Design Practice
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Lecture – 30
Basic steps in Material Selection Process

Hello everyone. Welcome to the course of Design Practice. in lecture module 28 and 29 we are discussing about what are the steps involved in a material selection. And till now we have already learned about learned the first two steps that is the translation and screening methods that is required in a material selection process. Now in this lecture module I will discuss remaining two steps that is involved in a selection process and those steps are ranking method and completion with existing information.

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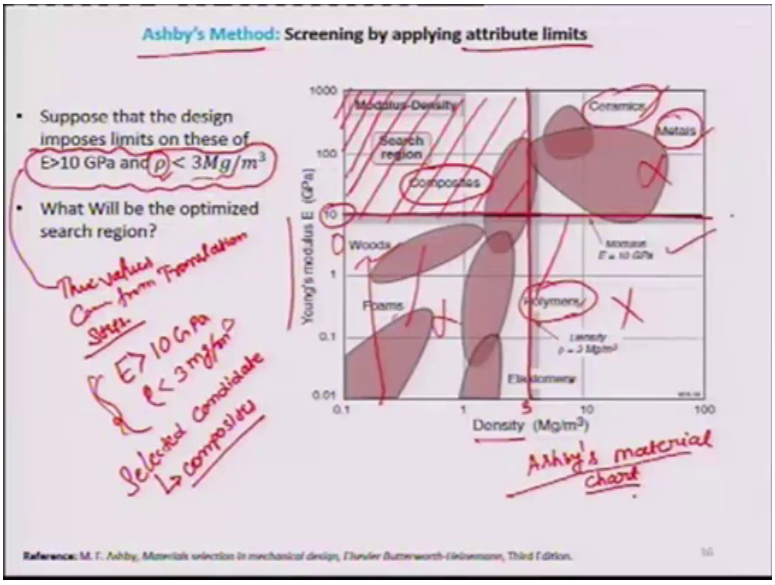

Now, we will discuss in this module about screening by applying attribute limits, that is the Ashby's method ok. In this method what happens suppose that in translation steps we got some constant optimized value that material for particular application should be such that, their elastic modulus is higher than 10 Giga Pascal and material density will be lower than 3 mega grams per meter cube.

So, they this value these values came from translation steps. Now after getting these value now we have a variety of materials. So, how we will screen materials for our particular requirement? So, we will take help of Ashby's chart that is called Ashby's material chart.

Here what we can see that this is the plot between Young's modulus verses density and the other.

Log plot; so suppose that our constraint is E should be greater than 10 Giga Pascal. So, there will be a line we can draw horizontal line parallel to x axis corresponding to 10 Giga Pascal. Then another const value is we got density should be lesser than 3 mega gram per meter cube and three will be some over here ok. So, again we will plot one line that will be parallel to y axis ok. So, now you can see that in material chart here variety of material placed at different-different location, woods, woods as an around 8 Giga Pascal Young's modulus and density is very low compared to polymers.

So, what we have density should be lesser than three then it means our region search region will be this one ok. And whatever material will lie between in this region all material will be selected candidate. Suppose that here one thing is mentioned that is composite; it means selected candidate is composite for a particular requirement. it means now we what we are saying we are eliminating ceramic metal polymers elastomers form wood etcetera these materials we are we have simply eliminated using the Ashby's material chart for particular condition.

So, this is the simplest way to screening the material and or you can we can say that eliminating the non usable material that should that that is not suitable for these materials are not suitable for particular application ok. all though these have a very good property polymers have a good property metal have a very high strength, ceramic has a very high strength, but you can say see here that for particular reason these are the useless ok.

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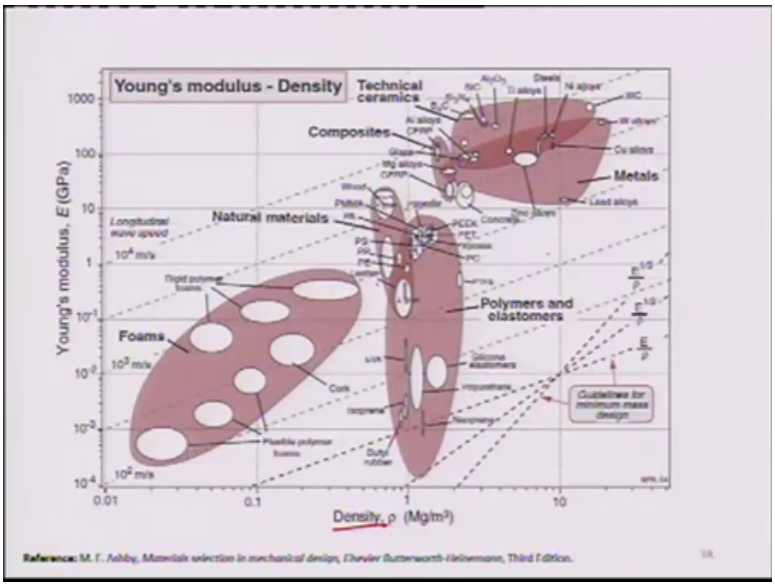

