**River Engineering**
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**Lecture No -20**
**Riverbank Stabilization (Part -2)**

Good morning all of you for these presentations as discussed in the last class, we talk about Rivers stabilizations. Today I will discuss about the Rivers stabilizations of Part 2 and you know it we there are a lot of experience on how to stabilize the river bank throughout the world most especially in the Brahmaputra basins or the alluvial rivers in our country but else where in the world like in river Mississippi, river yellow there are a lot of experience the field experience used to protect the river bank.

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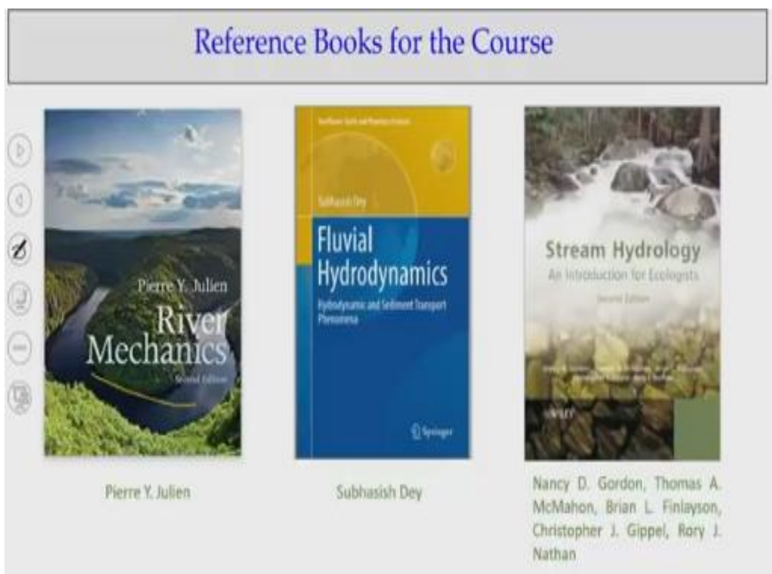


So mostly I am following it this part of the book as river bank stabilizations with a series of case studies from different part of the world.

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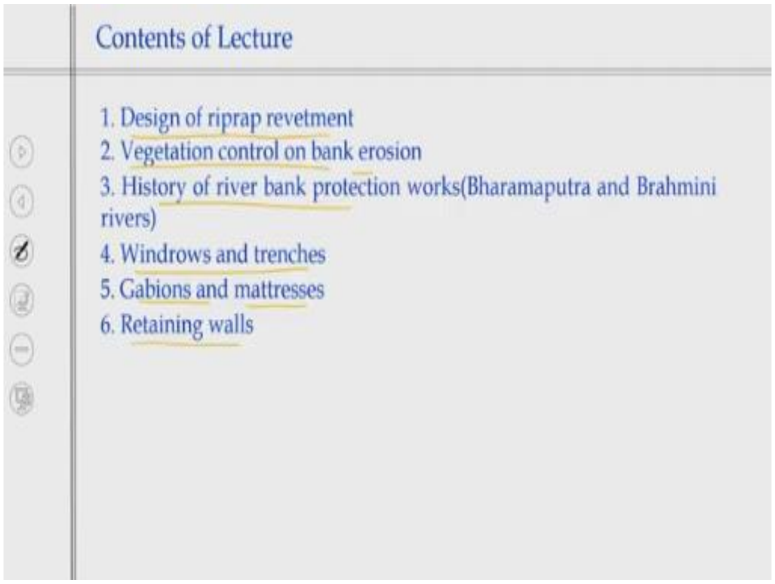


Looking that if you look at today contents will again talk about how to design the riprap revetment which you can see it is very easy to dumping the stones on the river bank, but that is not the correct we have to properly design the river bank revetment protections work which may be a stone riprap and nowadays we also talk about the river health so that is the reasons the new approach of our natural way to protect the river bank by planting the vegetations that the concept also is going on and he is also improved the river health.

We also very briefly we will talk about in presentation forms what it happens the history of the riverbank protections works in Brahmaputra rivers and small rivers like Brahmani rivers. Then we will talk about the windrows and trenches, Gabions and mattresses and the retaining walls, which a part of the geotechnical engineering. So here I will go contextually that what we need to do as a riverbank protections work.

But most probably we do not encourage to have a retaining walls for a bigger river like Brahmaputra rivers and all, but very site specific we can have a retaining walls.

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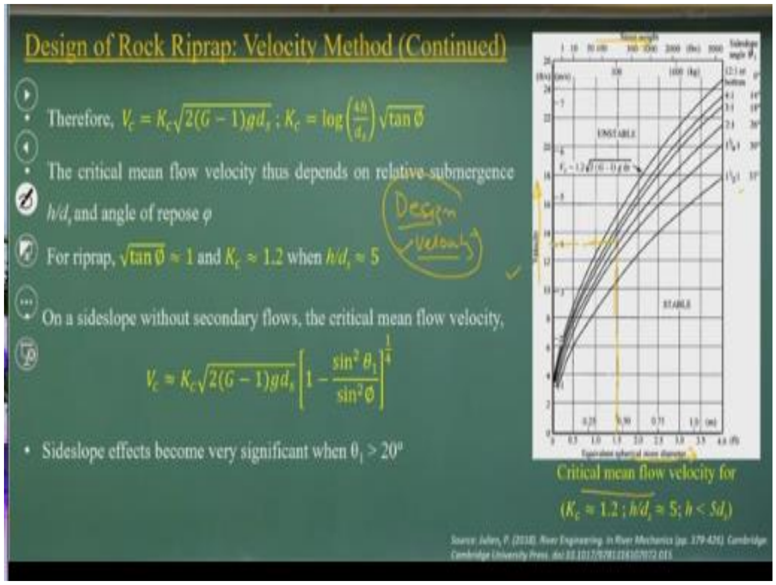


Let us go for the next slides which is the repeating the slides of the last class, if you know the design velocity so most of the times, we can find out what could be the design velocity that from the design flood our experience running the HECRAS models we can know it what could be the maximum velocity or that the velocity or the extreme velocity. We can consider the design velocity, so if I look at this curve really design chart.

If you look it is a very clear cut is a velocity versus the diameters the equivalent spherical stone diameters and the stone weight and you have a different degree of the slopes, different degree of the bank slopes, so we can find out for example if I am considered to design velocity 4 and I have where 2 is to 1 and that is the representative the size of the stones which is coming as closer to 0.5 meter that is what the d50 or representative diameters but we can have the gradations.

So look with this design chart prepared by US crop of armies which gives us a very interesting figures, that if I know the design velocity I can compute what will be the equivalent or d50 or the representative value for to obtaining the riprap size also we follow the guidelines, the what should be the gradations and what should be the packing of these materials.

