Soil and Water Conservation Engineering
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Lecture – 52
Stabilization of Sand Dunes

Hello friends, welcome to this week fifth lecture of week 11, of Soil and Water Conservation Engineering course. So, in this module actually we will we were discussing about the wind erosion ok. So, we have seen in these 5 classes that what is wind erosion, what are the different factors that affect the wind erosions or they can trigger the wind erosion.

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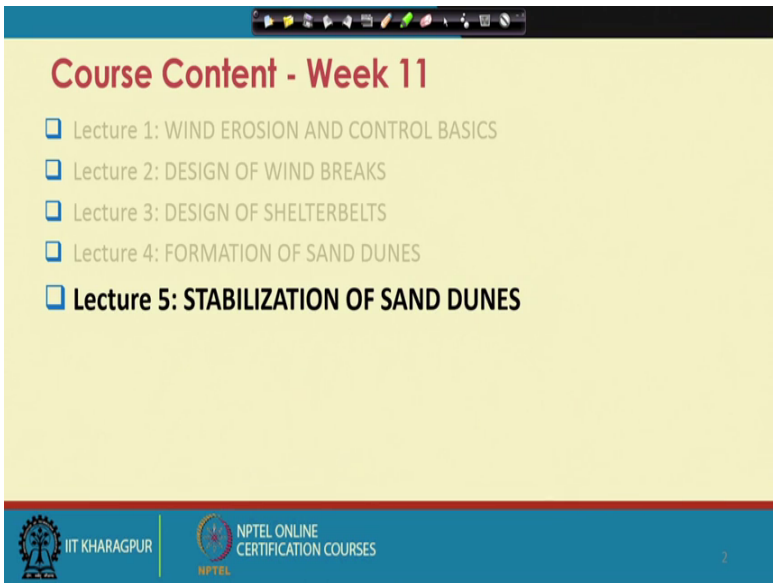

So, and we have seen the mechanics of the movement, we have seen how the initiation start, the wind erosion is a like, mechanism of movement in terms of initiation of the movement, detachment of the soil particle from the surface than, in terms of transport we have seen how it is being transported from one place to another place. We have seen the next step is deposition; and we have also seen the various transport mechanism.

So, we have seen the saltation, we have seen the suspension. What is mean by suspension? We have you seen what is mean by surface creep different mode of transport we have seen actually. And after that we have seen that to control wind erosion we actually need two things we either we have control or we have to reduce the erosiveness

of wind by constructing some kind of barrier; or we can make a soil surface more resistant to the wind erosion.

So, we have seen a different types of measures, to prevent the wind erosion, through to prevent the movement of soil from the surface. So, and then the next class we have seen mechanical barriers like, design of windbreaks and what can be the optimum spacing. And what are the different design requirements we have also seen, the shelter belts. Then in the next class we have seen what are the sand dunes, wind variability's, wind variability directions, classification of sand dunes and how sand dunes forms over a costal regions.

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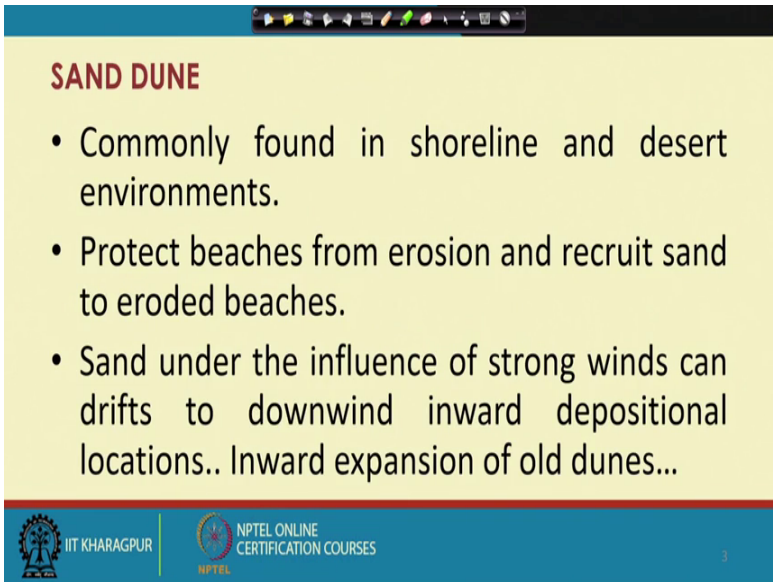

So, in this present class, will be focusing on stabilization of stabilization of sand dunes ok. How to stabilize the sand dunes? So, the sand dunes they are commonly found in shoreline and the mostly in a desert environment. Mostly they are found in the coastal regions or in the desert environment.

So, naturally they are essential, because they can be a natural defense mechanism by nature ok. So, they can protect, they protect the beaches from erosion and recruit new sand to the eroded beaches; formation of new sand ok. So, and this, but, because of the if the wind velocities are very high. So, the sand which are under influence of strong winds, can they can be drifted to downwind direction, downwind direction to more inward and it can be deposited to more inward depositional locations.

So, it can be that. So, that can result in to the inward expansion of old dunes. So, some times this is this can happen because of the natural process or sometimes it can happen because of the anthropogenic activities. Sometimes like if you can see, if you know (Refer Time: 03:45) reason or reasons which has sand dunes and which are more prone to wind erosion. So, because of the faulty agricultural practices if you are clearing or we are cutting the natural vegetation cover from the surface.

So, that the dunes; the older dunes may shift more inwards and new dunes may form. So, we will be having. So, there will be expansion of dune area. So, we need to adopt different measures to control this kind of expansion of dunes or expansion of dunes or we can say that transport of sands, transport of sand from one place to another place. So, sand. So, what we have to do? So we have to stabilize the existing sand dune so, that the sand drifting can be prevented ok.

