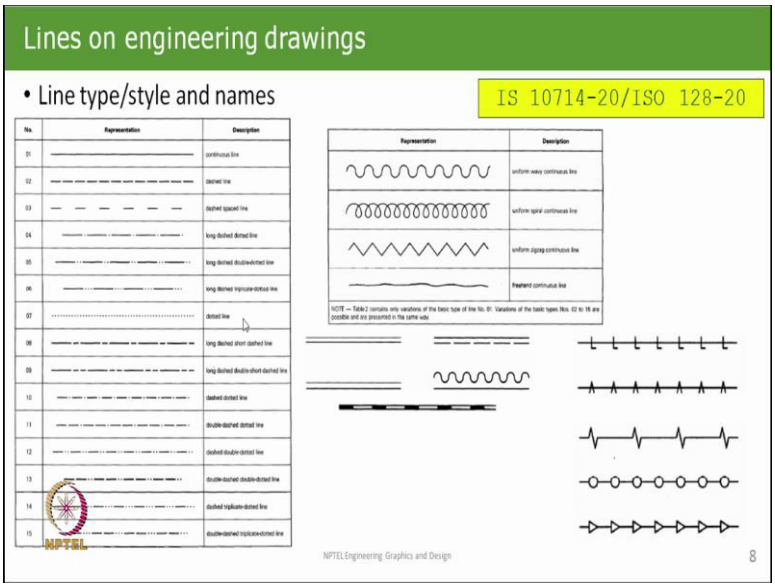

The line types that are used is very similar to the nomenclature that we had seen earlier. For instance, this has been taken from India standard 10714 which says that this type of line is called a continuous line, a dotted line, and if we go on down further, you have a double dotted line, you have dashed and dotted line, and so on.

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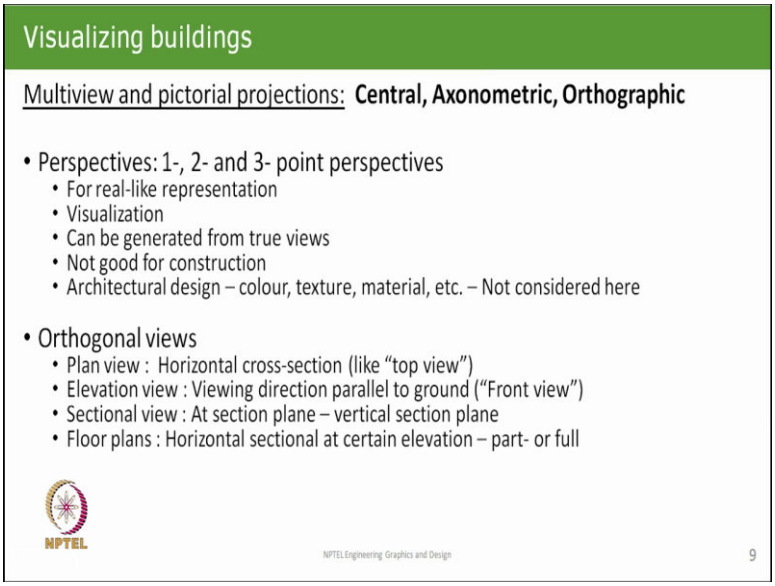

In visualizing buildings, we will use Central, Axonometric and Orthographic projections. But in this course, we will restrict ourselves to orthographic views. Perspectives, which could be 1-, 2-, 3- point perspectives, they are good for real like representation and visualization.

When we are creating say virtual reality we would go for that, but if we make the true views especially we make a 3D model in software package, we can generate these perspective

views as we like. However, these drawings are not good for construction and designers will not give a design in any perspective view.

An added feature in architectural drawings as against mechanical drawing is that here we heavily used color texture, the type of material and aesthetics which makes it which is an important part of these drawings. In this lecture, we have very briefly looked at and say not we are not going to go into detail in this.

Orthogonal views, as you have learned, we have the names are now different for civil and architectural drawings. Then first name is I have listed here as the plan view. That means, it is what you would view in a building or a construction when you take a horizontal cross section that is something like making a horizontal cut at a certain plane and viewing from the top, this is called the plan view.

The next is an elevation view, which is that we view the building in a horizontal direction a direction that is parallel to the ground. And this is somewhat similar to what we have called the front view in earlier learnings.

Sectional views are very similar to what we have learned earlier, we define a sectional plane, which could be a vertical section plane which is then called a transverse cross-section or we could even take it in the other 90° direction orthogonal to it, that will give us a transverse cross-section. An additional feature that comes in is what is called floor plans.

For instance, in a multi-storey structure, whether it is a residential office or an industrial design, we will have floors and each floor could be different from the other floors. So, for each floor, we have to give a plan of that floor which is what is called the floor plan and this is the but typically like a plan view, which and this could be in part or it could be in full.

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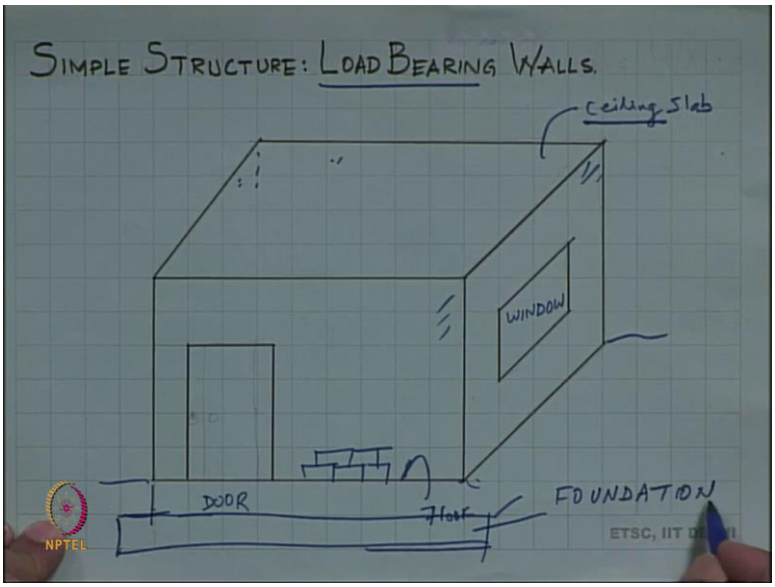