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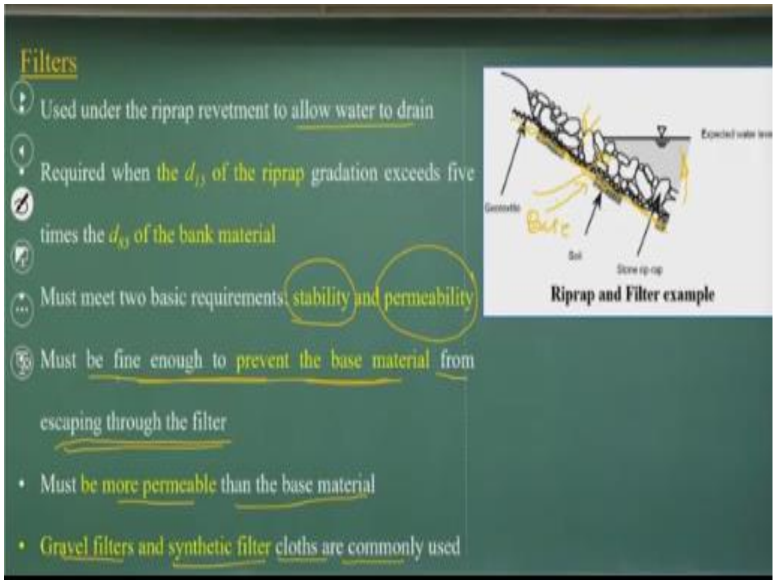


Looking that part let us go for the next part which is very easy part is that we talk about the filters, so when you do stone riprap or the gabion mattress, you can have a stone riprap and gabion mattress just below of that, you should have a the finer materials below of that you should have a geotextiles. If you look at that the geotextile materials are there which acts like a filter between base and revetment the riprap zones.

So there is a best materials and these filters act like prevent it should be fine enough to prevent the base materials from escaping through the filters that is what is the idea, but it should allow the water can seeps from these filters comes out, that is what it will take care of as we have the increasing the level of the rivers and the ground water table fluctuations will be there and the water fluctuations can seep through this but not the base material.

That is the reasons is to be fine enough to prevent the base material from escaping through the filters and it must be more permeable than the base material, so water can seep through that the gravel filter or synthetic geosynthetic cloth filters nowadays commonly we use. So like that the basically the revetment its allow water to drain it and it should have a stability and permeability the properties for better filter materials.

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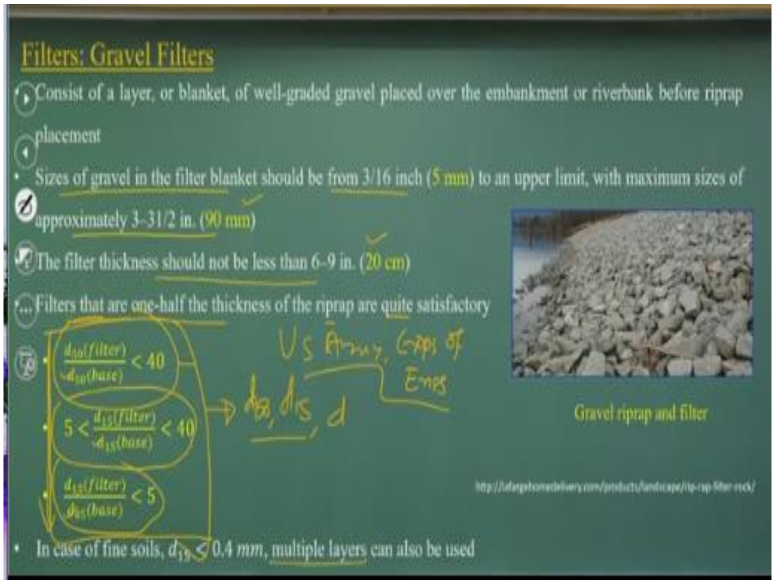


Now if you look at the next slides which we talk about what should be the filters, that is what the US army crop of engineers guideline design guidelines what they had said it should have a size of gravel in the filter blanket should be from 3/16 inch (5mm) to a upper limit maximum size approximately 90 mm, the filter thickness should not be less than 20 cm, the filters are one half of the thickness of the riprap is quite satisfactory plus it should satisfy these 3 conditions.

The ratio between the $d50_{\text{(of filter)}}/d50_{\text{(of the base)}}$ should have a lesser than the 40, the ratio between $d15_{\text{(of filter)}}/\ d15_{\text{(of base)}}$ should range between 5 to 40 and $d15_{\text{(filter)}}/d85_{\text{(base)}}$ should be the less than 5. So if you look at that as we know what could be the best materials that is the best already you can geotechnically test it what is the best material particle size distribution curve from that we can find out d50, d15 and d85 and based on these criteria, we can find it what should be d50 for filter d15 for filters.

And these two criteria we have to hold get it which will be allowed to have a proper drainage proper water escape from the best to the of through the filters to the out from the base that is the criteria and from the design guideline from US army corps of engineers, they decide this design criteria that is what we should use it to know it what should be the and many of the times we also follow multiple layers instead of single layers filters.

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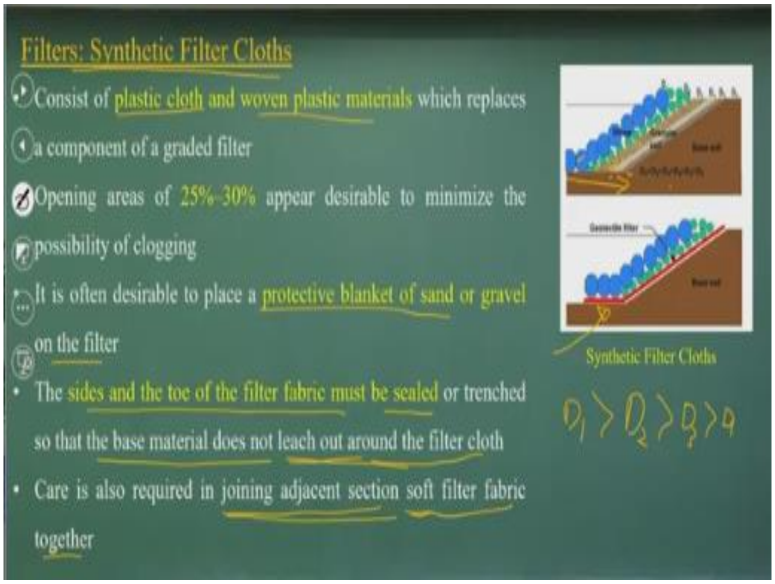


And if you look at that part where you have and it can have a synthetic filter clothes or geosynthetic materials, nowadays so often use it which will be the consist of plastic cloth and woven plastic material or geosynthetic materials, nowadays so oftenly used to put it this once and if you look at this figures, we should have a degradations. If you look at that if the bigger material smaller than that d1 is increasing d2, d3 and d4.