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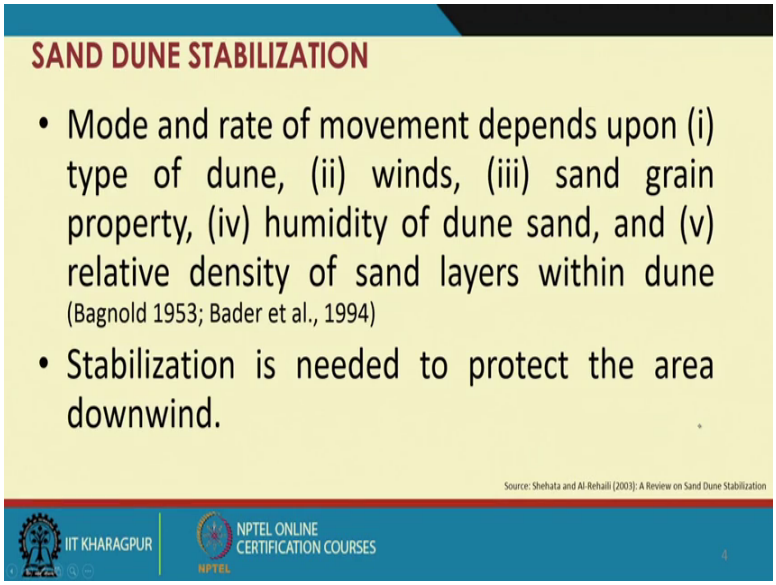

So, in the sand movement mode and rate of movement actually depends on the different criteria, first the type of dune and then the wind velocity, strength of wind, direction of the wind, then the sand grain property of the sand grain, the moisture content, humidity of sands dune sand and relative density of sand layers within the dune system ok. Then, so, this stabilization is needed to protect the area downwind.

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So, let us see what are the different measures. So, as I discussed earlier also, that to control wind erosion what we have to do. So, either we have to reduce the wind velocity or we have to slow down the wind velocity at some particular location. Or we can make soil surface more resistant to the wind erosion. In case, there are some measures. So, suppose if you are planning for long term solutions.

So, for long term solution means, the permanents controls measures; so, permanent control measurement means, you can go for afforestation to plant more trees, but normally it takes lot of time and investment. So, before that you can go for some temporary sand control system ok. So, basically this temporary control systems can be a initial step for a permanent solution or there can be a temporary solution to the existing problem.

So, the temporary sand control systems are actually can be in the form of shielding surface or covering the surface with a stable materials or by establish establishing or constructing the sand fences. Which can be which can trap the sand ok, and they can stop the further movement of sand ok.

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So, this as I said, this stabilization it can be achieved by either reducing the wind speed by different measures or by using vegetation cover over the surface. So, different measures include, the chemical measures, spraying of chemicals then mechanical measures for like, construction of barriers, windbreaks that kind of thing or biological measures. Biological measure means plantation of plantation of trees and shrubs that regions which are more suitable to that region.

And also by maintaining a proper soil plant and water balance so that the movement of sand or detachment of sand can be stopped ok. So, the purpose of sand temperature sand control is actually to control moving further moving dune or sand drifting, during the initial period of in permanent sand control system. And also to enhance the condition which can be suitable, which can favor the plant growth in future ok. And then there is a permanent control system.

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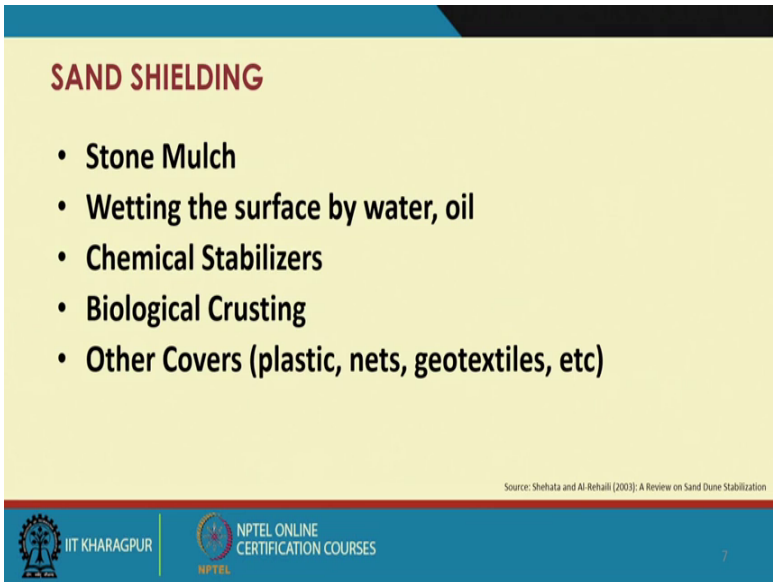

So, let us see the first type of temporary controlled measures. So, the first in the sand shielding; so, in sand shielding it includes by use of stone mulch or by wetting the surface, either by water or in some case, in some areas where the petroleum waste are available. So, we can apply some kind of some oil to limited area also the waste product actually I am talking about. Then uses of some chemicals stabilizer we can, which can favors the bonding between the soil grain grains particle. Then biological crusting then or by covering the upper layer of soil by different cover such as, plastic, nets and geotextiles ok. Let us see what is sand shield stone mulch.

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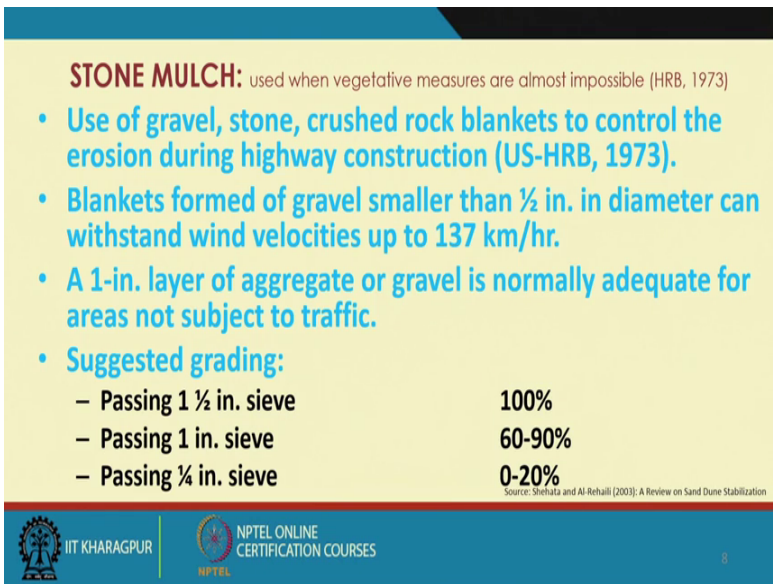

So, according to US-Highway Research Board 1973, so they advise or the recommend the use of gravel or stone or crush rock blankets to control the erosion during the process of highway construction. So, sometimes in suppose, the when the vegetative measures are almost impossible. So, in that case, this kind of measure can be used. So, they also this US-HRB US-Highway Research Board they specified that, if the blank the forming a blanket of gravel smaller than half inch in diameter. We can with stand of the velocity up to 137 kilo meter per hour ok.

