Application of Soil Mechanics
Prof. N.R.Patra
Department of Civil Engineering
Indian Institution of Technology, Kanapur

Lecture - 40

Next part of ambackment material will discussed about this highway construction materials equipment, and practice.

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So, basically we start with this function, and significance of subgrade properties that will it is come under basement of soil of road bed, and important for structural, and pavement life should not deflect excessively due to dynamic loading may be in fill or embackment compacted or natural subgrade.

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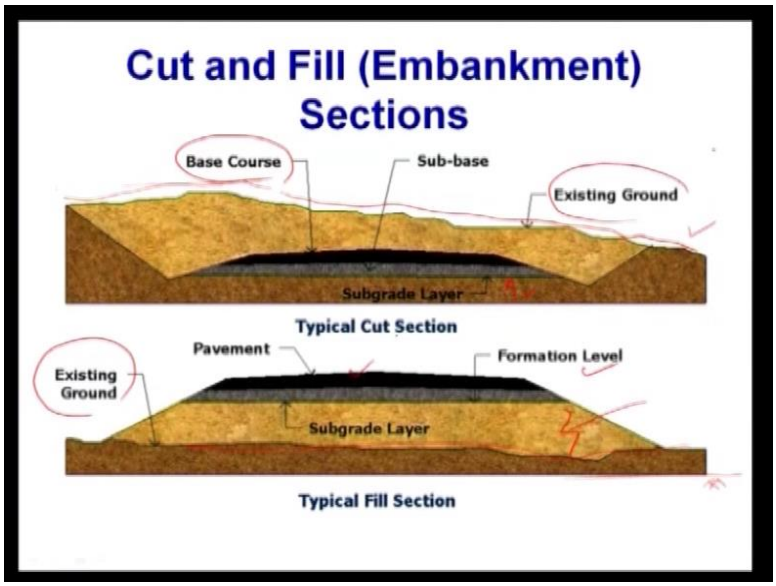

Now, if come back to embackment sections cut, and fill of embackment section. Now if you look at this figure, this is your existing ground, this is how this is your this enter top of part in your existing ground. If this existing ground, if you cut it, then I can classify into three parts one is your sub grade label, this is your sub grade lable, then middle is your sub base, then top page your base course. So, this is a typical cut section now in a payment look at this now typical fills section this is a typical cut section let means you are discussing cut, and fill of embackment sections per high wage. Now typical fill section in typical fill section what it will happen, will feel it will make this embackment, and typical cut section already ground lable will add the top we are cut it, and make the road or highway purpose or particularly fills section will make your ground surface is here.

Some are else here or may be below will be feel, and make it suitable for heavy. Now this is your this is your subgrade; first one is your existing ground surface some where else further here or may be here, this is your existing ground surface it is written here, then is your subgrade layer, and this enter part is your sub grade layer, then this is your formacy lable, and top one is your payment. So, these are the two sections one is our fill section other is your cut section.

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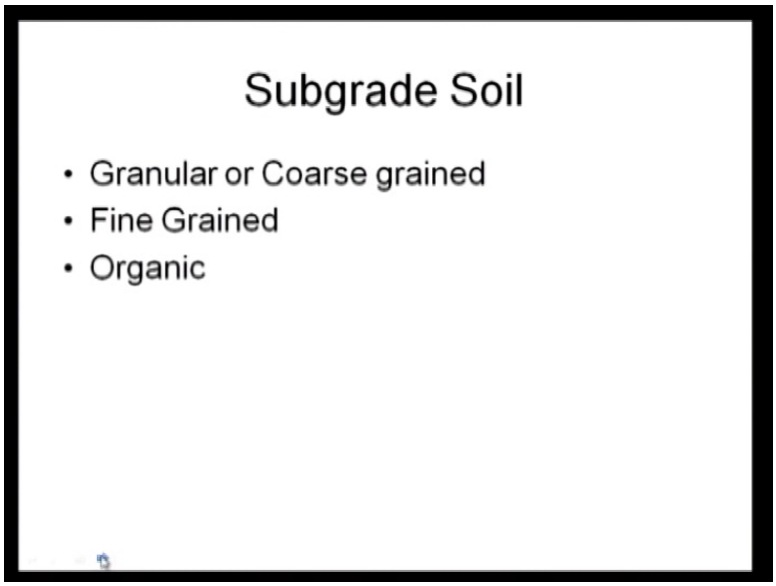

Now, subgrade soil, if you comeback to here if you look at here this is a subgrade layer that, and that this is subgrade soil, and this is also a subgrade layer; that means, subgrade soil both cut, and fill subgrade soil may be consist of granular or coarse grained, fine grained or organic.

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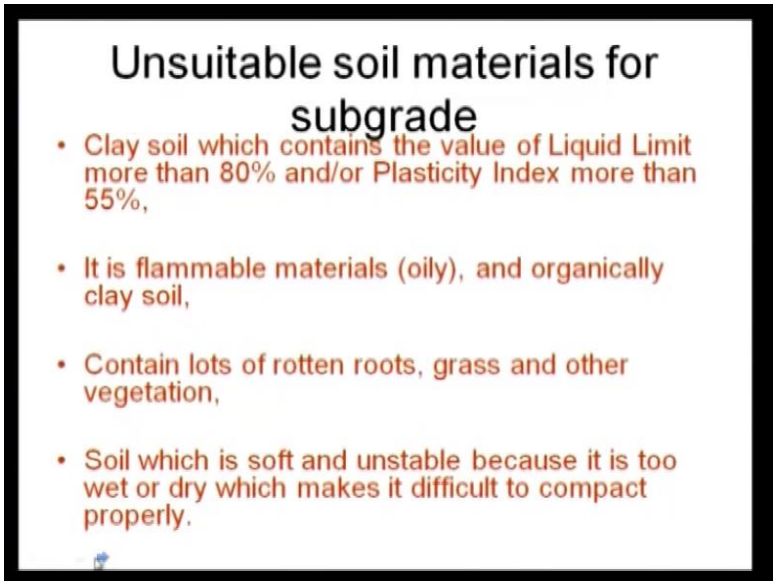

Now, what are the soil what are the conditions on suitable soil materials for subgrade, what are the soil material to be on sutaible that this soil should not be considered number one clay soil which contains the value of liquid limit more than eighty percent, which

contains the value of liquid limit more than eighty percent, and or or plastic index plasticity index more than fifty five percent. If at loss clay soil who is liquid limit is more than eighty percent, and or or plasticity index is more than fifty five percent in that case it is on suitable soil material for sub grade, if it is flammable material; that means, in flammable means, if some soil is mixed with all kind of material or organic or organic clay soil, then it is not suitable for sub grade soil material contents lots of rotten roots what happen sometimes in the soil inside this three route will go, and it has been award the period of time it become rotten. So, what will happen is... So, there are lot of rotten root grass, and other vegetations, then also it is not suitable soil which is soft on stable, because it is too wet or dry which makes it difficult to compact properly; that means, which is too soft, and too soft, then it is not going into consider for subgrade material properties associated with subgrade soil.

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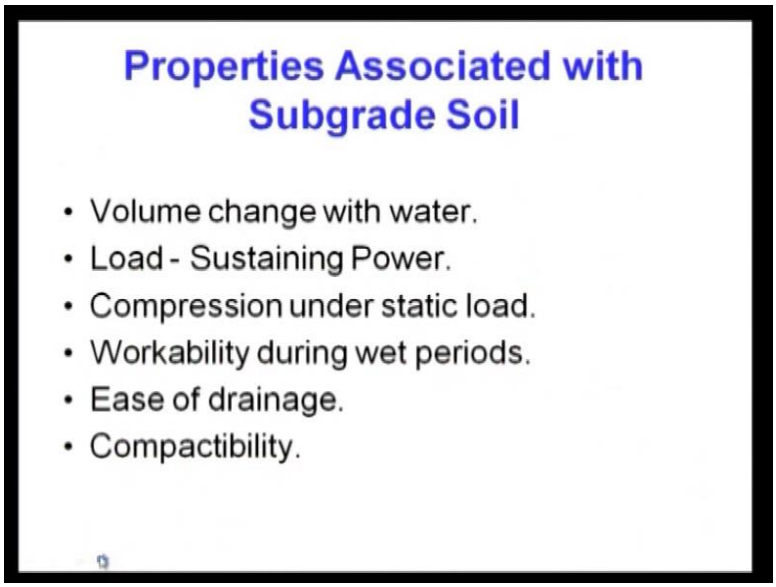

We are now discussing about this subgrade soil properties are associated with a subgrade soil volume change with water, load substanding power, compression under static load, workability during wet periods, ease of dralnage, and compactibility.

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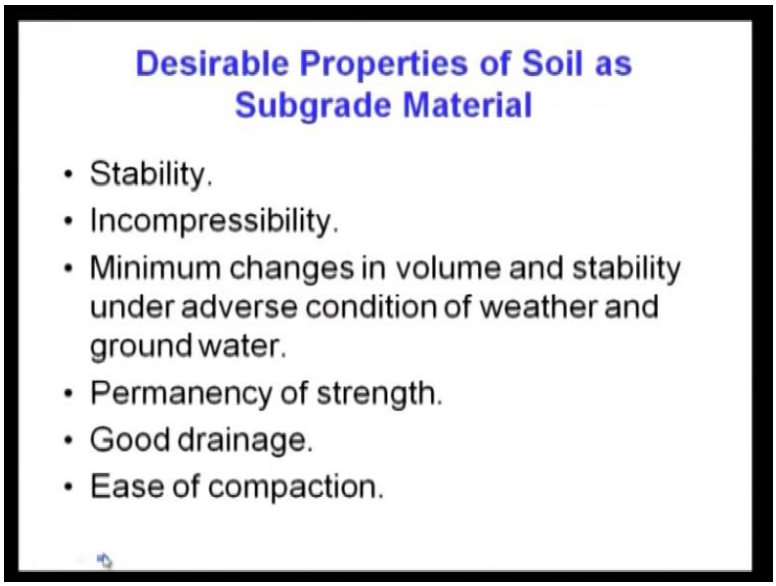

Now, desirable properties of soil as subgrade material its based on stability incompressability minimum changes in volume, and stability under adverse condition of weather, and groumd water, then permanency of strength good drainege, then eazy or ease compaction.