So we can have put the coarser to finer and finer grade so that is what is there and this is what your best materials or you can put a geotextile filters in between that to avoid this gradations from coarser to finers we can have a geosynthetic filters. So there are the design guidelines are there how to use geosynthetic materials what should be the property of geosynthetic materials which provide as a protective blanket and for the sand and gravel on the of filters the sides and the toe of the filter fabric must be sealed it.

The trenched so that the base material does not leach out around the filter cloth, the care also should take in joining adjacent section the soft filter fabric together. So we it can have a monolithic to stitching these geosynthetic geotextile materials, so the geosynthetic textile filters we have been reading it but we need to do a proper geotechnical design to know it how we develop such a way that this base material does not leach out around the filter cloth also the joining adjacent sections the sub filter fabric together.

So we should take care of that so you can see that how geosynthetic materials as a filter cloths we use for as a filter materials for revetment and the base soil.

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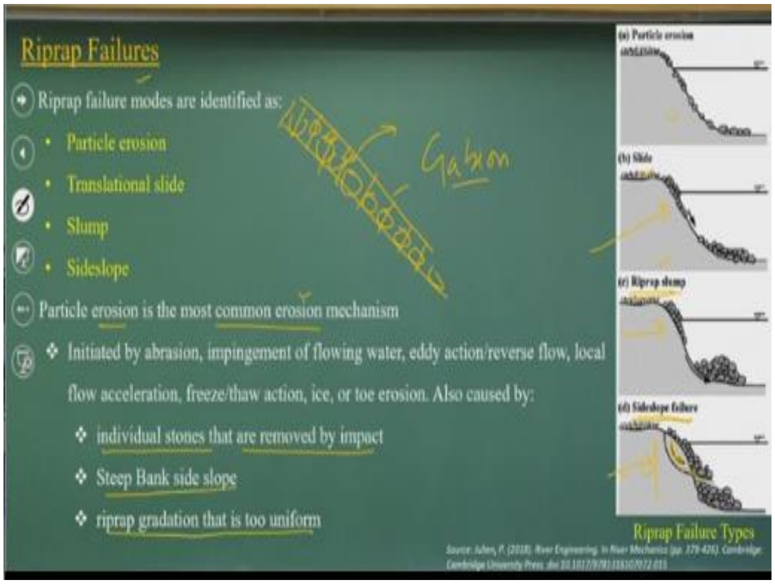


As we designed the revetment with a filter and best compactions and changing the slope of the bank, we also should know it what type of failure can happens it? What type of riprap failures will can happen like it can have a particle erosions, that means if as you put this stones so it can erode the particles wise one by one as you see that that type of erosions can happen is or it can sliding it you can see it this figures.

So as a block the all these riprap material can slide it or it can slump it or it can have a sides slope failures, many of the times we have this type of failures if you look at the revetment you will have a either riprap slump will be there or side slope failure is there if you do not design the riprap accurately or properly or you cannot do the layout of the riprap effectively.

Then you can have a side slope failures we can have a riprap slump or the particle erosions and the slides that is what nowadays we try to avoid it, because we follow a gabion mattress concept that is what I will show to you. Nowadays we follow this gabion mattress concept, so these type of particles erosions or the slides does not happen it but it can happen the riprap slumping or the side slope failures and if you look at that if these ground water tables are fluctuating more you can have a saturated zone and that the slope failures can happens it.

So you can have a geotechnical study more details about the bank materials and the hydraulic characteristics, if you know that very well then you can avoid the side slope failures of the revetment structures, that is the point and if you look at that again just to have today that the particle erosions is a most common erosion mechanisms but we try to avoid nowadays because you have gabion mattress concept, that is what the individual stones are removed by the impact the steep bank side.

And riprap gradation that is too uniform as that the ripraps should have the gradations it should not be the uniform size that is what we discussed in the last class the same things, if you look at that the riprap gradations is if is too uniform you can have a particle erosions same concept is that.

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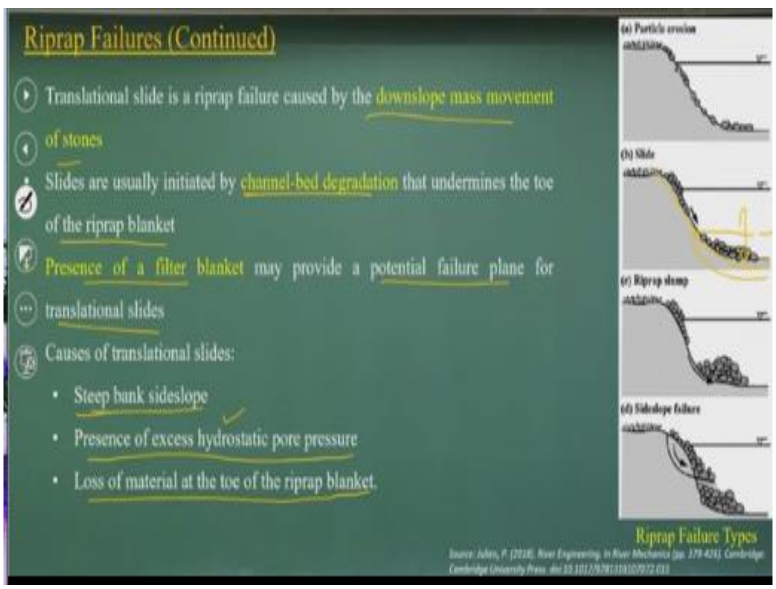


If you look at this sliding failures which is a down slope mass movement of the stones, its happens like that and this slides usually initiate by channel-bed degradations, what it happens is that if the channel bed is like this and it is degraded. So its if erosions are happening the deepening of the channels are happening it can have it the channel bed degradations happening it which undermines the two of the riprap blanket then you can have a this type of slide.

The presence of filter blanket may provides a potential failure plane for the translation side, so thus you try to understand it if you have a of your filter blankets and which can also a failure plane for the sliding or that because after that steep banks slideslope, so presence of excess hydrostatic pore pressures, loss of the material at the two of riprap blankets. We just try to understand it how the structure fails it if you have a degradations and if you have a excess hydrostatic pore pressure develop in the bank soils.

And steep bank side slope is basically when you protect the bank we do the slope reductions we cannot put it in a steep banks.