So, or we can say, we can use, a round one inch of layer of aggregate of gravel, which is normally adequate for areas that are not subjected to the traffic. So, this is in terms of roads ok. So, (Refer Time: 09:20) grading include that, that there should be a 100 percent passing in one and half in sieve, then the 60 to 90 percent passing in 1 in sieve then passing one-forth is around 20 percent.

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So, this kind of grading can be used. Then also according to this is Egyptian Desert Institute, so recommend the recommended to use gravel of size greater than 2 mm. So, and then we specified the quantities also so the fine gravels can of around the quantity of 20 tons per acre can be used. And the medium gravel of quantity around 50 tons per acre can also be used and then crushed or crushed rock or clay can be used around 100 tons per acre.

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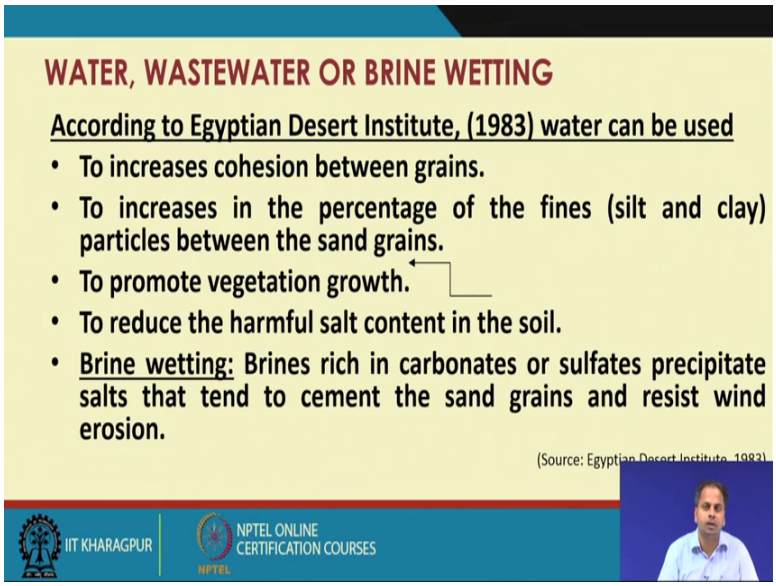

So, this is that stone mulch, then comes to the water another popular water; another popular temporary control system is the water or application of water or brine wetting. So, water can be used, water can be spread on the surface. So, to increase the cohesion between grains, so we can spray it to increase the percentage of fine particle between sand grains.

So, presence of water can promote a vegetation growth and it also reduce the harmful salt content in the soil; which can further relate to the growth of vegetation ok. Also in brine wetting; in the brines which are normally rich in carbonates and sulphates precipitate salts. That tends to cement the sand grains and resist the wind erosion ok. So, brines wetting can also be used here.

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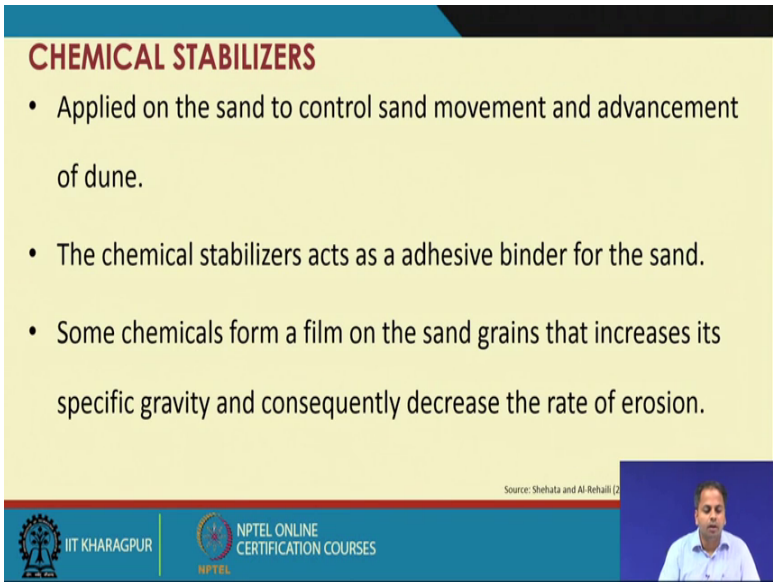

Then uses chemical stabilizers; so, some kind of chemicals which are available and which are cost effective, it can be used to prevent the sand movement. So, these chemical stabilizers are normally applied on the sand; to control the sand movement and advancement of dunes.

So, this chemical stabilizers acts as a adhesive binder for the sand and some chemicals they form a film on the sand grains, that increases the specific gravity and therefore, the consequently decrease at the rate of erosion. So, they form a some kind of thin film over the surface. So, which can prevent the erosion soil erosion.