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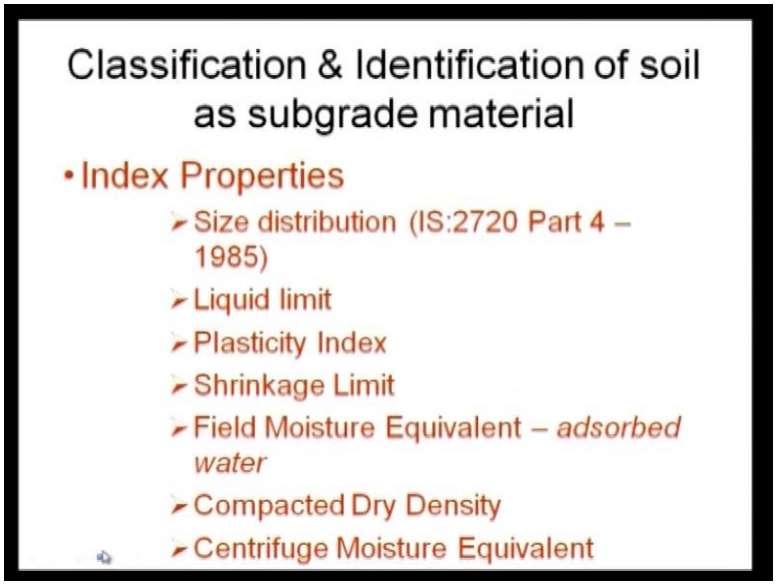

Classification, and indentification of soil are subgrade material how to identify these means there are many soil materials are their how do identify who soil material to be considered as a subgrade material it is based on the index properties; that means, size

distibution. Liquid limit, plasticity index, shrinkage limit, field moisture equipmemt equupment field moisture equivalent; that means, absorbed water compacted dry density centrifuge moisture equivalent.

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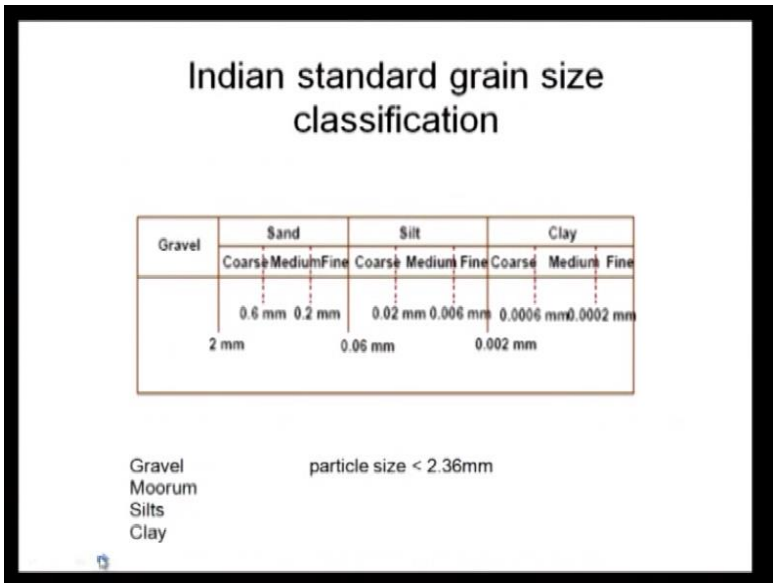

Indians standard grain size classification generally indian standard, we have discussed also earlier gravel sand silt, and clay as per the indian standard, we have four soil classification one is gravel, then your sand silts between two mm to zero pont zero six mm with in this sand, then it classified has to three parts coarse medium, and fine, then clay silts between zero point zero zero two mm zero point zero zero Six mm, and zero point zero zero two mm. So, it silts between coarse medium, and fine. So, grain size distibution.

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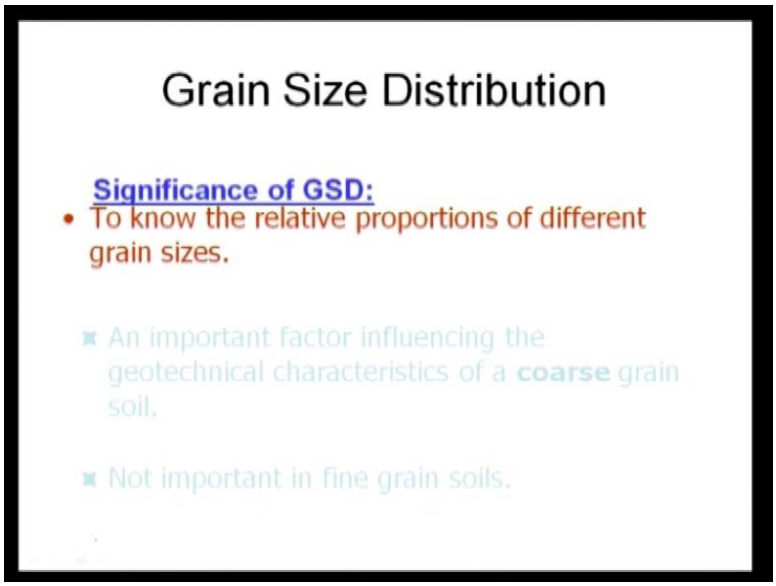

So, significance of here g s d grain size distibution to know the relative propersion of different grain sizes, what is the significance to know the relative proportion of different sizes, and important factor influencing the geotechnical characteristics of coarse grain soil.

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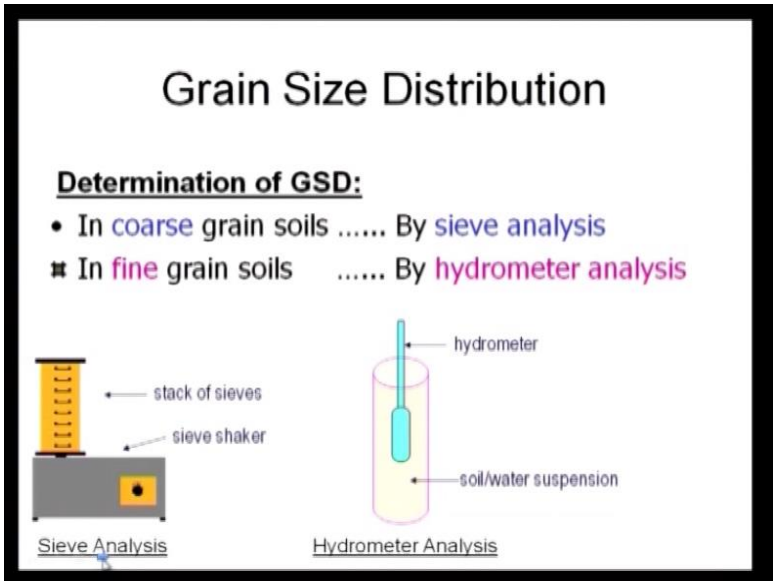

Last one is grain size distributuion is look at here significance of grain size distribution means to know the relative propo proportion of different grain size an important factor of influencing the geotechnical characteristics of coarse grain soil not important in fine

grain soils. Now will start the fast one is your to know the relative proportion of different grain size is in coarse grain oils by sieve analysis this is have doing the sieve analysis by means of stock of sieves, and sieve shakar is adving this analysis in fine grain soil by means of hydrometer analysis using this hydrometer; that means, soil, and water suspension in a maturing jar, then putting hydrometer insite you can find out a fine grains soil as well as coarse grains soil by means of sieve analysis.

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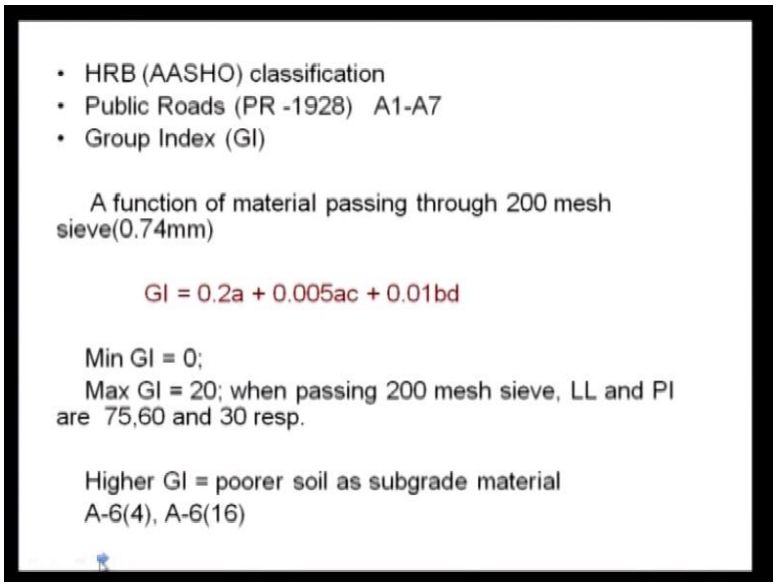

So, based on a a s s h o classification based on public road p a ninteen twenty eight a one to a seven classification based on group index g i a function of material passing through two hundred mesh sieve; that means, zero point seven mm group index may be calculated as zero point two a plus zero point zero zero five a c plus zero point zero one b d. So, minimum index is equal zero maximum index is equal to twenty when passing two hundred mesh sieve liquid limit, and plasticity index are seventy five sixty thirty respectively higher g i; that means, higher the group index; that means, poorer soil as subgrade material, if the group index is very high that we see indicates poorer soil; that means, it is a poorer soil as subgrade material.

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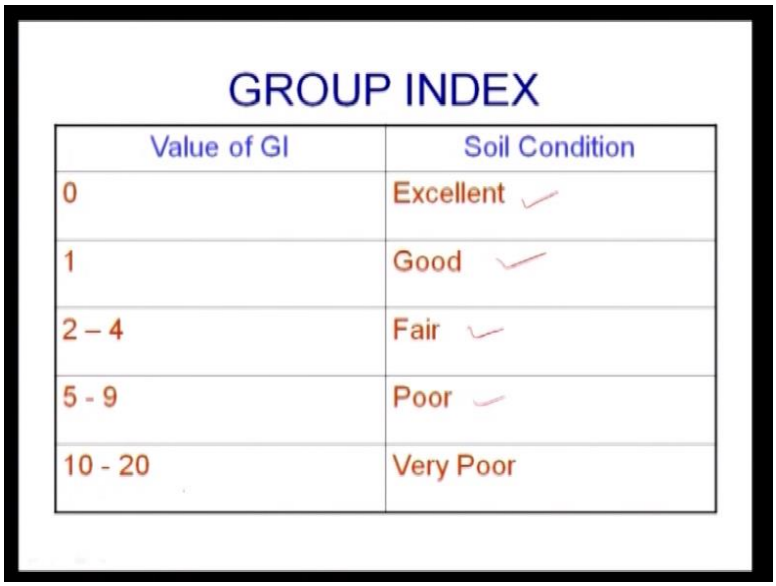

If you look at the group value is as per even in the table are formed if group index is zero at means soil conditions are excellent. If group index is one that is good between two to four it is fair five to nine it is poor ten to twenty is very poor; that means, if the group index value is very high; that means, it is not suitable for high way material or subgrade material.

