Sustainable Architecture
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Lecture – 22
Sustainable Sites - II

Good morning, welcome to this next lecture for this week where we are developing, we are learning about the Sustainable Site Development for Sustainable Architecture. This is your online course on sustainable architecture and I am your instructor Dr. Avlokita Agarwal.

In the previous lecture, we have seen what are the broad aspects which we should keep in mind while selecting a site for sustainable development, sustainable architecture. In this lecture today, we will look at what are the strategies which should be employed for sustainable site development. We are largely talking about the design and construction phase when we are developing the site.

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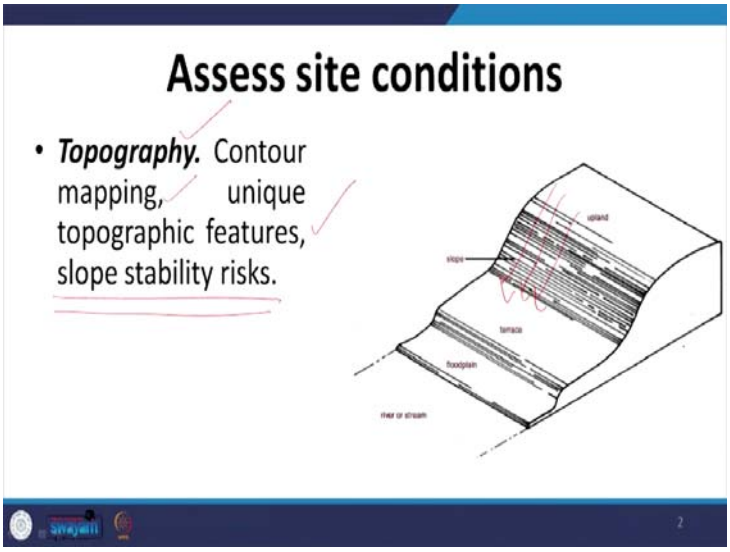

So, while starting with the sustainable site development, we have to first assess the site conditions based upon different parameters. So, the first and foremost parameter is topography. Here we have to look at what is the contour map of the site, what are the unique topographic features; for example, there might be a rock outcrop, there might be a water body, there might be a thick dense forest. So, what are the unique topographic

features which are there, and we will also do an estimation of the slope stability and the risks associated with it.

Now this topography is important, because it affects a lot of other parameters, other factors. One very important is how the storm water runs through the site. So, if there is a steep slope, the storm water runs very fast; and when we are talking about storm water, simultaneously soil is getting eroded along with the storm water.

So, how the slope should be utilized, how the construction activity on this topography this variation shall be done will be dependent upon how, what is the contour map and what is the topography. So, it is important to assess topography.

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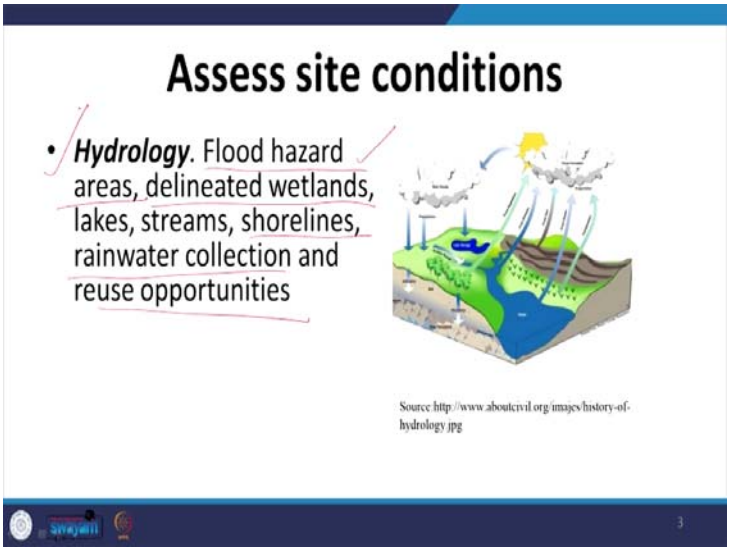

The next is hydrology: we have to understand the hydrology of the site. Now that includes flood hazard areas; we have to see where the nearest water body is and how much is the flood hazard. That is what we were talking in the previous lecture, where we talked about the flood plains; we have to ensure that the site does not come in flood plain. Even when it is not coming under the flood plains, we have to see what are the flood hazards for the given site.

We have to understand whether where are the delineated wetlands is our site or part of the site is part of that wetland or lake or any other water body, what are the shorelines if we are talking about the coastal areas, what are the shorelines, what are the rainwater

collection and reuse opportunities depending upon the topography analysis assessment that we have done. So, topography and then hydrology is very important to be understood before we go on to design and develop the site.

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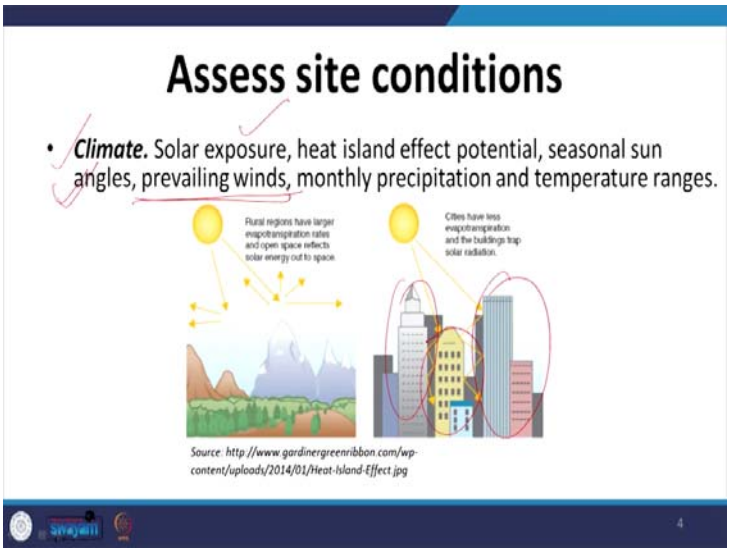

The next is climate. So, we have already done a detailed understanding of how the climate of a place we understood, what are the different parameters, what are the different factors which are used to understand the climate of a place. Now that was the macro level study. Here when we are talking about climate, we are doing it specific to the site; here we are talking about the solar exposure.