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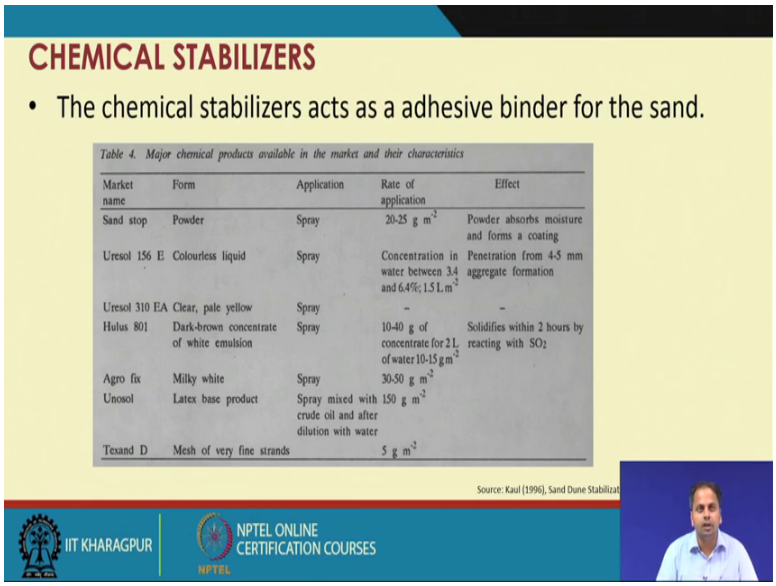

So, this is according to Kaul 1996, they have mentioned, so in the contexts of Thar deserts, in India. So, they have mentioned different major chemical products that are available in market, which can be used to control the, which can be used as a chemicals stabilizer to prevent sand movement ok. So, they are in the form of powders like, sand top are some of them are in the form of liquids or some of them in the form of, mesh, some of them are in the form of; some of them are in the form of mesh of very fine strands ok.

So, the application can include by spraying or spraying on the surface and they have different, under application doses are mentioned here. So, this kind of chemical stabilizer can be selected by proper considering the different; by proper considering the requirement of the of the reasons.

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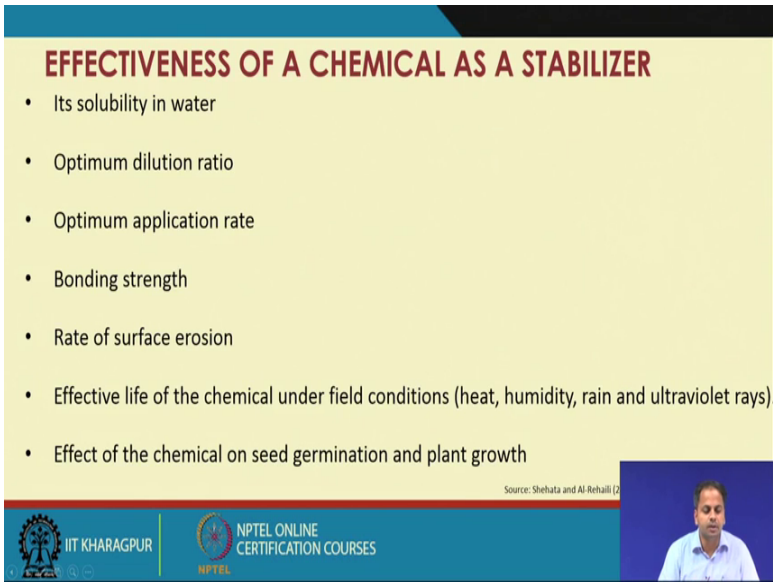

So, this chemical stabilizer can be the effectiveness of this chemical stabilizer can be decided based on by assessing its solubility in water; by calculating the by knowing the optimum dilution ratio. Then optimum application rate what is optimum application rate. So, that it can be cost effective, then bonding strength of the material, then rate of surface erosion. So, to what extent the erosion is happening over that region, then effective life of the chemical, which is being applied over the field.

So, that it can sustain, the natural field conditions which it can sustain the heat, humidity, rainfall and ultraviolet rays then effect of chemical on seed germination on seed germination so, it should not affect the growth of plant also. So, our purpose is to, our purpose is to maintain a proper plant the cover also. So, this by the chemical which you are using it should not harm the plants. So, this care has to be taken, while selecting any chemical stabilizer.

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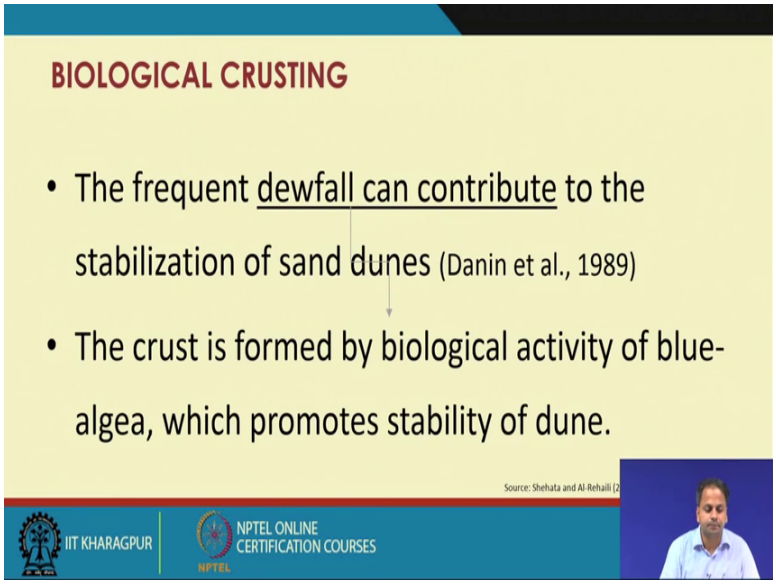

Then biological crusting. So, in the regions where frequent dewfall is observed. So, this frequent dewfall can contribute to the stabilization of sand dunes. So, this available moisture from this frequent dewfall can be a source of moisture for formation of formation of biological crust over region. So, this clust are actually formed by biological activity of blue-algae, which can promotes the stability over the dune ok.

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Then this is most common and most popular temporary measures to control the sand to control the sand movements. So, that is the sand fences or construction of barriers in the form of fences. So, the idea is here they will trap the sand, and they can stop the further movement of sand. Or they can stabilize the sand dune or they can form, an artificial

sand dunes ok so, that the further movement of sand to the inward direction can be stopped.