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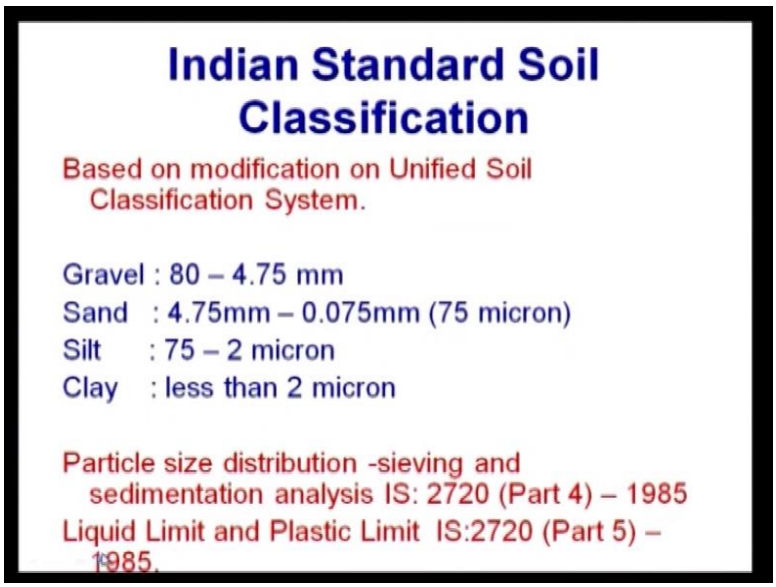

So, indian soil classification; that means, best on modification unified soil classification system gravel generally we take eighty to four point seven five mm sand four point seven

five to zero point zero seven five mm silt seventy five micron to two micron clay generally less than two micron. So, particle size distribution sieving, and sedimentation analysis as per indian standard two seven two zero part four ninteen eighty five, and these are the two coarse, and liquid limit, and plastic limit as per indian standard two seven two zero part five ninteen eighty five.

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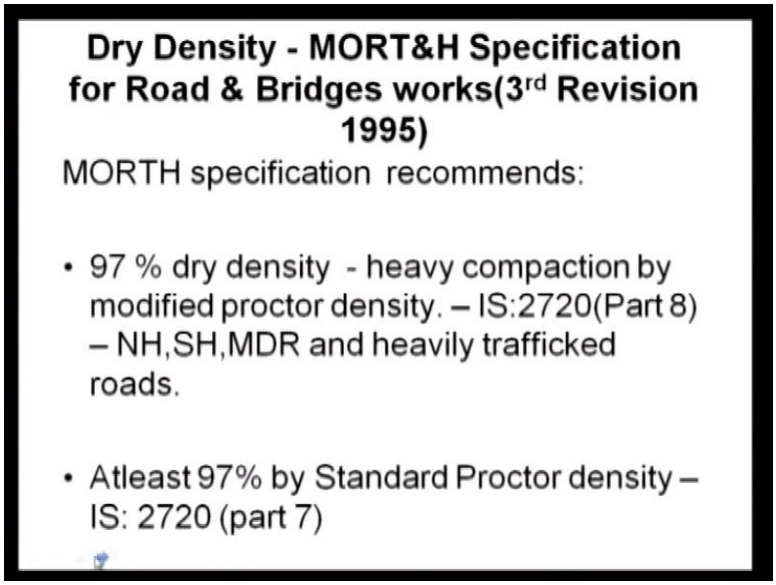

Dry density specification for road, and bridge third revision ninteen ninty five m o r t h morth specification specification recommends ninty seven percent density; that means, heavy compaction by modified procter density as per i s indian standardtwo seven two zero part eight it as the ninty perc ninty seven percent density it as been used national highway state highway m d r, and heavily traffiked road atleast ninty seven percent by standard procter density one one is your by heavy compaction by modified procter density one is modified procter density; other is by standard proctor density atleast ninty seven percent, it has been given by indian standard two seven two zero part seven.

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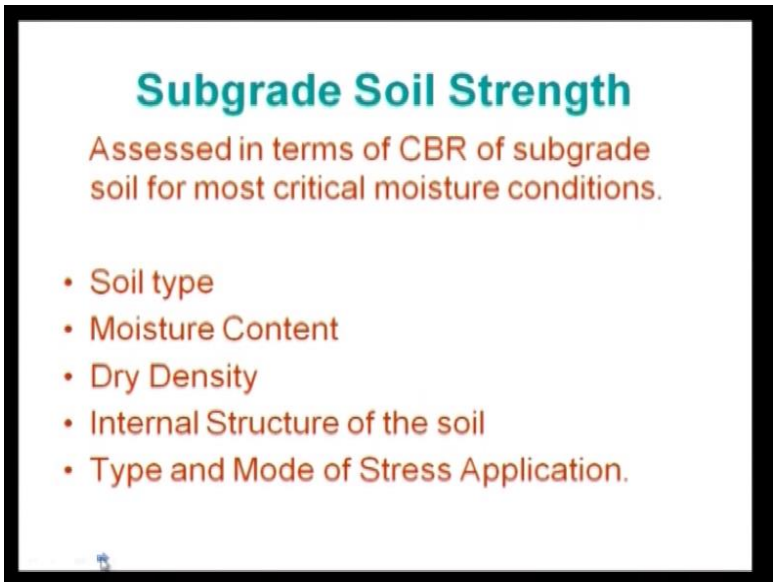

Then subgrade soil strength that is assessed in terms of c b r of subgrades soil for most critical moisture conditions strength has to be measured by by means of c b r califormia bearing ratio test this strength has to be measured; that means, soiled type moisture content dry density internal structure of the soil type, and mode of stress application.

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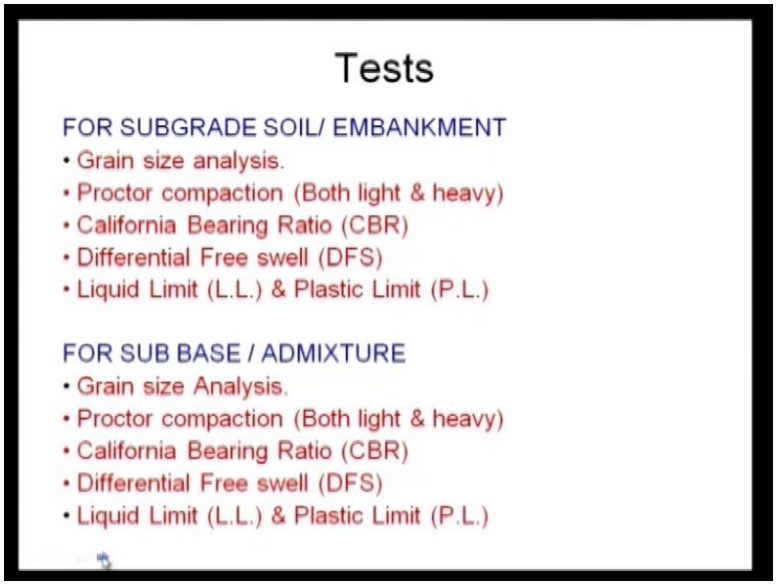

What are the different tests for subgrades soil or embackment for subgrades soil or embackment you have to do grain size analysis proctor compaction both light, and heavy heavy means modified procter light means procter comparision califormia bearing ratio;

that means, c b r, and differential free swell that called d f s liquid limit plastic limit for sub base or admixture grain size analysis procter compaction both light, and heavy californiа bearing ratio differential free swell, and liquid limit plastic limit you see for a sub base or admixture or may be subgrade soil embackment what are the test required in the laboratory.

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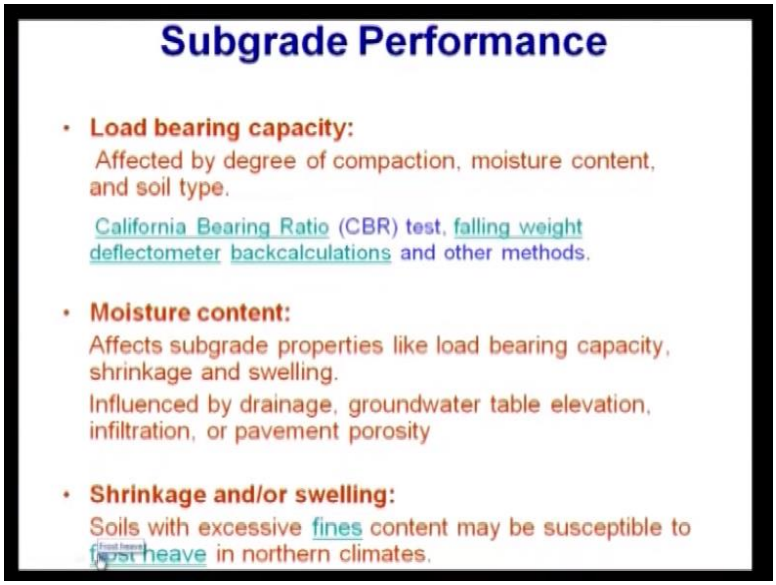

Subgrade performance: load bearing capacity in load bearing capacity is affected by degree of compaction moisture content, and soil type californiа bearing ratio test, and falling weight defectomater backcalculation, and other methods are has been used have been used moisture content affects the subgrade properties like load bearing capacity it affects the subgrade properties like load bearing capacity shrinkage, and swelling influence by drainage ground water table elevation infilitration or pavement porosity.Shrinkage , and or swelling soils with excessive fines generally soils with excessive fines content suppose soil as more than fifty percent or sixty percent fine content, then this may be susceptible to heave in northen climates.

