Urban Governance and Development Management (UGDM)
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Lecture - 49
Essentials of Infrastructure and Engineering Design

Welcome to lecture 49. In this lecture, we are going to discuss few elements of engineering and infrastructure design. In this week, we are discussing the project management and its various aspects. The project management is required for effective implementation of the projects. In urban development what we everyday do and it is one of the very important mandate.

But it happens that those who are not technical person as such and those are involved in the urban development projects in a day-to-day basis, for them sometimes few engineering terminologies, few infrastructure terminologies becomes ununderstandable and as a matter of fact they face lot of difficulty and in the beginning I told you that this course even though it is mainly for the masters level and Ph.D level courses for the architecture planning, management, social studies or geography.

But some of the people who are already working in the urban local bodies or development authorities they also will be benefited from this course. So this lecture, I have kept especially for those who are not as such technical person but who have been working and dealing the technical matters from long time and will be dealing the technical matter in near future for them.

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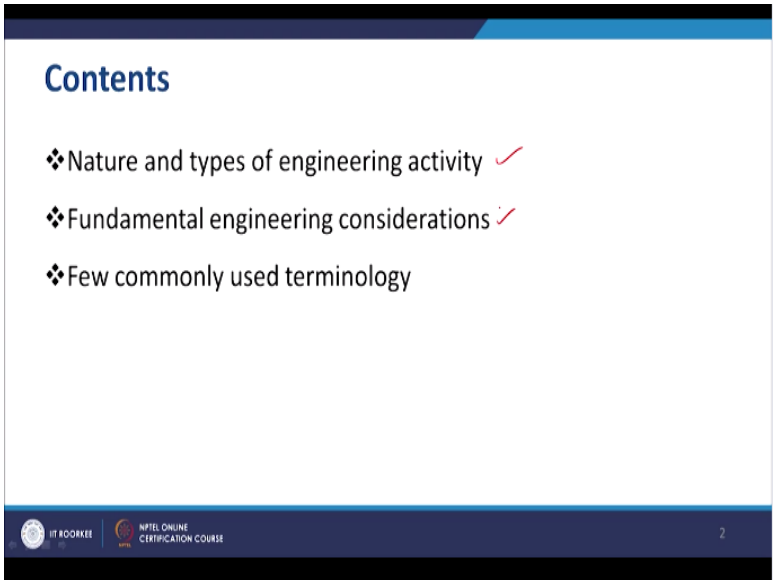

So for them, I would like to discuss in today's lecture basically the nature and types of engineering activities what is there in the urban local bodies, the fundamental of engineering considerations. When we design a major infrastructure or building or any structure, what are the major engineering consideration are there and few commonly used terminologies which we use day-to-day basis that also I may discuss.

Not being a technical person, you can deal the matter with the technical persons in a better way that is the objective.

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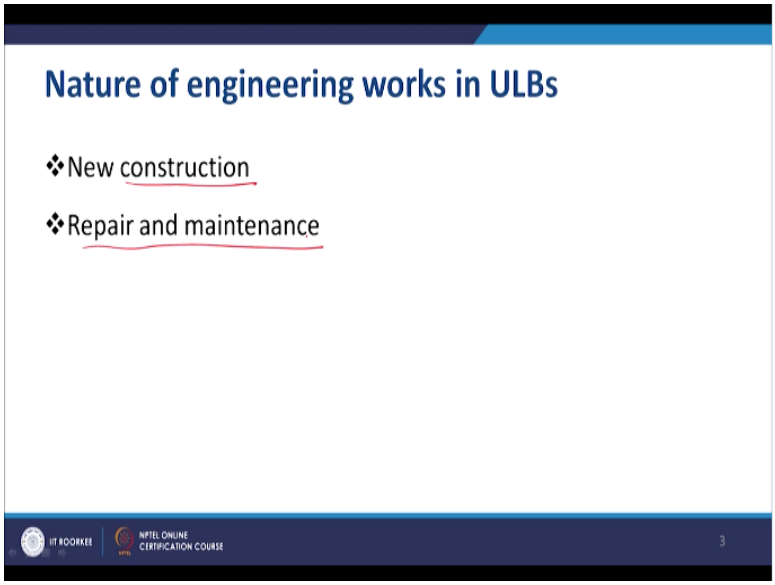

So you know that the nature of engineering works what we do in urban local bodies is 2 types, one is new construction and second is the regular repair and the maintenance of the construction or the infrastructures. As per the 74th Constitutional Amendment Act, you know

that all the urban local bodies they are supposed to deliver quality services for the water supply, sewerage, sanitation, drainage and then socioeconomic services to the citizens.

So as a part of that they are required to create lot of new construction, new infrastructure and once those infrastructures are created it is also required to maintain those infrastructure.