So, for example, there are there may be a lot of buildings around the site and they may actually block all the sun which is coming onto the site; or there might be buildings on one side of the exhibit the site under consideration and the other side might be free, how much of the hard surfaces are there around and all that, that will also come in climate. Also when we are talking about the site, specific climate issues and assessment we are talking about prevailing winds; because the direction of winds may change inside the city, once they are inside the city. Because the built mass, the skyscrapers and high rise buildings they divert; they deflect the wind when it passes through the city. So, it might be a different experience, it might be a different direction altogether.

And besides that the overall macro factors which define the climate of a place.

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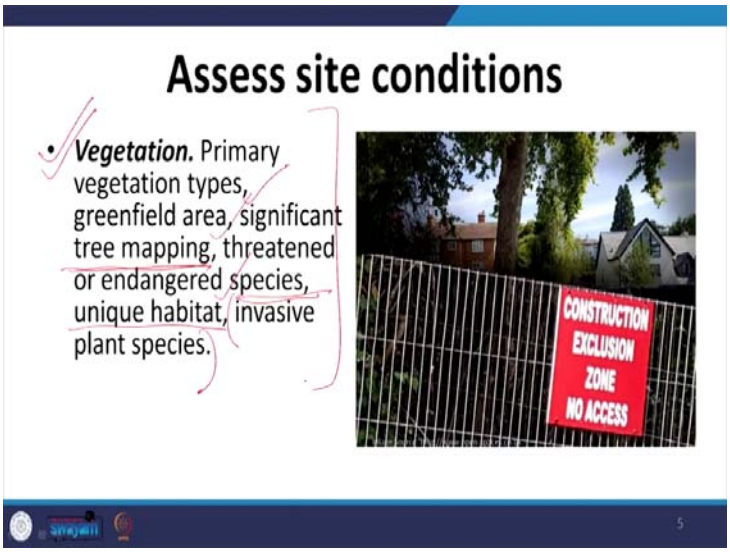

After this we also have to understand, we all also have to assess the vegetation which is present; because we are talking about sustainable site development and at no given point of time should we be compromising on or exploiting the natural resources which are present. And vegetation is one very important resource.

So, we have to know what are the different types of vegetation which is present, how much of the Greenfield area is there. We have to do that, we have to properly map what all trees are there, where they are, what are the different species which are there, and if any of these species is a threatened or endangered species. Even plants have endangered species, some plants are on the verge of extinction; because they have been overused and there is no replantation or regrowth of them. And if it is the site is a unique habitat to certain plants and animals that is what we have to see.

We also have to understand if there are any other invasive plant species. If you remember our initial lectures we talked about alien invaders; now alien invaders are not just animals, they may also be plants. So, certain plant species may be invasive and they may just take over the entire area. So, we have to identify those, all this has to be done when we are assessing the site for its vegetation resource.

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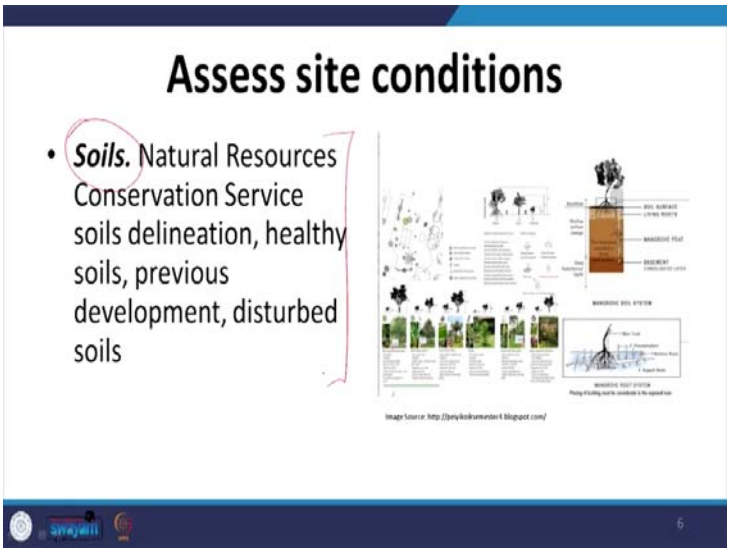

Besides this we also have to look at the soil characteristic.

So, what are, what is the type of soil, what is its retention capacity, what is its bearing capacity; besides all those, we also have to see whether it has been previously developed, whether there is a potential for redevelopment, the kind of plantation that can be grown in the soil, is there any disturbance which has been caused to the soil. So, all that will come within the discussion on soils.

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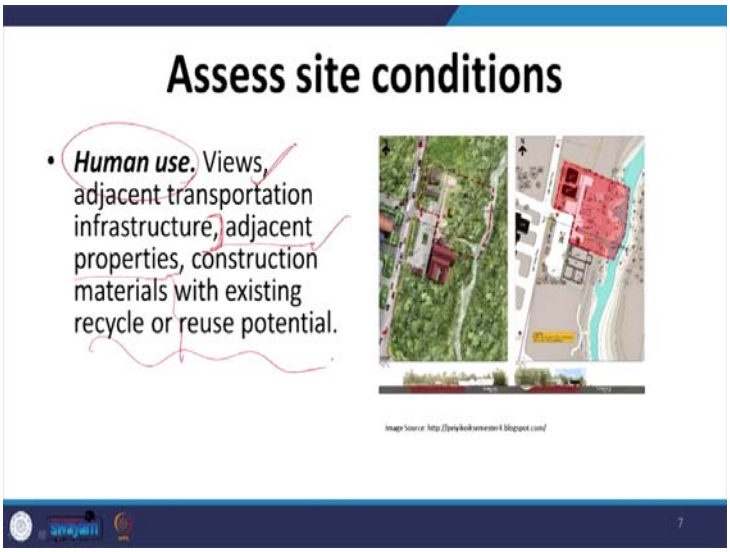

Now, besides these physical and tangible aspects of resources which are already present; we should also look at how the humans have been using the site or what are the possibilities in which the humans can use. Now here this we would do on the basis of some factors; few of these are views. Now what kind of views and vistas are available to humans, to occupants from this site and at what height.