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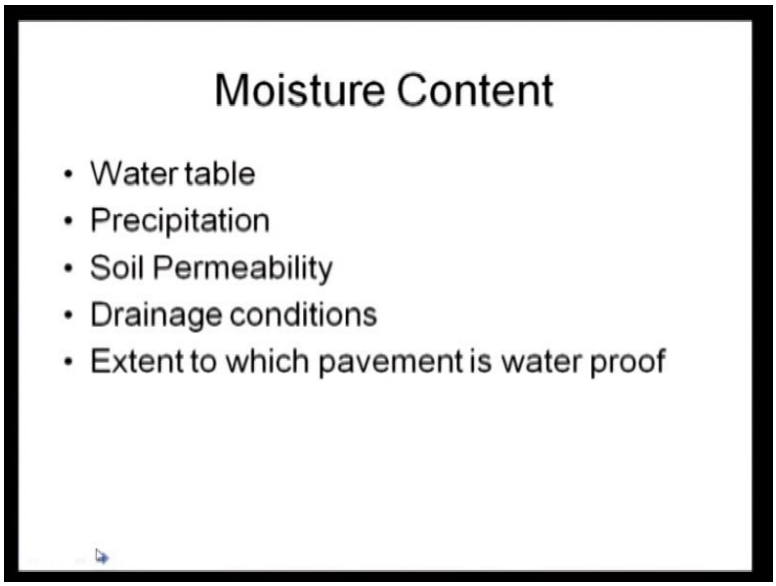

Moisture content water table precipitation soil permeability drainage conditions extent to which pavement is water proof .

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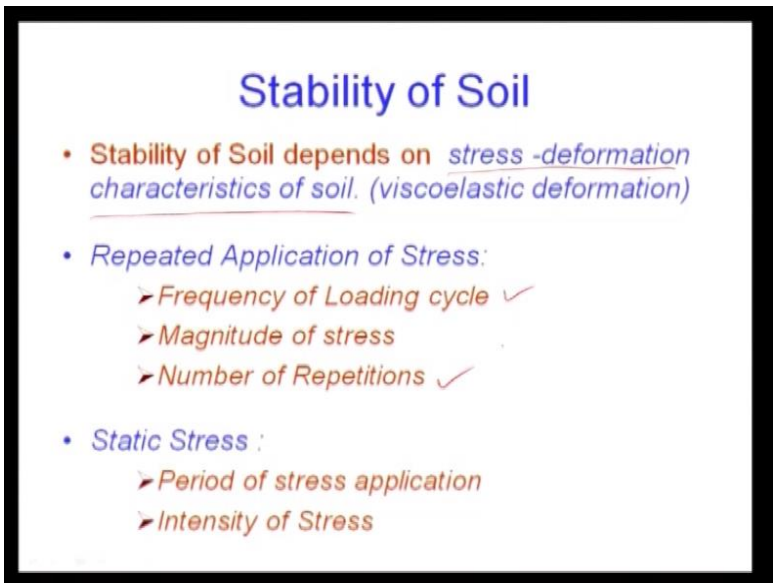

Stability of soil, if you look at the styability of soil it depends upon stress deformation characteristics of soil stability of soil is depends on the stress deformation characteristics of soilthat means viscoelastic deformation viscoelastic deformationrepeated application of stress repeated; that means, repeated note generally applied by means of trafic loading repeated load means suppose there are n number of vichcle passes in the road; that

means, what will happen again, and again they will apply this load same position. So, repeated application of stress generally by means of frequence of loading cycle magnituse of a stress number of repetitions number of repetitions, then stastic stress period period of stress application, and intencity of stress period of stress application, and intencity of stress .

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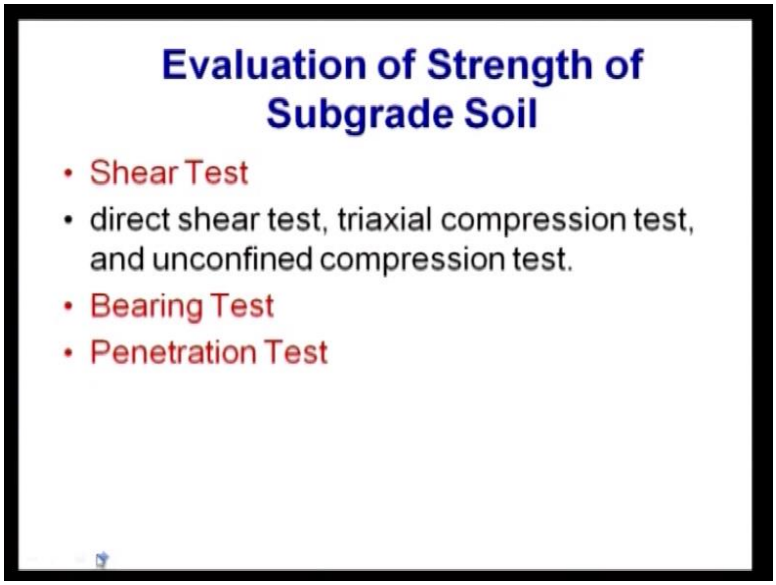

Then next part is your evaluation of strength of subgrade soil how do you fin out of this subgrade soil; first one is by means of shear test or you can shear test in that shear test what are the different shear test you can do by direct shear test or triaxial compression test or unconfined compression test, then bearing test you have to conduct, then have to go for your penetration test.

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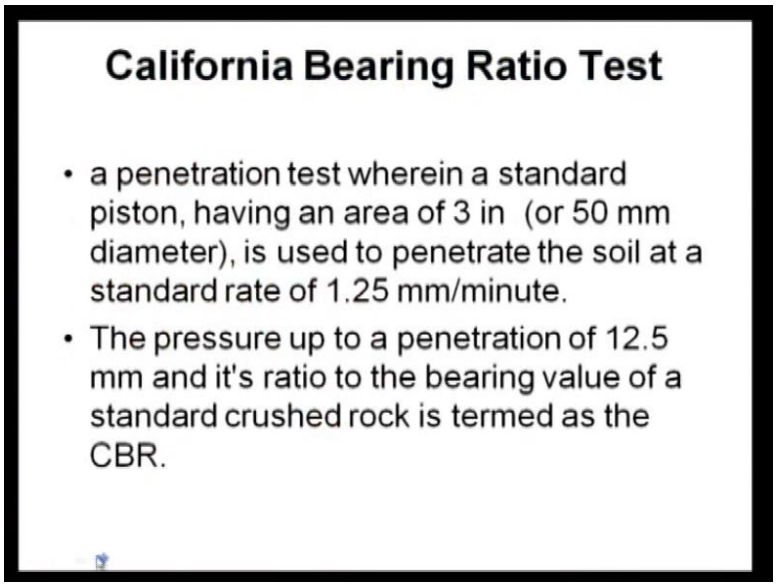

Then next most important part that is your californiа bearing ratio test a penetration test wherein a standard piston having an area of three each that is it is fifty mm diameter is used to penetrate the soil at a standard rate of one point two mm per minute; that means, every minute, it will penetrate one point two five mm the pressure of to a penetration of towel point five mm, and its ratio to the bearing value of a standard crushed or rock is determined as the c b r look at the definition to pressure of a penetration towel point five mm is up to towel point five mm, how much pressure coming to the soil , and its ratio to the bearing value of standard crushed rock is termed as c b r; that means, californiа bearing ratio.

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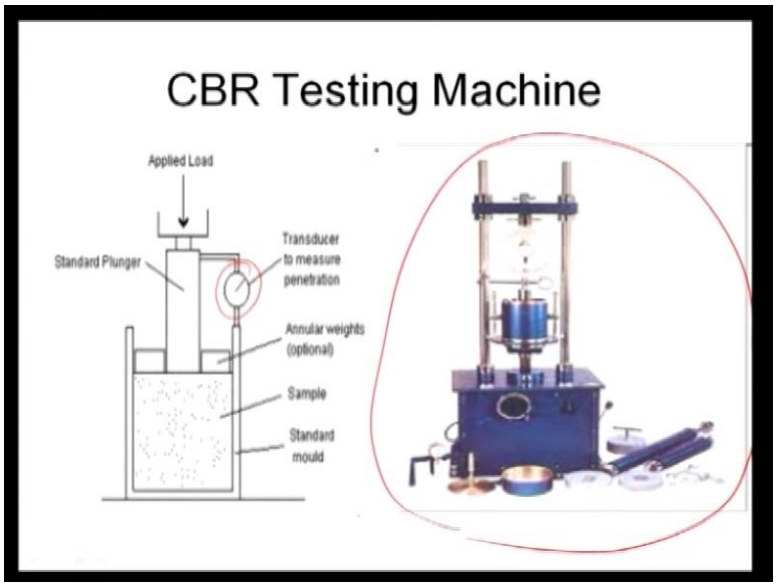

CBR testing machine, it will it will look at the c b r machine there is a standard plunger this is your standard plunger, then with this annular weights some times optional, then your sample this is your soil sample, then this is your standard mould in a standard mould in a standard mould soil has beeb taken, then we that a standard plunger is their from why are this apply load which be load has been applied, then transducer a here is a transducer route will connected to your applied load to measure the any trison this is the pictural view pictural view of this of c b r testing machines complete six c b r testing machines.

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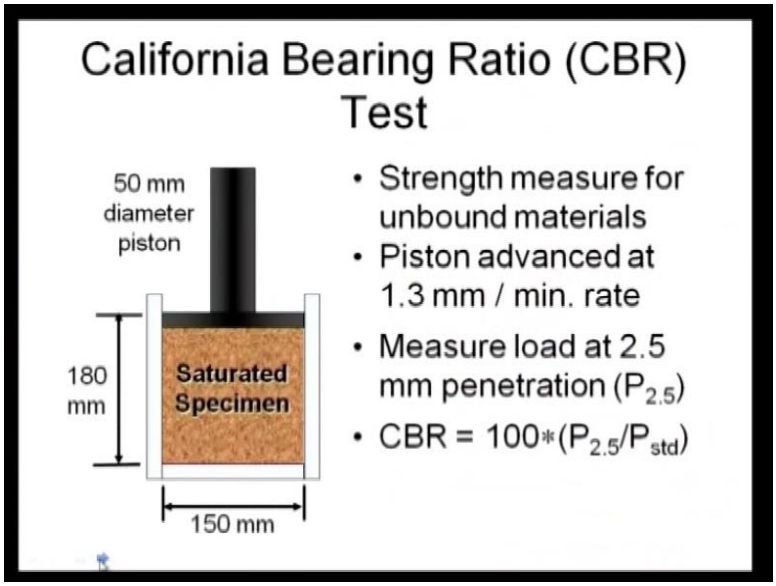

California bearing ratio test: Now strength measure for unbond materials piston advance at one point three mm per minute rate measure load at two point five mm penetration means what ever load, it is coming it measure every two point five mm penetration. So, c b r is equal to hundred into p two point five means how much measure is coming about two point five mm by p standard pp standard p p s t d .

