Advanced Concrete Technology
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Lecture - 00
Introduction to Course

So welcome to course on advanced concrete technology. This lecture is only going to be about an introduction to what we will have in this course, what material will cover in this course and what background knowledge you are expected to have I will give you a brief glimpse of that also.

So we are essentially talking about material science of concrete and what we will talk about is how different ingredients of concrete interact with each other to produce a unique composite, whose properties help us produce all kinds of engineering structures. We all know very well about basic properties of concrete. Concrete is a material that is extremely strong in compression but it is weak in tension.

And for structural purposes we have to provide a combination of concrete with reinforcing steel and essentially use it as a composite called reinforced concrete. Nevertheless, although we are interested in an engineering sense in the properties of the composite material, from a material science perspective if we look at the possibilities that we have within cement, understand the interactions at different levels within concrete, it can present a whole new glimpse of how this material actually performs in real engineering structures.

So, in other words we have to try an unravel the material science at a fundamental or a micro level to try and estimate the behaviour in a macro level as we do in engineering. So I will just briefly give an introduction to this course.

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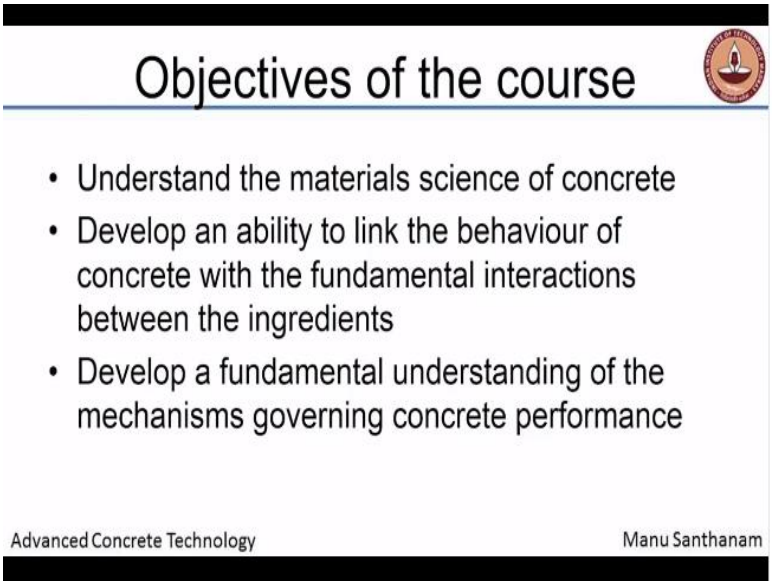

So, the objectives of the course are as follows. You have the first objective is, to understand the material science of concrete. I know that is a very complicated terminology to use here because material science can mean a variety of things, but here we are going to talk essentially about the chemistry of cement, how cement interacts with water and produces a different kinds of hybrid assemblages which lead to unique properties in the long-term for concrete.

We will also look at developing an ability to link the behaviour of concrete with the fundamental interactions between the ingredients and that is very important for us because, we are dealing with materials that are functionally graded I mean we have materials that are different in size ranges. We talk about cement particles which are of the order of 100 microns or less.

We talk about aggregates which are of several millimeter size and then we talk about the hydrates of cement, when cement reacts with water it produces these products which are actually micron size or nano size. So how do these materials actually interact and how can we understand what the long-term properties or engineering characteristics of concrete would be given a certain assemblage of these ingredients at the micro or nano scales.

Then, finally we want to develop a fundamental understanding of the mechanisms governing concrete performance. So again concrete performance could mean a wide variety of things, how it behaves in terms of its engineering characteristics, how does it behave and response to its environment, so there are several different things that we can study as far as concrete characteristics are concerned.

So, we want to develop this understanding to ensure that we can predict concrete behaviour in a given situation, understand what will be the response in a particular environment given a set of loading and so on and so forth.

