

Modern Construction Materials
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Module -01

Lecture -00

Prologue

Hello and welcome to Modern Construction Materials. I am Ravindra Gettu. I am a professor of Civil Engineering at IIT Madras. And I have been teaching Modern Construction Materials as a course at IIT since 2005. So, it's about seven years since I've been teaching this course. Before I joined IIT Madras, I was a researcher and the head of a structures lab in Barcelona, Spain. And before that, I did my PhD at Northwestern University. I got my Masters from Marquette University, again in the US. And my Bachelors is from the University of Madras. I studied in the Government College of Technology, Coimbatore. So, that's a little bit about my background.

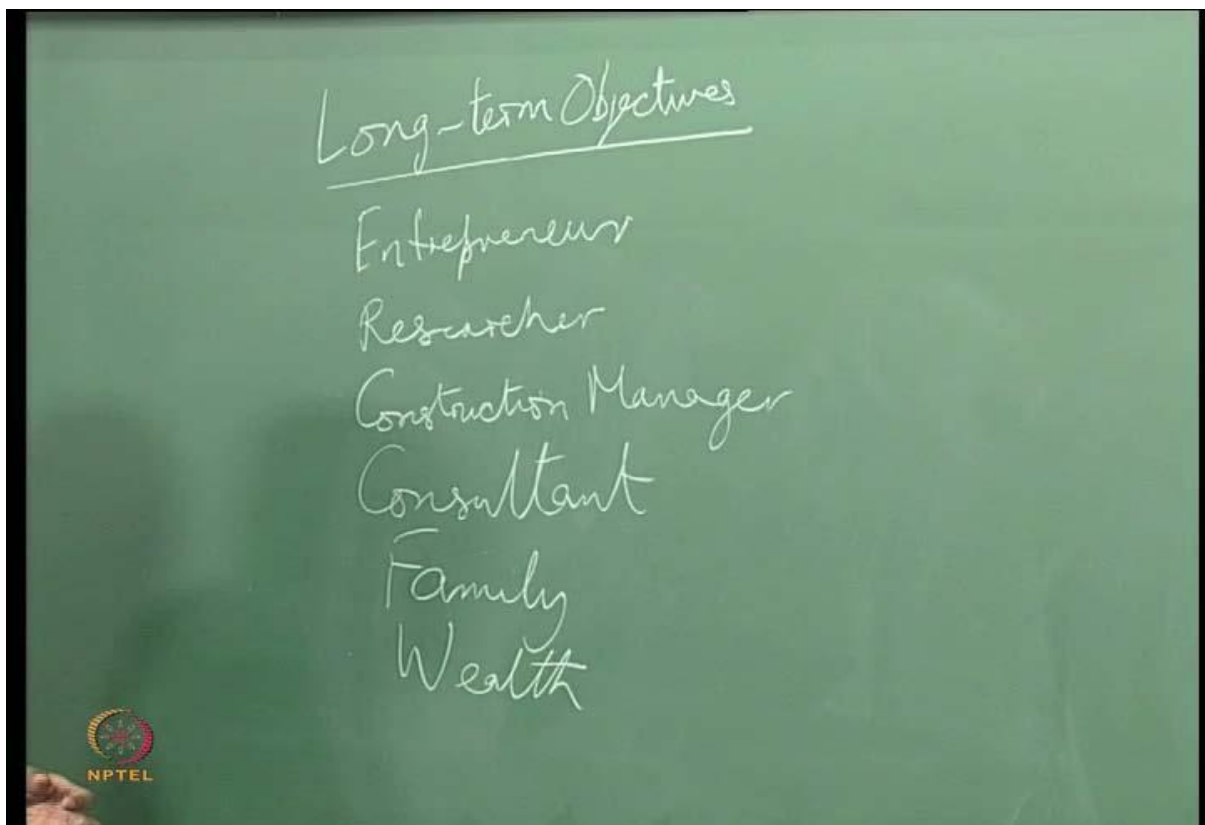
When I have the first class of this or any other course, I go through an exercise of trying to know the students better. And this is something that I would suggest that teachers follow. And we'll try to do it on video also. Let's see if it works. So what I have people do, people who are attending the class do, is close their eyes for a minute, blank out everything sort of I say **reboot** and then we'll try to find out what the long term goals are, of the people attending i.e. the students and also what is the expectation from this course.

So let's try it out, even though you are not sitting in my class and you are in front of a computer or a TV screen; let's see if you can do this. So, you can put the video on hold and close your eyes for a minute and blank out everything, and then we will see what you come up with, in terms of your goals and your objectives for this course.

So, close your eyes for a minute. You can put the video on hold and then you come back and play it when you have blanked out everything. Okay, so, so you've done this. Now again close your eyes and hopefully you have something that you can write on. This time, close your eyes for a minute or so. Again you can put the video on pause. When you open your eyes, write down what you think would make you happy to have achieved ten years from

now. So, ten years from now what do you think, you would be or you should be, to have had a successful career? Okay? So close your eyes and do this, and come back.