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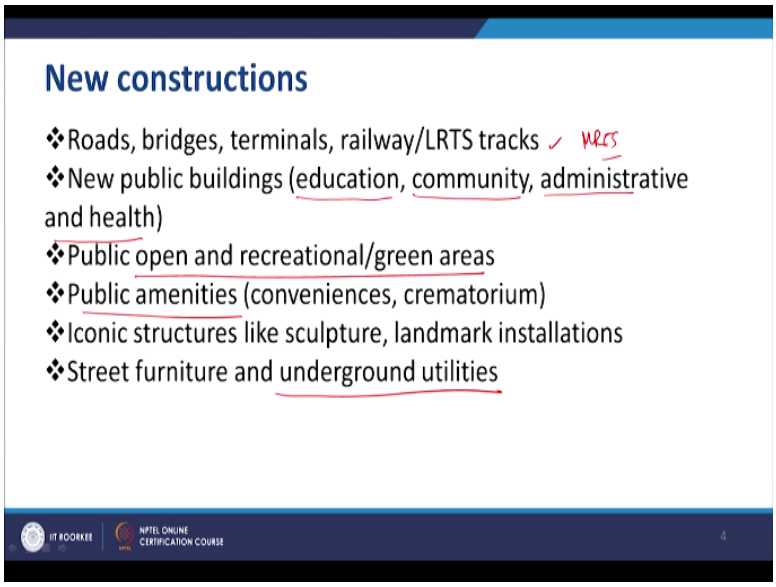

Now out of the new construction, you may be required to create new roads, bridges, terminals, railway or light rail tracks that is tramline or the metro rail MRTS tracks. Then, new public buildings, for example education, school building mostly the urban local bodies are involved in this school education, community centers, community halls and the marriage halls all those kind of buildings are also done by the urban local bodies.

Administrative and health related, many municipalities they are required to build their own office building, the ward offices, the offices of the other related organization and health institution. For example, the primary health institution at the ward level or at the higher area level, those kind of buildings are also need to be either constructed individually, separately or as an individual as integrated manner.

And public open and recreational green spaces, even though you are not required to create large infrastructure and large building but making designing and creating an open and recreational spaces also needs significant amount of engineering details and skill of urban design so those kind of construction also needed. Then, we make public amenities for example public conveniences, public crematorium all these are required.

Iconic structures like sculpture, landmark installation. Sometimes we make landmark installation in the road intersection or in the terminals so that it can create an iconic structure for the landmark of the building. We create sculpture and all the landscaping elements, street furnitures and sometimes underground utilities which also helps people for various kind of utilities. Those kinds of constructions are required in the urban local bodies.

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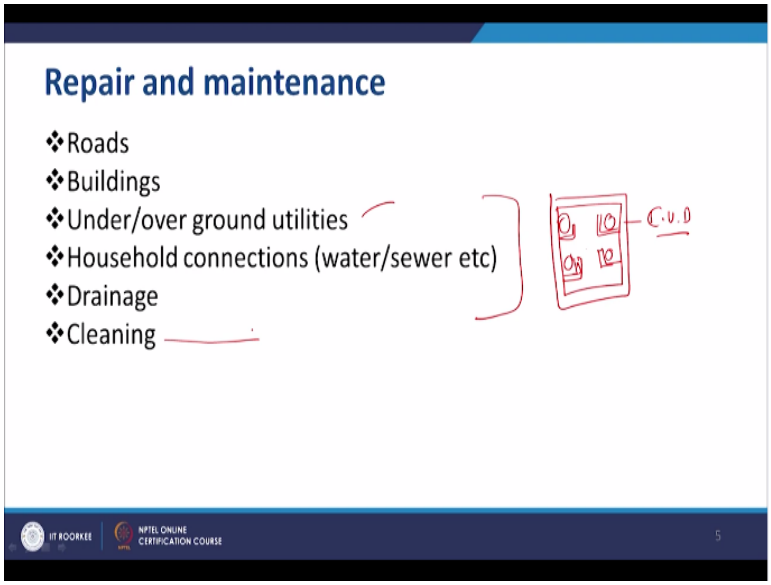

At the same time, we do repair and the maintenance like roads needs a regular repair work and maintenance work. Most of the time, the municipal engineers are busy with road repair and they are not able to devote their time and attention for any other work because road is such a matter which needs regular supervision and the maintenance due to adverse weather condition throughout the year.

Buildings, buildings also needs significant amount of repair and maintenance. Underground and over ground utilities. For example, the sewerage line, drainage line, electrical line, water supply pipeline, so many networks are there in the cities which we need to maintain in a regular basis. Household connections, water, sewer, etc drainage, cleaning. Now all these are dedicated work and major municipal corporation of the cities they have started doing now is to integrate all the service pipelines in a common duct.