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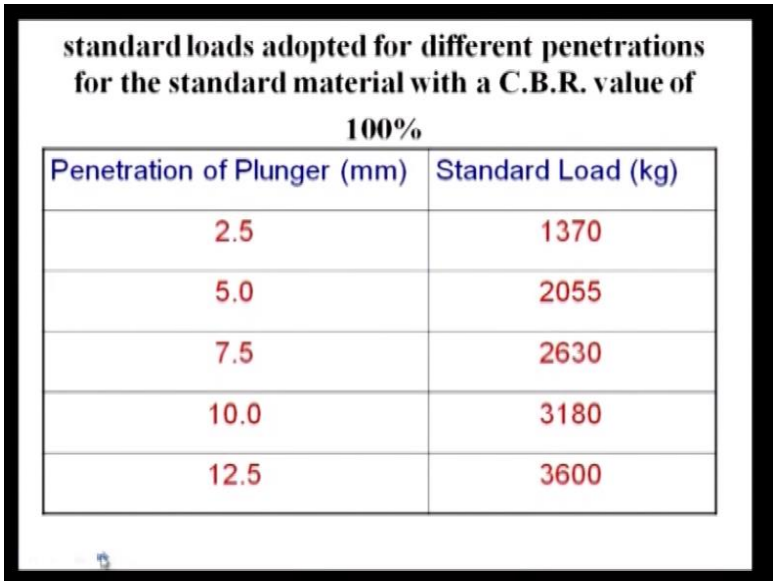

Standard loads adopted for different penetrations for the standard with a c b r value of hundred percent penetration of plunger generally standard load; if you are using one three seven zero k g it is two point five mm. if it is two zero five five k g it is five point zero mm if it is two six three zero k g it is seven point five mm, if it is three one eight zero k g it is ten mm, and if it is three six zero zero k g it is twelve point five mm.

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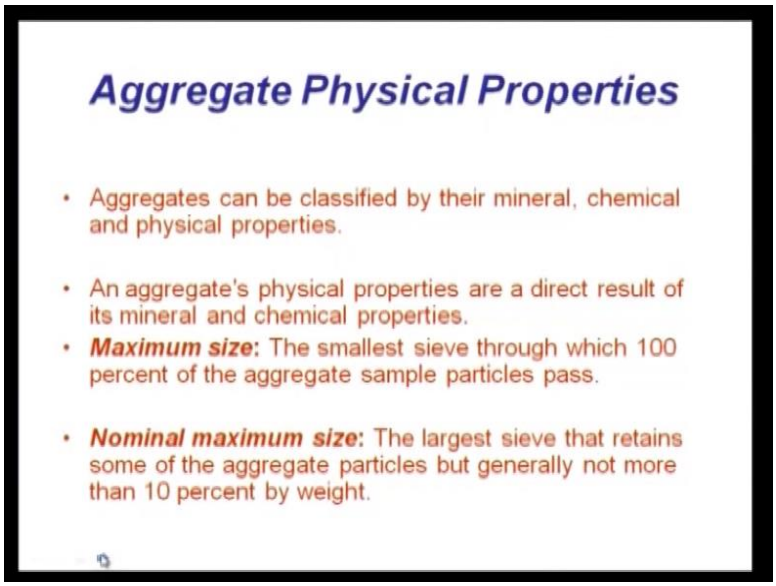

The next part is aggregate physical properties; that means, aggregate classified by their mineral chemical, and phisical properties you will have the classified the aggregate best on their mineral chemical, and physical properties an aggregates physical properties are a direct result of mineral, and chemical properties maximum size is the smallest sieve through which hundred percent of aggregates sample particles passes, this is called you maximum size that mean the smallest sieve through which hundred percent of aggregate sample particles passes this is called maximum size, then your nominal maximum size the largest sieve that retains some of the aggregate particles, but generally not more than ten percent by weight nominal maximum size is the the largest sieve which retains some of the aggregate not more than ten percent of total weight suppose say total weight. You are taking two hundred gram about this ten percent to the two hundred gram not more than; that means, the retaining retaining retain less than ten percent of two hundred gram. So, this is called nominal maximum.

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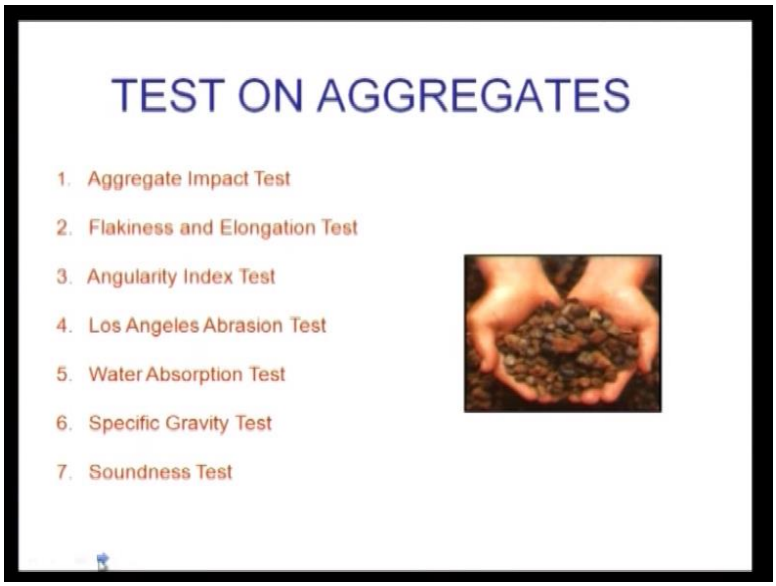

Size. So, what are the test on aggregates generally will go for. So, test on aggregate will generally go for aggregate impact test, then flakiness, and elongation test if you look at this is your aggregate flakiness, and elongation test, then is your elongarity index test, then los angeles andabrasion test, then water absorption test specific gravity test, and soundness test these are all test to find ot out into come back to here. If you look at the here in the as a cut, and fill section we have discussed subgrade layer; that means, subgrade soil wt kind of what kind of soil you have to consider if you consider best on what, and what are the test required, then you are if you look at the generally this aggregate base coarse this aggregate will come here formation level or may be base coarse label this aggregates wt kind of test you are suppose to do, and what is the best aggregates accordingly you have to deside these are all test on aggregate will have to carry on will decide to aggregate feet for this sub grade material.

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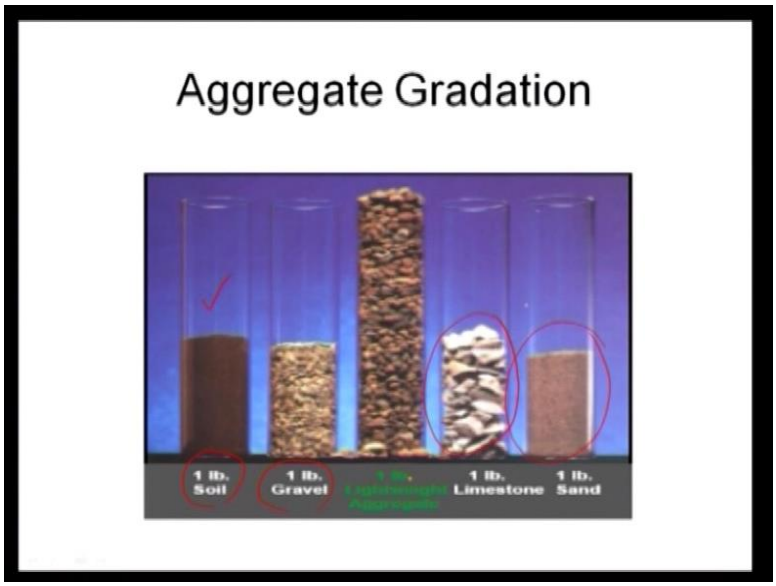

That means, road material or not of you look at here in a bikker in a basin in a basin aggregates gradation in basin, if a look at here first one is your in a basin this is tour soil one l b of soil, then it will be look at here one one l b of gravel, then light weight aggregate how the aggregate gradation has been done, then this is your limeston, then this is your sand; that means, if I take a same dikker or same jar in the same jar the volume is fixed the volume is fixed in the same volume. If I am taking a certain a amount of one found of suppose a one k g of soil. If I put it how the gradation comes into picture it fills half it fills half now light weight aggregate, it is fills full. Now the line stone is lightly higher, now the sand is less than your soil this is how this aggregate gradation generally with do.

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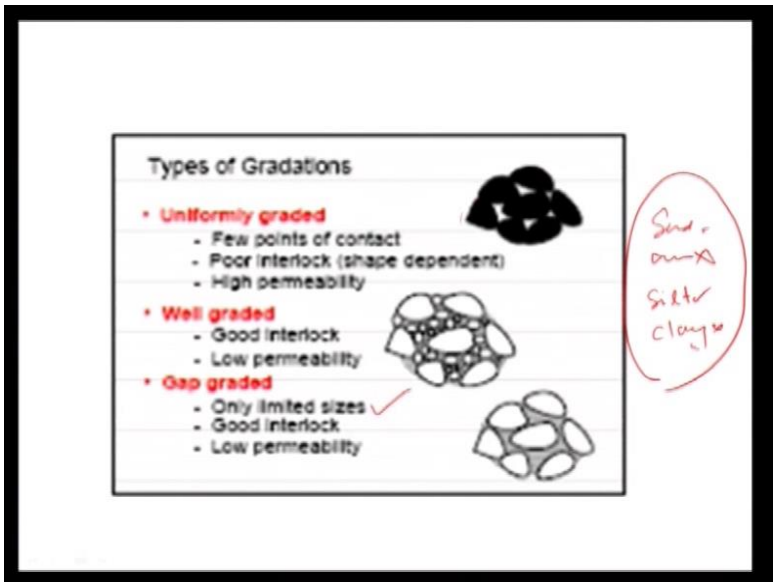

Now, if you look at here types of gradation, if you look at here types of gradations now different type of aggregate, if you look at here am am putting this one two, and three aggregates now uniformly graded. If I say this aggregate is uniformly grade graded what does it mean it means uniformly graded means few point of contact few point of contact, then poor interlock poor interlock; that means, particle to particle interlock will be very poor, then high permaeability. If I say uniformly graded; that means, it surface characteristics. It will allow, it is allow what to flow surface characteristics will be more, then the movement i say aggregate well graded that is there is a good inter lock good interlock means paticle to particle particle to particleinside, this the process the particle to particle process inter lock process will be very strong thats why this is called inter lock low permeability.

