Introduction to Composites
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Lecture – 01
Definition of Composite Materials

Hello, welcome to introduction to composites MOOC course. This is a twelve-week course as I had explained in the introductory lecture. So, each week we will have lectures on this particular topic, from Monday through Saturday. So, there will be six lectures and also during the week you will be expected to complete an assignment, and the questions in this assignment will be multiple choice questions. So, you have to make the right picks, and answer those. As I explained in this introductory lecture last lecture, is that we have two tutors or teaching assistants, Anubhav and Madhav their contact information is already given to you. And we start this course from today, and over the span of this course what we plan to do is so, first we will introduce the concepts related to composites.

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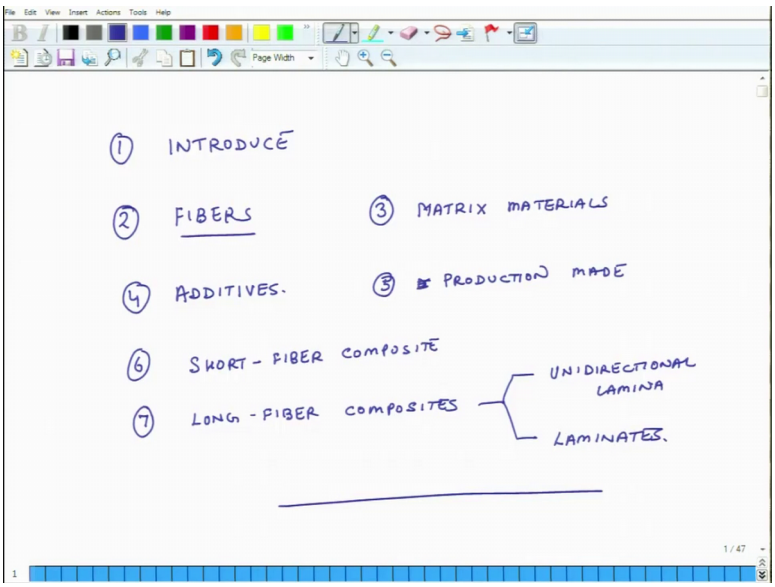

Then what we will do is we will discuss different types of fibers different types of fibers.

In context of the fact, that most of the discussion, which will be happening in this course will be about engineered composites. And in that context for most of these composites which are used in engineering applications. They have fibers and a matrix material. So, we will explain what do we mean by this term called fiber, and then we will discuss properties of different

matrix materials. Now composites it happens, that are not only mixtures of fibers and matrices, engineering composites. But there are some other additional additives also in the system. So, we will also discuss about other additives, which are used during fabrication or manufacturing of composite materials.

So, this is there then we will discuss how are composites made. So, this is another thing. So, manufacturing or I will call it production methods. How are different types of composites made? Their host of ways and in that context we will learn not only how are composites made, but also how are fibers created, how are different materials developed, and ultimately how are the two things combined to develop composites. Then once we are done with these fourfive topics, then we will start discussing the mathematics underlying the performance of different types of composites.

So, first we will differ discuss short fiber composites, mechanics of short fiber composites. So, we learn how to predict their strength, they are modulus and so on and so forth. Then we will discuss the mechanics of long fiber composites. And in this case a specifically we will discuss two types. So, one is unidirectional lamina. And we will explain in the course what do we mean by a lamina and things like that, and then we will also discuss the mechanics of composite laminates.

So, this is the overview of this course. And what I hope is that you will find this course you know it will provide you with insights into mechanics of composites, and hopefully you should be able to use whatever information, I share with you in your professional lives and in your a student lives. So, that it can be a fruits for you. So, that is the overall scope of this course. And once the course is over we will have a final exam.