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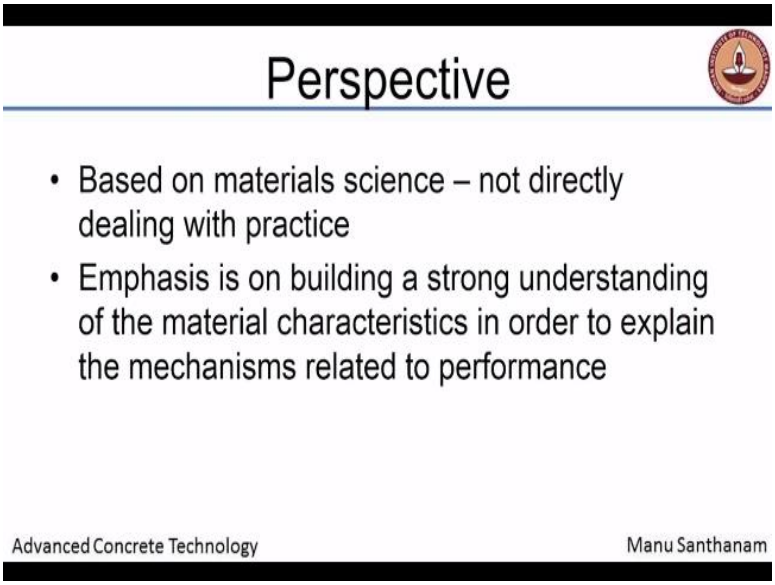

Apply in this course essentially as I said earlier it is based on material science and we are not going to be directly dealing with practice. This is not a course for the practicing engineers, this is the course for people who want to understand the subject deeper, and apply it to practice in a way that they have not done before.

And so as a result the emphasis is definitely on building a strong understanding of the material science or material characteristics in order to explain the mechanisms related to performance of the material, okay. So please remember that you will be dealing with the subject that is highly experimental, concrete science is very experimental, lot of the results that are generated are based on years and years of testing.

And because this material is actually engineered on site, there is a high degree of unpredictability in its behaviour. So all the more we want to understand the fundamental nature of the material in order to link it to performance because on-site there can be several things that can go wrong, there are several things that are not done as per the book, most of you know that very well.

And if you have to understand how this material is going to perform on-site without having a clear understanding of how it performs at the micro level, it is very difficult to really understand that performance. So the emphasis here is basically to build the strong fundamental understanding of the characteristics.

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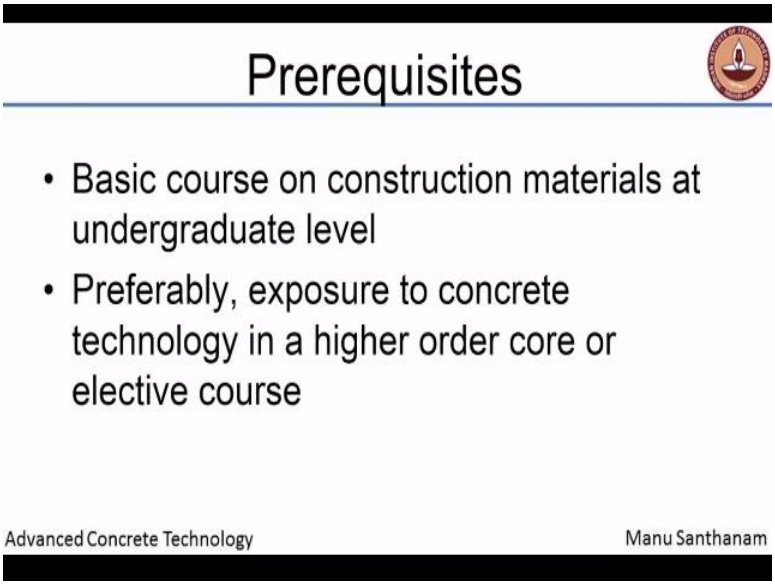

Prerequisites for the course although technically there are no prerequisites but it is definitely important that you have had a basic course at the under graduate level, on construction materials and preferably exposure to concrete technology in a higher order course or elective course.

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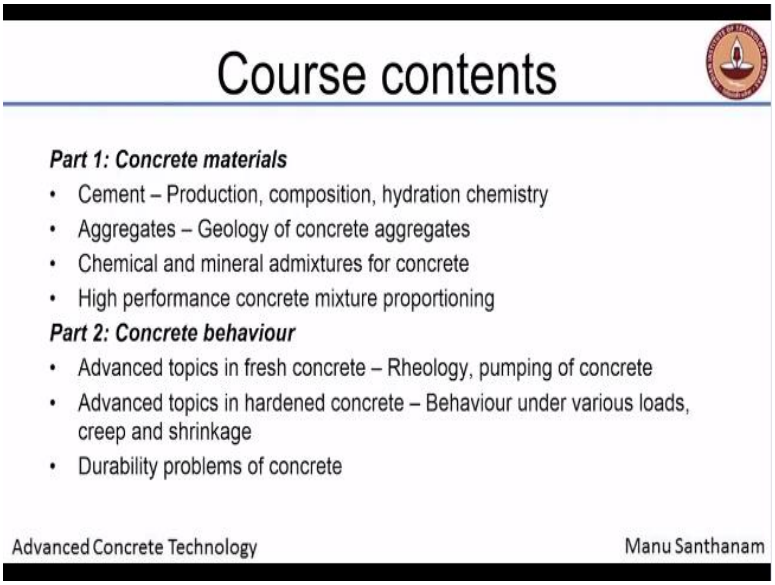