So, the sand fences they are widely used for beach preservation, dune restoration typically it is consist of lightweight wood strips, wires or perforated plastic sheets attached to regularly space takes. So, they are actually based on different kinds of materials, so it which is actually locally available like woods or plastic nets or we can use also the residual of plants; or we can use the plastic cover wire mesh, the different kind of material that can be used collectively to establish of sand fence so, that the movement of sand can be stop ok.

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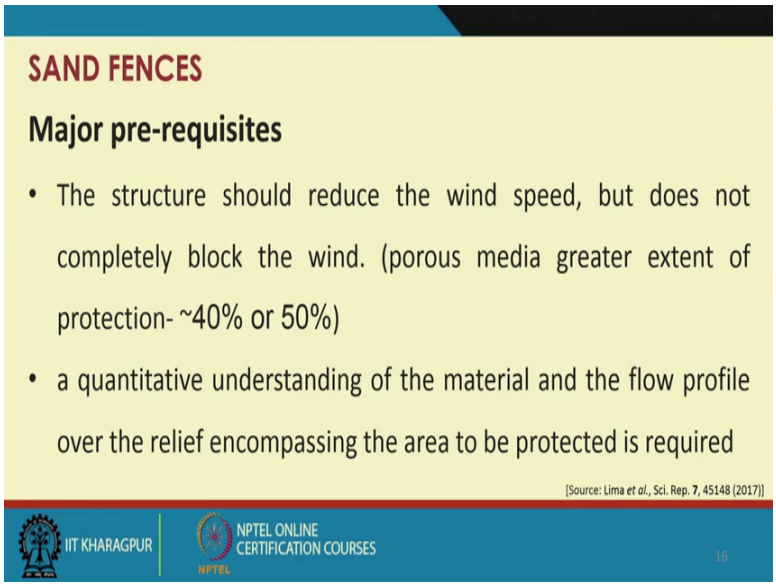

So, these are the major prerequisites for sand fences. In the structure, the structure which we are selected or sand fences which we which are selected or design for a particular area they should reduce the wind speed, but that this that does not complete they should not completely blocked the wind. So, in case of windbreaks actually we have seen that, windbreaks actually, the windbreaks or any kind of barrier, it should actually allow some kind of air airflow within the porous media. So, the barrier should not be complete solid; because the porosity is less of it has more solid, then there is a possibility of formation of vortex ok. So, we need to be we need take care of that also.

So, it is recommended that around 40 to 50 percent porosity is good; which can provide a greater extent of protection ok. So, on also in addition to that we need to do some kind of

initial study to understand the material ok. So, how this material reacts with the wind, and we also should know the wind profile over a height so that we can increase the extent of production ok.

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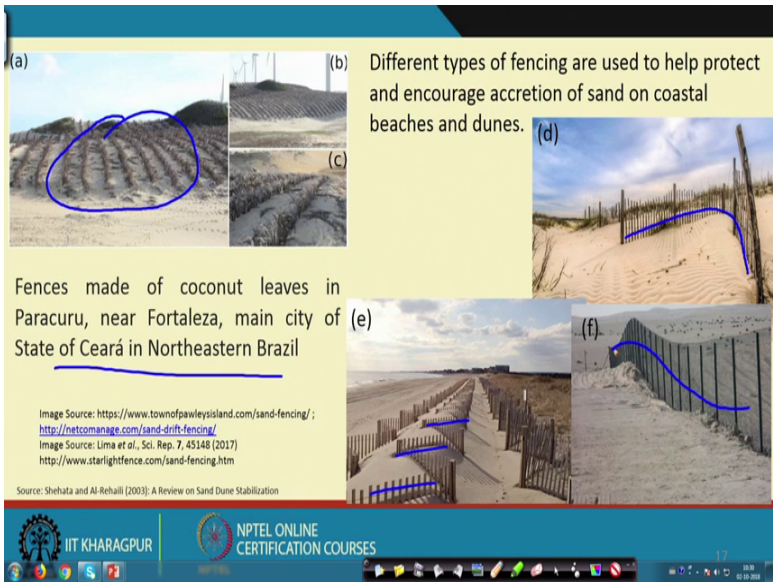

Then this is the typical example, this is a different example of sand fencing. So, different types of sand fencings are normally used, to protect and encourage accretion of sand on coastal beaches and dunes. So, this is first case, in the first case here you can see, yeah can we stop here?

Student: You explain sir.

No this icons are not visible ok. So, these are the different so we can use different types of fencing. Different types of fencing can be used to help and protect and encourage the accretion of sand on the coastal beaches on sand on coastal beaches on dunes. Now, this is one example, here we can see, the use of the coconut leaves and fences are made because of fences are made from the coconut leaves in Brazil area and there are different types actually.

So, here we can see the, different types of wooden planks are used as a sand fences here, we can see some kind of development of some plants, growth of plant over the dunes. Here they have used some kind of wire mesh. So, different types of materials can be used to construct the sand fences.

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So, this sand fences are can be like, Checkerboard fences or they can be are Fore dune fences can be again, impounding type or diversion types and sand fences.

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So, this is a typical checkerboard fences. So, here we can see, there is a series of rectangles which are actually made up of plant residues or plastic nets ok. So, these are actually there made up of plant residues. So, approximate height is around 50 to 70 centimeters and we can form a mesh of this rectangle's of size around 3 by 3 meter. So, idea is here, that they can withstand weather condition for few years so, that they can

make a favorable condition for future growth of a plants or they can they can withstand weather condition for few years, which is long enough to implement or to incorporate the permanent solution. So, this is just one example of checkerboard fence.