So, that final exam will also have multiple choice questions mcqs; but, both in assignments as well as in mcqs. It would not be that you will just have to very right away; you will be able to click the right options. But that wills in several other questions we would expect you to do some computations some calculations which will help you arrive at the right answer. So, that is the overall a structure of this course once again, the course is going to run over twelve weeks, six days a week, one assignment every week ending with and end semester examination. So, let us start discussing the whole area of composites. And before we go into details of composite materials, we should have a very clear understanding, as to what do I mean when I use the term composite.

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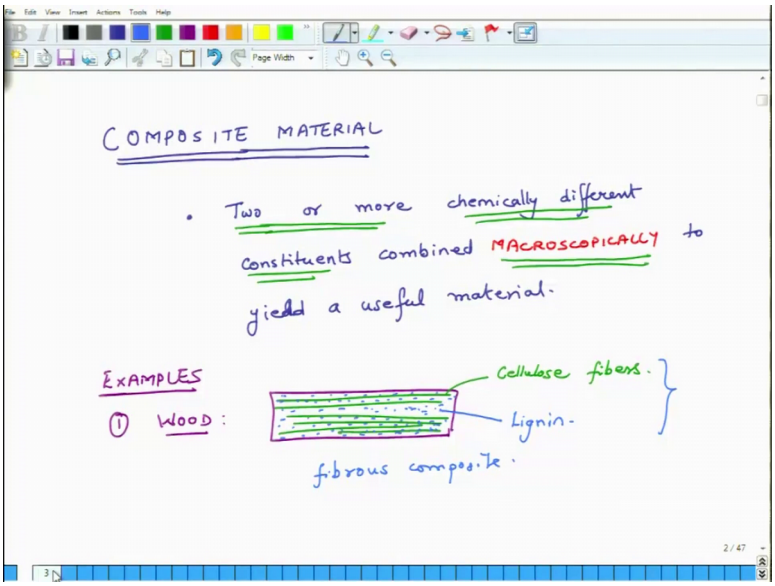

So, what is the meaning of this term called composite? What is a composite material? So, I will define it. So, it is any material and which has the following. So, the first thing is that it should have two or more chemically different constituents combined macroscopically to yield a useful material. So, this is the first thing that I call any material a composite material, if it has two or more chemically different constituents chemically different constituent, chemical structure of different constituents should be significantly different.

And when I add them up they should be added at a macroscopic level not at a molecular or a crystal level, but at a macroscopic level. And then of course, when I mix I should get something useful out of it otherwise, it is just a exercise. So, what are the important things? Two or more, this is number 1. The second thing is they should be chemically different constituents, and the third thing is they should be combined at a macroscopic level.

So, let us look at some examples. So, these composites could be both natural or artificial or synthetic. So, let us look at some natural composites. So, one composite we come up very regularly in our lives day to day lives, and that would be wood. Now why is wood a composite material? It has two or more chemically different constituents, because if you cut a piece of wood if you cut a piece of wood. What you will see across along it is length is that it has some fibers. It is something like this, and all these fibers are emerged in some reason. So, they are bound in a sea or in an ocean full of some resinous material. And these fibers are made up of a material called lignin, no these are these are cellulose fibers. And this reason

which is which fills up the entire area that is called lignin. So, they are again chemically different materials. So, what do we see in wood? They have two or more chemically different constituents, and then they are not added up at a molecular level. You can actually physically see a cellulose fiber and lignin physically you can see them separated, and they are sticking to each other.

So, this is one example. it is a natural comb you know, this is a natural composite. And because it has fibers. So, we can call it a fibrous composite. Because it has fibers, but doesn't have a it is not needed that all composites should be mixtures of fiber and some matrix.