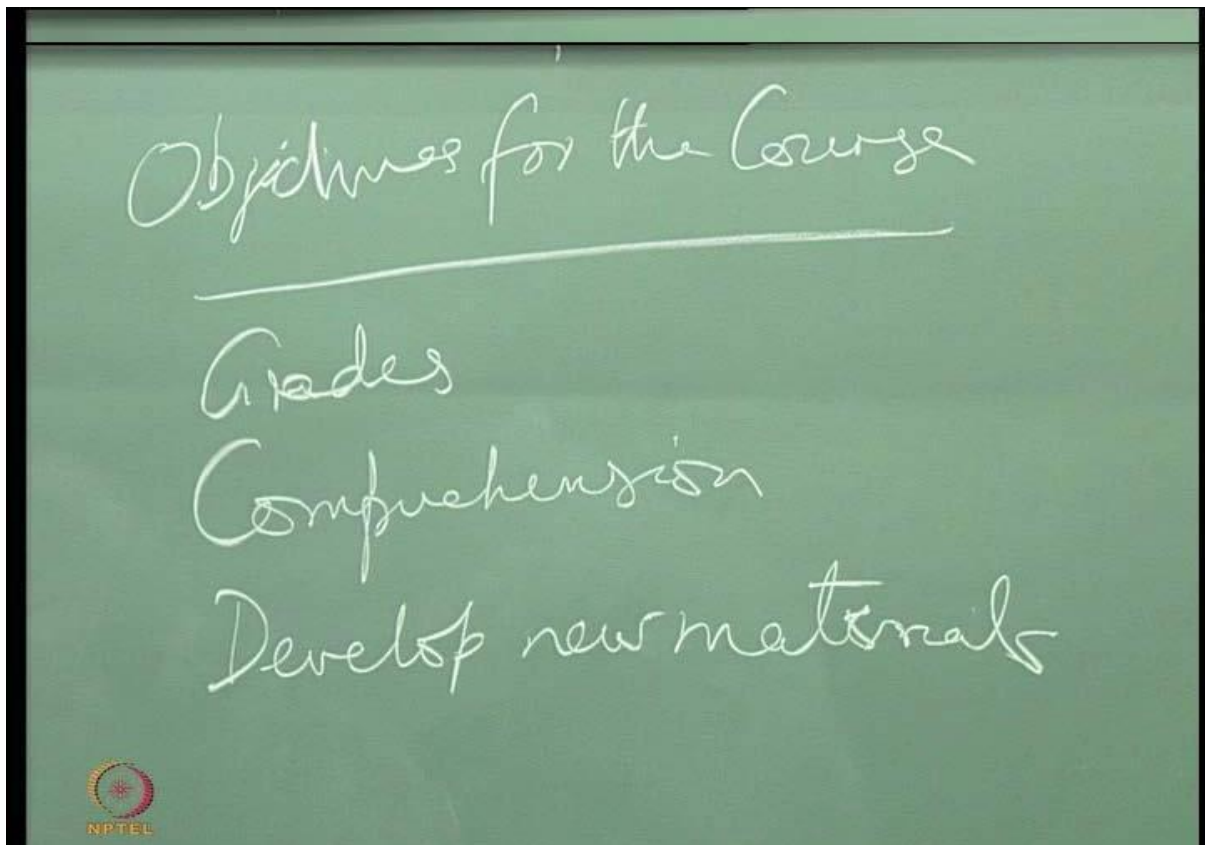
Okay. So, when I do this in class, I have a range of answers from the students. And generally in the course on Modern Construction Materials when I teach it, I have M.Tech. students of Building Technology and Construction Management. I also have M.Tech. students from the programme that we have with Larsen and Tubro, where we have students with some experience on site, so slightly older students, in the programme of Construction Technology and Management. Then, we have some dual degree students i.e. the students who would be in the fourth or fifth year and research scholars are doing their MS and PhD. So, there is a range of people who could be sitting in class and the answers that we get about their thoughts on where they will be ten years from now also varies. Now you would have written what you want to be, ten years from now. Let me tell you some of the answers that I get.



So the long term objectives could be: Becoming an entrepreneur, becoming a researcher, a construction manager, maybe a consultant or it could be something not really related to the field, it could be that the main objective would be to have a happy family, or it could be wealth. Maybe the most important thing that a person would desire would be to be rich. So there is no right or wrong answer, but, as a teacher, it tells me and if you are a teacher, it

will tell you about what are the things that the students aspire, something about the entry behaviour which we sometimes refer to.

Now, what we will do now is, now that you know where the students want to go ultimately, and you know where you want to be ten years from now, close your eyes again and now when you open your eyes, write down what do you want from this course, why are you watching these videos, why are you taking this course? And same I would ask my students, why are you doing this? Okay? So, close your eyes for a minute. Again you can put the video on pause and then come back and play it again. Now then, I suppose you have written down what you want. And again, the answers that I get from class vary a lot. So, let's look at some of the answers.



So the objectives for the course could be as simple as getting good grades or comprehension- we want to understand about the subject or it could be to develop new materials or to understand what can be done in terms of material science or materials engineering, and things like that. So it could be that simply a person is studying because they have to, they have to get good grades, They have to pass this course. In your case, it's not like that. Generally it could mean that you want to develop a comprehension, you want to understand and improve knowledge, and get the basics of materials engineering related to construction materials.