Now, another material property chart you can take in a broad manner, you can take in this you can see here for density verses strength are variety of materials lie between them, that is the you can a this another type it is called material index another way it is called material index. You can you can take help of this plot either Young's modulus or density or strength verses density plot. Here you can lot of materials are given here.

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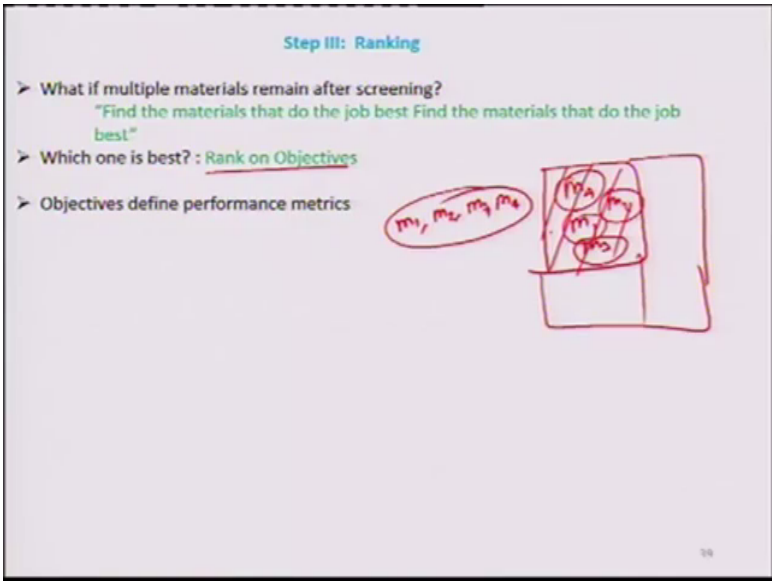

Now third step is the ranking after eliminating the several materials from the for our requirement, now whatever material we found that in that search region suppose that was our

search region in that plot, this that was our search region. So, whatever material suppose that m1, m2, m3 material is there in this region. So, now, which one is based? So, rank one objective defining performing matrix ok. So, what we will do, to decide which material will be most suitable for our requirement? From we have m1, m2, m3 m4 four type of materials which can full fill our criteria. So, there are several methods are available for to rank these materials so that best can from that this ok.

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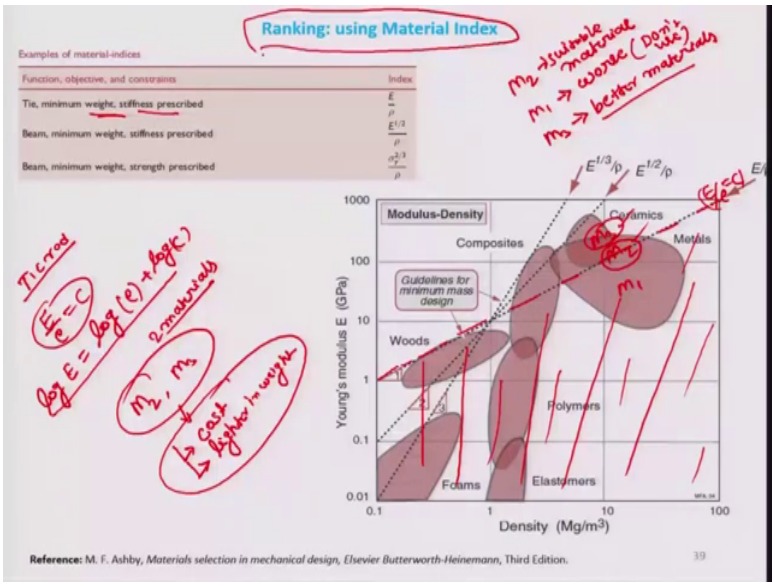

So, first method is using ranking using mat material index. This is very simple way to represent to rank the material. In this approach here you can see that for some for example, for tie rod minimum weight is stiffness described. So, for tie rod and for lighter weight and stiffed material the $\frac{E}{\rho}=C$. And by taking log what we did? We got log E is equal to log row plus and log C and same thing is plotted here ok.