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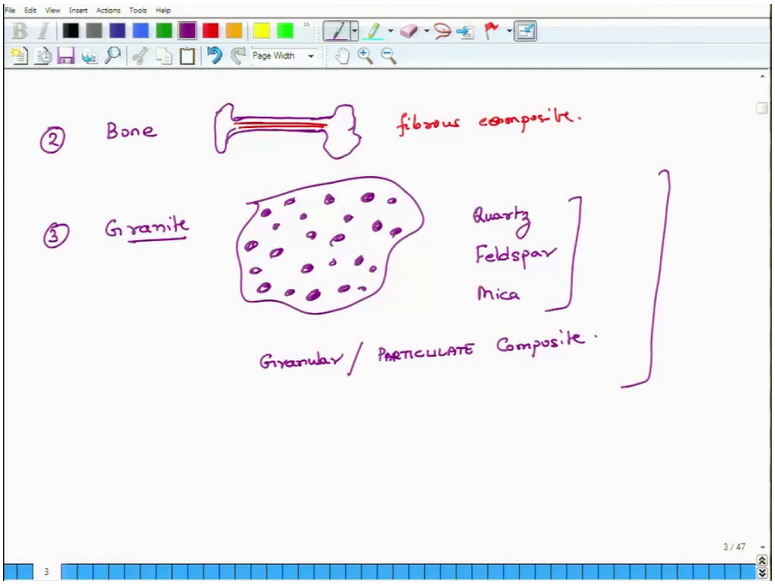

So, let us look at another example. So, another example would be bone, this is again a natural composite. Now when you look again look at a bone; It looks something like this. Something like this, and if you cut a cross section here. You will see that there are fibers like this. And again, it is bound by some matrix material. So, there are fibers running along the length of the bone, and then it is emerged in a soft organic matrix.

So, again this is also something like a fibrous composite. I will go with one more example. So, this is again a natural composite and within natural composite it has fibers o, we can call it a natural fibrous composite. Another example would be granite. So, the other two examples bone and wood, they are from biological systems. But granite is not from a biological system, but if you look at a piece of granite. Some piece of a rock, and if you cut it or even from outside, you will see it has it is a mixture of different materials. And you can see these

different materials. So, once again these materials are present at a macroscopic not microscopic level, you don't necessarily need a microscope to see all the details or electron microscope to see all the details.

So, it has all different types of materials and it is mixed up and you can see all those different materials. And what are those different materials? They are as different as quartz, then there is another rock called feldspar, and then mica, and then there are some other materials. So, here this is not a fibrous composite, but it is a granular composite.

Or better would be particulate, because it has particles of different materials, particulate composite. And this particular composite does not come from biological systems, but it is still naturally occurring. And finally, I will give an give some examples of manmade composites. So, what are the examples of manmade composites? One of the most, widely not one the most widely used example of a composite material would be concrete.

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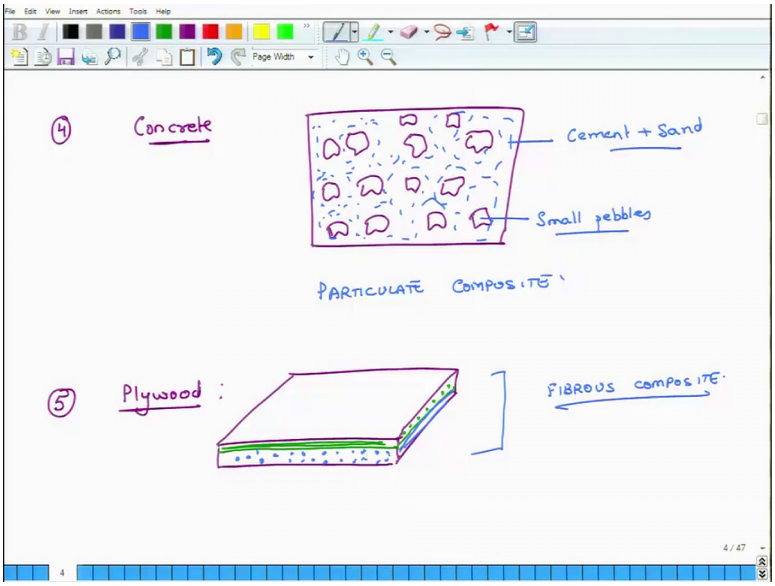

What is concrete? If you look at a piece of concrete, what does it have? It can have of course, it can have pieces of steel, but it also excuse me you don't need steel to in the concrete, but it definitely has two things.