We will now look at various examples of all the other topics that I have just said. We will begin by looking at a simple structure which has load-bearing walls. A small structure would be like this, that we have, here what we have shown is this is one wall here, this is another wall similarly at the back there are two more walls and on the top there is the ceiling. The bottom of this, this is your floor.

So, what we have done here is we call it a load bearing wall. Because these walls they could be made of bricks. And after they come to the top, the weight of the ceiling the slab is taken by these walls. What it also means that if you try to break some of these walls you are compromising the integrity of the structure.

And in this I have shown two typical features, one year this is a door and on this side, this is a window. This is sitting on the ground. But all these structures they start below the ground and this is a very important part called the foundation.

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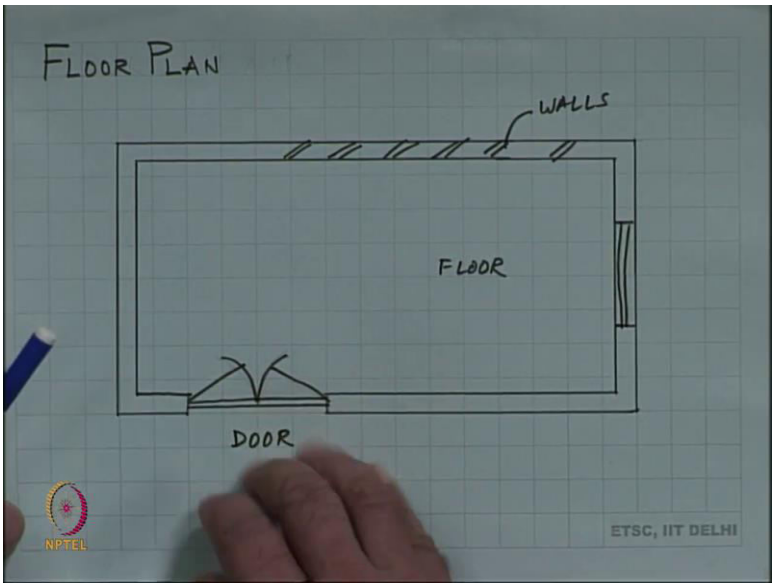

So, let us see how we can show these in orthogonal views. We will start by looking at what we call the floor plan, which means that if I cut this building. In a horizontal plane somewhere there all the way through, what will I see? So what we are looking at is typically a plane, which is cutting at some point here.

So this is a plane, that would be something like this. And then let us say, if I see from the top, what remains, How do I draw that? So that is our floor plan. What you are seeing here, all of this, these are the walls. And they could be either just shown like this, or we could put the symbol for it.

So all these walls will come wherever they are continuous. But there are two things that are happening here. And that is what we will look at now. The first is there is a window where we cut. So here, we show it by making this thing which is the width of the window, and then drawing two lines, straight lines, which tells us that this is a window.

Similarly, for the door, we do not show the full wall, because it does not go down all the way. And what we have is that we showed these two, or we can even sometimes even delete this. And we just showed this symbol. And this symbol denotes that this door has two leaves, both of which open inside. This is one particular type of door.

You could have a single leaf door, you can have doors, the leaves which open both inside and outside, or you could have leaves which open on the outside, but that is the symbol that you use for showing it.

So in that particular construction, we have now shown everything that we needed to see and so this is the walls, this is your floor, that is the window and that is the door. So, all the important features that were there in that simple construction, they have now got represented in a true view and it is on this view that we will give all the dimensions

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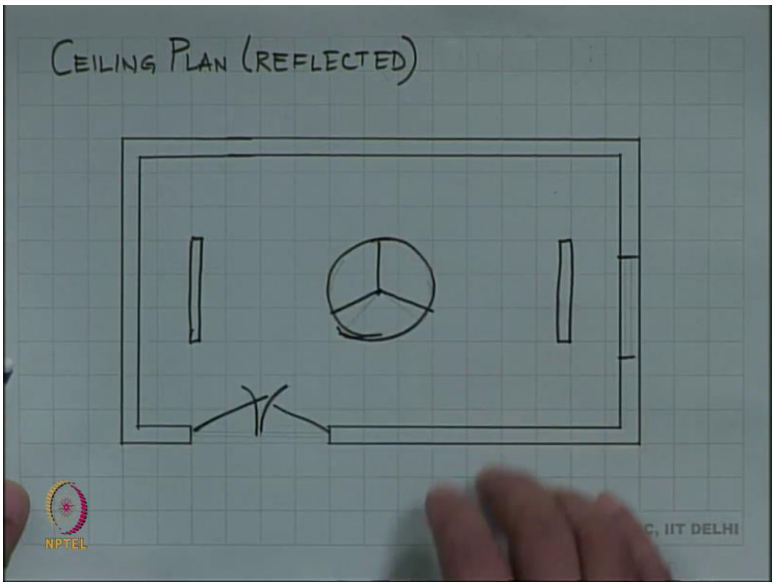

The other type of view is a ceiling view or the reflected plan which is what is it that we would see if we were to look up and say what is there on the ceiling. Now ceiling has several things on it. An example is a ceiling fan almost everybody has a ceiling fan.