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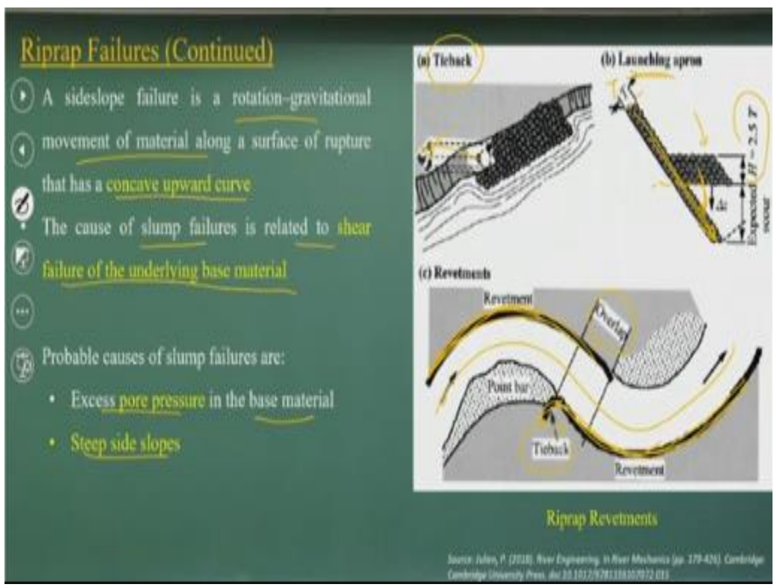


So if you look at the next one which is a riprap slump that we can understand it that side slope failure is a rotational and the gravitational failure movement of materials that is what it happens it is concave upward curve, because slump failure is related to the shear failure of underlying best materials basically its giving about a geotechnical way the failure part excess pore pressures in the base of materials and steep side slope.

Now if you look at that what to avoid these failures what we do it we always have a tie back, so we extend it the mattress the gabion mattress are the riprap mattress inside the bank which act like a tieback, also when you do a launching apron if you look at thickness is a t we put it additional height is 2.5 times of the t, that is what initially we put it that once as the rivers covers happens it this materials goes down it and falls in like this.

So we have to take care of because of the scouring mechanism because of river degradation mechanisms, the river bank protections what we have done it thus should take care of the scour formations, that is the reasons if you look it even launching apron, we provide it which will have a thickness t is here the on the bank on the bed we put it the thickness which is 2.5 times of the t and after the expected scour this materials can again can have a fall like this.

So similar way if you look at the planform how you do the revetment so if you have a river going like this you can see this you should protect the river bank in this side because there will be point bar formations and also this side. But if you look it there should be overlapped zone there should be tie back this should be designed properly the tie backs would be there, the overlap should be there and the protections of both the outer banks should be put in.

Such a way that it should not have a failure mechanisms will happen it because of if you protect the partly it is not the successful story, so we have to protect the river as a single entity as the river curvatures are there we should have the revetment in both the sites, we should have a tiebacks and we should have at a overlap. Lot of design guidelines are there what should be the overlap, how to make the tieback or you can have a more detailed geotechnical.

And hydraulic experiment the laboratory experiment to find out what should be the dimensions of this planform of these revetment structures, so if you visit any of the river bank you can see this revetment structures where you have a bank erosion is quite dominated.

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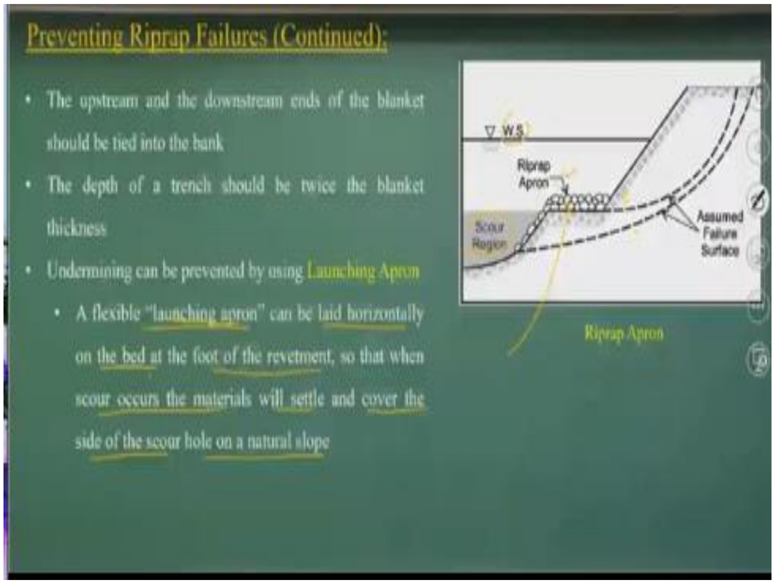


Next points what we are talking about when you look at this launching apron you should have very much knowledge about the scouring mechanisms, how much of scour is going to happen it like this is a riprap apron which we provided this is the water surface slope. So we can see that there will be the failure things is changing it is this failure surface is changing it because of the scouring regions, so the scour you have to anticipate it what could be scour happening because of these river protections work.

And hydrodynamic force and the river curvatures that way you can find out what could the failure surface will happen it and based on that we should have the protection mechanisms. The launching apron is a flexible apron can be laid horizontally on the bed and foot of the revetment, so this is the launching apron is what you will it is very flexible and the scour occurs and the material will settle it over the side of the scour hole on a natural slope that is what we plan it.

So that is what we should anticipate it if there is a scour holes the launching aprons should be very flexible, so that the launching apron the materials can cover up on the scour whole holes and the scour zones can be protected naturally by the river dynamics you can settle down with that is the reasons, it needs to have a lot of experience in the river levels we design something some river revetment work, implement the river revetment work, monitor river revetment, work to try to know it what should be the criteria follow for launching apron.

So that the river bank can protect it during the steam scour formation states that is a quite challenging one, it is not a just dumping the stone on the river bank, that is my point to tell it is not a just dumping the stone on the river bank then eventually that part will be valid. We should have a proper designing of the river revetment work.