Now I will tell you the significant of this line on material chart ok. Suppose that we had three material m 1, m 2 and m 3 ok. So, what happens the line whatever material which lie on the line that will be the suitable material for design, and the material which lie below the line suppose for example, m1 that is the worst material. So, you do not use [FL] and for m3 which is lied above the constant line, then this is called E by row is equal to C line is the better materials.

So, using this plot what we are doing? We are doing 2 kind of thing. First whatever the material which is lie below the line with this constant line, we just discover these material this is not usable for our design. So, now, we have two options m3 and m2 either we can use m2 or m3. So, if suppose that we have m2 and m3, two materials ok. So, now, we will have to check different criteria for selecting the best material either you can check cost or since your goal is to make lighter in weight. So, accordingly we can choose the material either m 2 or m 3. This is the selection of material based on the material index.

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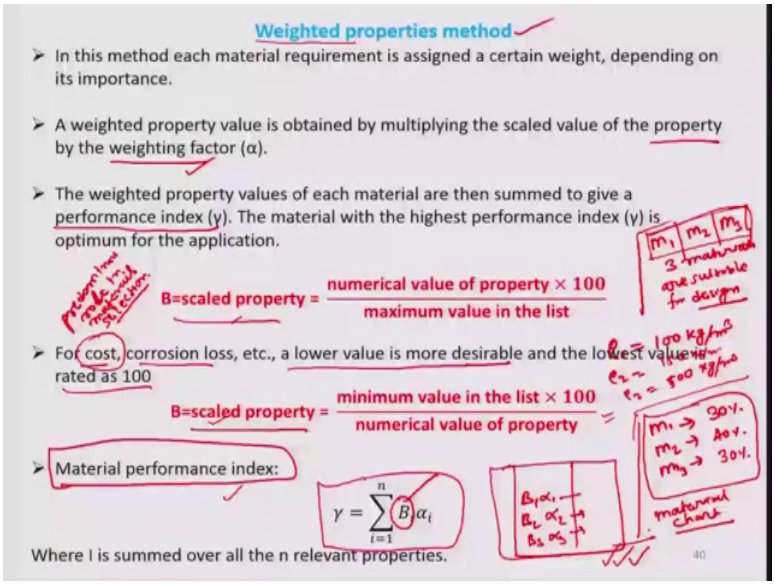

Now second method of ranking is that weighted properties method. In this method what we what did it in this method each material requirement is assigned a certain weight, depending on its importance. And a weighted property value is obtained by multiplying the scaled value of the property by the weighting factor.

These are the term which is to be used in this method weighting factor and scaling factor. And the weighted property value of each material are then summed to give a performance index, the material with the highest performance index is optimum for the application. So, in this method our goal is to make a performance index using the weighting factor and scaling factor ok. So, first here B is equal to scaled property.

So, numerical value of property and maximum value in the least, suppose that after screening you found that there is a m 1, m 2 and m 3 material are suitable for design. Then what you will do? You just judge these materials on property basis. So, you calculate for each material

scaled property. So, how you will calculate? There is a numerical value of the property suppose that each has a density ρ_1 is equal to 100 kilo gram per meter cube ρ_2 is equal to.

Something like that 150 or ρ_3 is equal to 500 kilograms per meter cube now. So, in this list what is the maximum 500 kilo gram per meter cube? So, and if you are you are calculating scale property for m 1 then what will happen? 100 into 100 divided by 500 ok. For m 2 150 into 100 divided by 500 and for m3, 500 into 100 by 500. It means you are scaling the all materials suitable materials ok. Now and you can also scale your material based on the cost corrosion loss etcetera and you know cost is a very its predominant role in martial selection ok. So, you cannot ignore the cost of the material. So, on based of cost what will be desirable? A lower value is more desirable and the lowest values is rated as 100.