So, one are small pieces of rocks or pebbles.

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So, these are things. And then all these rocks are bound in a sea. So, you have the rock. And all these small pieces. So, they are not big rocks they are small pieces of rocks. They are bound together, in a sea or in an ocean. Which is made up of so, these are small pebbles or rocks. And the sea is made up of what? Cement plus sand. So, again so, cement plus sand makes the matrix, and it binds all these small of pebbles together. And this is one example of man made composite. So, once again this is not a fibrous composite, but it is a particulate composite. This is a particular composite. let us look at some other examples. So, another man-made composite would be plywood, it is plywood. Now, what is plywood? It is basically several thin layers of wood, and they are stacked up on top of each other.

So, when you look at a piece of plywood. Suppose this is the plywood, and plywood can have several layers. It can have several layers. So, let us at least in our case consider that this particular plywood, which I am drawing. It has only two layers, but typical plywoods has several layers seven eight layers, depends on the thickness of the plywood. But for purposes of our class, when making a quick drawing, it has only two layers.

And what you will see is that this plywood, may have in the top layer there may be lot of fibers in this direction. So, if I look at it from this side it may look like this. And the other layer may be something like this. And here it may look something like this. And they are different ways these plies. So, each of these layers is called a ply, each of these layers. And each ply itself is itself composite because that is also not naturally occurring, there they pit put different pieces of wood together. And then they glue them and then all the plies or layers are stuck together. So, that is there.

So, here this is another example, and here it is primarily I will call it a fibrous composite. Each ply itself is composite, but then here you have put several plys or layers glued together.

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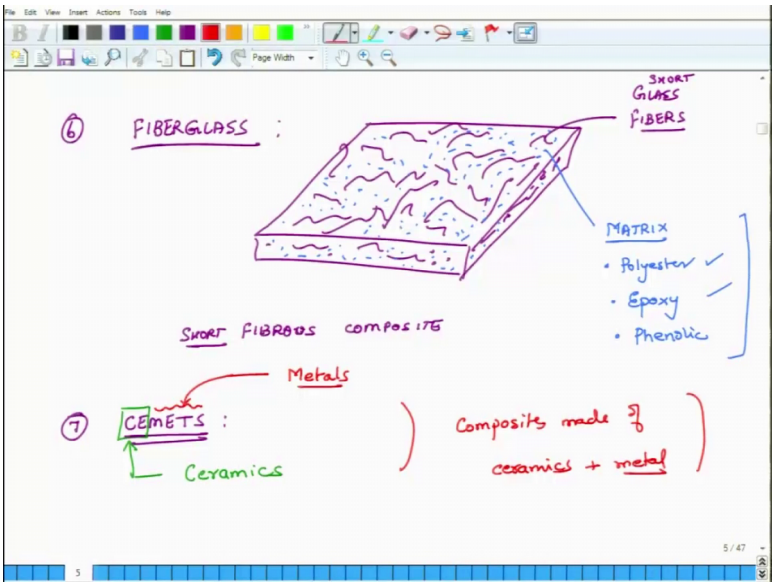

So, that is why it is called plywood another example would be 6 fiberglass. So, what is fiberglass? You may have seen it. You may have seen big tanks, or sometimes in houses some wall or roof, is made up of fiberglass, or lot of times some nowadays people make boats of fiberglass. Lot of things are made of fiberglass.

So, what is fiberglass? Basically, it's a piece of plastic. And what is it made up of? It is made up of short fibers. These are not long fibers, and these fibers are oriented in all sorts of directions. So, if I look at the cross section, it may look at or in all sorts of ways. You may see ends of some fibers and also some fibers. So, these are all fibers. And, they are immersed and glued together in some plastic material, matrix material. So, this is how it looks like.