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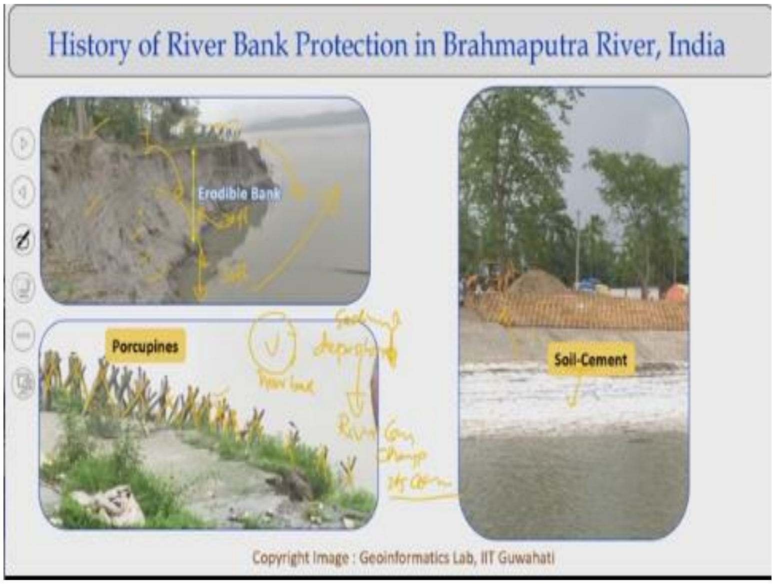


If you look at that what the experience the river the stabilization work is not very easy task, when you talk about river like Brahmaputra it is a large dimensions, we cannot think it the river bank protections are a simple job, so if you look at these figures you can understand it what could be the height of the bank the height of the bank is a 6 feet tall person is standing here and you can understand with this scale which could be more than 30 feet that is what is above the free surface there could be below any another maybe 30 feet.

So if you look at this river bank, so gigantic, so high river bank of 60 feet and if you look at the river erodible bank materials which are close to the sand and the silt, they does not have are some clay compositions and if you look at the river bank protections which is a porcupines structures which are standing over that and which is falling down it and you can see that how erosions processes are happening it very dynamically instantly say eroding the toe materials collapsing these bank materials.

And at the top the river bank protection standing it trees are standing it, so if you look at that the bank erosion process what it happens in Brahmaputra rivers in the scale that does not happen in many part of the world, so we should try to understand what type of bank erosion process are happening it and we have a small structures like porcupines if you look at this concrete structures the basic idea for this concrete structure is to reduce the velocity.

If I reduce the velocities that is what can start the sedimentations depositions the siltations will start it and that siltations can facilitate river to divert from that locations, so this type of smaller structures we have been putting in river bank of Brahmaputra rivers just to have a expected that the velocity near the bank is going to decrease it and as it is going to decrease it can initiate the sediment depositions and because of the sediment depositions as we expected it river can change its course.

It can go from the locations where it is, but some success stories and failure stories are there but this is what the riverbank protections for this alluvial river like this where the bank erosions are really it is a quite challenging process what it offends it, some of the cases we can have a protect the rivers with a soil cement a compositions of soil and cement bag you can see it and the top you can have a protections work.

But that is what also can be possible where you have not these compositions are you want to protect where you do not have much secondary current is there you can think it to protect the river bank with the soil cement and with a some sort of gabion or this surface protection systems like putting the some stones or even the bricks to protect these ones, so if you look at that implementations what is going on

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The same way if you look it this is what I explaining it the huge porcupine structures that is what is called porcupine fields and this is what because of these porcupine structures it may be facilitating depositions. If you can see that porcupine structures and this the depositions and because of that river might have changed its course from these protections to other part so these are the structures what is implement is it is a simple tetrahedral structures and it is quite stable.

And those structures we use it just protect which are the vulnerable region success and failure stories are there and I am not going to discuss much detail on that but this is what the basic idea when you do it.

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But if you look at this river bank protections in Brahmani rivers where it is a smaller rivers as compared to the Brahmaputra and you can see this rivers bank, you can see the embankment, you can see this floodplain cultivations so as we have been discussing the same concept is there is a floodplain, there is a embankment, so we have enough flood plain we have given it to rivers and it has the agriculture activities within the floodplain and that is what is there.

And the cases where you have a river bend, the channel bend is there in Brahmani and you can see these spur structures from even from Google data you can see this river spur structures which is facilitating the river to go like this not to attacking this bank. So you can see this a series of spur structures are there which is divert these flow stream lines away from the bank that is you can see it and there are earlier there used to have a weir structures to protect the maximum flow or protect the maintain the navigable or flow depth.

So if you look at that way our success stories for the smaller rivers is quite impressive but bigger river like Brahmaputra and partly Ganges are not that successful because the dimension of the problems are you as we have been discussing it is still it is a complex task to protect the river bank in Brahmaputra where you have a so dynamic processes are helping it.

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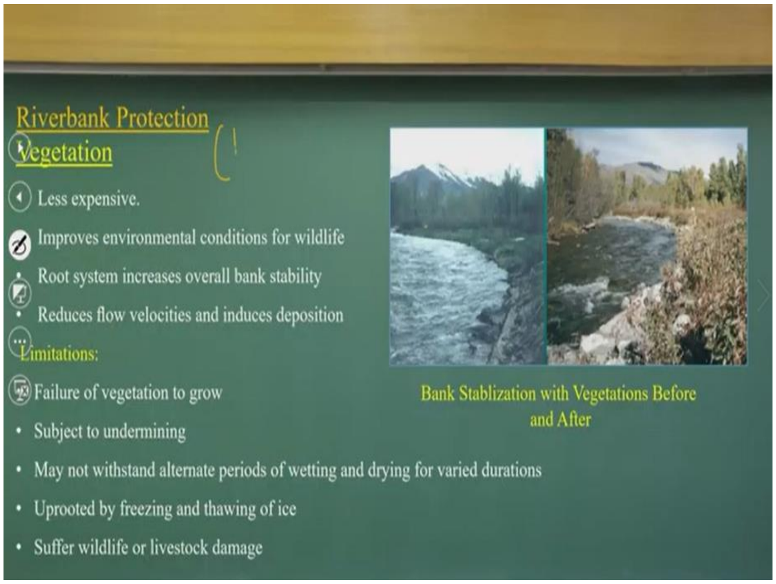


Like this is the concept many of the peoples in the world wide they are talking about river health. The basic idea is that to bring the river as close to natural conditions that means any rivers you can have protect with a vegetations, protect with natural vegetations and because of this protection of natural vegetations what is going to happens is that the velocity reduces as we increase the roughness Manning's roughness coefficients putting this vegetations.

What is happens is velocity reduction happens which is facilitated for the sedimentations which we need it during the high flood periods if there is a sedimentations and that what will facilitate also the growth of the vegetations. So we try to look it how we can reintroduce the vegetations on the river banks and the it is potential plot plane area so that we can improve this increase this Manning's roughness coefficient.

Which we can know it because of increase of Manning's roughness coefficient velocity reductions will be there and which can facilitate the sedimentations. And not only that near boundary near bed and the bank the flow structures will change it. Flow and sediment structures will change it which is quite complex that way so if you try to understand it that is what is there and if you look at that the examples which is there.