Now, this may be view and vista to natural scenery which is available around or it may also be some iconic structure which may be available, which may be there in the vicinity, it may be something else also. So, the views to that; then we have to look at how the transportation, adjacent transportation is there. So, in case of large sites, there are several such cases where on one side there is a metro line coming and on the other hand there might be a public transportation. Now where would the entry to the site be has to keep in mind, where would largely the people be coming from, what kind of transport mode they would be using.

We have to look at the adjacent properties, how humans would be using those adjacent properties. So, suppose there is a commercial building which is being developed, and there is a commercial build a huge mall, shopping area which is right next on the site. Now it is absolutely human that the people will be using the adjacent site. So, how, what kind of connections should be provided, so that it is easy for people to use. Now for that the assessment of adjacent properties has to be done.

Besides this the kind of construction materials which can be used for their recyclability and reuse potential, may also be assessed at this stage. This is also the stage where we are looking at what kind of uses are going to be there, when we are talking about occupants, human. So, suppose we are developing a school for differently abled children; now what kind of materials shall be preferred when we are talking about differently abled children and their school?

So, this is not based upon any other factor; like local availability of the material or its durability or any other property, but we are primarily looking at the human use aspect of it. So, this is the social aspect of site assessment.

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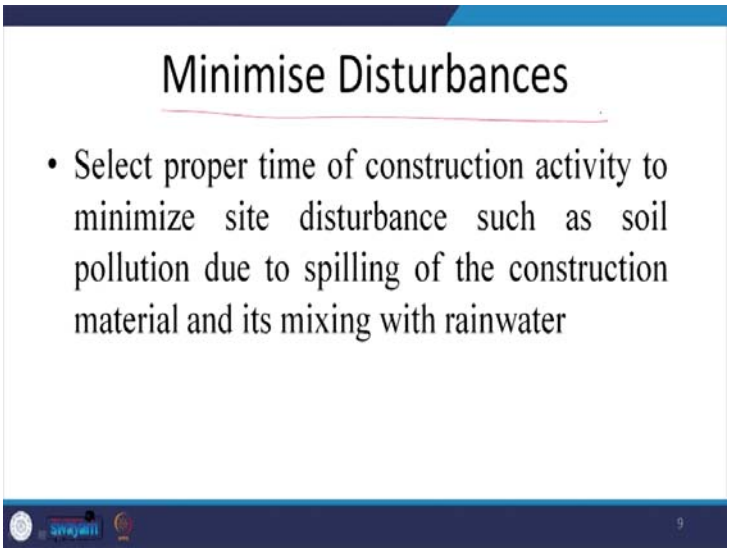

Once we have assessed the site for all of these, we would then go ahead with designing the site for a sustainable development. So, couple of aspects that we would keep in our mind while designing and also developing. So, it is design and construction both together, when we are talking about sustainable site development.

So, there are certain aspects which we would keep in mind; the first and the most important we being we have to minimize the disturbances to the site. The natural systems to the soil, to the vegetation, to the open area, to habitat if it is of any other species, to the stormwater pattern; so there was a natural stormwater drainage pattern, which was existing before the development would take place. We have to minimize the disturbances to each of these; to hydrology, to topography, to vegetation, to everything this is what our main aim should be.

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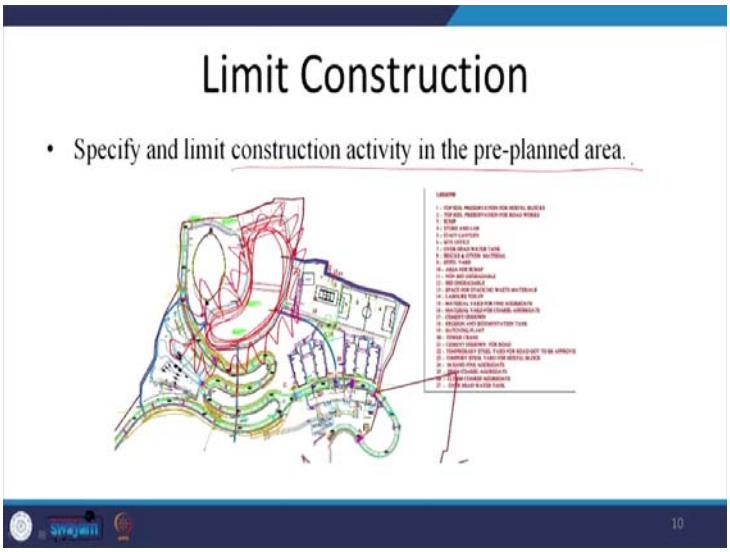

Now to do that, we have to limit the construction. So, one the design should be developed in such a manner that it respects the topography and hydrology of the site, and ensures the retention of maximum amount of vegetation which was already present there. In order to do that, we will have to limit the construction. So, suppose a building has been planned, a building block has been planned; now when the construction goes on a lot of spillover because of excavation and construction material being brought in, a lot of spillover is there.

So, though the building may be restricted limited only to this much area, but the spillover of this construction may be even wider; we have to limit that. So, if you look at different rating systems; there are different guidelines which are prescriptions that the disturbance to the site may be limited within 1 meter, 2 meter, 3 meter of the building boundary depending upon what kind of construction it is.