They are making a common permanent duct and within that major duct they are accommodating all the pipelines like this. So this kind of installations is also possible but definitely this is costly but definitely even if it is costly this is permanent. So here a person

can enter and they can repair this so this is called permanent common utility duct. So this kind of trend is also coming in big way in our cities.

Then, cleaning is another regular maintenance work in our cities. Everyday municipal workers need to clean the road and the other public places. So what kind of considerations we must take for the engineering design? First is the now I would like to take example just to recall you that you might have seen the great public building or the public infrastructures created by the earlier generation.

They are very nice and permanent and nicely maintained but in current generation what we do sometimes it may be lack of cost or lack of attention in the minute engineering details. Sometimes it lacks that kind of finish and that kind of durability in terms of the lifespan of the building. So why not we also create buildings and infrastructure which are durable, which are good looking which is giving a pleasant effect and which is also giving essential utilities and the benefit to the citizens of the people for long years.

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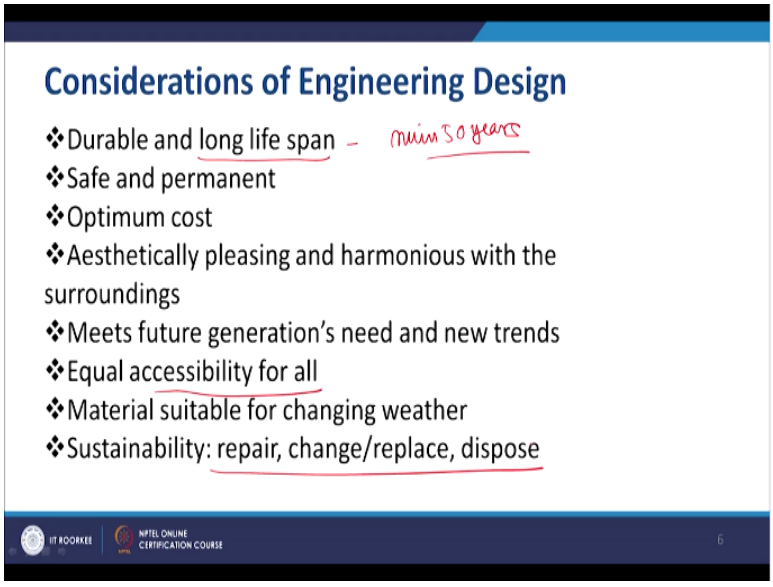

So major considerations for such kind of engineering design is number one, it should durable for long lifespan. When I say long lifespan, it should be minimum 50 years. Now if you see the major infrastructures, municipal infrastructure which was created during British period colonial time, more than 100 years back it is still performing well in some of the cities like Kolkata, Chennai, Delhi or Mumbai and for the infrastructure what we are creating in today's time it should have minimum lifespan of 50 years.

Then, safe and permanent, the infrastructure should provide a safe, secured and permanent facility to the citizens with minimum maintenance and the repair. It should have optimum cost. I am not using the minimum cost because if we only focus on the minimum cost not the quality, definitely the durability and the other aspect of the project may not appear. Therefore, considering the quality in all respect, the cost should be optimum.

Definitely, we are not going to spend much cost for a particular infrastructure but keep this in your mind that if you just for sake of construction if you construct one building or one infrastructure and after one or two years, it becomes fragile and it becomes additional liability for you, it is not desirable because in our municipal governance there are lot of liabilities already we are having in terms of the infrastructure, in terms of the manpower, so do not add another liabilities within one or two years.

So make permanent investment which is in the infrastructure which is durable, good looking and safe. So those kind of infrastructure is possible if you really focus on the quality and cost can be optimized. Then, aesthetically pleasing and harmonious with the surrounding, definitely whatever you create that should not be clean and beautiful in isolated way, it should be in integrated way it should be pleasing and harmonious with the surrounding.

Meets the future generation's need and new trends, all the technical persons who are working in the urban local bodies, you need to think about the future generation's need and aspirations, what kind of requirement will be there, think about the infrastructures which were created 100 years back in our countries in some of the cities and which is satisfying our need in this current generation.

So why not we try to see the recent future at least 10 years, 20 years so that what we design today it can cater to the current generation and the next generation also in terms of the material durability and also the design element. Then, equal accessibility for all engineering design infrastructure design what we do.

It must be given a maximum priority for the accessibility for all categories of age, sex and all categories of person including the differently abled persons using wheelchairs, etc and material suitable for the changing weather. In India, we have variety of weather situations, so

based on the weather situation at your workplace you should choose the material which should be permanent in nature.