That if you have a river bank like this and if you put the vegetations and you can see that how it is a very natural vegetations can have an effectiveness in terms of protecting the bank but be remember it is may happen for a smaller rivers where that significant order of flow is not there or the velocity is not there so smaller rivers we can protect naturally with help of the vegetations changing the near bed and bank flow and sediment structures changing the flow resistance and changing the velocity that is what we facilitated it and variations grow it.

So this is what basically environment conditions which is as I said that it will improve the river ecosystems, root system may increase the overall bank stabilities, reduce the flow velocity, induce the depositions that is what I explain it. And there are limitations there is a failure of vegetation subject to undermining, may not have withstand alternative periods of wetting drying periods, uprooted by freezing thawing of ice suffer wildlife livestocks.

It is just expected if you grow the vegetations it may not effective for all the cases it can effective for certain range of the flow the velocities and all but if you have a extreme flood event it may not sustain that way or whether these vegetations remain grow throughout the years taking care of wetting and drying of different durations.

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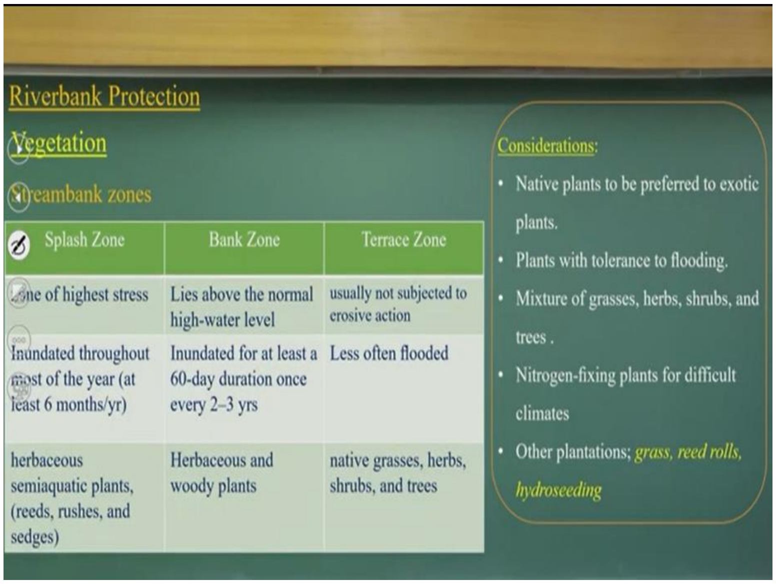


Now if you look at next part which is very interesting that what type of vegetations we can put it for your river bank if you look in like, this is the flow but there is a zone you will have the flow where you have the flow which is called the high stress zone which is inundated throughout the most of the years that is what this is a low flow this normal flow so this part of the vegetations which is a splash zone.

Where we can have a throughout the year you can have the waters in that case you can have a semi aquatic plants you can have reeds, rushes and sedges. So this is the area so often the water will spreading it there and there you can put the some vegetations will be semi-aquatic plants. You have a bank zone which is above the normal to the high water levels this is the bank zone which above the normal high water levels.

It is inundated at least a 60 days durations once in every 2 to 3 years. Inundation does not happen so often here it is inundation at least a 60 days durations that you can have a herbaceous or woody plants we can put it that. If you terracing zone beyond that you have a terracing zone you have a splash zone and you have bank zone which is usually not subject to the erosive action less upon flooded native grasses, herbs, shrubs and trees can be planted it.

Most oftenly I can take it in natural for river systems mostly follows like this whether we can facilitate to have a same natural conditions by artificially planting these trees, native grasses woody plants or semi-aquatic plants so basic idea as a river engineer is that we try to improve the river health as well as we can protect the bank protections because we change the near bed or near bank hydraulic conditions that is we try to understand it.

But how effective it is only at the big questions marks when you talk about extreme plot conditions that is where do we look at more technically how effective it is but there are the cases we have been advocating to have a ecosystem based river protections work which can be implemented for the smaller rivers where we are not we have modified the river ecosystems so those reasons we can plan it to have a different type of vegetations like a splash zone, bank zone terrace zone.

We can put the different vegetation and we can make it river ecosystem as closer to the natural conditions and by the way we can improve the river health and also we can protect the river bank.

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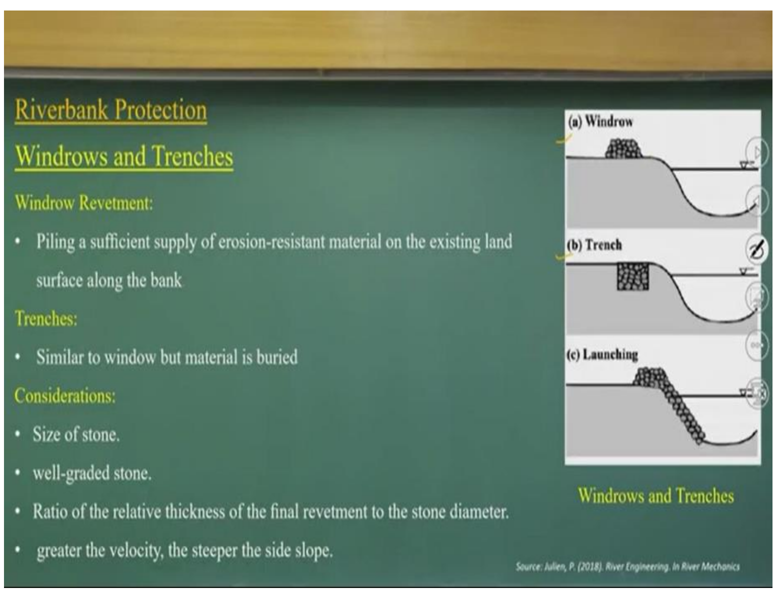


Let us look at river bank protections what we look at very traditional way to protect the river bank like wind row or the trench if you look at these figures it is very simple way you just dump those stones on the river bank or you create a trench and fill up the stones. What is our idea is that as the river eroded as it is widening the channels this stone materials will fall down it after that it will be naturally have a protections it create a natural formations of river blankets.

Bank blanket you will create it its natural. So that is what is the windrows just you dump the stones of different sizes and you just wait to river to erode that part as its river erode this part and its fall it during the natural conditions and it will create a blanket of river protections work its naturally by river dynamic forces but this is what nowadays we are not practicing it because it is quite expensive.

And we do not know whether river can come to that locations or not and it is same way we can have at the trench facility to have a protections of the bank and or you can have a launching aprons so you can have a launching this materials from the top and you can go like this so we can have windrow revetments is piling a sufficient supply of erosions resistance material on the existing land surface along the riverbank that is what is.