So, suppose it is a walkway, it is just a paved walkway; the allowable limit is smaller. So, it may just be half a meter from the side of the walkway; when it is a larger building a huge full-fledged building, this limit may exceed, the increase to around 1.5 to 2 meters depending upon the type of building structure which is coming up, depending upon it is height. But the overall impact of this construction shall be limited to certain areas and this will happen if it is being done; the construction activity is being done in a pre planned manner.

So, there has to be a planning of construction which has to be done. So, construction planning and management has to happen.

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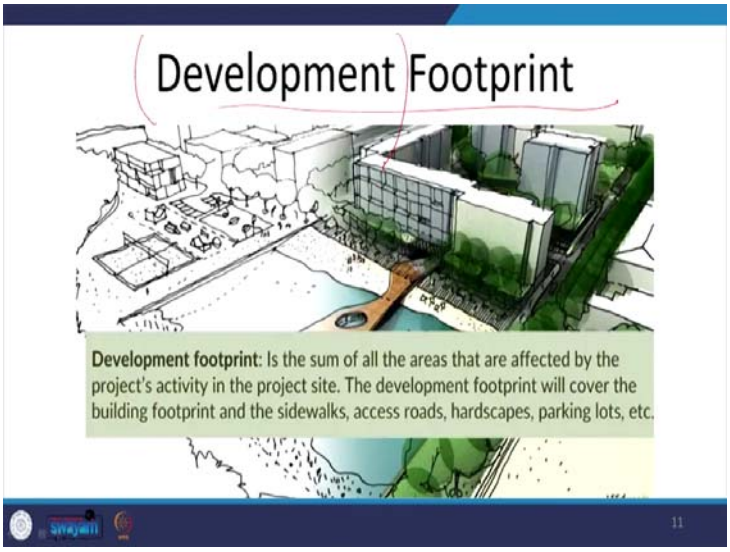

So, we are talking about; when we are talking about limiting the construction, we are talking about, also talking about development footprint. So, it is not just the total building area which is being developed, it is the overall site which is being developed. So, many are times; even though the building footprint is small, the development footprint is quite large.

So, there are roads, there are walkways, there are some play areas. So, there is hardly any site which is left which is not developed or which is undisturbed. Now these are two different things; so we talking about building footprint and we talking about development footprint here. We have to reduce the development footprint.

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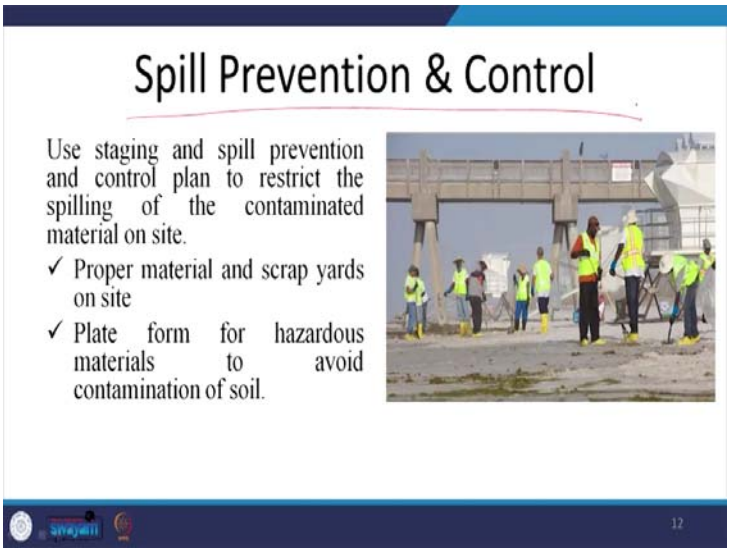

The next aspect would be spill prevention and control; now often the construction material which is used on site is spilled over almost everywhere on the site. For example, say we are using bricks very simple, it is a very common building material in our country.

So, if bricks are being used, now those bricks will be brought from somewhere, they will be stacked on your site, they will be soaked in water, they will be then taken to the actual construction where the building is getting constructed. Now in that process there is a lot of spilling of this material. So, not just, now brick is relatively a safe material and it can also be picked up cleaned; and the soil can be the original characteristic of it may be retained. But there are other materials; for example, there may be chemicals, there may be adhesives, additives which might be used on the construction site and they are.

Now, spilling of that may actually change the characteristic of the site forever the soil, it may not have the same characteristics.

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So, we have to ensure that there is no spilling which is happening and that will come with proper barricading and alienating of areas, where such materials will be stored, proper handling of these materials. So, chemicals on a proper sheet of metal plate, proper cubicles being made, areas being delineated categories to sort different categories of waste.

So, all that who will come as part of the construction management plan, which will help in reducing and preventing the spilling on site.

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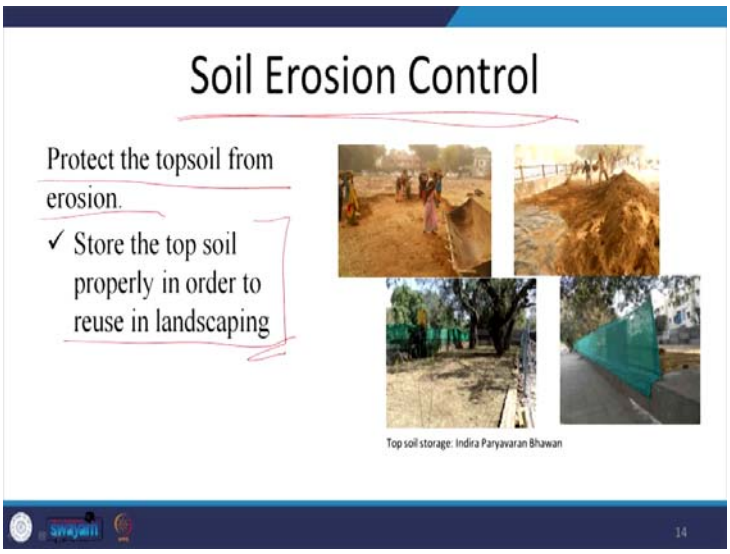

The next aspect is soil erosion and it is control. Now often during the construction a lot of soil is eroded, because of rains and also wind; that has to be absolutely controlled, minimized and brought close to zero. So, no soil should be eroded during the process of construction. Now there are multiple strategies and practices which are which will come when we are talking about soil erosion; the first and foremost is protecting the topmost soil topsoil from erosion.