And sustainability, you should think about the repair, change, replace and dispose. I told you that you should not choose a project only based on the capital investment. In a project, if you find the capital investment is less but your recurring expenditure like repair, change, replace, dispose all these are much more then you should not choose those kind of projects whereas if the capital investment is little higher than the minimum.

But the repair and the maintenance and the operation is much lesser and it is manageable and sustainable, those kind of projects should be given maximum priority. Having said that I will just mention few common design and the planning terminologies which you will understand as a nontechnical person and this will also give benefit to the technical persons as well.

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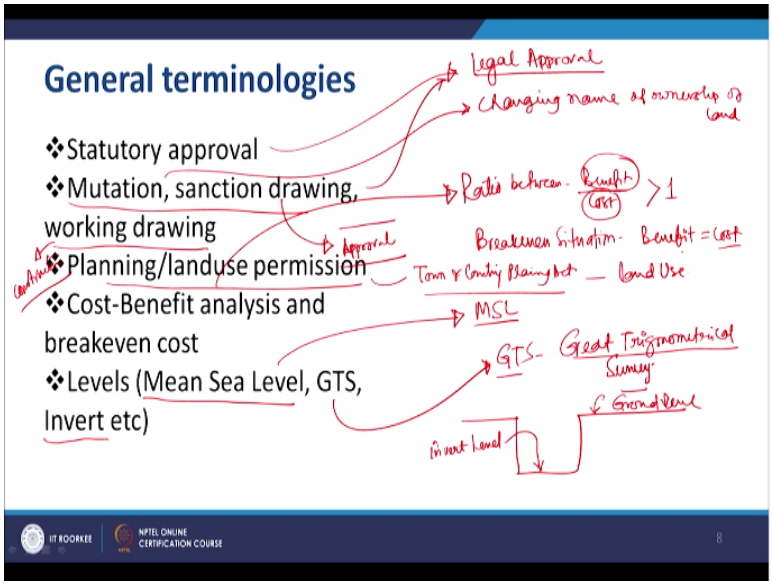

Now few general terminologies which we use in the municipal governance are like cost-benefit analysis, breakeven cost, levels. Now cost benefit analysis basically the ratio between the benefit by cost, so if the benefit is basically higher than the cost, it should be more than 1. So in a breakeven situation, so breakeven situation is where in the breakeven situation our benefit in terms of the financial benefit is equal to cost.

That means there is no loss and no profit and most of the public infrastructures are built in this way but I feel that even in the public infrastructures also the cost benefit ratio should be more than 1 so that there is some amount of surplus amount which can take care about the

sustainability of the projects. There are various kinds of levels we use in engineering design. For example, most of the cases we measure the level based on the Mean Sea Level, in short it is called MSL.

In some cases, the GTS level is used, GTS is nothing but in British period there was a great trigonometrical survey by (()) (13:33) surveyor general George Everest and based on that survey even till now we take GTS levels in making all this land filling or the public infrastructure in cities and regions. So some times GTS levels are also used. In some cases, the invert levels are used.

Invert levels are the bottom most level of any trench or so if this is the ground level and this is the trench, so this is the invert level right. So these are the few common terminologies. Then, I tell you few other terminologies like statutory approval. Statutory approval is the approval is basically legal approval. The opposite of the statutory approval is a non-statutory approval. For example, you are making a project report and getting the project report sanctioned by your funding agency.

So it is not statutory approval whereas you are making a city development plan and the city development plan is need to be approved first by the board of counselor or the mayor in council or board of counselor as the case maybe and then it need to be approved by the state government or the district planning committee or metropolitan planning committee. So those are the approval which is termed as a statutory approval.

Similarly, when a common citizen submits a building plan or they develop in permission, the approval which is given for that development is called statutory approval for construction of the building. Now statutory approval could be for the building, could be for the land use, could be for the infrastructure both, so statutory approval is every time should be mentioned under some law, so usually it is mentioned in the Municipal Act or Town and Country Planning Act or Land Registration Act and so on.

Similarly, the terms like mutation, sanction drawing, working drawing these are very much popular in municipal governance. Mutation is the process of changing name of ownership of land. So when you purchase land or sell a land, you need to transfer the land from the person X to person Y so that is happening in the Land Registration Department and when you

transfer that change over from the Land Registration Department in the municipal office that process is called mutation.

The sanction drawing is utilized for the legal approval basically for the approval in the statutory approval. Objective of the working drawing is mainly construction and objective of the sanction drawing is for the approval. So sometimes your role will be as an approval authority, sometimes your role will be as an authority asking for the approvals and planning and land use permission.

Planning and land use permission is given under in most of the cases Town and Country Planning Act and it is the permission of the land use. For any construction of the building or infrastructure, you need to take the permission of the land use in particular so that permission is called planning permission or land use permission. In most of the cases where development authorities are there or metropolitan development authorities are there entrusted or delegated this power.