So here we have this is the symbol which tells you that at this point in this building there is a ceiling fan of this much diameter we could show a small rectangle like that. And this shows a lighting fixture like a tube light and addition to that we always would have our windows there and the door there.

It is at this stage one can see whether there is any interference step between the ceiling fan and the wall or maybe the ceiling fan and a door. There will be many other things in a typical ceiling, for example, there could be fire extinguishers sprays, there could be fire detectors, there could be different types of lights, things suspended from the ceiling, all of that can be shown on this picture.

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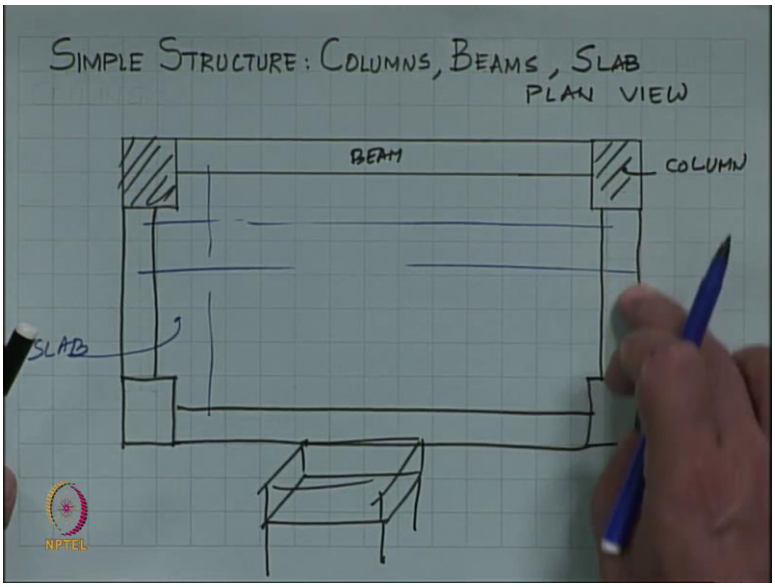

Besides the load-bearing wall, civil structures are of one more kind which is columns and beams. So, the difference is that we first erect a structure of beams and columns, then put the floors as a slab. So we can what we can add that here and then we erect the walls on these structures. So the walls that we now erect they do not carry the load.

So load-bearing wall structures are small in height. These structures is what you would see in all types of high-rise buildings and even industrial constructions. So what we have is this rectangle here, this rectangle here, this rectangle here, and this rectangle here. So, this entire thing this is a Column we are looking from the top. So, this is the plan view. Between these two called Columns, which are rising upwards we have put one more structure here this is our beam.

Similarly, there could be a beam there and a beam here and to complete the structure we could have this. So if you just want to look at it very simply instead of looking at the thickness of the beams, we have basically made a structure which is like this and on top of that, we could keep on adding more such structures.

It is like constructing a frame of sorts and this is what is carrying all the loads. Once that is done, we can then on this entire thing we put steel, various shapes and sizes you can pour concrete on this and that is how you get the floor which is what would be called casting of a slab.

And then further to make the floor plan on top of that, we can then show everything else like we have shown earlier because those walls, by and large, will be brick walls there might be very few which would be completely cast concrete walls.

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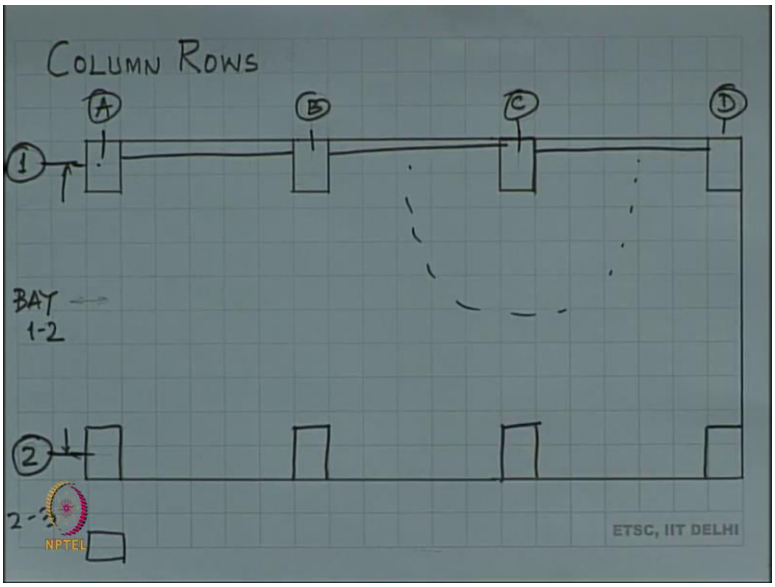

Another type of construction which is fairly large in size is a rows of columns. This is what you would see in a say a factory. So, what you have here is that you have this column here, this column here, this column here, this column here and with respect to the central line, we specify all their spacing and the column is specified by its dimensions which is this dimension and this dimension. So, all these columns and there could be hundreds of them one after the other all of that is classified as one row.

Like this, there could be many such rows. So, is one more we will show and this we have called here as two. And that is the way it is shown on construction drawings. So, what we have is a long space in between where you can keep all types of things, now machines, you can even put say offices desks like that.

So, this continuous long area this is known as a Bay. And you can call it Bay 1-2, just after this there is another Bay over there, this could be Bay 2-3 like this, there could be lots of Bays and the important thing from an engineering perspective is the dimension between that you create here from here to here. This could be several meters like 10 m, 20 m, 30 m also is possible.