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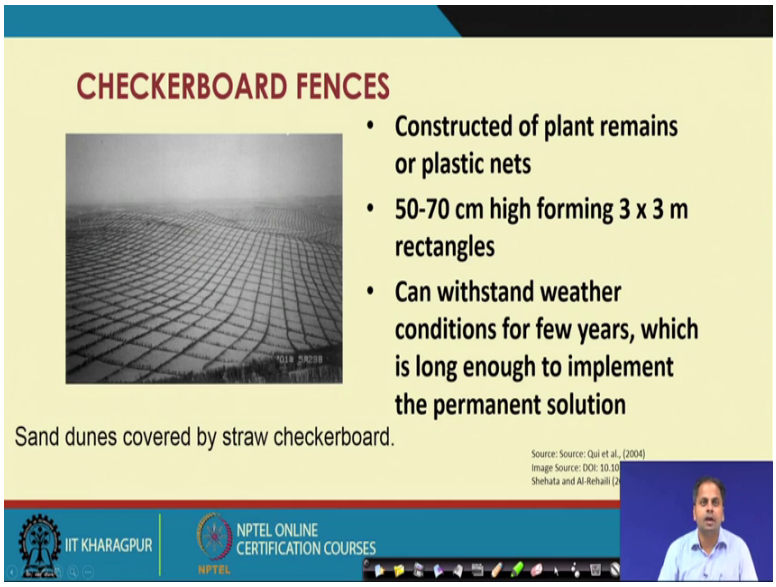

Then, if you see ok so, this is another example of a checkerboard system where straws like, other side the plant residues are used here ok.

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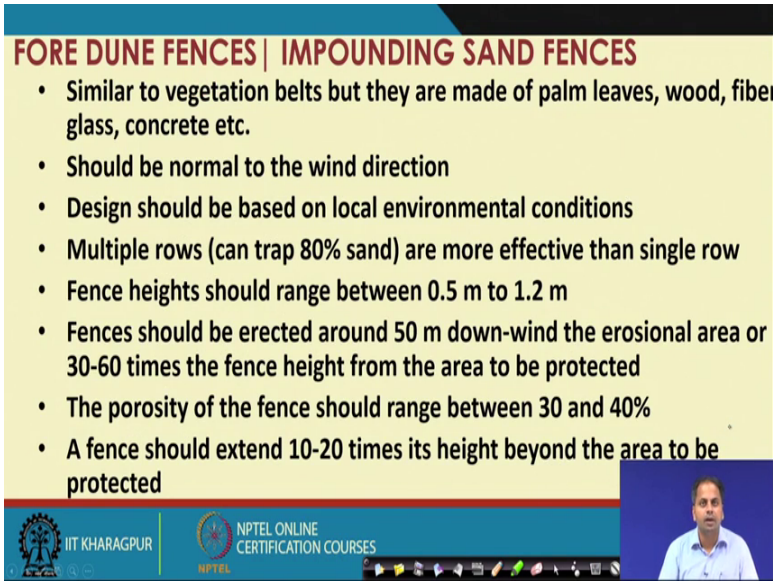

So, then comes to the fore dune fences. So, first we will discuss about the impounding sand fences. So, idea here is to trap more sand so to stop further movement of; to trap

more sands so that we can we can we can stop the movement of sand dunes ok. So, these are similar to vegetation, these are similar to vegetation belt, but they are made up of palm leaves woods fibers glass or sometimes concrete ok. So, as in the case of windbreaks and other measures we have seen that the, the construction of barrier should be normal to the wind directions. So, here also they should be, they can be normal to wind direction. So, design should be base and the design should be based on the local environmental conditions.

So, first we have to study the local environment; what is the required our, what are the different materials which are available there. Then we can consider using of multiple rows as compared to the single row. So, and then the height also we can see, it can be normally range about 0.5 to 1.2 meters. Another important thing is that fences should erected of 50 meter downwind of the erosion area or approximately 30 to 60 times the fence height from the area to be protected ok. Then this porosity of fence should be as I discussed all before also that porosity of the media should be porous enough so around 30 to 40 percent or sometime 50 percent is can be used. Then fence they should extend around 10 to 20 times its height beyond the area that needs protection ok.

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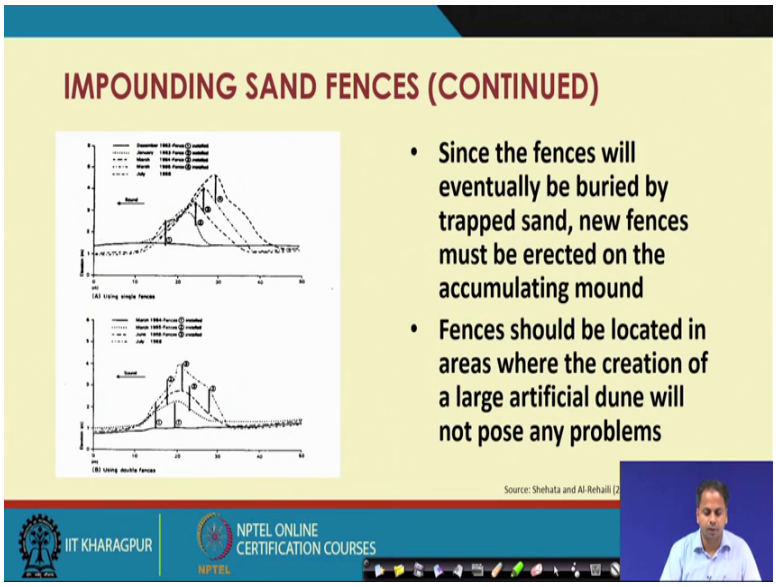

So, this is one example of impounding sand fences. So, idea is here. So, we are constructing series of; we have to construct series of this traps. So, this fence they

eventually they will be buried by the trapped sands; so new fences must be erected on the accumulating mould ok.

So, we can form a bigger sand dune, which can stop the further movement of sand to the more to the inward land ok. So, the fences should be located in the areas, so the important condition is that the fences this kind of fences should be located in areas, where the creation of large artificial dune will not pose any problem to the local condition.

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So, this is one another example of impounding type sand fences. So, this kind of fences they need a regular maintenance and sometimes renewal to avoid deterioration. Or sometimes we can we can it can be constructed from better material. So, this was the actual impounding types sand fences.

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Then let us see the diversion sand fences. So, idea here is to divert of deflect the sand movement, or deflect the wind ok. So, they trap the sand. So, the purposes of these diversion sand fences are so that the trap the sand as well as deflect the sand away from the area that needs to be protection. That needs to be protected ok. So, the effectiveness and the lifespan of divergence fences depending on the material of construction height in porosity.