In some of the cases, municipal authorities they can exercise this power also if it is given by the state government for the land use permission. After the land use permission, they can go for the statutory permission for the building and the infrastructure. After that there are few terms which is related to road and transportation which we use every day work.

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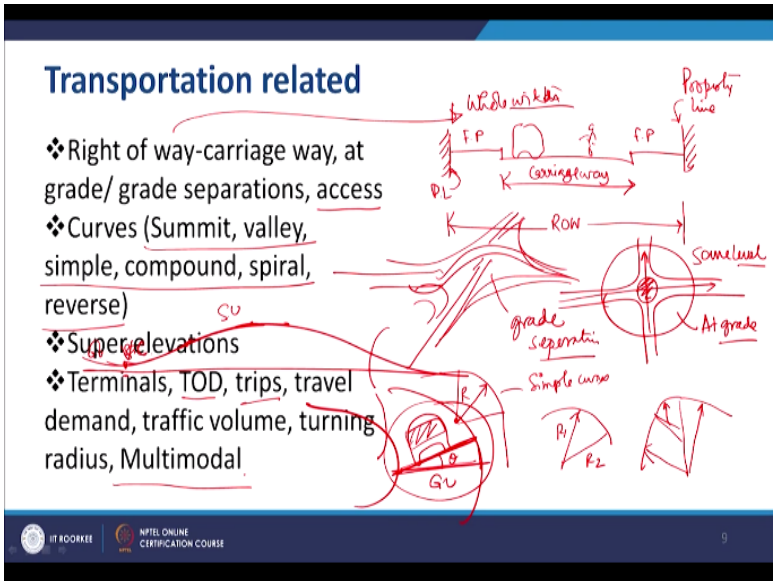

For example, right of way, carriage way; right of way is the whole width of the road. For example, this is a local road, so this is the property line and this is also property line and this

is footpath and this is the area for the vehicle. So this particular stretch which is used for the vehicle is called carriageway whereas the whole width of the road which is available which is called as right of way.

So usually carriageway is lesser than right of way because right of way consist everything like carriageway, footpath, cycle track, landscaped area for the networks everything. I have just drawn a very simple section of a local street so that you can understand. Then, grade separation, grade is basically the level where the road passes.

For example, I am showing typical traffic intersection which is happening in the same level without any level difference where all the journeys are maintaining in the same level either using by any signaling system or by some roundabout. So this kind of level and the intersections is called as intersection at grade. So at grade means mostly is basically at a single level and in some cases we can use the flyovers like this.

You must have seen flyovers like this, so if this kind of arrangements are done this is called grade separation. So grade separation is basically separating the grade into various levels so that one particular movement is given uninterrupted flow by making various grades. So this is the term used for making the transportation planning, making new flyovers, updating the existing flyovers or existing traffic intersection.

Access is a common term but access is also a technical term in terms of whenever you are going to give a permission of a building, every building or premises must have a means of access and without the means of access the building permission cannot be given. So first thing which you should check is the land ownership document for giving any permission, second is the means of access.

If there is no acceptable means of access, sometimes municipal authorities they make a benchmark that less than 3 meter means of access building cannot be given permission. So those kinds of stipulations are there, so access needs to be checked before giving any permission. Further we use various curves like Summit curve, valley curves, simple curve, compound curve, spiral and reverse curve.

In this kind of traffic intersection when there is a curve like this simple curve it is called a simple curve with having only one center and radius. Then, we can make a compound curve. Compound curve is having more than one radius, we can have spiral curve like which is used mostly in the traffic intersection spiral curve or we can have reverse curve something like this and then we can have Summit curve and valley curve.

Summit curve is when a flyover is made like this, so this is called Summit curve sorry this is called Summit curve which is utilized for reaching the top most portion of a flyover and this is called valley curve which is taking the vehicle from the ground level to the higher level. So these are the terminologies related to curve we use either for geometrical design of the building horizontally and vertically both.

Geometrical design of the roads horizontally, vertically or other than roads we can design also the flyovers. Then, super elevation, super elevations as you know that is used when we calculate a turning of a road and vehicle and when a vehicle turns along a road there is a super elevation by which it needs to be if this is the ground level and if this is the turning, this should be the level where the okay this is the nook.

So this is the angle required to maintain the speed of the vehicle and to maintain the safety of the vehicle. So this phenomenon is called super elevation. It is essential design element which we maintain whenever there is a curvilinear pattern of any road or flyover. Then, there are terminals. Terminals are basically the termination point of any transportation network. It can be railway terminals, it can be a bus terminals, it could be a metro rail terminals.