If I compare those this to uniformally graded, and well graded; that means, it drainage capacity will be low as compare to uniformly graded, then gap graded is, if I say this is a gap graded only limited size, if I say gap graded means only limited size as their not all size. Suppose I say it will start with the sand gravel silt or a soil or clay if i say in these if it is a gap graded; that means, only some part of silt, and sand is their, and some part is missing, and some part of the grading some part some proportion of the aggregates are missing, then good interlock in this case the interlocking process interlocking process between this aggregates it will be a good aggregates good interlock, then next is your as compare to this to; that means, uniformly gradede, and well graded this will be a low

permeability this will be a low permeability.

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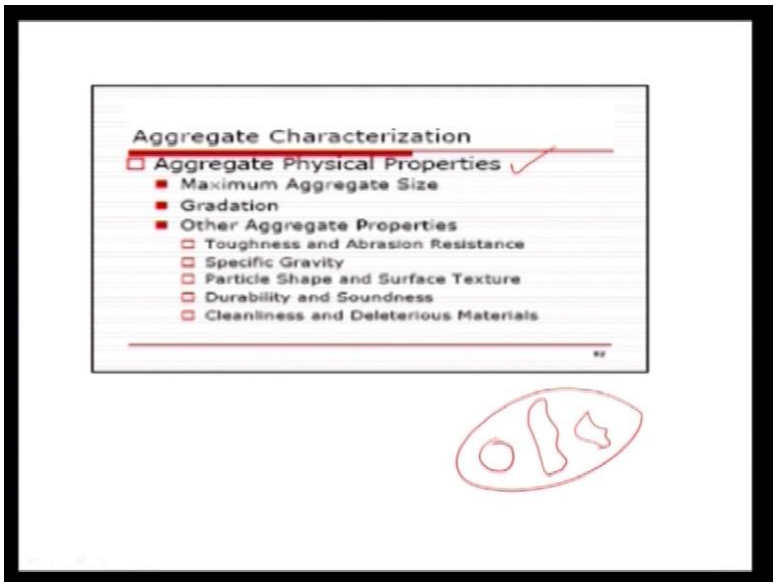

Next is your aggregard aggregate characteri zation. Now how do characterise your aggregate aggregate physical properties. First one is your aggregate physical properties in aggregate physical properties maximum aggregate size means there are different sizes of a aggreagate you will have to find it out maximum aggregates size, then what is your gradation write. Now you have discussed this gradation about uniformally graded well graded, and gap graded, then you have to make it what is the gradation, then other aggregate properties; that means, what are the other aggregate properties toughness resistence specific gravity of the aggregates particle shape, and surface texture particle shape means how it looks? What is the shape? It is circular particle shape, it is circular or it is angular or may be it is sub angular or may be any any kind of shape what is the shape, then surface texture how your surface texture is their texture means how surface looks surface looks is very like shiny or may be it is dented that that as to be classification ah you have to do it, then durablility, and soundness, then your cleanliness how clean it is means whether it is a clean or not how cleanness it is...

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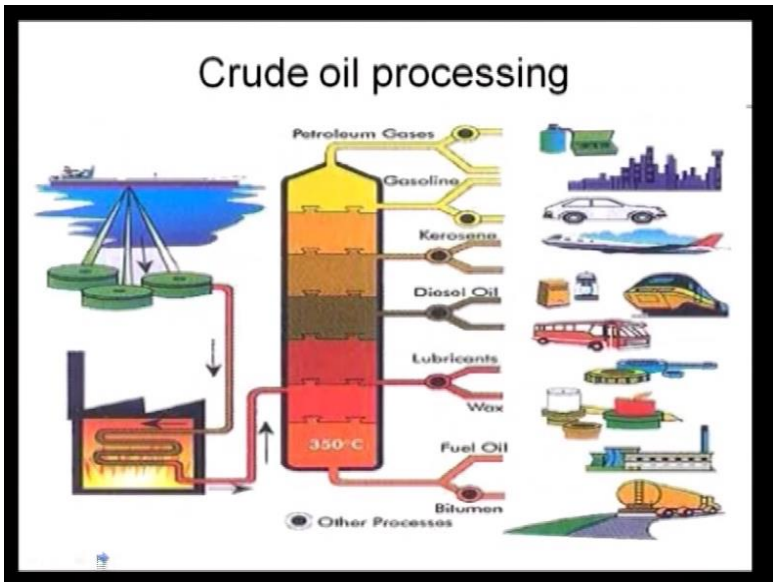

If you look at herecrude oil processing these has to be means by have this crude oil processing has been done, but this subgrade mass, because once you put once you put your subgrade, then your aggregate, then you have to allow your between, and other part.

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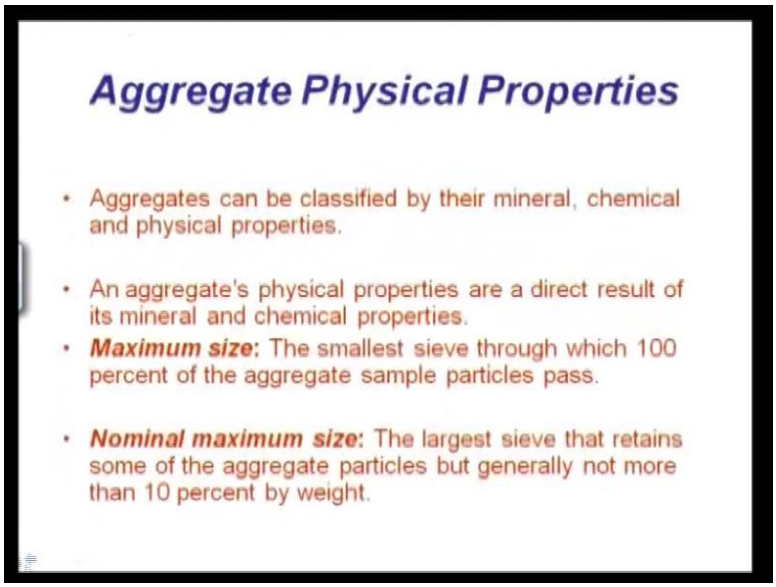

So, if i divide in to if I take it into cut section or may be into fill section fast layer is your ground surface this is your existing ground surface, there is your subgrade layer sub grade layer means it is a soil what kind of subgrade you are going to take it, then your formation or a aggregate what we we have to discuss now this your aggregate about this

aggregates label you have to make a coating by means of crude oil it may be in the form of bitumen tar paving grade or industrial grades.

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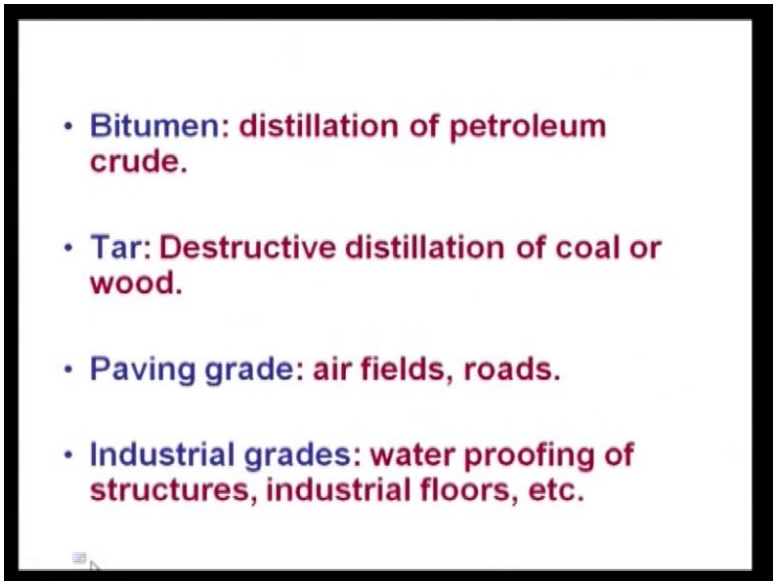

If you look at the four parts bituymen is your distiliation of petroleum crude its a distiliation of petroleum crude, then tar is your destructive distilliation of coal or wood; that means, bitumen what we are getting is from your petroleum, then tar we are getting from coal or wood, then paving grade this has been generally used particularly air fields or roads, then industrial grades means its a water proofing of structures or industrial fllors.

If you look at here generally we used this bitumen tar generally for road purpose for paving grades generally for air wood drem air fields or industrial we are providing water proofing of structures or industrial floors; these all its comes from your crude oil processing this is this just a how the crude oil as come from this petroleum gas gasoline kerosene diesel oil lubrecants wax fuel oil, and bitumen these are given in detail from wire. If you will look at here gas wire it has been used, then your gasoline, and kerosenes, and diesel oils, then lubrecants wire it has been used, then fuel oil, and bitumen. If you look at here bitumen wire it has been used these detail in in in a diagramatically view, if you see this view if you see this view, then you can have an idea.

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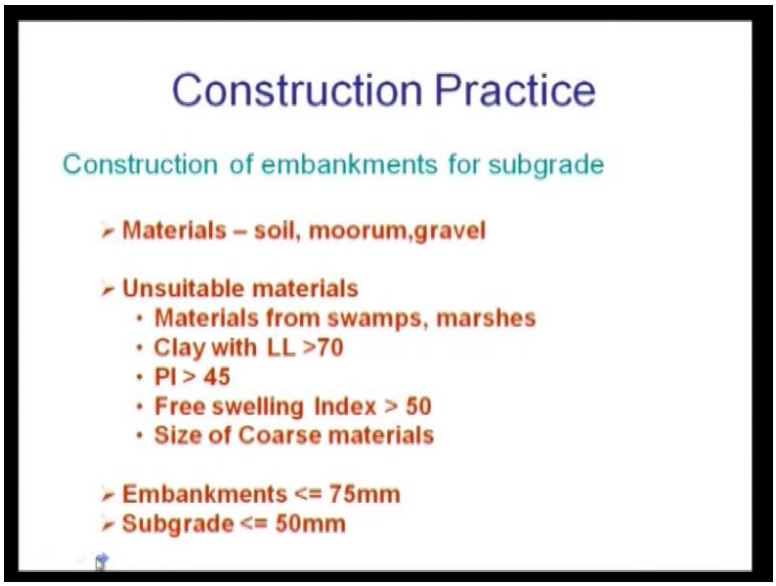

So, what are the construction practies construction of embackments for subgrade material generally materials use for construction of embackments for subgrade material soil moorum, and gravel these are the materials has been used soil moorum you have seen red color moorum, and gravel on suitable materials, and materials from swamps or marshes clay with as I said earlier liquid limit get than greater than seventy plasticity index greater than fouty five free index swelling more than fifty that is it is a highly expensive soil size, of course material these these are all your for these are the requirement for your material to be wether it is suitable or not to be suitable embackments less than equal to seventy five mm.