The contents of the course are broadly in two categories, you have concrete materials and then concrete behaviour. In concrete materials, we will talk first about cement; we will look at the production; composition and the hydration chemistry of the cement. The aggregates, we will

look at the geology of concrete aggregates; most of the other properties of aggregates you would have already learnt in your basic courses.

But what we will talk about here is how does the source of the aggregate or the origin of the aggregate in terms of its geology, how does it affect performance of the concrete, how can you actually look at the influence on the different engineering characteristics based upon where the aggregate are sourced from. The other important aspect that we will cover is chemical and mineral admixtures.

Because today no concrete is simply a mixture of cement, water and aggregate. We invariably always have some form of chemical or mineral additives that are there in the concrete. Then, finally we will look at how to put these ingredients together in ways that we have not looked at before that means we will take a step forward from the conventional mix design procedures and look at how we can design high performance concrete.

And look at different mixture proportioning techniques that employ techniques or methodologies from other branches of engineering also. The second part of the course is as I said deals with concrete behaviour. So the idea is we built the fundamentals in the first part, try to understand what is the basic cement chemistry and how it will actually affect the behaviour of concrete in the long-term.

As far as concrete behaviour is concerned, we will look at advanced topic in fresh concrete including rheology or the flow of concrete and the pumping of concrete, because today increasingly pumping is a common method of delivering concrete at the job site and there are several interesting characteristics concrete needs to have for being able to pump it, okay and the prerequisites there obviously you all know very well about different types of fresh concrete properties.

You must have already had lab course that deal with these fresh concrete properties, so I assume that you already know the basics of workability of the concrete. Then, we will look at advanced topics in hardened concrete, looking at behavior of concrete at the various loads and we will look at creep and shrinkage which are related with long-term deformation, time dependent deformation of the concrete.

And finally we will have an extensive look at durability problems of concrete that means how does concrete respond to its given environment, what is the response of concrete to aggressive chemicals that may be present in the environment and what are the characteristics of cement chemistry that really make a difference in our understanding of the concrete performance in a given environment, right.

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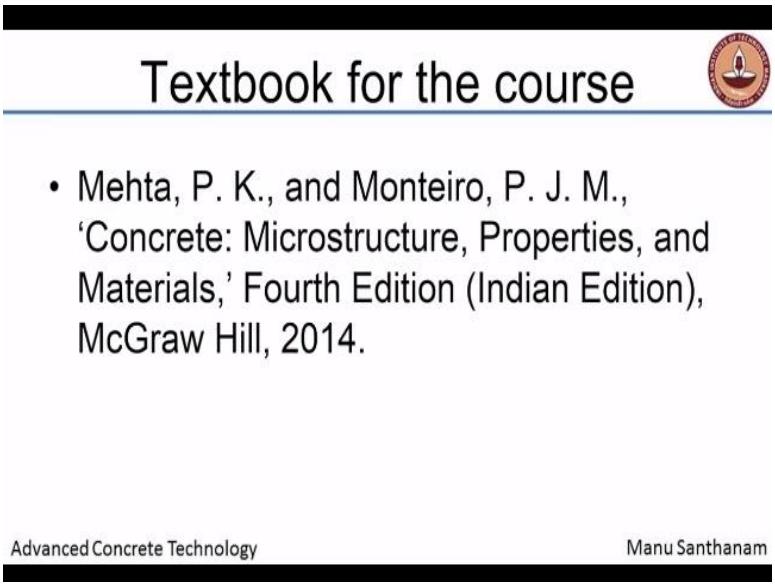

So this time I am prescribing a textbook for this course. I typically have not prescribed a textbook before but this is the first time that I will be asking the students to actually purchase this textbook and read contents from the textbook because it always helps to have an additional source of good quality information that you can use in addition to what you have from class discussions and lectures.