Now, topsoil is the most fertile soil all of us know that, that is also the soil which is most neglected and abused, misused during building constructions. We excavate and that soil is either dumped used back for refilling is not properly taken care of, dumped for some other purpose dumped somewhere else. Now that topsoil should be stored properly in proper manner, so that it can be reused in landscaping because it is a fertile soil.

In addition to just reusing the soil, it should be we should try our level best to bring the same soil back to the same place; because a lot of bacteria are there in the soil which is the characteristic of that soil. So, if the soil which was excavated from say site A is brought back to the site A it will be beneficial and the overall site will be healthier more sustainable.

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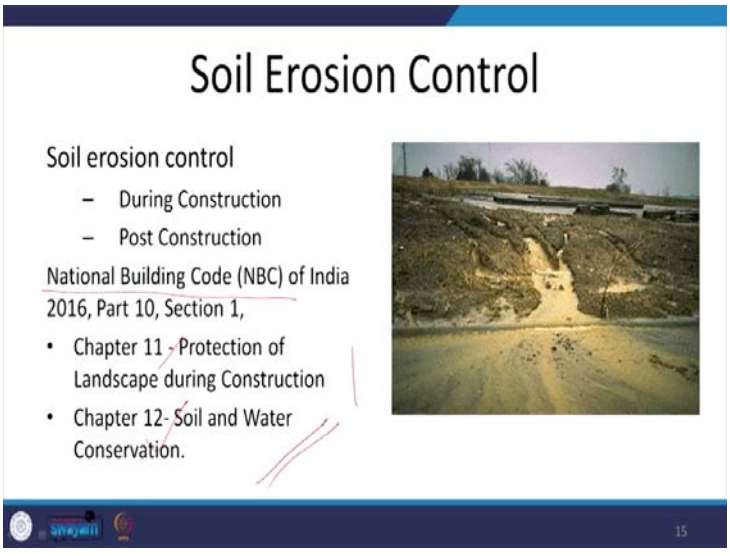

So, two different strategies and these practices for soil erosion control are also mentioned in NBC 2016 in chapter 11 and chapter 12, where protection of landscape during construction and soil and water conservation are being addressed.

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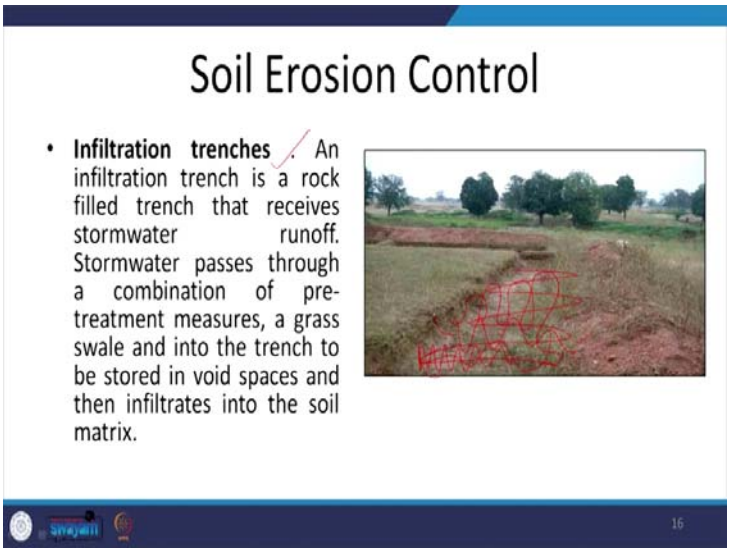

There are many strategies which are given as part of NBC and which are also being practiced. I am just mentioning few here, but there are many more; it is not a comprehensive list of strategies which can be used for soil erosion control. One is infiltration trenches; if you can see here, this is an infiltration trench. Now this is nothing, but just a little depressed area which is filled up with rocks and boulders and it allows water to stay to hold.

So, it one we have to reduce the speed with which the stormwater flows. Once we are able to reduce the speed, we are able to reduce the amount of soil it carries. So, reducing the speed and then holding it in one place where the soil is settled. So, if the water which is flowing comes here settles, all this soil will be retained within this trench and there will be no soil erosion which will be taking place.

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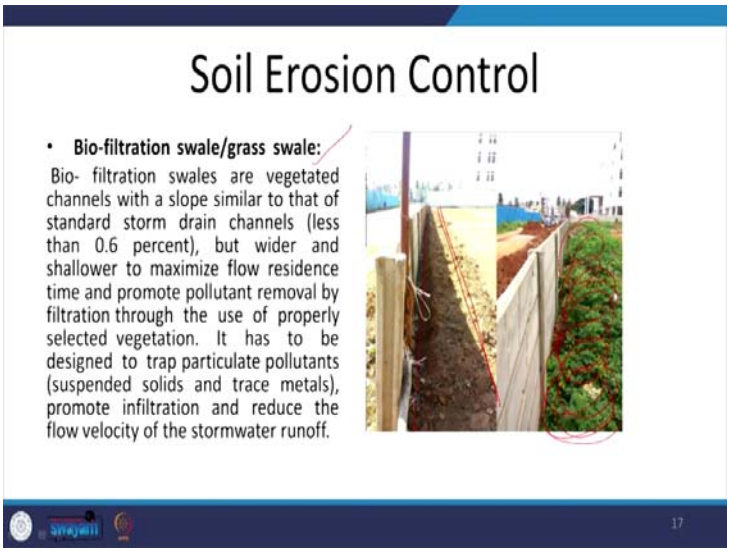

Besides infiltration trench, we have bio filtration swale or grass swale.