Hopefully, there is a link between the two columns. There should be a link between these two- the long term goals and why you are sitting here for this course. If there is no link, then you are making a mistake. You need not have to go through this. And I'm telling you this as I would tell my students that if you don't know why you are here, and if you don't know why this course is at all useful to you, then you are making a mistake. We have to understand where we are going and hopefully whatever you do every day will lead you to this goal. So, this is something that is very important. As a teacher, it tells you what the students expect from your course and what you can deliver.

Now, I also tell my students what my goals are and what I will try to deliver. My long term goal would be that what I teach and the research that I do ends up in something useful in terms of a landmark structure or development of a new technology or the use of new technology and something pioneering. That will make me happy say ten years from now if you look back and see that this has happened.

Teaching Philosophy

The teacher and the course should help the student in:

- Developing comprehension
- Practising analysis
- Becoming confident in decision making
- Improvement of communication skills
- Get the right attitude for learning and being an engineer



Short term goals, what can I give in this course, in terms of what I would like to give in this course and what I think a teacher should be able to develop in a course should be these: Developing comprehension so that understanding is improved, the breadth of knowledge is improved, and that is what we will try to do in terms of construction materials in this course. Secondly and very important -the analysis. We always have choices; we have pros and cons, there is no clear cut answer always in engineering and technology. So we should have the ability to analyse choices from different angles and this is something that we do every day in our personal life and this similar type of analysis is needed in engineering, if you are at the site or if you are at the design office or you are a manager of a project. The above two lead on to the third aspect which is becoming confident in decision making. After you have the choices, finally you have to make a call on which material to use, which technology to use and how to go about it. And this is something that you will see that has to be done in the context of this course. We have a lot of materials which can be used in a certain application. We have to decide which material to use. These choices become very wide when we go to finishes and fittings and accessories. There is a tremendous choice and this choice seems to be increasing in all parts of the world. Now, how do we choose, what do we choose and how to reach this decision? It is important that during a course, the student develops this ability to understand, analyse and reach a decision. The other two aspects of what I try to develop in a course that is taught directly are communication skills and attitude. Communication skills come through report writing, assignments, and so on. This is something you will have to do your share as far as this video course is concerned. But this is probably as important as the other three aspects. Because unless you are able to communicate well, as an engineer, you will not be able to convince others that what you are saying is correct, you will not be able to convince others that your decision was taken right. And we find lots of time that students who are very good in taking exams and answering questions, they are not able to do well in report writing, in communicating their results or their decisions. So, in today's world it is very important that we develop this ability to communicate well with others, who might be your superiors, your clients, the users of the structures that we are building and so on. Lastly, attitude is always an issue. There should be a right attitude to learn. The fact that you are sitting in front of this TV screen or computer screen means that you have the attitude. This attitude should continue. Only if you have the right attitude for learning and for being a complete engineer, one can be successful. And I hope that this course goes to some extent in helping you this way.

Course Objectives

- To provide the scientific basis for understanding and development of construction materials.
- To give an overview of the fundamentals needed to understand material structure and behaviour.
- To discuss the important materials used today in construction.



What are the objectives of this course? First of all, to provide the scientific basis for understanding and developing of construction materials. We will provide the basics, the science behind the behaviour and properties of construction materials, and we will spend a lot of time in discussing the important construction materials of today. We will span the range of materials that have been probably used for centuries, if not thousands of years, like timber, going on to modern materials like fibre reinforced plastics and other finishing products that are coming to the market today and being used more and more today than ever before. Now, in this course, we will assume that you have had some course in building materials before, say, in the first or second year of engineering assuming that you are a final year student or close to the final year of engineering, or in the beginning of a post graduate programme. So you should have read something on building materials covering the usage of materials, the basic properties and I also assume that you have had some courses in chemistry and physics. So, they will be only a review of these aspects and it will not be comprehensive.