So, this the effectiveness of this structure, it actually depends upon the material of construction and the height which we have selected and the also the porosity of the barrier ok. So, sometimes they are erected either as a single fence which are actually 45 degree from the wind direction or in the form of V shaped fences pointing in a up wind direction so that the we can deflect the quantity of sand, away from the region which needs the protection ok.

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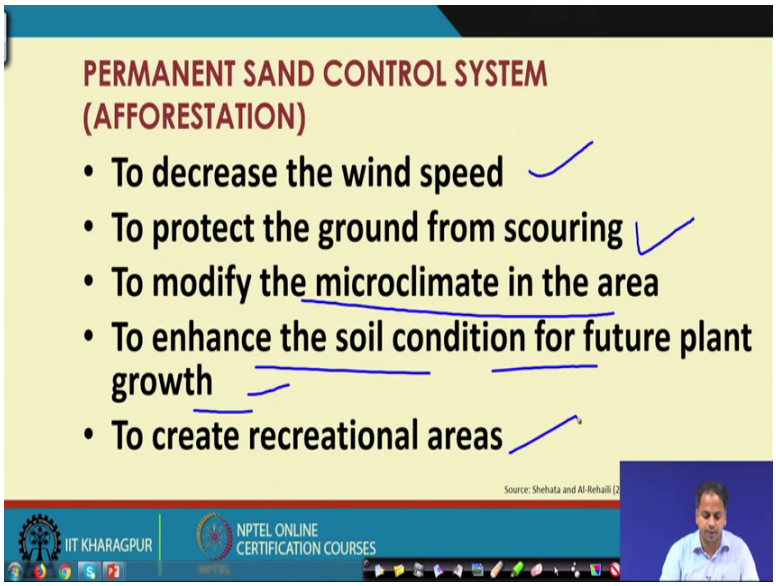

So, now as we have seen the different types of temporary measures to control the sand movement so, idea of using temporary system is to make region to make condition more favorable for; more favorable for adopting a temporary or permanent control. So, the permanent control system we means afforestation, means establishment of proper tree cover or vegetation cover over the surface ok.

So, the idea here, idea of permanent or permanent sand control system is to decrease the wind speed by; decrease the wind speed and to also to protect the ground from the scouring, then if the if there is a proper afforestation happening or means establishment of tree covers, then it can modify the micro climate in that area. So, also to enhance the soil conditions for future plant growth. So, these are the actually goals of the permanent sand control system. First to decrease the wind speed, then to protect the ground from scouring, then to modify the microclimate area; to modify the micro climatic condition over that area and then to enhance the soil conditions for future growth of plant ok.

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And also sometimes it can be used to create a recreational area ok. These are actually these are actually the goals of permanent sand control system. So, this example show the different types so we can see, so if there is a proper vegetation cover is present. So, it can help in forming the or it can help in stabilizing the dunes over that regions. So, it can further, which can prevent actually the further movement of sand ok. So, they can bind the soil particle together so that the drifting of sand can be stopped.

So, it is a most appealing way to mitigate the dune migration hazard. So, this example is actually over the desert region this is in the coastal regions. So, you can see, wherever there is a vegetation present we can see, the soil particle can be done together. So, it can stabilize the surface condition over that region ok.

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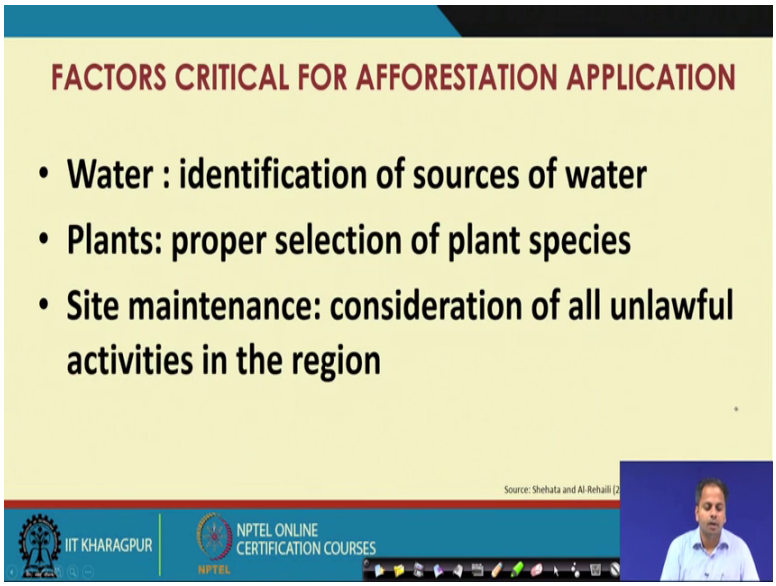

So, the different factors that are critical for afforestation application. So, the key factors that includes the availability of water if you are going for afforestation so you should check whether the enough water is available. Or in the absence of water you should know what are the different you should identified different source of water ok. Then vegetation the plants, the proper selection of plant should is more important actually, the plant should be tolerant to that environmental condition or that region or that climate ok. And then of course, the site maintenance so once you adopt any kind of permanent control system measures you should be you should maintain that that site.

So, by any for, so the effectiveness of permanent control system can be visual can be observed ok. So, site maintenance means consideration of all unlawful activities, so or stopping of tree passing or any, you can say any human induced activity which can lead further expansion of expansion of wind erosion area.