Once you have put this column together at some level you will also put beams and finally on top of this, we will put some more structures to complete the roof. So this is row one, row

two and these would be nomenclature as column A, this would be column B, this is column C and this is column D.

So like that, we can very quickly refer that you look at column one, row one, column C. So you know that it is here. And this could be a referencing style for things which are in the vicinity of this particular column. So, columns and rows, this is quite common in very large constructions.

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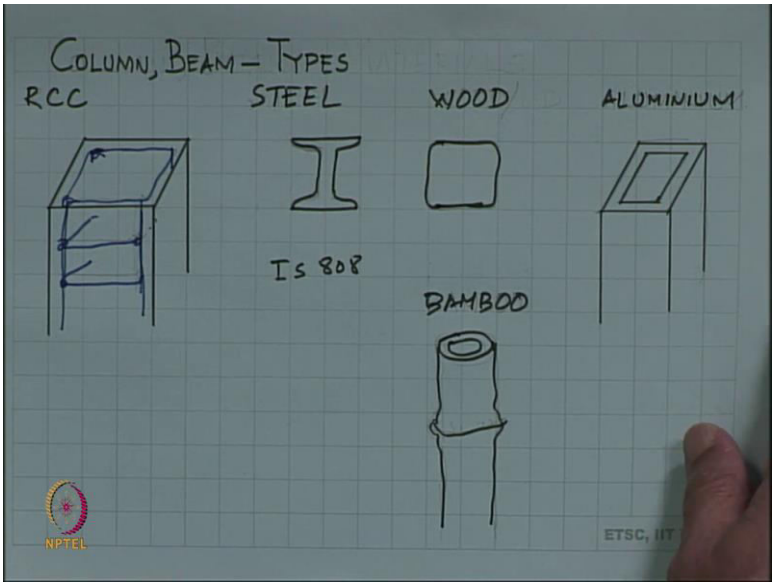

Now let us see what type of materials are used for putting together columns and beams. The first one that I have shown here is what is reinforced cement concrete and what is done here is that we put up a steel structure. So, this is, these are long straight rods which are joined by rods like this, which have been bent and tied to these rods. So, this is, they are tied over here. So, like this there will be lots of these. So, you have created a series of long wires there could be this or there could be even more in between there could be some would be thick in diameter.

Some could be thin depending on what load has to be taken. And then they are all tied up together after this thing is tied it is put in place and around it we have a box-like structure in which the concrete is poured, it sets, and then it is outside is removed and we have our column.

The second type of columns that you will see are those made of steel. So, what you have is various steel sections and for this you can look up IS 808. These are standard rolled sections. I have shown you one here, which is called I beam, I section.

And this is kept vertically it goes normal to the paper at the bottom it is welded to a plate that plate is anchored into the foundation and then on this T structure we attach the beams and fix other elements.

In many cases, the columns are made of wood, and in some cases as in shamiyanas, even made of bamboo. So, the wood could have various cross-sections. I am showing one over here bamboo is nothing but straight and got it knots in between, and this can be screw up to each or tied to each other. In some cases, we also use aluminum, if you have seen some of the tents being put up these days, it is an aluminium frame in which these are hollow aluminum sections like this one.

This is a rectangular hollow section, these are bolted together to form the structure, and then on top of that, a plastic sheeting is wrapped that creates a temporary structure. So, these are the various materials by which we can make columns and beams, and using columns and beams create a structure permanent or temporary the type shape and size that we want.

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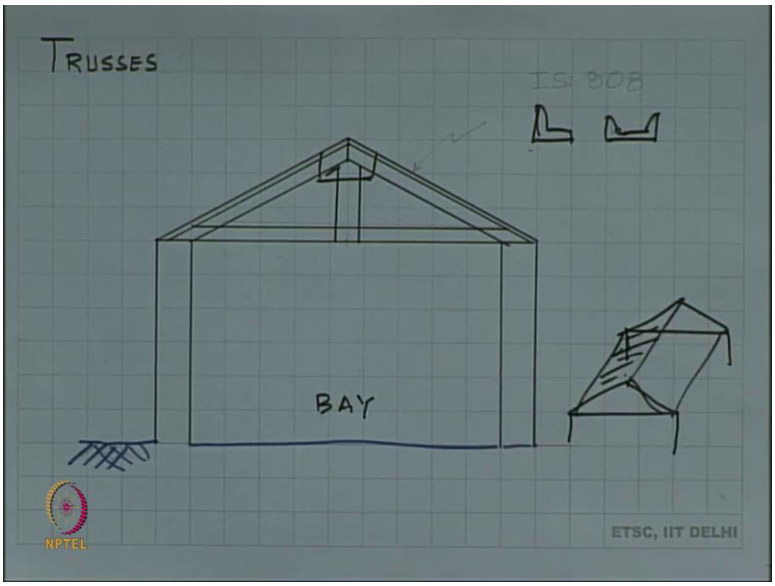

In industrial constructions. We put the columns as we have shown here. All of this is sitting on the ground inside this, this is the floor and outside this is the ground which is soil. On top of this these columns in one pair, we put a structure like this and this there could be lots of other designs on this. These are called trusses.

They are made by welding together pieces of various types of sections like angles or channels and they put plates over there to which they are welded. And like this, these truss is put together and placed in position.

So there is a method of showing all these drawings. We will not go into detail of that. But important to know that there is a particular way of showing trusses. Remember that this distance from here to here between the base this could be several meters tens of meters. So, what you are seeing here normal to the paper is a typical Bay.

Once this trusses are put up the structure would look something like this and then there will be another one at some distance. These are then joined and finally on top of this, aluminum sheeting or translucent composite materials sheeting, fiberglass type that can be put and that completes our structure.