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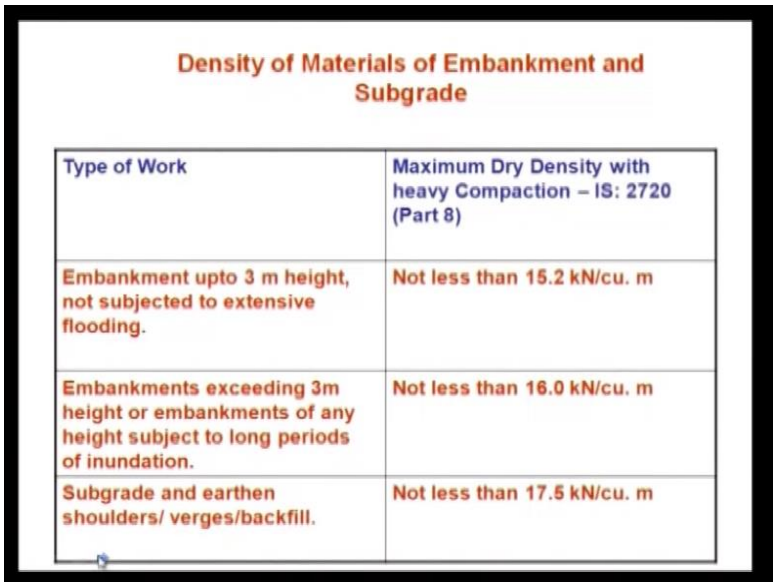

So, subgrade particular thickness is your less than equal to seventy five fifty mm density ofmaterial of embackment, and subgrade, if is look at your type of work embackment up to three meter height not subjected to extensive flooding , then maximum dry density to with heavy compaction as per. What is the IS - indian standard two seven two zero part eight reccomand not less than fifteen point two kilo meter per cubic meter similarly embackment exceeding three meter hieght, and embackment of any height subjected to long periods of inundation; that means, flooding not less than sixteen point zero kilo meter per cubic meter subgrade, and earthen shoulders, and vergers, and backfill not less than seventeen point five kilo meter per cubic meter.

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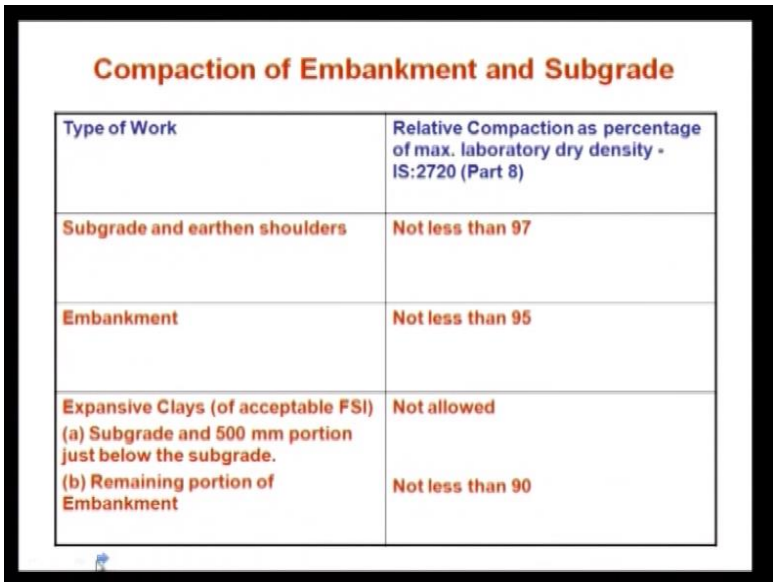

Subgrade, and earthen shoulders not less than ninty seven. If you see embackment not less than ninty five expansive clay of acceptable subgrade, and five hundred mm portion just below this subgrade not allowed. Similarly remaining person of embackment not less than ninty m m these are all you are, if you look at this two tables one table is your density materials of embackment, and subgrade what is the type of for, and what would be a maximum density this, this is about the table.

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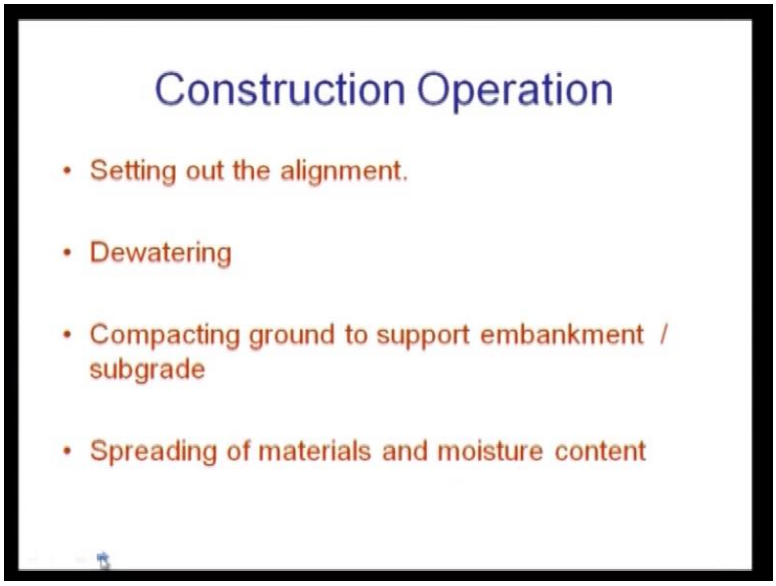

Then construction operation setting out the allignment dewatering compacting ground to

support embackment, and subgrade.

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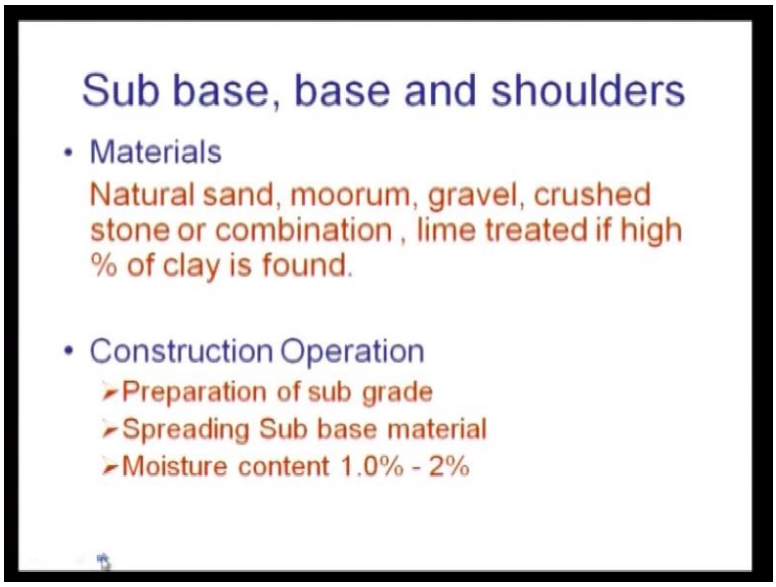

Then spreading of material, and moisture content sub base base, and shoulders material naturals, and if you look at if you are using a sub base of or base sub base; one is your first part your discussed this is about your subgrade. Now if you comeback to here first one again subgrade subgrade this is your subgrade, then sub base, and then base we have discussed about sub base, then your sub base or base material for particular sub base, and base naturals, and moorum gravel crushed stone or combination of all lime treated, if high percentage of clay is found, then construction operation preparation of sub grade.

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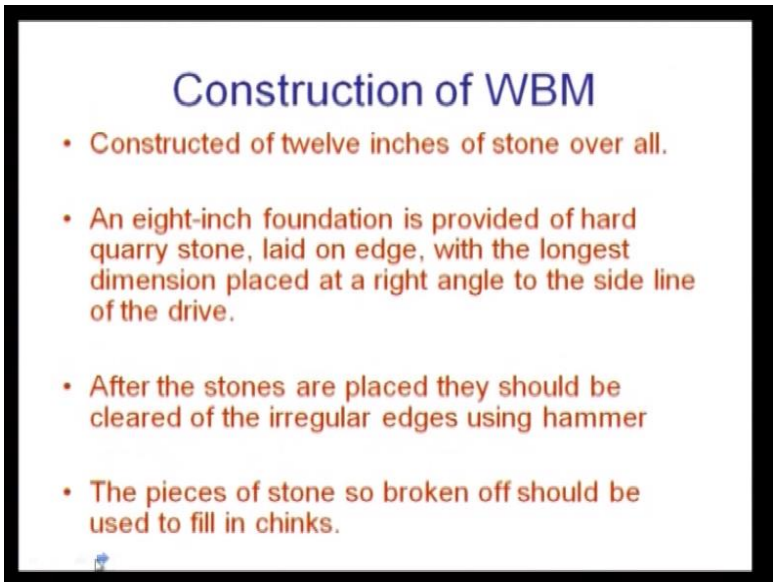

Then spreading sub base material, and moisture content generally maintain one percent to two percent, then construction of water bound mechandom role w b m is a water bound mechandom role constructed of twelve inches of stone overall overall you have to put it twelve inches of stone, then these are all the procedure how will follow this construction of water bound mechandom role.