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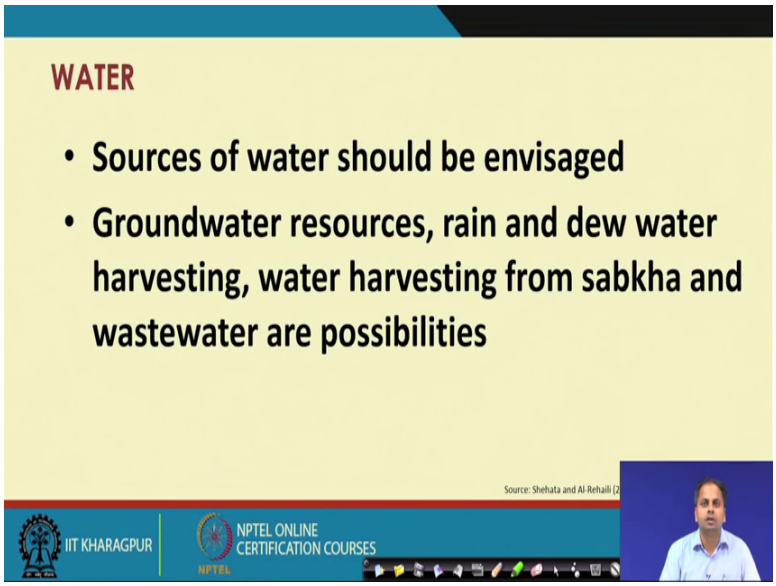

So, so of the first components we have seen the water. So, we need to identify the source of water. So, if the water is not available so you need to identify the potential sources ok. So, in some cases ground water can be used for a limited applications, then rain water harvesting, dew water harvesting can be can be thought off, can be think off. Then water harvesting from sabkha and waste water also it can be used they are different possibilities. So, we need to identify the source of water.

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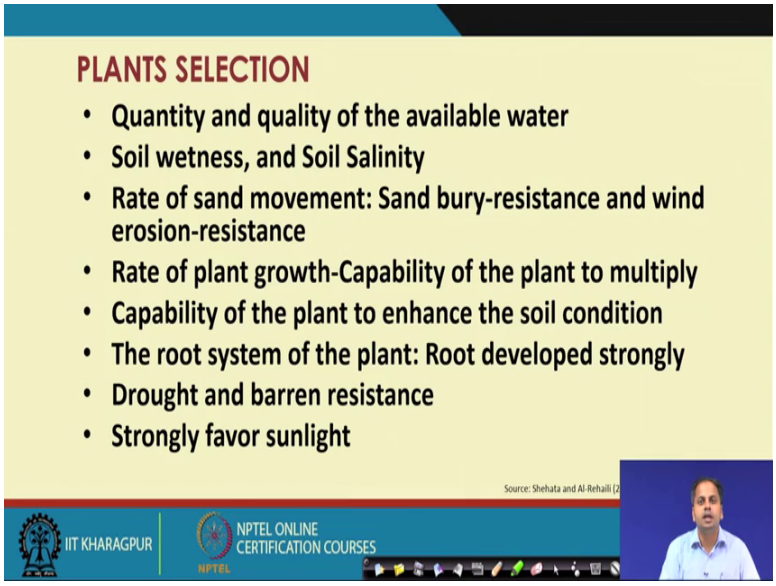

Then selection of plant, so this is fences most important component of afforestation or permanent control measures that we need to identify a variety of plant, which is more suitable for that that region ok. So, the plant growth should be optimum in that region and they should not, there should be actually tolerant to the actually to the climatic condition or region. So, what the sand dunes suppose they should be sand bury resistance and they can sustain the erosions of wind ok. So, wind erosion resistance, the root system should well developed ok. So, the root should be developed strongly then they should be resistance to the drought and barren conditions. And they should strongly favor the exposure of sunlight ok.

And other measures are like the depending on the other soil moisture, the salinity over that region soil salinity over that region, then quantity and quality of available water depending on that you can select typical plant species; which can be used as a permanent control system.

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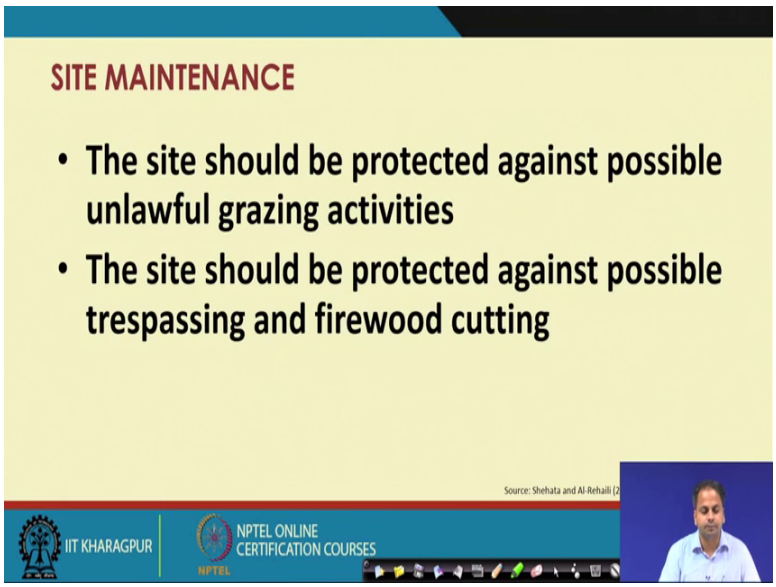

Then comes to slight maintenance; so, once you are decided that you are going for this permanent control system by application of by using a particular method by using a buyer application of plant cover over that region. So, you need a regular maintenance ok. So, the side should be protected against all possible unlawful (Refer Time: 30:58) in activity and side should be protected against possible traversing and fire wood cutting. So, human and physical activities like, cutting of trees for our vegetation for fuels and

fodder or maybe any kind of activities which can deteriorate the condition over that reason so, all this kind of activity should be should be prevented.

So, with that actually will stop here. So, in this module actually we have seen what is wind erosion and what are the different factors that triggers the wind erosions and different ways in which we can prevent wind erosion we have seen the process of wind erosion. We have seen the how the wind erosion start the initiation step the transport, the deposition then the transport in the form of in the suspension, saltation, deposition and we have seen the different types, different kinds of measures that can be used to prevent the wind erosion. We have seen the application of using the application of vegetation we have seen the application of different measures actually which can prevent the wind erosion. So, idea here is to effectively to control wind erosion. We need to consider two things either to reduce the wind speed or to make for and to make the surface condition, more resistant to the wind erosion.

So, this can be achieved by planting or by establishment of some kind of mechanical barriers in the form of windbreaks, shelter brakes or in some kind of in case of sand dunes we can see establishment of sand fences so that the dangers due to wind erosion can be prevented ok. So, with that will stop here ok.

Thank you very much.