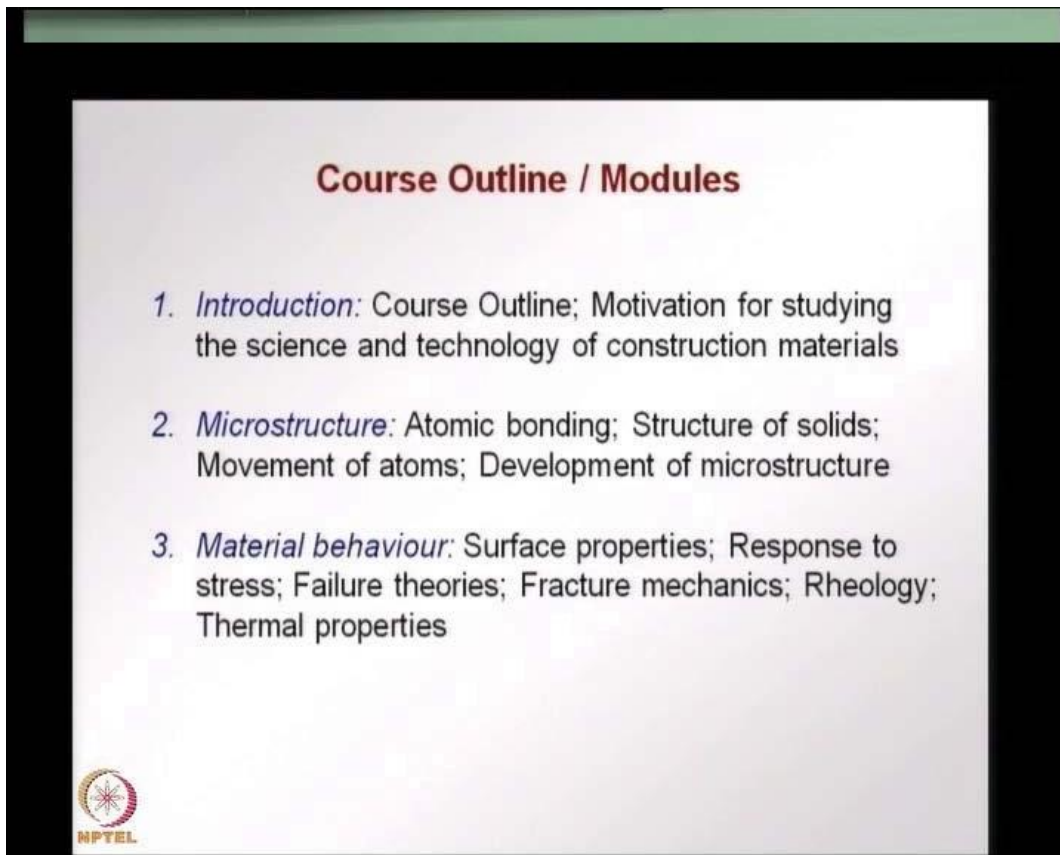
Course Objectives (continued)

- For researchers, the course aims to provide a review of basics and a unified approach to materials based on the chemistry, physical phenomena and mechanics.
- For engineers, the course will help understand why materials behave the way they do and how one can go about selecting the right material for a certain application.



Now this course is expected to help not only people who are studying now, but also people who are practising engineers and people who are starting off their career as a researcher. For the researcher, I hope to provide, through this course, a review of fundamentals and a unified approach to looking at materials, not studying one material at a time, because for research you have to understand why things happen in the material and why you get the properties that you have. Only then you can improve a material or develop a new material. So, a material science approach will be taken here, where fundamentals will be built up, reviewed, and you go on to see, understand why materials behave the way they do. Similarly for engineers, practising engineers, it is good to understand the properties, where they come from and the behaviour of materials. And often, as an engineer you will find, I am sure that you will find through your career that you will come across materials that you have not studied before. Because this has just come onto the market and you have not had a course which dealt with that particular material. Understanding the family of materials and fitting in the new material to this family, you will know how to deal with this material and hopefully also be able to predict how this material will behave in the application that you are dealing with. So this

course, I hope will help you, not only as a student but also if you are thinking of research as a career and also if you are a practising engineer.



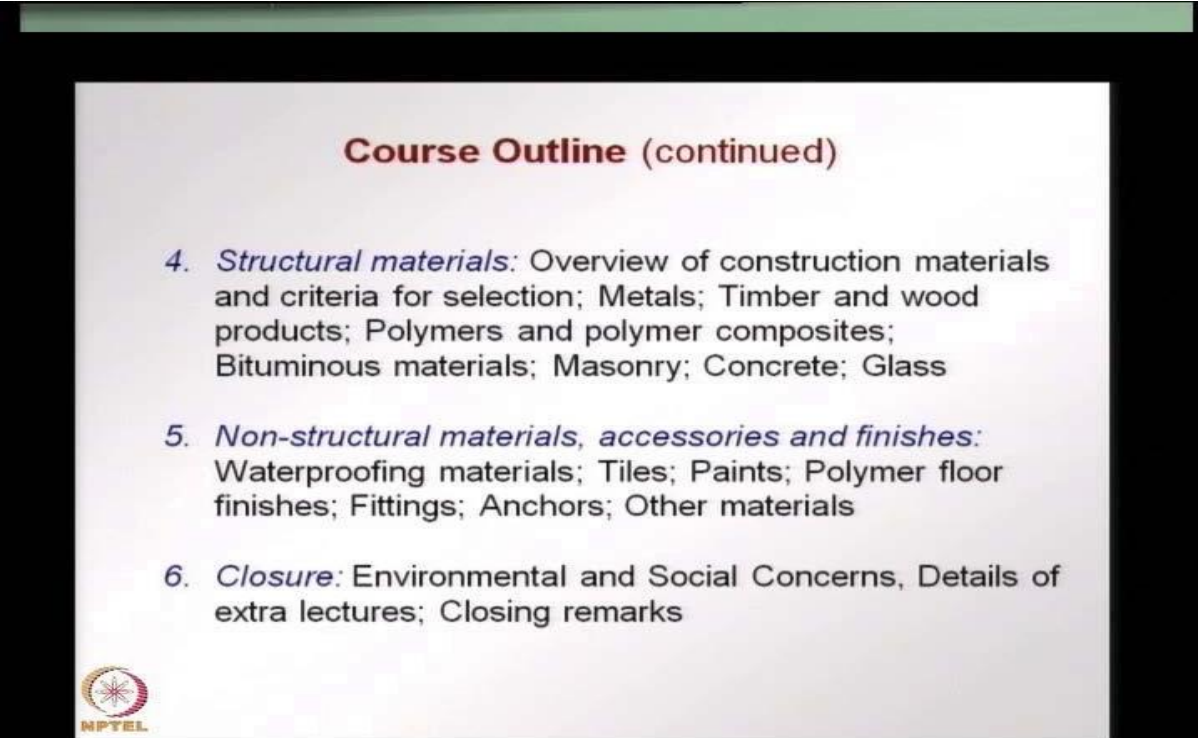
So, this is the course outline: It is put into several modules. And how you should follow the course is that, go through each video. We will try to have a question answer session thinking of possible questions that could come up and answer those. Other than that, there are exercises that will be given for each module. And in some cases, we will also try to do some demos or show how materials look; not only in pictures but we will see in, at least in the studio we'll have the material so that you get a better feel for how the material looks like. But I would encourage you to have a textbook, read material on the web, or in your library or any library that you are close to, so that you get more information. This course is by no means comprehensive; we don't cover everything that you should know about any of the topics given here. It is more of a review and in some cases, we go into some depth, but it is by no means comprehensive.