So, in infiltration trench rocks and boulders are used as a lining, they just filled up. So, the water percolates down and the soil is retained. In a bio filtration swale, instead of rocks and boulders, we use vegetation. So, this is an example where they have just created a trench, a kind of depressed channel; and gradually the vegetation has come up. Now the roots of the vegetation, the plants which come up in this swale, bio filtration swale; they keep the earth porous, and they help the water to percolate down and to retain the soil.

So, it helps both in stormwater management as well as the soil erosion control. So, it is a strategy.

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The other is a sand filter. So, sand filters are devices that filter stormwater runoff through a sand layer into an underground drain system. Now here what we are doing is, we are mainly lining the entire channel of this stormwater with sand, which will help to filter, which will help to reduce the speed, and also help in percolation of water down to the ground; and during the process of this filtration, the soil is held back by the sand.

So, this is another very effective strategy. There are sedimentation tanks.

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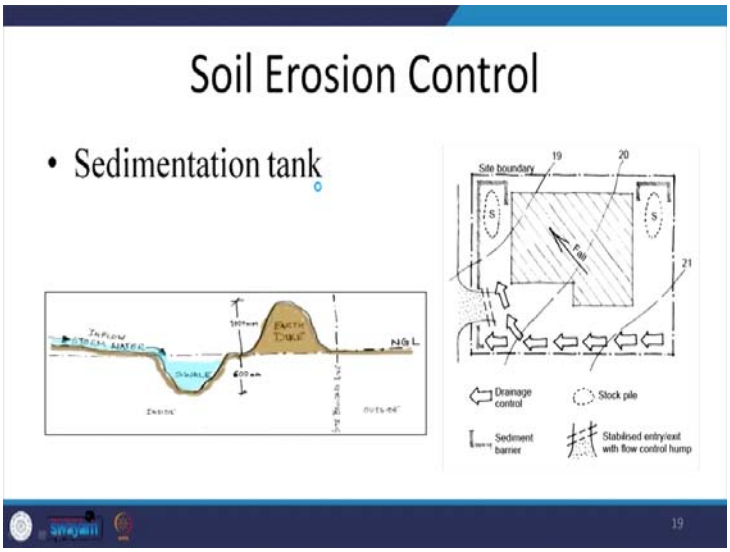

Now, sedimentation tank; the previous three strategies which we just discussed, require less of space; they are just channels. So, depending upon how much area do you have available, smaller channels can be created; they can be created at regular intervals and all of that; however, sedimentation tank requires larger area.

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We need huge areas where the water can be, the entire water from the site during a storm can be brought; it will be allowed to stay there, retain. It helps in charging recharging the groundwater, because the water will percolate down and it will control the soil erosion.

So, a lot of water bodies in villages and all actually acted; the ponds which we normally see in villages are actually serving the purpose of a sedimentation tank. So, all the, and these will be created in the low lying parts of the site, where the contours are low. So, that all the water comes together there, there is no additional means additional channel which is created to bring water to these. Naturally through the natural slope, the water gets collected to these into these sedimentation tanks. The soil is held and the water is percolated down to the ground.

So, these are some of the examples. Now these tanks may require lining; like this one which we see here, this is also a sedimentation tank, or properly done lining, or it could just be a loose lining; it may not be lined at all, it may just be very naturally occurring.

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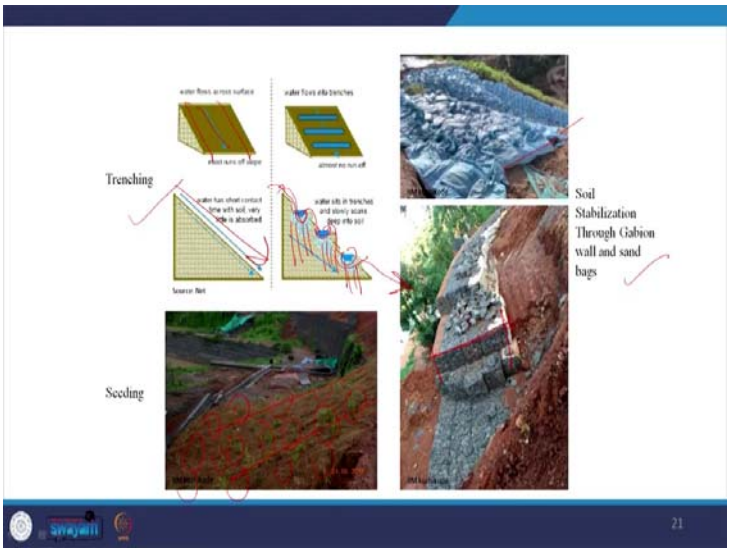

But sedimentation tanks will again help in both; reducing the stormwater flow out of the site, and holding the soil back.

Besides sedimentation tanks, we are we can also look at trenching. So, instead of a regular slope, this slope can be broken. So, smaller trenches are created. Now once the water comes instead of running directly, water comes here collects. So, the speed is broken. And then once it overfills, it is further flowing, again the speed is broken and like that. So, there would hardly be any water which is flowing through the slope, and there will be more percolation down to the ground. So, we are allowing for more percolation to the ground and at the same time we are reducing the speed of the stormwater, so that no soil is carried along with the water, stormwater.

The other methods are seeding. So, the slopes will then be seeded. So, there will be vegetation which will be there. So, lose and not a very manicured planned manner; but just seeding the entire slope, will help in reducing the flow of water and percolation of it down to the ground and reducing soil erosion. Others are using gabion wall, the very thick gabion wall which is loosely filled wall with gravel and boulders and sandbags; sandbags like these, they may be placed to stabilize the soil wherever there are slopes. So, these may be used to reduce the sliding of the soil, carrying of the soil with water or wind with the help of these.