Earlier we used to do it similar to windrows but material is buried here the same concept we also depend upon the size of the stone, well graded stones and we also talk about the relative thickness of the final revetment the stone diameters greater the velocity steeper the side slopes. Basically this is the practice used to do from the Brahmaputra Ganges rivers in Bangladesh and they have been very old practice to do this type of riverbank protections using windrow or the trench concept to protect these things.

But nowadays we cannot do those type of bank material we cannot put it huge and we cannot wait for the river to erode it and have other protections but we go for the launching way and proper river bank protections work.

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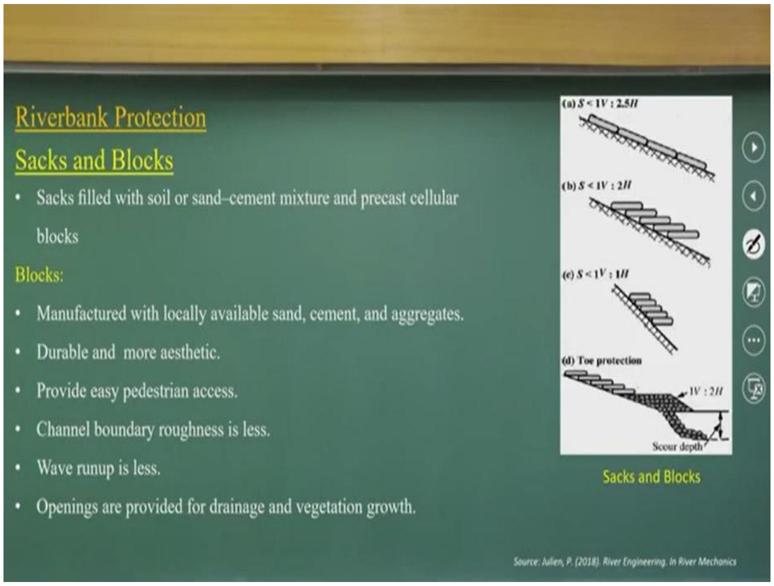


Now if you look it sacks and blocks which most oftenly use it one is that you can have a one by one like this we when you have a the side slope ratios like this or you have a one over one by one this is a stacking will be there or you can have like or you can have a stacking like this then you have a two protections and the scour depth and after the scour the filling materials. So if you look at this once which in generally if you go to any of river bank protections you can see that.

Depending upon the slope you can stack it the sack and blocks that is what is that and most probably you have to look at what you have been doing it and protecting the river bank.

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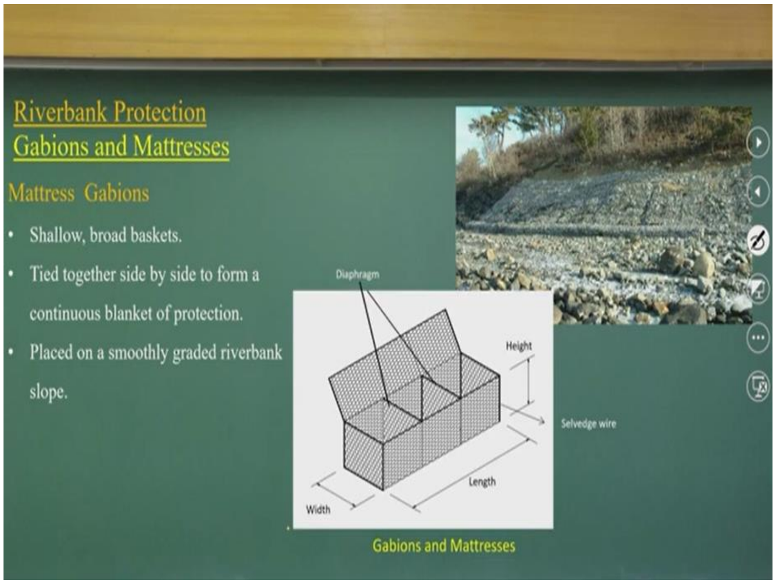

Most of the nowadays we talk about the gabion mattress because as you know it the individual stone if you put it there could be a particle erosions there could be a chance to have a slidings to avoid that we last few decades is introduced the concept of the gabion boxes if you only see that there could be a box with a length and height and you can fill up the stone here and box with a wire mass mesh so if you have a box with wire mesh.

So you can put these stones and those stones can have a particle level stability as well as it can act like a mattress. So if you look at this act like a mattress so that is more stables will come it when you combine the riprap stones with a gabion boxes and if you tie off all these given boxes it can act like a mattress it is a big mattress, we can put a stone gabion mattress on the river bank which is more much more strength as compared to the individual stones.

So that is the reasons nowadays we have been using this concept of gabion mattress on riverbank protections where we need to protect it because the cost is quite effectiveness in terms of reduction of the thickness of the stone revetment and as well as it creates a monolithic structures single structures so that any sort of the failure mechanisms can be prevented because of gabion mattress.

So the basically it is a broad baskets tied together by side by side to from a continuous blanket after protection is played on smoothly graded river bank slope. So we have to first smooth it river bank or you make a reduction of the side slope on the reduction of the side slope you can lay out gabion mattress and as the gabion mattress is simple things it is a boxes with the oil frameworks so we can have a from like a baskets you can have put the stones it can be tied down it side by sides and can have a place on a river bank. That is nowadays the technology;

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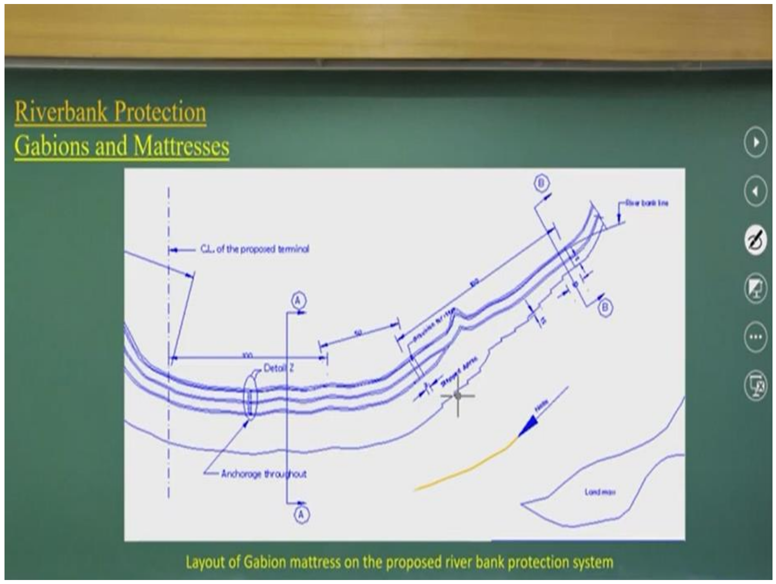


And if you look at that part we have designed for similar conditions for the Brahmaputra rivers and if you look at this is a plan for this is what the jetty locations we try to design the protections of the jetty with the Brahmaputra rivers the design velocity is about 5 meter per second the scouring depth as it goes beyond the 30 meters, so we try to protect these things that is what we design it riverbank protections work for Brahmaputra rivers.