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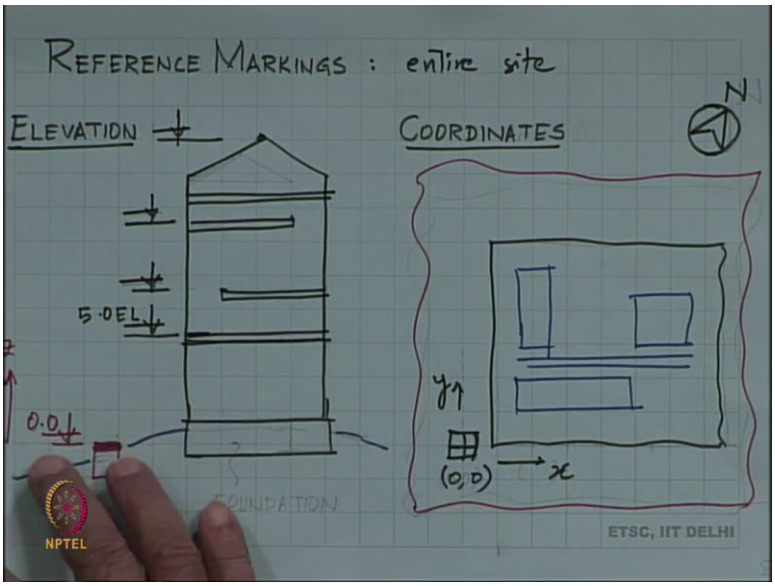

An important feature of civil drawings is how to do reference marking. Recall that these structures are very large, hundreds of meters in some cases several kilometers, they are made on the ground, the ground is not flat, it is undulating, there are many other things in between. And if you are making a series of things, it is important that their relative orientation should be kept same which means that all of them should reference themselves to one standard reference marking for the whole site. So a unique marking for entire site.

The site could be big, it could have many types of buildings, scattered over different places connected by roads, but all of them will refer to a particular reference marking. So, there are two types of markings that we will look at one is elevation, the other is about coordinates. So here is what happens with elevation.

Suppose we had this ground which was like this and on this ground, we are going to put up a structure. So what we do is, we say that Okay, I am going to put the structure over here this is my foundation and on top of this the structure will come up.

The next structure could be somewhere else the ground level could be something else. So, what one does is on the site a particular marking is done, which is like a small pillar about half a meter square which is fixed and the top of it is taken as a reference. So, this is accurately placed based on various measurements techniques.

And this becomes our reference point for the vertical direction, we may call it the Z direction and the symbol to show that this is our reference is an arrow like that, there we write 0 point 0. This is our reference elevation on this as we build the structure.

So, the structure is going up now here like this. And on this we put different floors. So this is one floor, this could be a partial floor, this could be another partial floor and there could be another floor over there. And now we want to specify the location of these floors in the vertical direction.

So, what one does is to draw a line referencing to the top of the surface of the floor put this and write the number here. For example, this could be 5.0 elevation. So I either 5. 0 or 5.0 EL elevation, this will tell us that relative to the top of this the top of this floor is at 5 m. Similarly, the next top of the floor, this could have another value there, this could have another value there and so on. We could even indicate that the top of this, this would be at a certain elevation.

So that would happen to one building. We have referenced it to this, adjacent to that if there is another structure, it will be referenced to that and if there is something say a pipe running from here to the other building, its elevation will also be given relative to this standard.

So that is as far as vertical integration goes. Now, the site is spread on the ground. So, we now have to have two more coordinate axis, which is what we are going to see here. And for this what we have shown here is that the overall site is say like that and within that the site that we are working with the construction there is over here.

On this, we could be placing many buildings, we could have one building over there, there could be another building over there, there could be a road in between, there could be another building over there like that. Now, while we design each one of them separately and make

their drawing, the relative placement is very important. And for that we make reference to a common coordinate origin.

So, like this, the same thing on the top of it, there will be put two marks and this becomes our (0, 0) for our x and y directions. If need be all dimensions of this building could be given in terms of this. Or we could reference one of these to this reference point and give all the dimensions relative to that point.

One more important thing about civil and architectural drawings is the direction. This was not an issue in mechanical drawings. So on every drawing, There will be a symbol, some of them could use this type of symbol, and write N. So that tells you which is the North. This is a very important difference between mechanical and civil drawings. So, that completes our discussion. And say that we can now uniquely specify everything in a building or a set of building on the site to a common reference point.

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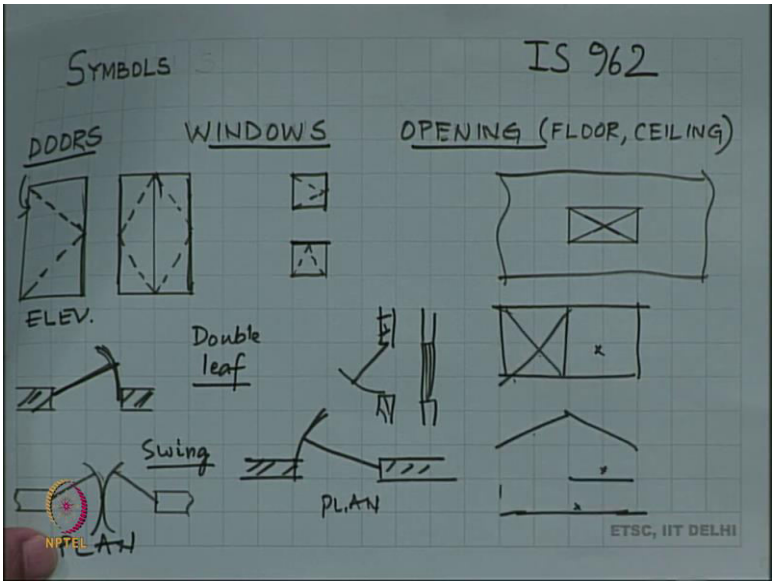

Now, we will come to symbols that are used in architectural and civil drawings, we have got the floor, we got the ceiling, we got the beams, the columns are the load-bearing walls. Now, So I want to show various things that will be there on the floor, various things that will be there on the walls, various things that will be there on the ceiling.