So, in the that case you will first you will find unit cost per strength means unit cost for to fabricate to fabrication of each material m1, m2, m3 then suppose that your calculating you are scaling the m1. for m1 material then minimum value in the least whatever the minimum cost for any material, you will put here then numerical value of that particular material and after from calculating using this formula, you can calculate the scale property now. So, then after calculating the scale property, then what we will calc our goal is to calculate material performance index ok. So, how we will calculate? We calculated already we calculated this one the scale property now here as the line says weighted property method we. So, you will have to assign certain weightage m1, m2 and m3 suppose that you decided that its weightage will be 30, 40 percent and 30 percent ok.

And this weightage is based on martial chart or you can say material index now as well as you as per your requirement. So, after that for each material you have a scale property as well as weighting factor, then you just using this formula you calculate over all material performance index ok.

Now you using you can make a table and you will find that B1 alpha1 B2 alpha 2, B 3 alpha 3 each for each material, you will get some value and from this table you can easily screened out which material will be most suitable for you that is the weighted properties method. And it requires for since for simplification process, we consider only 3 materials per in actual practice you will get around 10 to 50 some something like that group materials, which are suitable for your design. Then at that moment this calculation is very time consuming. So, for

this purpose specific software and computer you can take help from computer. So, that you can find or the most appropriated material for your design that is the ranking method. Now after ranking after ranking you will have to again recheck ok.

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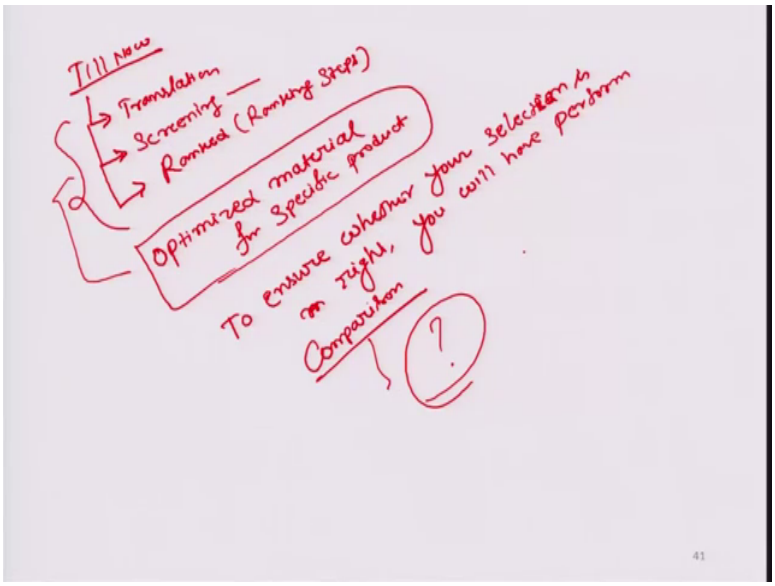

Now till now what we did first we did translation, then after translation of program we just screening out some material eliminate eliminated some material in a screening steps. After that we ranked each selected material that is called ranking steps. And now you have a now after following this steps you have optimized material or specific product.

So, but after optimization you achieved you got material appropriate material for your design, but whether you have to ensure whether your selected selection is right you will have to perform compression ok. Now question is that compression with what, how you will compare your result ok. So, there are variety of variety of methods are available so, that you can compare your result, but few results few methods are that is the step four ok.

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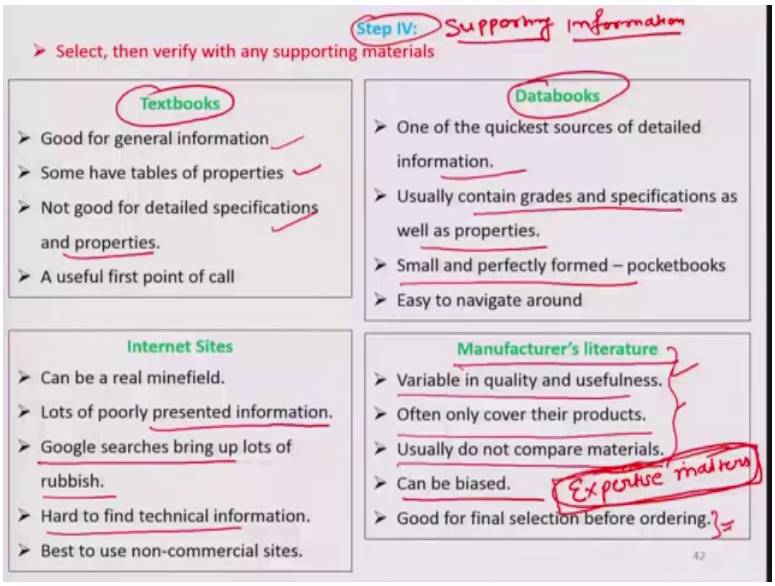

Here what you are doing? You are taking help of supporting information. A supporting information here text book is available, here good for general information everything has a certain advantage and disadvantage both some has table of properties not good for detailed specification property, a useful first point of call.