And you can see this plan view for design velocity and you can see there is a apron here the stepped apron you put it and there is a tie concept is there and there are different length is there and if you look at this covering stepwise apron we have been propagating it so just follow this all and this is the gabion mattress what we have design it and more detail I am not discussing it but these things partly is implemented in many part of the Brahmaputra rivers protecting the banks. But it is a bit expensive as compared to the others.

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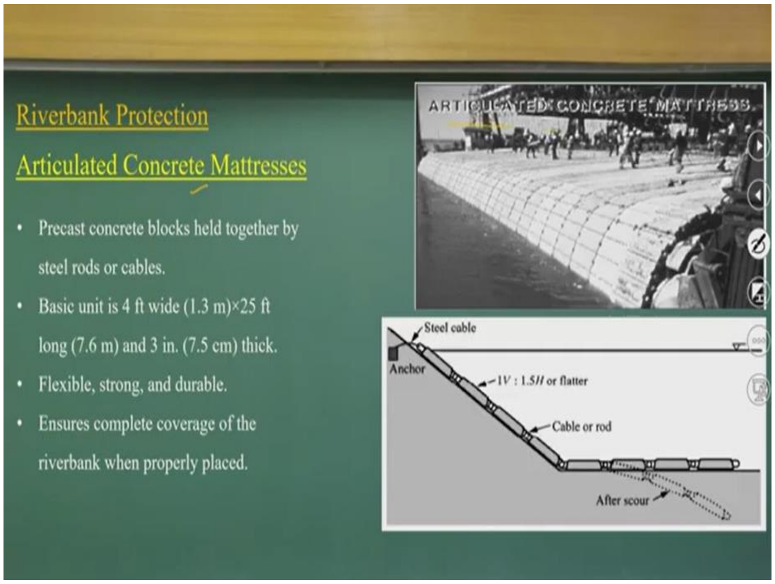


Now if you look it which is this technology is bit costly because is articulate concrete mattress can be put it as it will be a concrete mattress which I believe it can be for a smaller rivers and in the urban areas we can think it to have a the cable connected and you have a concrete mattress and you can put in this apron area after the scours being its flexible it can come to the stage and you can have an anchoring concept.

So the basically this type of protections work we do it its quite expensive for a urban area where the land cost is too high to protect our urb area we can have a articulate concrete mattress last just like that what we talk about the gabion mattress so similar way you can have a concrete mattress and you have a arrangement of cable and the rods you have a steel cable, anchoring, scour protections after the scour all you have to the design concept is same but we have changed the materials.

Is a articulate concrete materials is a precast concrete blocks held together by steel rods and cables basic we need can be committed to be 1.3 meters, 7.6 meters and 7.5 thickness its flexible strong and in complete coverage of the river banks when properly placed it. But it is too much expensive and you need to look it what type of protections you will they do the landmarks which regions you are putting it but as I said it in case of urban area.

We can think about have a precast concrete block which is advantage for us because we can do the constructions of river bank protections very fast because precast concrete blocks are there and we can just join it and the protect the river bank with having this allowance for the scouring zones and proper anchoring should be there and should be the flexibles and should place over the filter materials that should be the conditions as we discussed.

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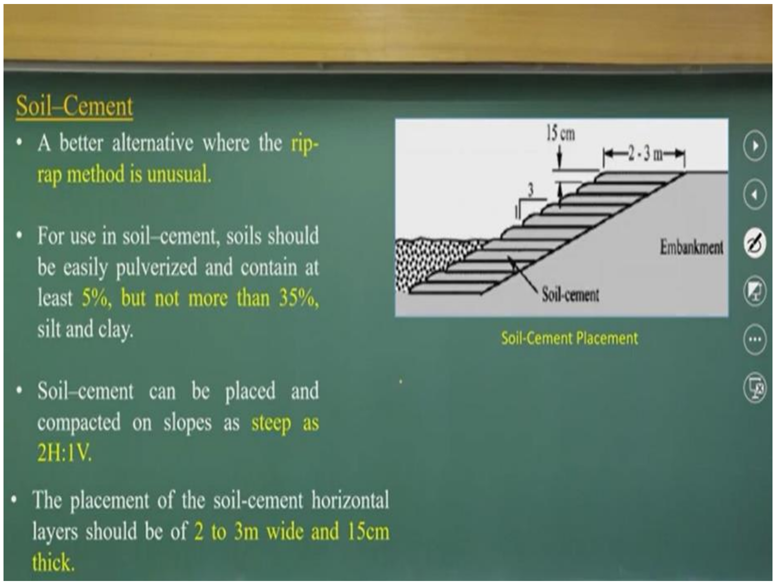


In the previous slides they are concept as a so there could be a soil cement you can have a riprap its quite alternative but unusual way what you do it a soil cement soil should be easily provides it and contain at least 5% not more than 35% silt and clay. We just make the soil with the cements with some percentage of the cement and soil cement can be placed and compacted on the slope as steep as 2 horizontal, 1 verticals.

The placement of soil cement in horizontal layers could be 2 to 3 meter wide 15 centimeter thick so this is what showing it but what I am to tell it this soil cement concept more detail you can get it from but it is can be used for a smaller rivers where we do not want to put a lot of we do not have to put more expensive river bank protection work and we can take a risk for the river bank failures and we can improve the soil cement.

The basically we are increasing the critical stresses just we are increasing the critical stresses because of soil compositions and that critical that is the reasons there will be no erosions will happen it and that way we can protect it that is the basic idea here you improve the critical shear stress by combination of the soil cement and thus will give us a soil cement blocks which will have a higher the critical shear stress and because of higher the critical shear stress for erosions.

And that is what is there it is protect the banks that is what it protects the bank now if you look it.

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I think we will be discussing more about the retaining wall in the next class and with this let me concluding these lectures and this is my research groups who have been helping me to develop this course but before with this if you look at that people talking about a concept is called a Road map for a Healthy Ganga so if you try to understand it river protections work we should look it in terms of river health not in terms of just protecting the river bank so with that concept we should move it and with this let me conclude this lecture thank you.