So here are some symbols and all of these are taken from IS 962, which we will make available. And we will also compile all the required symbols for this course, and make it available on the course homepage.

So we look at doors, windows, and say openings. There is one set of symbols a door is shown by a rectangle and within that, we show some dashed lines. So this is in the elevation view. It could be that we have this door with a line in between solid line and these dashed lines going like that.

So what it tells us that when we are looking at this door, this part of the door is hinged. And this edge can go normal to the plane of the paper. So the door opens about this axis. Now it could open only inside that is called a swing or only outside or both sides. So that the symbol for the swing part of it.

So this is what you will see in both these cases in the plan view. So we show this line and show this here, this is our wall and it tells you that the door is single swing opening on one side. This particular door, the corresponding view for that will be the opposite of this one. So this is the wall, this door is opening that way. So the line should be shown that way. So there is a door swinging that way. So this is a depiction in the elevation. This is the depiction in the plan. If there are two leaves of the door, So this is called a single leaf. This is a double leaf.

That means, this half of the door hinges over here, this half of the door hinges along here and so in the plan view this is how it will look that this door is opening on this side this door opens on that side. It could open both sides that is possible. So how it goes this way. This is called the swing. So this is the leaf and this is the swing. There are also doors which could be sliding doors. There are doors which could be revolving doors. They all have the symbols in the standard we can look that up.

Next is windows. So, like doors the symbol is similar, but of course smaller in size. And this type of window means that it is hinged over here and opens about it is single swing, the window could be like this where the hinges on the top and this door this window opens about this axis.

So in this elevation view, this window, this is the wall this is the wall over here, this window would open like that. So that is again as before in the elevation view, this would be in the plan view or we if we do not show this, we can also show it the way we have shown earlier we just do it and in between, we have two small lines which tells you that this is the window. There are many designs where there are openings. So that is shown by a symbol which is the shape of the opening with a cross in it.

So for example in the if there is a floor over here, and the second floor over here and then the roof comes on top of this. This is an opening. So in the plan view, we will show it like this is like this and this is open. So this is this floor, the rest of it below that is this floor and this is open goes all the way to the top.

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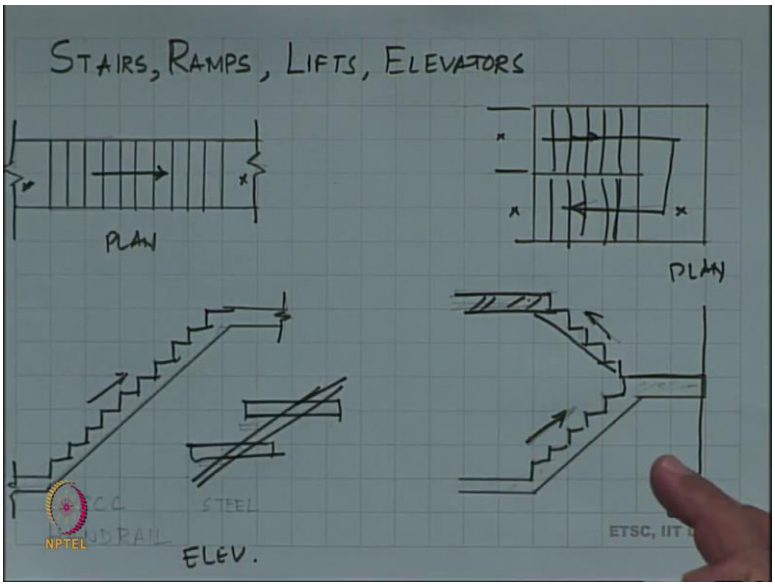

So that is for doors and windows. The next thing is when you have multiple floors, we need to show the axis and we will show stairs ramps, and the other techniques that are there we will not go into the details of that. That goes our lifts and elevators.

So let us look at first a simple staircase. In the plan view this is what we will show so this is continuing this floor is at the lower level. This floor is say at the upper level and the direction in which the stairs go up is shown by an arrow.

In the elevation view, it is a staircase which could be say made with a concrete slab over there. And then these are again all cast in concrete. with, of course, reinforcing steel. Here we do not need to give an arrow but it is quite clear that the stairs rise left to right.

So this is the depiction in the plan view this is a depiction in the elevation. There are many cases where you could have stairs which turn around like in this case, this is coming from a lower floor and this is at an upper floor.

So you could have a staircase which goes like this and you keep climbing up so here there are stairs and the arrow shows that this goes up this is a landing and then again it continues say there are stairs over here and the arrow can then go like this and show that the stairs are going upwards.

that is the plan view in the elevation you will have to show it in two parts. This is this part which is the landing and then there is a slab here with the stairs over there which come up to the landing and then, of course, you are turning around but in the elevation view this will continue to be going up like this and this is the upper slab so you are going up this way and then going up that way.

These are the type of stairs that you put a concrete slab then put steel in it and then pour concrete to make the stairs and then finish them off by putting a layer of stone or tiles. The other type of stairs that are there. And this you do not see in residential buildings so much is that you have a steel frame in the elevation view and on this steel plates or steel sections are welded. So, these are all just rectangular pieces here. They are welded to the structure on both sides and that becomes a staircase.