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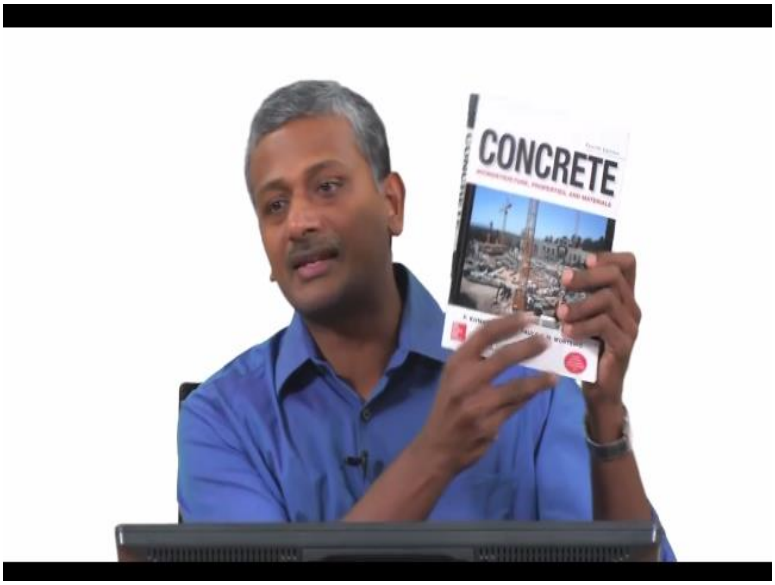

So this is the textbook. There are several types of editions that are actually available, but this is the Indian edition of the book by P.K. Mehta and P.J.M. Monteiro, both of them professors at the University of California in Berkeley and this book is extremely popular all over the world and I believe it is an excellent resource material for a subject like advanced concrete technology.

So this book is concrete micro structure properties and materials and as I said this is the fourth edition and this is also the Indian edition and is published by McGraw Hill and I think it is available in most book stores, so please do buy a copy for yourself. This will be the reference book that you will be using or textbook that you will be using for the semester and most of the content from this book which is relevant to the course material that I am going to cover, I will be giving you an indication of where to look at in this textbook.

Of course, it is difficult for a student to read the entire book during a semester, so I will try to point out the sections that are relevant to the content that we are covering in class.

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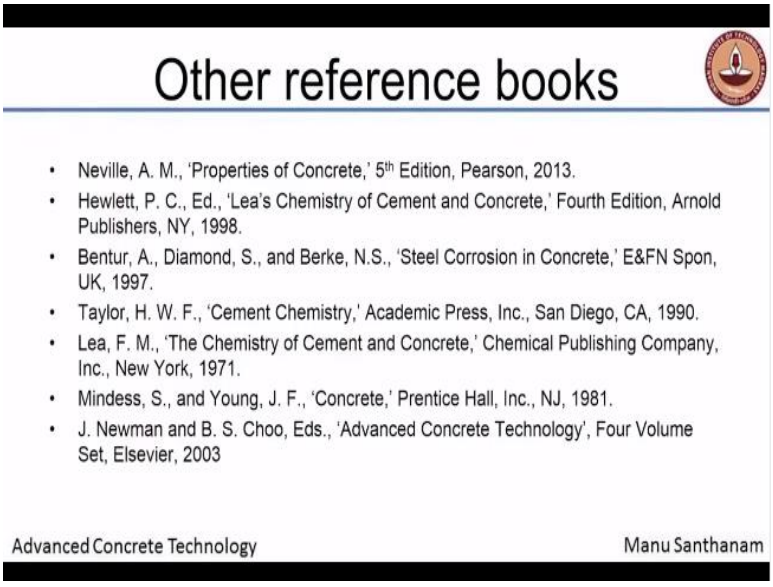

There are several other reference books also. As I said concrete is a material that has been extensively studied across the world. As a result, there are probably as many experts as there are concrete engineers. So every expert writes their own book but there are several experts who have written better books than the others, so some of the better books in concrete technology are listed here.

All these books are available either in our library or with the faculty members individually. If you do need to refer to any of these books, please do borrow it from us or look for these in the library. I am sure that you will be able to find one copy with in IIT quite easily.