So, in the first module, after giving the course outline, I talk about the motivation in studying the science and technology behind the construction materials. This is again not very common; most curricula will not have the material science explained in civil engineering. We, generally

traditionally, have dealt with materials one by one. There will be course, which starts with cement, then aggregates, then concrete, timber and so on. But, here, in IIT Madras, we believe that the students should have an understanding of the fundamentals before the material is actually discussed.


In the second module, we will be looking at atomic bonding, structure of solids, movement of atoms within the structure, and development and changes in the micro structure. So this will tell us how materials are put together, what chemical and physical laws govern the development of the microstructure. Anything that requires a microscope is what we classify as microstructure.

Then, we go on to look at material behaviour, that would be the third module where we look at surface properties, response of materials to stress, failure theories, fracture mechanics would be introduced, we will look at rheology, which is the science of how materials flow, and thermal properties which are of very high consequence in civil engineering. So the material behaviour follows from the microstructure and from the examples, you will be able to understand why the material behaves in a certain way and what are the fundamental aspects that led to this behaviour.



Course Outline (continued)

4. *Structural materials:* Overview of construction materials and criteria for selection; Metals; Timber and wood products; Polymers and polymer composites; Bituminous materials; Masonry; Concrete; Glass
5. *Non-structural materials, accessories and finishes:* Waterproofing materials; Tiles; Paints; Polymer floor finishes; Fittings; Anchors; Other materials
6. *Closure:* Environmental and Social Concerns, Details of extra lectures; Closing remarks



Then we will go on to two modules specifically on materials. First we look at the structural materials: materials that are used to make the skeleton or the shell of the structures that we

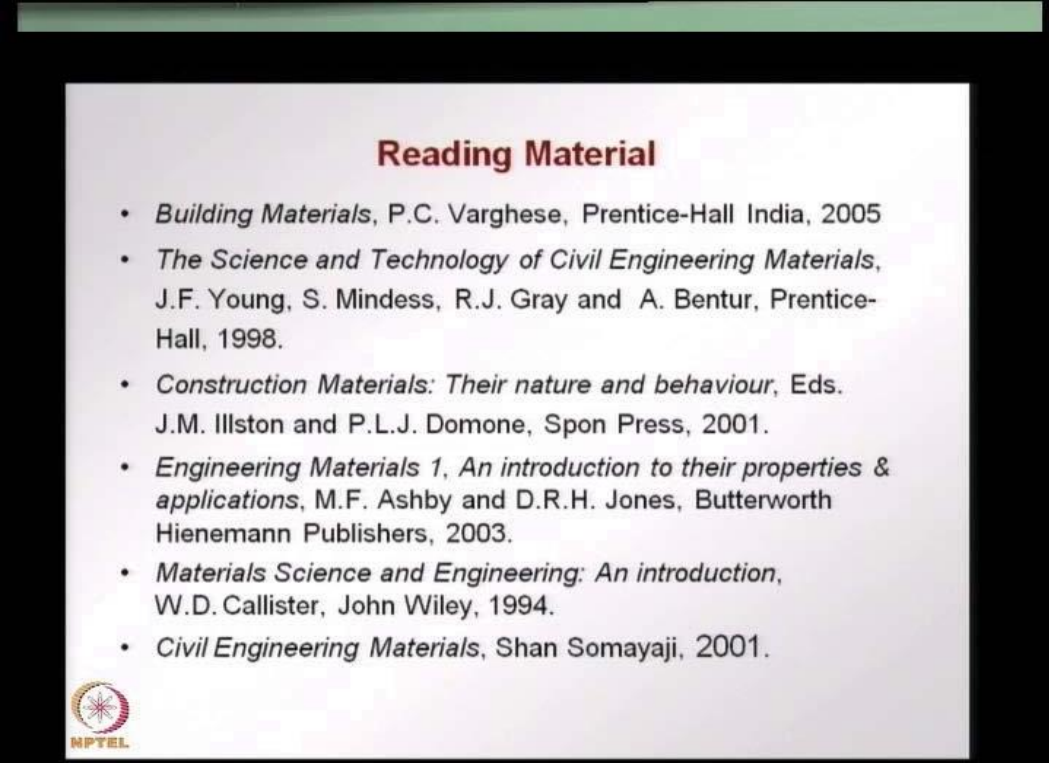
use or live in. Before that, there will be an overview of different construction materials, how we make choices, how do we decide to use a certain material. We will cover materials commonly used, like metals, timber, concrete, asphalt and so on. We will also touch up on glass which is becoming a very important structural material. Glass is not confined to just windows and shutters, but it is also being used as glazing which is a structural component of a building. Then we look at non-structural materials- accessories and fittings like floor finishes, waterproofing, tiles, paints, anchors and so on. These are also important because you have a wide range of choices and in terms of budget, sometimes we find that non-structural materials are also important to your pocket when something is being constructed. Finally, when we close in the last module, before my closing remarks, we will look at environmental and social concerns. How does the choice of the material help in the impact on the environment? Can we make a choice such that the environment is least affected? Also we look at social perception of materials-Why do we choose a certain material, why do people like certain materials and they don't, beyond just the technical aspects.