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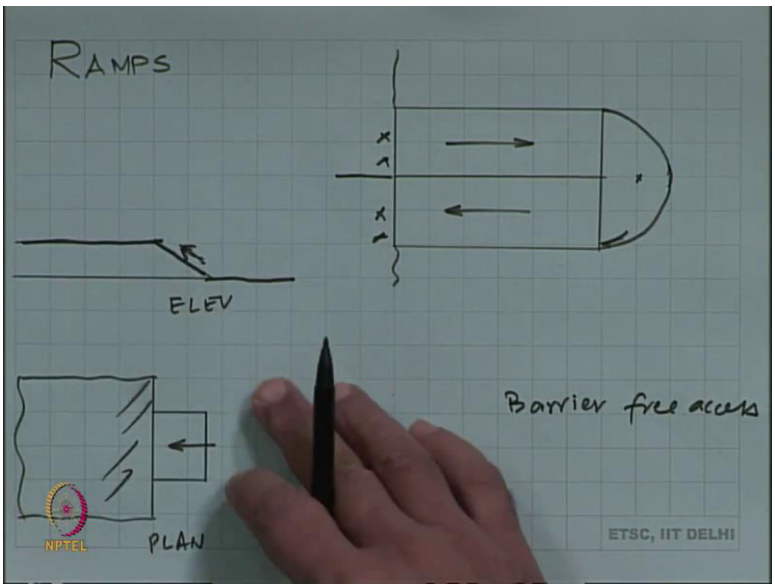

Now, we look at ramps and this is a very important feature these days because now, all constructions that are made must have barrier-free access. That way somebody who is on a wheelchair should be able to go everywhere that a normal healthy person can go. Wheelchairs, crutches, those handicaps do not let you go up and downstairs. So, ramps have to be provided, and here are a depiction of the ramp.

So this is the floor which is here at an elevation This is a lower part, so this could be a ground or a road and then we have to provide this thing which is a ramp and it shows that it goes up and this way the ramp goes up here. So, this is in the elevation view this is in the plan view.

In many buildings, you will see large ramps to go up and down. So, what you are shown here that, here is a floor at a lower elevation. This is floor at a higher elevation and this is the ramp. This is a landing so this is at the same level. So, by showing this arrow we are showing that this is the ramp on which you go up all the way here then flat you turn around and continue walking up. So that way even the wheelchair can just go up like this or in this case can go like that. So that is about ramps.

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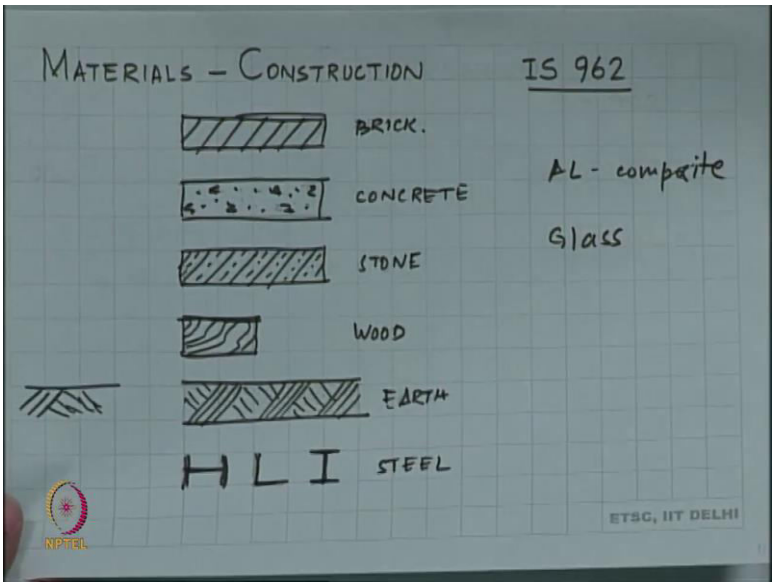

A quick note on various materials that are used in buildings and construction. The symbol with dashed lines there this design shown here it tells you that this is a brick construction. Then, if you have this symbol some large symbols like this and smart dots in between this is concrete.

The third is the depiction of something we see very common these days in many constructions, a solid line, a dashed line, this is various types of stone. Then we have wood and we show that by these types of lines basically showing these grains of wood.

And earth, this is shown by a series of lines like this and similar lines over here. We have also shown earlier on one of the drawings that in some cases we could even depict this as, in this way. And steel structures instead of showing the full detailed cross-section. We can just show it this way and this tells you this is a H section, this is a channel or we could say that this is a I cross-section. So, these are steel cross-sections.

There are many other materials which are there one can look up IS 962. Many new materials have come up. For example, we have now the aluminum composite, which is pasted to the

outside wall of buildings. There are many places where now you have extensive use of glass. So they all have their own symbols and we can pick it up from the relevant standards.

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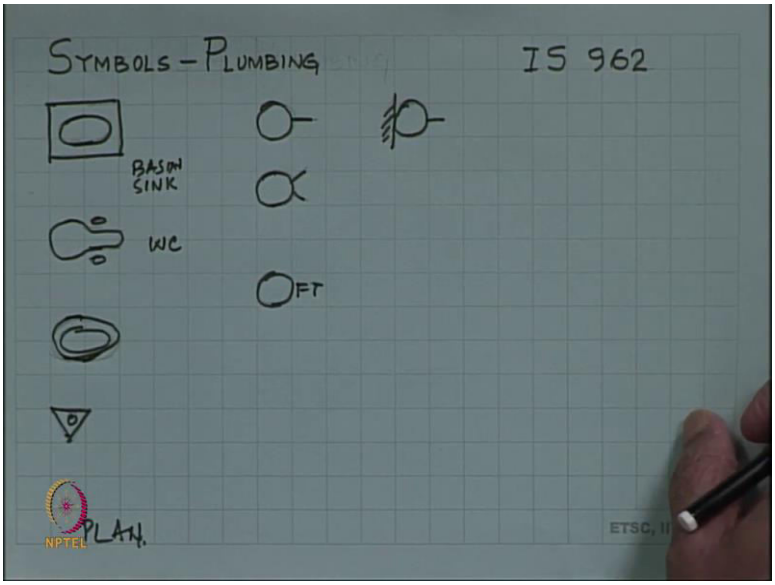

We now come to symbols for plumbing. And here are so I have reproduced some of the symbols that others are there in the standard and the rest we will put up on the website. One of the symbols is like that. And that tells you that this is a washbasin or a sink.