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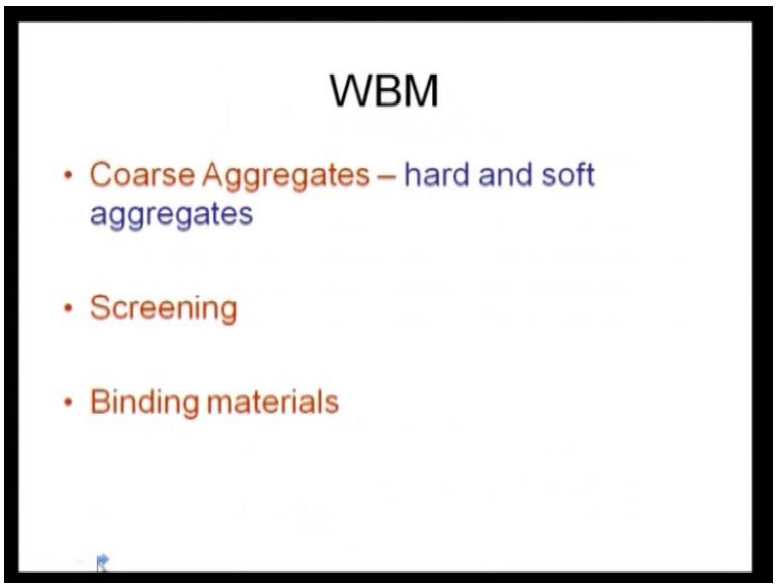

Coarse aggregate water bound mechandom rolethen in that case hard, and soft aggregates, then screening, then binding of the materials.

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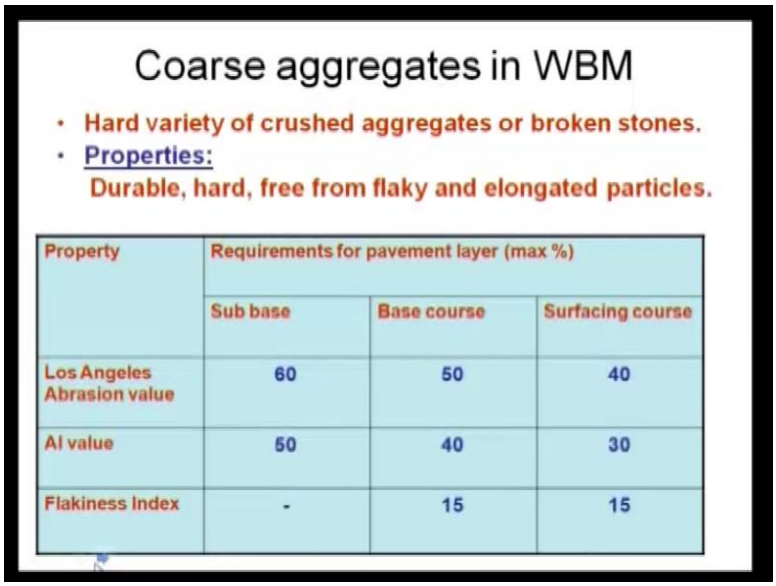

Then what are the different properties different properties durability durability hard free, if I take it by means of losangeles abrasion value per subbase maximum, it should be sixty base course it would be fifty, and surfacing course, it would be in fourty a i value fifty fourty, and thirty flakiness index; first one sub base it should not be their, then it should be fifteen. and fifteen for base course as well as surfacing course soft aggregates in w b m.

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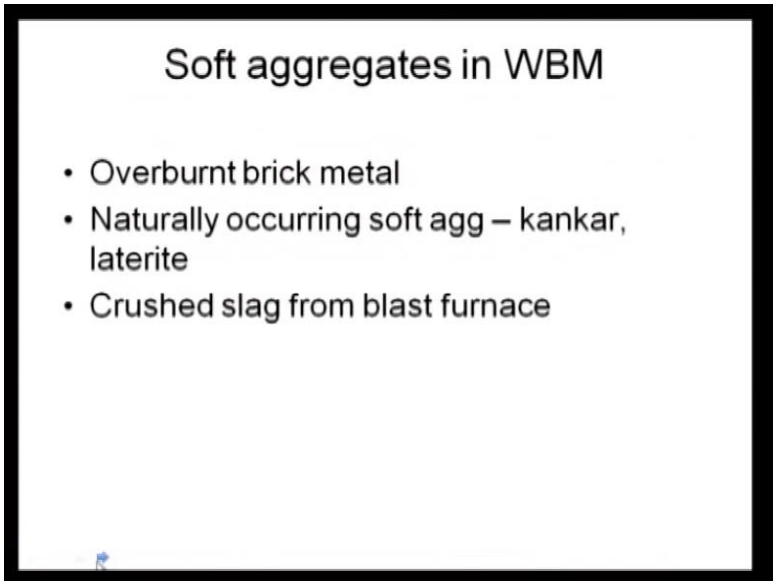

Overburnt brick metal generally used or naturally occuring soft aggregate or kankar or

laterite, crushed slag from blash fumace also sometimes it has been used size, and grading requirements of coarse aggregate for w b a, this is detail given different size if for taking ninty to fourty.

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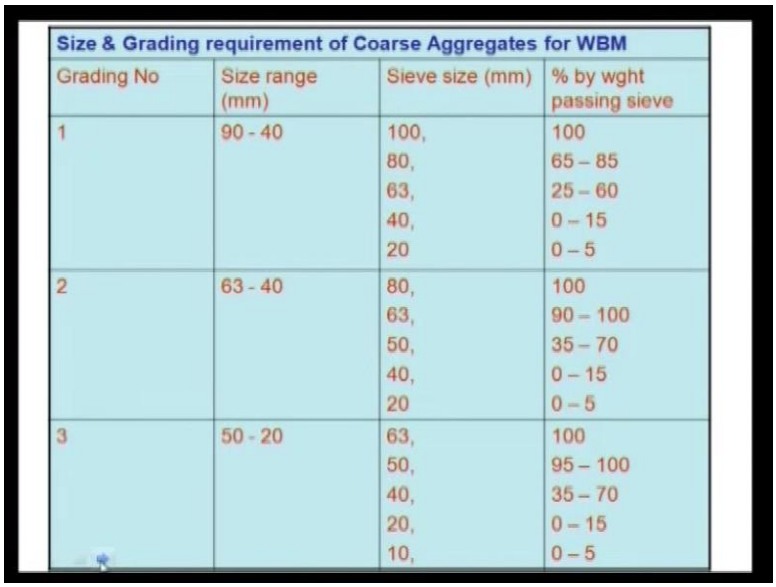

Size & Grading requirement of Coarse Aggregates for WBM

Grading No	Size range (mm)	Sieve size (mm)	% by wght passing sieve
1	90 - 40	100, 80, 63, 40, 20	100 65 – 85 25 – 60 0 – 15 0 – 5
2	63 - 40	80, 63, 50, 40, 20	100 90 – 100 35 – 70 0 – 15 0 – 5
3	50 - 20	63, 50, 40, 20, 10,	100 95 – 100 35 – 70 0 – 15 0 – 5

And what is by percentage of weights, it would passed these are tables it is given.

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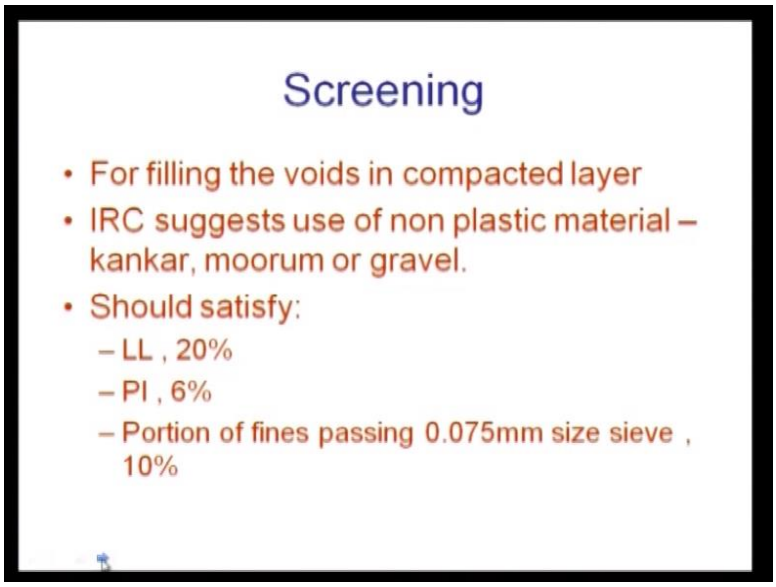

How do screen it for filling the voids in compacted layer i r c suggest use of non plastic material; that means, kankar moorum or gravel should satisfied, this is the condition should satisfied liquid limit twenty percent plasticity index six percentportion of fines

passing seventy five microns sieve its would be ten percent.

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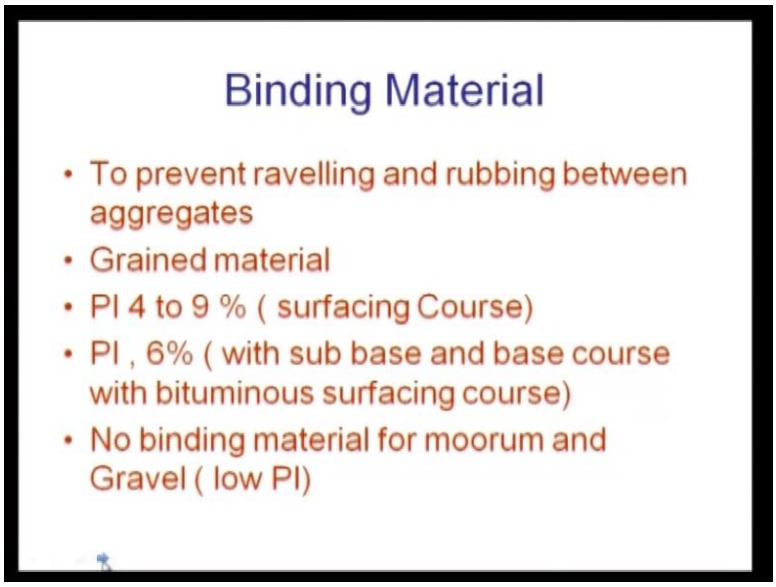

So, binding material generally you used the binding material to prevent ravelling, and rubbing between the aggregate grained material. So, plasticity index four to nine percent for surfing surfsce surface course plasticity index is equal to four percent with sub base, and base course no binding material for moorum, and gravel of low plasticity index this is all about ambackment material requirement for high way constructions how what is your sub base what is your base, what is your base material or sub base material or subgrade material what are the requirement this is all about particularly construction of embackment or highway materials.

Thank you.