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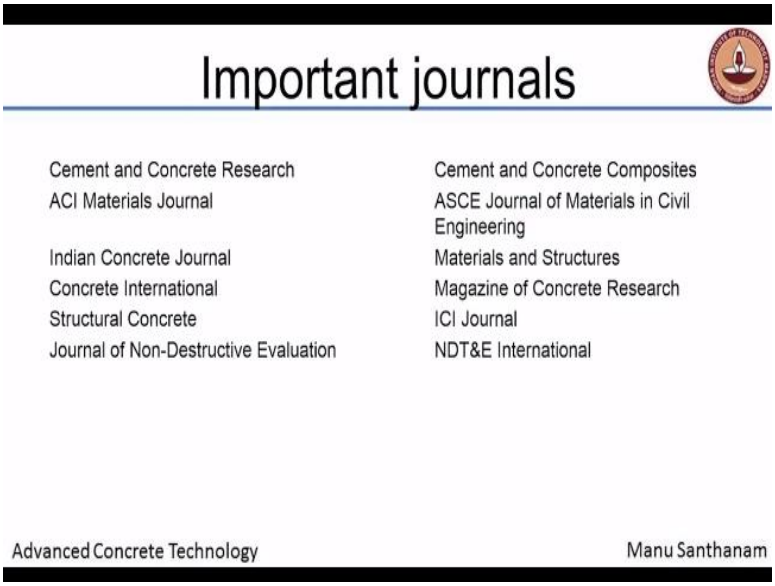

There are several journals from which you can get very good information about concrete technology and the primary journals which are important for concrete cement and concrete are listed here. When you actually work through the semester there will be assignments and term papers for which you may have to refer to these several papers that are published in these journals.

So I urge you to try and get access to these journals, definitely from an IIT we have access to all of these journals, so you can definitely try to inculcate a habit of getting information from journals also.

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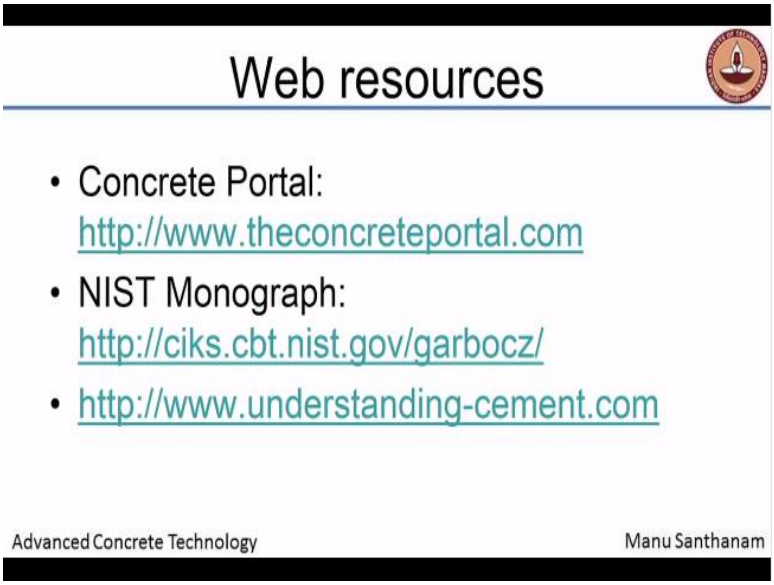

There are several web resources which are available on concrete. I have listed a few primary ones here. The first one is actually the concrete portal which has content that I have put on the website on my own, essentially it is a collection of various materials that I have looked at for my classroom teaching as well as some contents from my research studies that have been put together in a set of topics which are either fundamental topics or advanced topics.

So for this level of a course definitely you will have sufficient number of the advanced topics also covered in the course and you can look at the content anytime, anywhere. This is free to access and all the content I hope will be updated very often, I am not doing it as much as I want to but I definitely would try and update it as much as possible. The other one is the monograph by the National Institute of Standards and Technology in the US.

It is a very interesting monograph and it deals with very specific advanced topics in concrete technology. So it is not for everybody but then there is content there which will be quite useful for people who are looking at further studies and research in the subject and there is another basic site understanding cement.com and this site can give you a lot of information on a more basic level.

So these 3 are definitely web sources that you can use in addition to the textbook that you already have and several other papers and journals and other textbooks and web resources that you may also get access to. Of course, you all know very well that today there is a lot of content available on YouTube. There is actually a lot of videos which can be quite usefully utilized for the purpose of this course also.

Especially dealing with aspects of application of concrete in different situations, for example pumping in very difficult areas, all of you know about the example of pumping in Burj Khalifa which is the world record for pumping 600 meters vertical upwards pumping was done for Burj Khalifa and that was for self-compacting concrete. So it can be quite a daunting challenge for the people on the site to execute something like that to pump a concrete which is highly flowable to a vertical distance of 600 meters.

So you can imagine the challenges there. Those have been very well covered in certain videos which are available easily on YouTube and other web resources. So please make sure that you utilize these resources as much as possible.