Course Viewing and Downloading

- *Web site:* nptel.iitm.ac.in/
- *Viewing:* on NPTEL web site or YouTube (lower resolution)
- *Downloading:* from NPTEL site (high and lower resolution formats)




In terms of how you access this course and how you can use the course; you already know that the website for national programme for technology and science learning is **npTEL.iitm.ac.in**. So this course is a civil engineering course within this programme. You can view the videos of this course on the NPTEL website or on YouTube. YouTube you would see videos in lower resolution. Best would be to download the videos. You can download the videos in higher or lower resolution and that way you can see them often and you can see them leisurely, you can stop and proceed and so on. So the best way to follow this course would be to have downloaded the videos. And as I said, get reading material to go along with this course. And ideally I would suggest that along with each lecture, do the reading corresponding to that lecture. And at the end of each lecture, I give the references, and in the NPTEL site you would also have text giving you a list of reading materials.

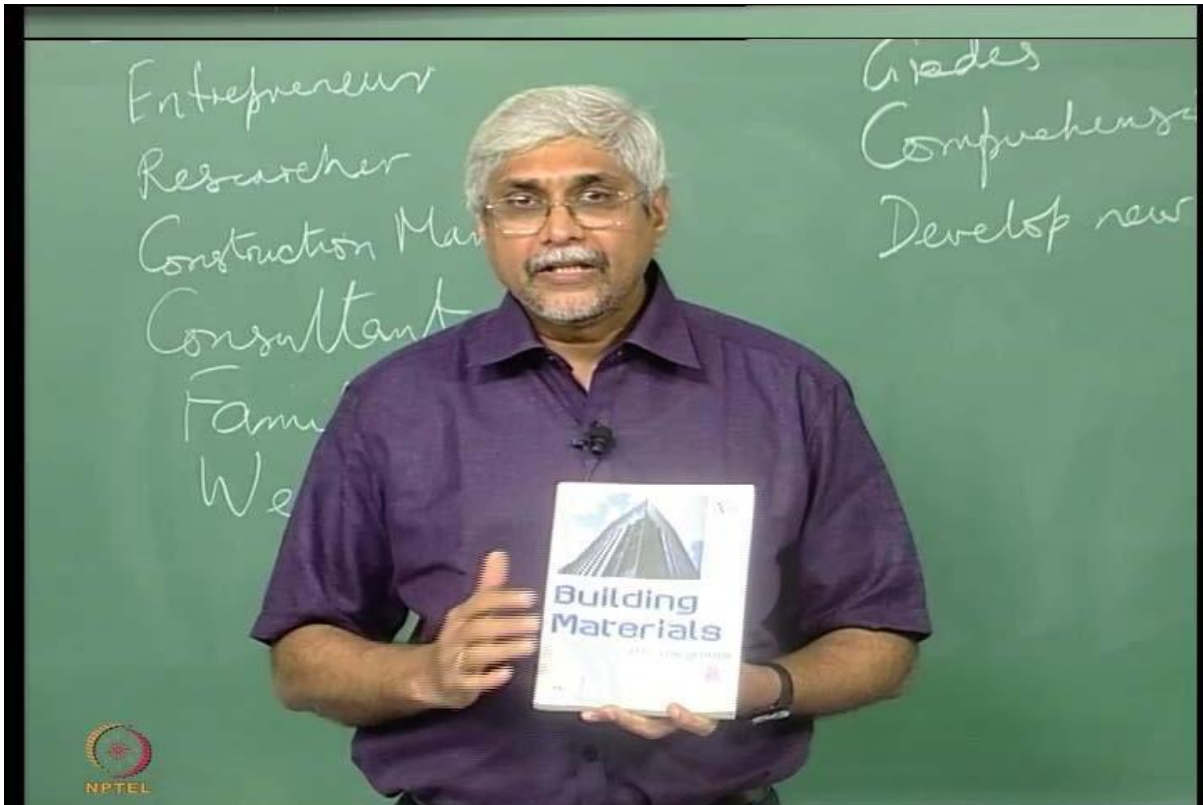


Reading Material

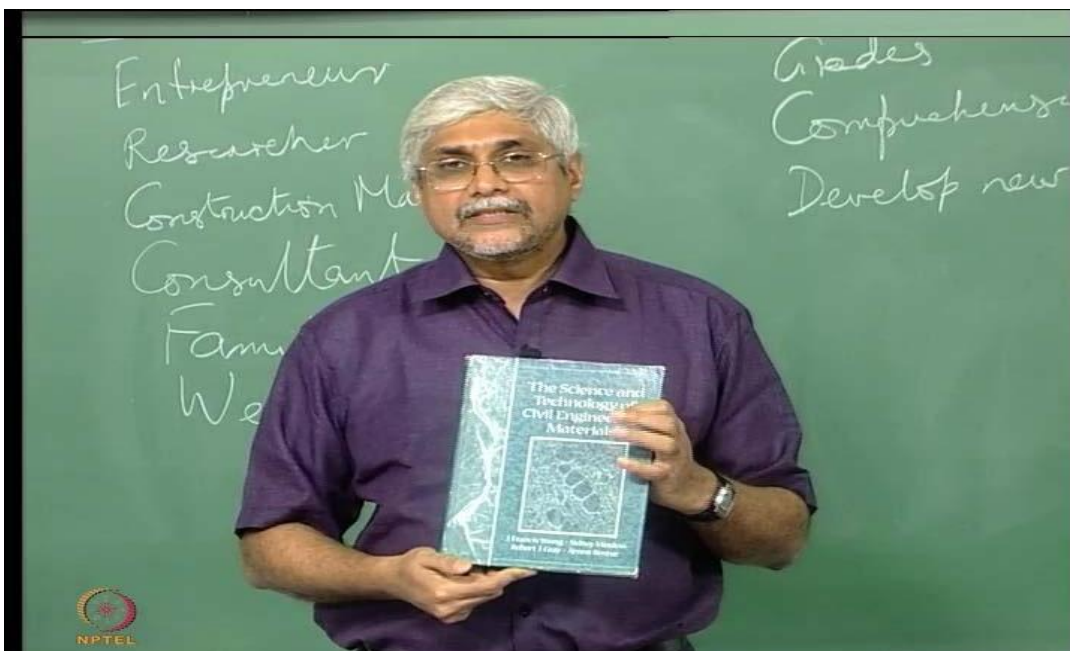
- *Building Materials*, P.C. Varghese, Prentice-Hall India, 2005
- *The Science and Technology of Civil Engineering Materials*, J.F. Young, S. Mindess, R.J. Gray and A. Bentur, Prentice-Hall, 1998.
- *Construction Materials: Their nature and behaviour*, Eds. J.M. Illston and P.L.J. Domone, Spon Press, 2001.
- *Engineering Materials 1, An introduction to their properties & applications*, M.F. Ashby and D.R.H. Jones, Butterworth Hienemann Publishers, 2003.
- *Materials Science and Engineering: An introduction*, W.D. Callister, John Wiley, 1994.
- *Civil Engineering Materials*, Shan Somayaji, 2001.



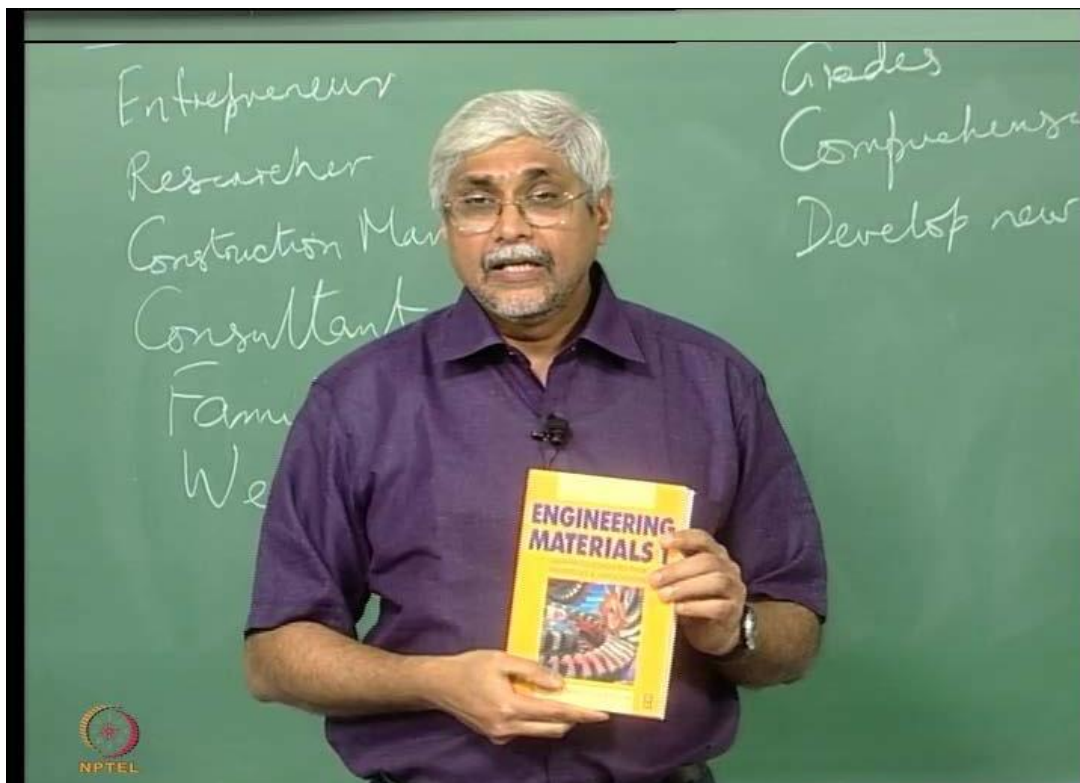
Now, these are some of the books that I have used. The first one on building materials is something very basic.