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There are strategies where the entire patch of the slope has been covered with geomembrane or other kind of fabrics. This one is a particular strategy and a product which is called Bhoomi Vastra. Now here the entire soil is covered with that, it is biodegradable, it is organic; but by the time the slope stabilizes this material decomposes itself. The slope has stabilized, because the vegetation has grown. So, there are roots and this will eventually degrade, because it is organic.

So, this is again another strategy of soil stabilization.

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Temporary seeding and mulching we have already seen, not just for slopes, but also for plain areas. The soil which is tagged, which is coming out of the excavation for large building product projects, it may be seeded and mulched temporarily; but it will help in controlling the soil erosion.

And then proper stacking of materials; many a times because the material is not properly stacked, it disturbs the compactness of the soil, it makes it loose and that is what also increases the soil erosion. So, besides soil erosion, another very important factor aspect is preserving the vegetation which is existing on the site.

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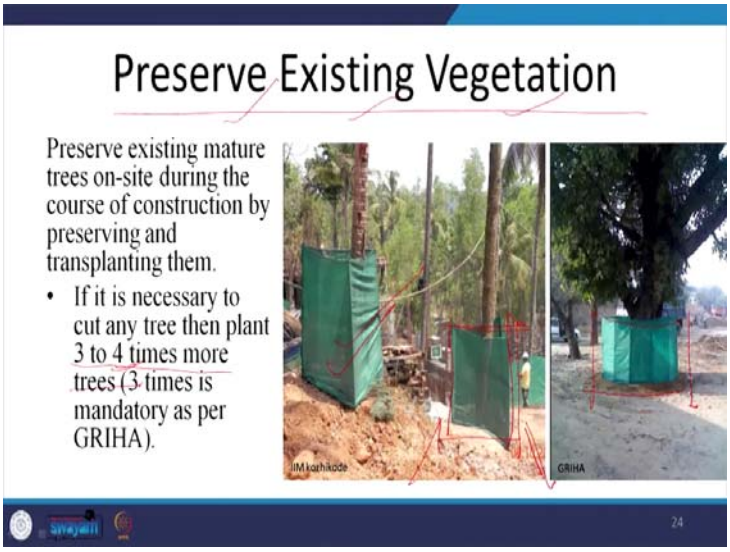

Now, majority of the times this will happen; because it is not just the building footprint, it is the development footprint. So, once we limit the development footprint, there are larger chances where we will be able to preserve the existing vegetation; but if we deliberately want to preserve existing vegetation, we have to design the buildings in such a manner that trees are not being cut.

The buildings may be chamfered; the buildings may be slightly shifted, so that a tree which is existing is preserved. And once through design, we have arranged to preserve these trees; during construction we have to actually physically preserve. So, there will be barricading, there will be cover which will be provided to the trees during the construction activity and we have to ensure that this root of the tree is not getting disturbed.

In case there is a tree which needs to be cut while the development, while the construction of the building has to be commissioned for different rating programs, green building rating programs, different numbers are there; but around 3 to 4 times more trees are supposed to be planted. In one of the rating systems, you can see that as high as 10 times the number of trees cut is to be planted on the site; it is not elsewhere, but it is on the site that those trees have to be planted.

So, if one tree is cut say, four trees need to be planted and provisions need to be made. But the best strategy is to preserve the existing vegetation through design first, and then through construction like this, proper covering of these trees.

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In case we cannot preserve the tree for some reason, tree transplantation could also be done. Now it is not a very easy thing to do, because the tree has to be excavated along with it is root. So, for all the fully grown mature trees, they have a huge large root structure as large as their foliage above on top.

So, this entire root has to be taken out. So, it becomes quite a challenging engineering exercise to transplant a tree; and at times the tree may not survive because of the change in the soil condition and moisture and a lot of other things. But in case there is no possibility of preserving the tree, tree transplantation can also be done.

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Another very important aspect is dust prevention and control. So, often when building development is taking place, the construction takes is taking place; the soil becomes very loose and it creates dust all around the construction area, all around the construction site. And it is a major cause of air pollution in cities; because a lot of construction activity almost keeps going on, and these suspended particles of soil which is dust, very fine particles they create air pollution.

To control that dust, there are certain measures which need to be taken into account, which need to be practiced during construction. This is largely during construction. So, we have to barricade the site. Now you would find that, in India earlier there was no barricading which was happening; but now almost all large projects are barricading. So, the entire site would be barricaded with at least 3 meter high barricades and these barricades may go up. So, this will contain the air pollution to the construction site only. In addition to that washing the wheels of all the vehicles which are exiting the site; because this soil is loose and it is taken by the vehicles and through their wheels. So, wheel washing. So, this is a water body, a water tank a very shallow tank which is created full of water.

So, every time any vehicle goes out of the site, the wheels are automatically washed.

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So, there are different strategies which are used for wheel washing, this is for dust prevention. In addition to that coverage of fine aggregate; here we can see that the fine aggregate and also the soil which is excavated and it is available on the site is properly covered. Not just what is there on site; but all the vehicles which exit the site and they carry a lot of construction materials, they need to be properly covered too, so that they do not carry dust with them.

In addition to that, what is sprinkling on the fine aggregate and excavated earth; so water will control the dust from rising up and creating problems.

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For all the diesel generator sets on site which are to be used, they should have proper chimneys with their outlet us facing away from the site. And in case of large tall buildings, the use of dust barrier; so these geomembranes should be covering the entire site, not.

So, this is just one portion which is there, but actually the entire building has to be clad using these geo membranes, so that no dust during the construction of the building comes out.

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So, this is what I was talking about, where the vehicles have to be properly covered, the vehicles which are carrying loose materials.

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Now, to implement all these strategies, to practice all these strategies; a proper site management plan has to be created, where would the vehicles enter and exit from, where would that wheel washing happen, where would the different materials be stacked, where would the earth which is excavated that will be stabbed.