And if you are taking help from data book, then one of the quickest source of detailed information usually contained grades and specification as well as property small and perfectly formed pocketbook like that, you can store it in a you can see this are in your iPad mobile etcetera is it to navigate around internet site. Internet site can be real mine minefield that is true, but lots of poorly presented information, because nobody has controlled internet every can everybody can upload anything and may be good or wrong information or internet or if you will do Google search. Then, it may be possible that you may find at a in a first attempt wrong information and if you will compare your optimized result with that wrong information so, that your design will be get failed. So, hard to find technical information best to use non commercial sites; when you can also follow manufactures literature.

Suppose that you are going to make a pen so, that already variety of pen are available in market which are fabricated by various industry. So, you can take help variable in quality and usefulness often only cover their product. Usually do not compare materials because these manufacture what they so, only their good thing not limitation or bad thing ok.

So, if you will compare with your result with these data. So, you may find that a some may be possible that you have done something good, but after comparing these literatures you will you may think like a I have done some wrong thing. So, it can be biased good for final selection before ordering ok.

So, their variety of sources are available to compare your result, but after that at the end we can say that of expertise matters in material selection. So, that you can if you have a expertise in this area. So, you can always choose a good material, for your fabrication of your product ok.

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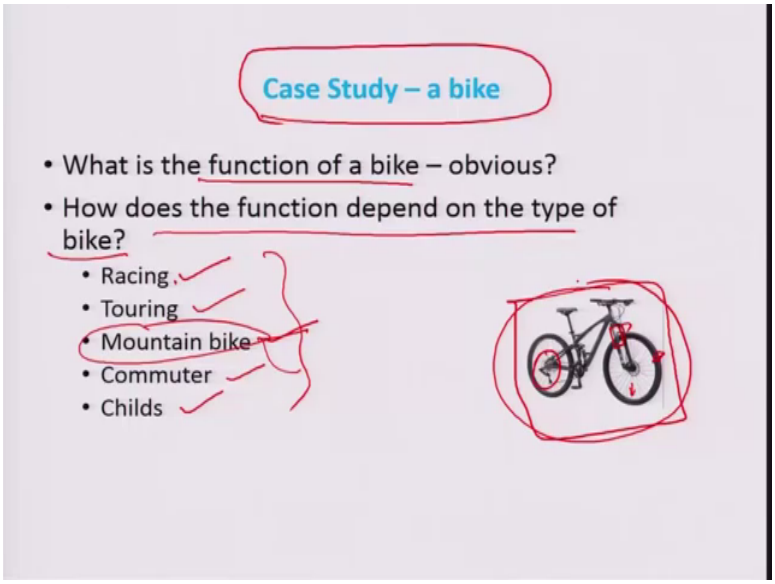

Now this is a case study of a bike, this is a one real value problem. So, you can see goal is to make a bike. So, what you based on your previous our discussion, what you have to do? First you will have to decide what is a function of bike ok. So, what does the unction depends on the types of bike? Variety of types of bikes are available or depending on your application racing for racing purpose touring purpose mountain bike, commuter child and for each purpose the design is there is a variety variation in designing of bicycle.

So, first you will have to decided whatever your designing what you're going to fabricate, what will be its main purpose. Suppose that you're going to make a bike for mountain bike ok. So, you will have design accordingly because in mountain bike there should be for example, there should be some shock absorber here, tire should be higher thicker tire and spore should be some thicker so, that strength will be high, gear system should be there ok.

So, this kind of things matters in mountain bike. So, you will have to choose every. So, first to make a mountain bike, what will have to do?