TOD is basically transit-oriented development, in many cities in India there are metro rails or mass rapid transit systems are being developed. Along the mass rapid transit system, there are high density compact developments are being encouraged. Those kinds of development based on the compact hidden city walkability and a mass rapid transit corridor is called transit-oriented development.

In the cities like Mumbai, Calcutta or Delhi, the suburban railway systems which is also based on the transit-oriented development. Trips, as you know that trip is a basically unit of transportation, travel from place A to place B by any means is called a trip. Trip could educational or for home and office or for any (()) (24:33) purpose. Travel demand, travel

demand is the demand in terms of the trips, number of trips from one zone to another zone so that is calculated based on the demand and it is calculated based on the surveys.

Traffic volume, traffic volume at a given point of time in any cross section of a road. Turning radius is the minimum radius required for turning a particular vehicle, turning radius for bigger vehicle will be more than the turning radius of the lower vehicle. For example, for a small car turning radius could be 4.5 meter, for a large truck it could be higher like 12 meter or 13 meter.

So all these are given in the IRC codes but I just mention for your better understanding and then nowadays we use multimodal terminals. Multimodal terminal is a common and very popular concept where from one terminal people will go will get all the facilities of transfer from one mode of transport to another mode of transport. For example, you are travelling by metro rail and after getting down from metro rail you get another suburban rail or bus connection or tramp connection or non-motorized transportation or even walkability.

So those kind of integration in terms of various kinds of modes in one point under one roof that is called multimodal terminals.

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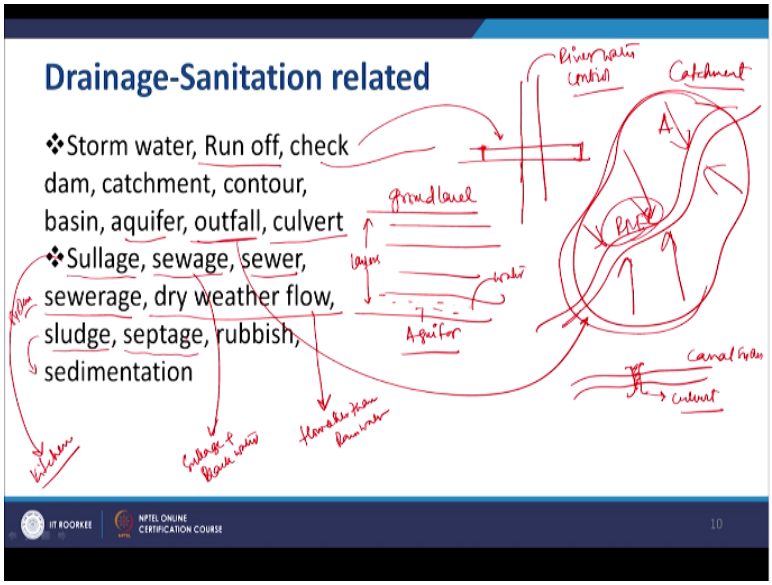

Then, drainage-sanitation related few terms are very much common which we use every day. For example, storm water, storm water is basically water accumulated due to rain. Run off is the phenomenon of the flow of the water in a given surface, so run off usually used or

calculated based on the surface condition and the quantity of water accumulated on that surface condition.

Check dam is used to if there is a flow of water like a river and check dam is used to control the water, control the river water and after controlling to use the river water by desired means so that is called check dam. Catchment is a technical term which is used in the drainage and other purpose also. So catchment as I discussed earlier also, so catchment is a geographical area like this which accumulates the water of a particular basin okay.

So if there is a river like this and the water of the surrounding areas are collected on the river only then that is the catchment area of that river and the whole area is also called as a basin area. Aquifer is the term used levels below the ground level if this is the ground level then there are several layers and below some layers there are layers of water so that water layer below the ground level is called aquifer.

Now why it is important because the level of the aquifer will help you to determine the depth of your foundation, depth of your various underground installation and also in some cases whenever you need to take water from the aquifer that also required will give you those kind of data. This data is available under Government of India websites and the aquifer is very common term in normal drainage and the sewerage construction.

Then outfall, outfall is the natural element like river or lakes or canals or the run off due to the some water will go and discharge there. So outfall is another technical term which is used here for example in this example the river is the outfall of this water. Culvert is used to make a temporary or permanent way along a river or canal system. This is the canal system. We can make a permanent or regular culvert.

So purpose of the culvert can be many starting from your regular pedestrian's connection to network connection so many purposes can be there. Apart from that there are terms like sullage, sewage, sewer, sewerage, dry weather flow, sludge, septage, rubbish, sedimentation, etc. Sullage is basically the waste water coming from your kitchen. Sewage is basically the waste water which is coming from the kitchen plus the waste water coming from your toilets.