Then there are two symbols for the toilet, that is an Indian style WC and this would be a western-style WC. All these what are shown in the plan view. A urinal, would has the symbol like that and various type of taps these are shown by symbols like that in a plan view at a particular wall or it could even be shown in the elevation also.

There is one side, double-sided and this is a flow tap which is a drain from these the water goes out and this could be a wall mounted tap which is what you show like that. So when you put all these things on a drawing, it also creates a requirement that at the back end, in this case you need to put the piping that will go through the wall or the floor.

In this case, you need to put the sewage connection coming up there. So these are all the important services which are there in various constructions and they all terminate over here. These days when you design a building, we go into the details of each one of these before the final plan for the building is even approved.

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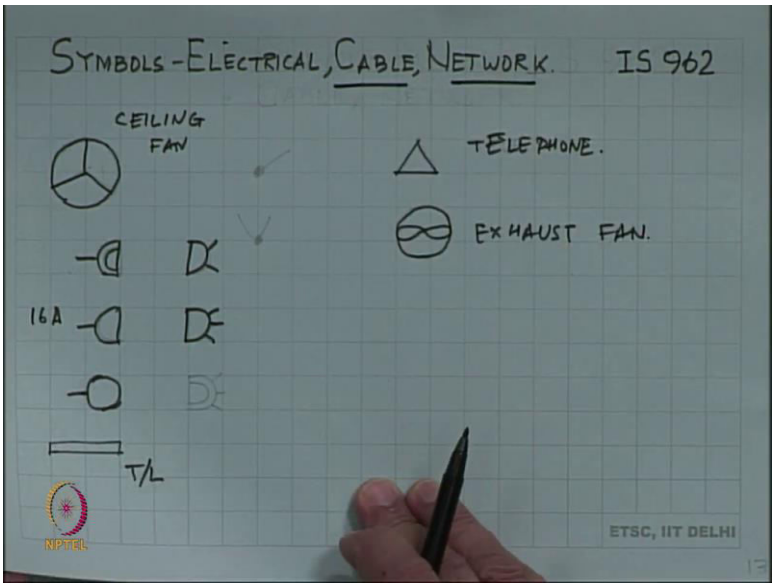

And finally, we come to symbols for electrical fittings. This one I have already shown is a ceiling fan. This is a plug for 5 A. This is a two-pin plug that is a plug for a power connection 16 A the three-pin socket would be like that and a light bracket on the wall would be like this during the plan view you showed this view on the wall if there is a light bracket there you need to have an electrical connection up to that point.

This is the picture for a tube light and this the symbol for an exhaust fan. This triangle would depict a telephone connection This is very limited in use these days. So many more symbols now need to come up for example for your cable connection, which is your could be a TV or data connection coming up, it could be a network point which has to be there. So these are additional ones for which new symbols have come up.

So all these things like our plumping thing give us the second important thing in the building construction, which is that wherever these points are there, up to that point electrical cable has to come which means that the entire structure should now have a whole pathway by which physical wiring takes place and terminates at these points. So that completes our discussion of civil and architectural drawings.

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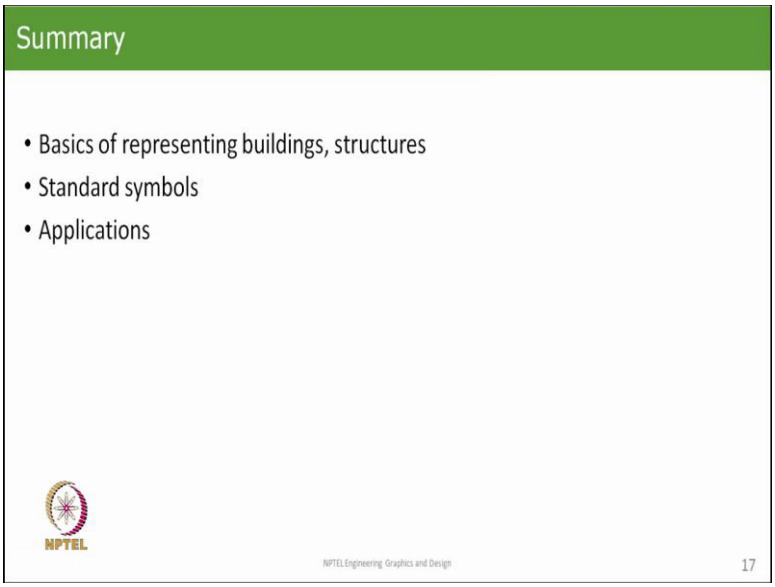

So to summarize, what we have learned in this lecture is that there is a certain way of representing buildings and some types of structures. We have seen the issues of floors, ceilings, walls, beams, and columns. We also saw how to show different types. Then we looked at various utilities, particularly plumbing, which includes water and sanitation, and electrical utilities. And we say that with all of this, we can put together a complete building design. Thank you.