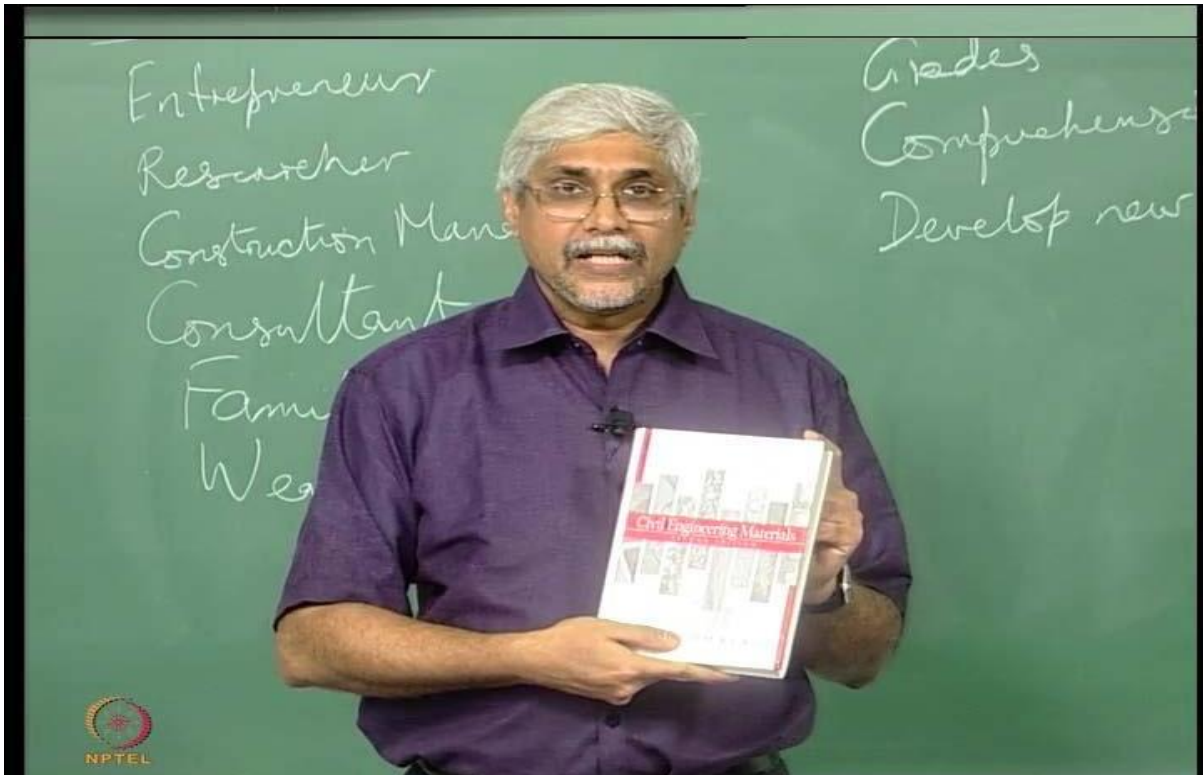
Actually, this is the book that I used, the book of P.C. Varghese. What I would expect is that you have read a book such as this before you start with this course. We start from this as the foundation. So you should have read, you should have gone through in your course work, or by yourself, the materials covered in a basic fundamental book on building materials, such as this.



Now as I told you, we have structured this course from the material science point of view and this was not very easy. And one of the sources which gave inspiration a lot was this book on science and technology of civil engineering materials by Young, Mindess, Gray and Bentur. And this book has helped us develop this course. It starts with the fundamentals, goes through different properties and then covers materials by materials. So, this is a book that if you can get your hands on, would be excellent.



Another book not pertaining to civil engineering but has been very helpful as course material is the book by Ashby and Jones, Engineering materials-I. It is an interesting book because it has short chapters and for teachers it could be interesting because the authors have structured the book such that all the materials needed for one lecture is given in one chapter. So there are twenty seven chapters. So if you plan the course well, you can deal with all the materials dealt within each chapter in each of these lectures.



There are other books also. Another book that I have here on the list is Civil Engineering Materials by Somyaji. This is a very popular book all over the world and this can help you in many ways.

So I hope we will have a good course together. And at the end of the course, feel free to send us feedback. You can do it through the NPTEL site and if there is any errata, we'll also flag it through the NPTEL site, so you will know if somethings have changed or needs to be changed.

Thank you and I am looking forward to having you in the first lecture.