Sewer is the pipelines which holds the sewage and sewerage is the system which connects not only the pipeline, the treatment plan and everything so sewerage is the system. Sullage is basically coming from the kitchen water and from the toilet we get the black water and it is the sullage plus black water from toilet and also dry weather flow. Dry weather flow is basically the flow in the sewerage system beyond the rain water flow.

So it is the flow other than the rain water. Then, sludge, sludge is the decomposed liquid which is discharged into sedimentation area after the treatment. Septage is the signs of sewerage and sanitation using the septic tank that is called septage. Rubbish is the construction and other waste which is collected at the municipal construction or various activities and also treated and disposed in some other particular place.

So these are also few terminologies which we use very common as a common day-to-day terminologies for the sewerage and drainage. Then, there are few terminologies related to building construction.

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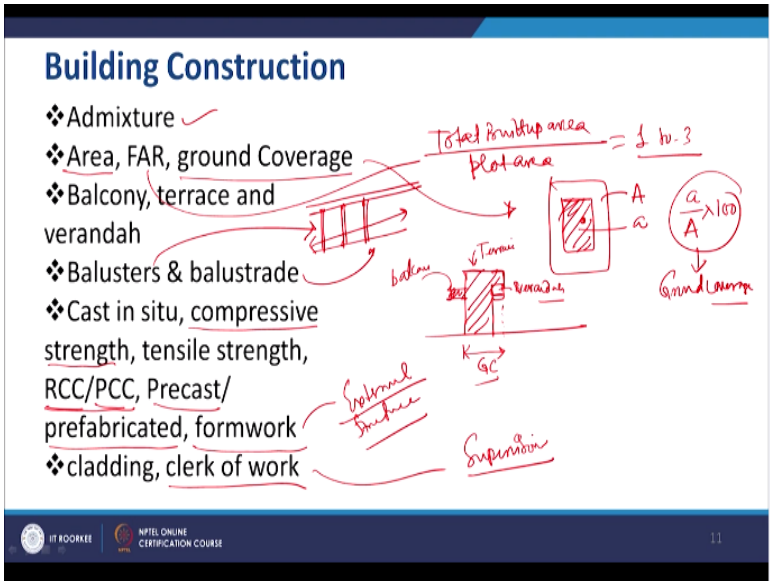

Admixtures are various mixtures used in the building construction, cement, concrete, cements, stone chips, sands all these are mixtures. Area, FAR, ground coverage, areas particularly after the (()) (31:38) we have discussed about the Real Estate and Regulation Act. We use carpet area; the carpet areas are basically the usable area within an apartment. If we add the areas of the walls and few common areas, it will be a built up area.

So built up area and the carpet area both are very important terminologies which we use in building construction. FAR is basically the total built up area/plot area, usually it is more than 1 it can be 1 to 3, usually you can check your local bye laws what is there. Ground coverage is if this is the plot and this is the building premises, so if the total area is A and the covered area is small a, so ground coverage is basically small a/A.

And it is expressed in percentage so this is the ground coverage. Now one common confusion what people make that if in elevation a building is like that having some projection like this, now the projected area also will come under ground coverage. So do not be confused that projected area also comes under ground coverage. It is not that you keep a setback in the ground level and in the higher level you just make the projections and it is not that.

Then, balcony, terrace and verandah; balcony is basically are projected area like this balcony and a terrace is a completely open to air area terrace and verandah is basically balcony but which is covered in the other floor so this is. Balusters and balustrade, whenever there is railing there are horizontal supports for taking hand rail and so these are balusters and when series of balusters are there, it is called balustrade.

Then, there are cast in situ that means which is the concrete or any element is being cast in site that is called cast in situ. Compressive strength of the concrete or any other material is the strength which is required to withstand the compression when you compress from both sides. Tensile strength is the strength required for withstand the tensile or when you pull the material for example concrete has a better compressive strength and steel has a better tensile strength.

RCC and PCC I hope you know, reinforced cement concrete, plain cement concrete. Precast and prefabricated concrete and the other element is also very much popular in current construction. Formwork is the external structure done temporarily to make the actual structure or to cast the actual structure that is called formwork and cladding, cladding is the external surface which is required over the wall or over an architectural piece.

Clerk of work is basically a supervisor who is entitled or who is responsible for the day-to-day quality supervision of a project, so therefore whenever you do a building project or any

infrastructure project, you need to have a clerk of work which should be included in the project cost.