So, these are all fibers and typically, and it is called fiberglass because these are fibers made of glass. So, they are glass fibers. And then of course, you have all these small glass fibers typically, these glass fibers may be in length anywhere from two millimeters to seven eight ten millimeters not longer than that. So, these are short glass fibers. So, I should write a short glass fibers. And they are emerged, in a matrix material. So, this is matrix. And this matrix could be of different types, some possibilities could be polyester, or it could be some epoxy, or even some phenolic.

There are other options also, but typical materials are polyester and epoxy. So, what they do is, they have a gun they have a pipe through which fiber comes, and it is sprayed on a on an area; where you want to make fiberglass board. So, you spray it and through another pipe

high viscosity fluid, which is matrix that also comes, and then you spray it and then you give it the shape you want it to be in and that is how a lot of times fiberglass boards are made.

So, again because these are made from fibers. So, this is again an example of fibrous composite. So, fibrous composite. And it is a short fiber composite. And another example would be CEMETS. Now you may not have heard of this material or maybe you have heard. Here, it is made up of two parts, C E and M E T. So, what does C E imply? C E implies ceramics. And what does mets imply? This implies metals. So, CEMETS are basically composites made of ceramics.

So, ceramics and here the matrix is of ceramic, no, not matrix the fiber is of ceramics. And the matrix is made up of some metal. And where do we use these lot of times we use them too in cutters. Suppose, I want to cut some very hard material, a lot of times you make some tips cutting tips made of CEMETS. Or some places where you have to may withstand very high heat. There also, you may use ceramics. And metal composites, because they can take high heat a lot of high temperatures.

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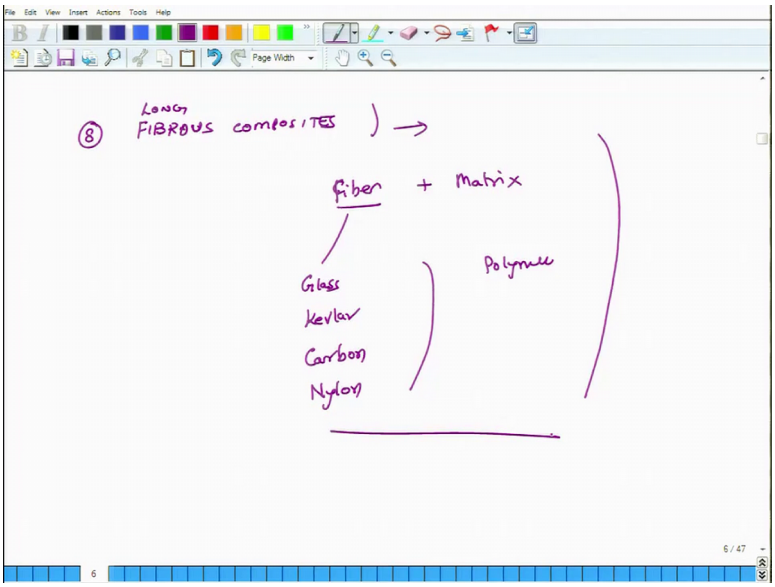

So, this is another example of engineered composite. And lastly another example would be fibrous composite. I will call it long fiber composite, and here typically you have some fiber. And you mix this fiber with some matrix material, and these fibers are long. So, of course, there is a matrix. And then of course, there are some additives. And these fibers could be of different types glass, they could be glass fibers, or some polymer-based fibers, or they could

be carbon fibers, or they could be nylon fibers, or even metallic fibers. And the matrix is made up of some polymer.

And you get different types of composites. So, these are high end engineering applications. You know where, you have sophisticated structures and things like that that is where you use these composites. So, this is the overview in terms of what the world of composites looks like, and what I plan to do in the next class is continue this discussion. So, that I want to make sure that you feel comfortable, with all different types of composites which are there in the world. And how are they classified. And also, I will give some examples, which we may think that they are composites, but they are not necessarily composites. So, but anyway it's the this lecture is done, and I continue to have this discussion ongoing in the next class. Until then have a great day, bye.