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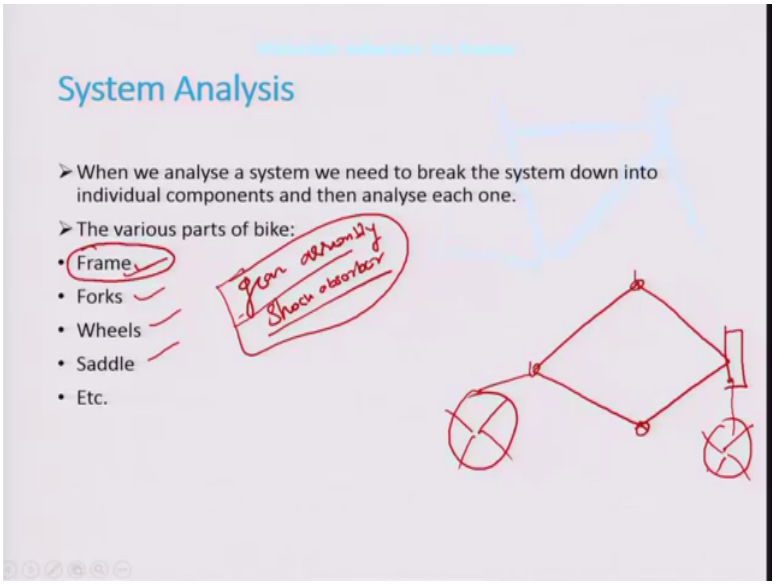

First we will have to divide it in a component. So, each cycle has a frame for wheel saddle and suppose that for mountain bike you will have to gear assembly shock absorber. These kinds of things are required for to fabricate a mountain bike ok. So, now suppose that if you want to select a material, appropriate metal for frame, what you will do? Frame has a purpose what purpose? Earlier I told you suppose that frame for your cycle. So, the purpose is to carry a load as well as to support the wheels these kind of things are.

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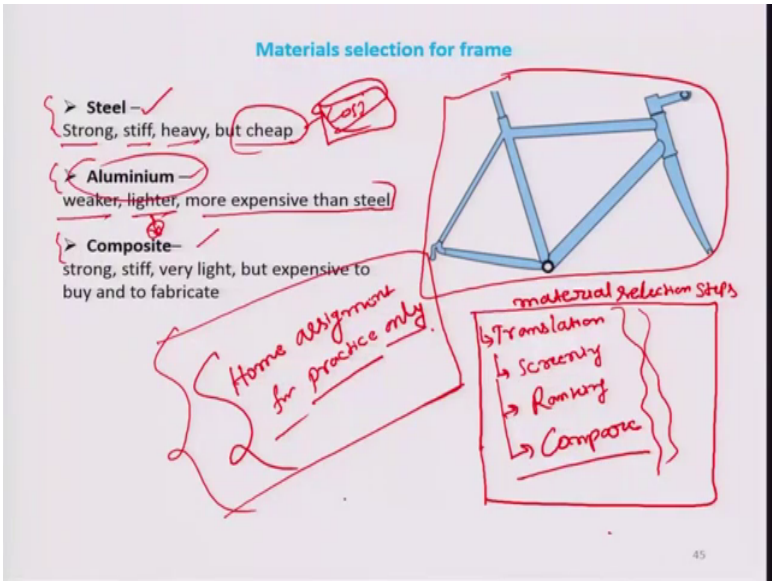

So, material selection for frame; so for initial screening, when you will do screening initial screening you will find that there are variety of materials and it will have used for fabrication of frame and this frame is not a new because lot of companies already fabricating this frame using either this material or a steel, aluminum, composite, but in your particular problem you have to decide which material will be appropriate for your particular bike ok.

So, suppose that if you want to make a frame using steel. So, their properties of a steel are strong stiff heavy, but cheap. aluminum, weaker, lighter more expensive than steel composite strong stiff very light, but expensive to buy and fabricate ok. So, sometimes when your design something for a specific purpose. So, sometime you will have to sacrifice your cost ok. We will have to pay more to get a better thing ok. Here you can say that if you will use aluminum rather than a steel. So, it will be lighter weight that will be very beneficial for mountain bike, but cost is higher than the steel.

So, you will have to scarifies sometime cost. So, this is your again home assignment for practice only. You just think or you will make a buy mountain bike and which material will be appropriate for what component and using what I discussed with you there are four steps, translation, material selection steps, then you do screening, then you do ranking and compare. You can simply follow these steps to select materials for your mountain bike. So, you can do it in home and this is for only practice purpose.

Now I am going to close this lecture module for material selection in engineering design and in next class we will discuss something else.

Thank you very much.