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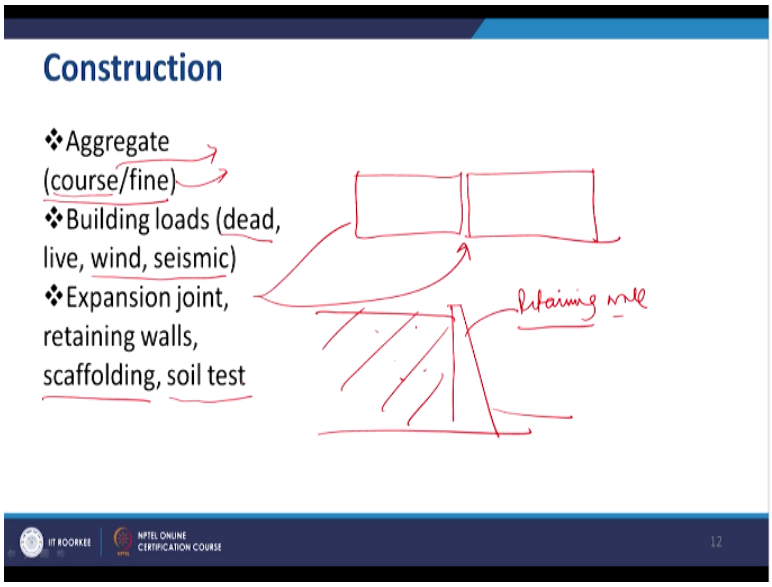

Then, there are few other construction terminologies like aggregate, course aggregate, fine aggregate. So as per the course, there are standards of how we can identify the course and the fine aggregate. For example, sand is there, then stone chips are there. Usually stone chips are the course aggregate and cement is the fine aggregate. Building loads, there could be dead loads, wind load and the seismic load.

Dead load is the weight of the building, live load is the weight of the living animals, living including the human and the plants, Then, wind, the wind load is also calculated when there is intensity of the wind much more special in the coastal area. Seismic load is calculated also in the seismic prone region. So all these are loads which are considered during the structural design by the engineers.

There are expansion joints between two parts of the building that is important. Usually as per the code, it is minimum 25 millimeter. So those kind of joint are very common when you construct a large building. Retaining walls are required to withstand the load of a higher build firm so this kind of structure you must have seen mostly in the hill areas retaining walls or build to withstand the load of some of the earth mass so that it does not fall below.

Scaffolding, soil test these are also temporary structure required to make the formwork of the building structure. Soil test is done for every construction before the start of the construction

so that the design can be done based on the soil test. It gives the criteria for designing the foundation of the building. Stirrup is basically the steel member which is binding all the reinforcement of a concrete structure and it is very common in concrete construction.

So I just mentioned few common engineering terminologies for your better understanding and I know that this is you must have heard many terminologies but those who are working at the municipalities or the urban local bodies these common terminologies are familiar but some of you sometimes have confusion between the terminology that is why I have discussed this but definitely I will share the reference material so that you can read and understand more.

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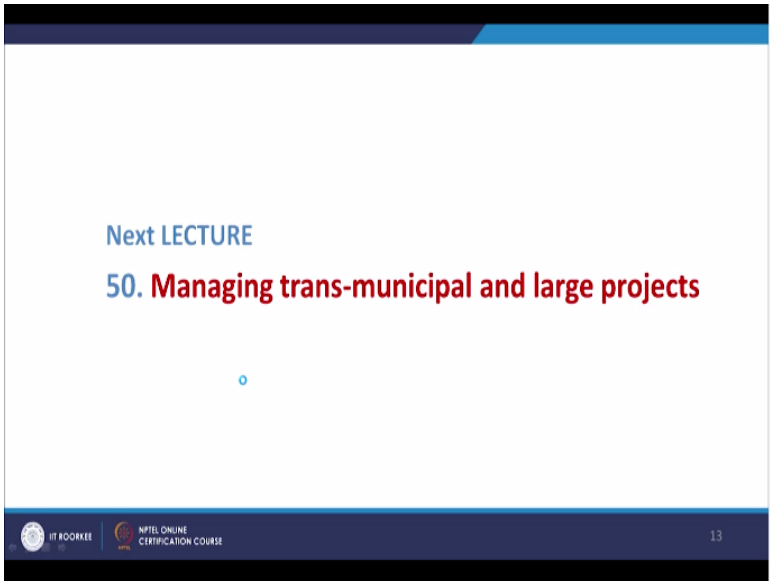

Having said that the next lecture will be another lecture on the project management. Will discuss how we can manage the trans and the large municipal project. So having said that I would like to quickly summarize and conclude today's lecture. Today, we discussed the various aspect of the engineering design. We have told that in earlier generation people made fantastic engineering designs and piece of infrastructures which is durable, permanent, having less amount of repair and maintenance.

In current generation also we can do that. There are several considerations for the engineering design of the infrastructure that we have discussed and also in the last we have mentioned various common terminologies related to building plan sanctions, building construction, road and transport, drainage, sewerage and sanitation. So I hope you got some idea about the engineering design. So having said that thank you very much for attending this lecture.