So, all that has to be developed in the form of a site management plan; how in a phase wise manner the construction activity will go on, so that the transportation of materials through the site is not happening as much the development footprint is contained. So, for all of that, proper site management plan will be created; there will be dedicated activity spaces, there will be dedicated roles and responsibilities for people and different phases of development will be identified and planned.

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In addition to these construction related strategies and practices, we also have to pay attention to provision of open spaces; whether they are we are developing commercial building or residential area or any other type of building, because that is the basic human need. Humans need to go out and interact with nature, with five different elements of the nature and for that we need open spaces. We are not talking whether these spaces have to be vegetated, they can be hard or not, which we will come to in the later slides; but here it is just about having enough open areas in the site.

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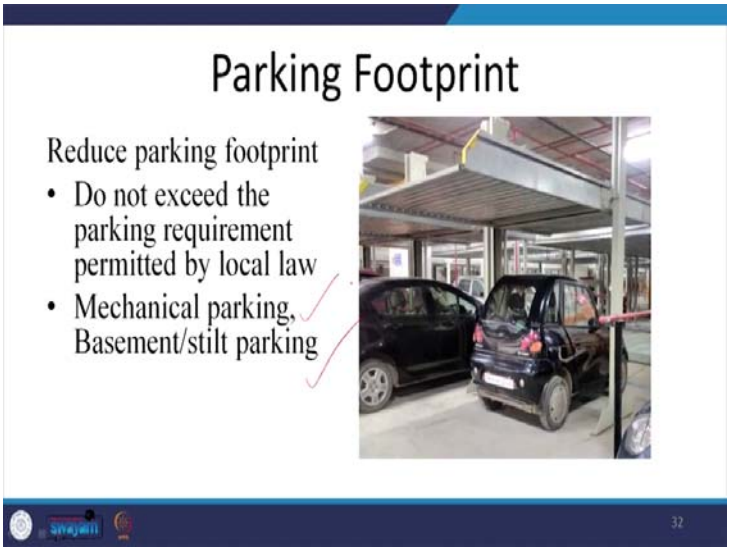

Now, one more aspect which is of great concern in cities is the parking footprint. The aim is to promote people to use public transportation and not come using their own vehicles; that can be done if we provide only the amount, the number of parking's which are prescribed as per bylaws, not providing anything more than that. So, people will be discouraged; if they do not find enough of parking inside the office building, they will be discouraged to bring in their cars that is the whole intent. So, the parking footprint has to be reduced; and to reduce the building footprint of the parking mechanical parking, basement or stilt parking they have to be used.

So, these are new technologies which are available where the parking's require much lesser amount of space. Separate though, it does not mean that visitor parking will not be provided.

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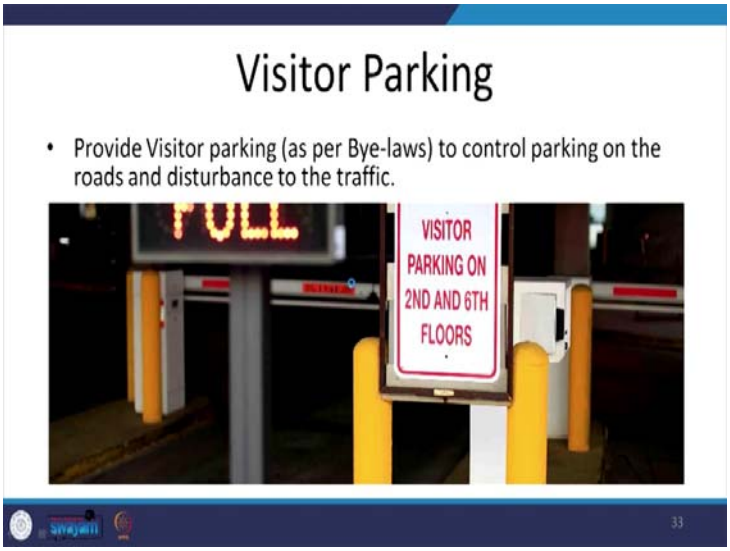

Separate visitor parking has to be provided, because often the occupants of the building are provided parking for, but the visitors do not have and they park their vehicles on the roads, outside the site which causes traffic jams and a lot of other problems. So, visitor, dedicated visitor parking has to be provided in any site.

To encourage alternative fuels, we have to look at the provisions for electric charging facilities where people can bring in, it will promote, it will motivate people to use more and more of electrical vehicles, which are non polluting at least at the site. And for that

proper charging facilities and there may be other alternative fuels and the charging facilities for them may also be provided.

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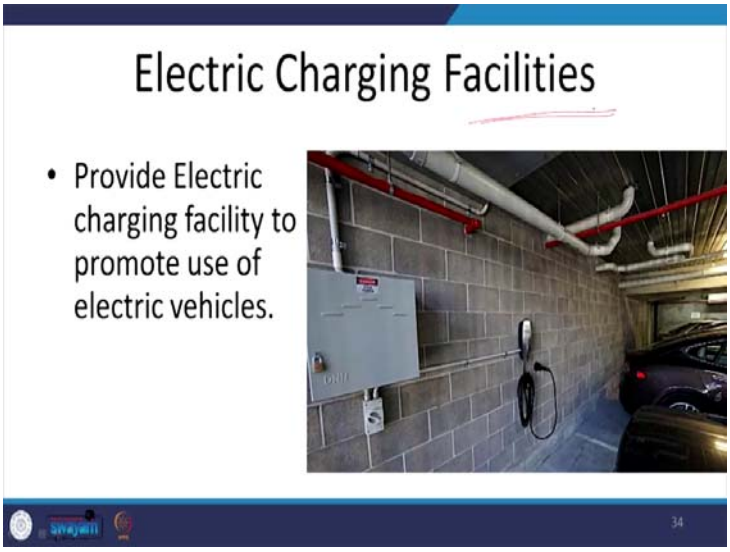

We will stop here for this lecture. And in the next lecture we will discuss about other features and aspects of sustainable site development.

Thank you for being with us, see you in the next lecture.