Geotechnical Engineering – II
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Lecture – 1
Introduction

So, welcome to course CE330. This is Geotechnical Engineering-II. And the prerequisite for this course is CE323 that is geotechnical engineering-I in some colleges you name these courses as soil mechanics-1 and soil mechanics-2 for the undergraduates. So, in CE323 that is geotechnical engineering one, what I have done is I have tried to make you understand about soil as a material. And if you go through the contents of the course, the course basically dealt with characterization of the soils; and for characterization, we started with the genesis of the soil, origin of the soil is depositional characteristics and so on.

And from there we switched over to the characterization methodologies by conducting different tests. We have tried to understand the basic characteristics of the material soil and then we have tried to answer the questions that how to utilize this material as an engineering material. How to compact it, that was under the compaction chapter which we studied. And later on, I moved on to the seepage theory, how the percolation of water takes place through the soils and nowadays people are calling these phenomena as soil water interaction. This has become a major theme for research and for the studies.

And followed by this we were talking about the compression characteristics of soil that is the compensability and consolidation characteristics. And then this is where I introduced the concept of one-dimensional consolidation, and generalized form of one-dimensional consolidation was the 3-dimensional consolidation that is the sand drains, band drains. So, in short soil has been considered as a material and how we can quantify its characteristics. Now, this course geotechnical engineering-II primarily will deal with understanding this material as a engineering material.

So, I am sure most of you must have done the course on fluid mechanics, solid mechanics and soil being a new material; the mechanics of the soils you might not have studied. But, the only difference between the fluid mechanics and the solid mechanics would be we are introducing here the concept of the material which is soils mostly predominantly generated by the natural

phenomena. Nowadays, people are talking about the manmade soils also. Good example would be industrial waste and the waste which is coming out of the municipalities in the form of MSW.

So, the concepts of the material and how to utilize this as an engineering material that is what I am going to focus more on this course; that is the geotechnical engineering-II. My suggestion would be please very quickly revise the concepts of geotechnical engineering-I.

So, that you do not fiddle with the mechanics part of this when we discuss in the geotechnical engineering-II. And the flow of this course becomes quite smooth. Another thing which I would like to say is most of the problems which you are facing in the society in terms of the infrastructure development; you will find that this course is going to be extremely contemporary; and the concepts which you have acquired until now in geotechnical engineering-I would be directly applied to solve day-to-day problems.

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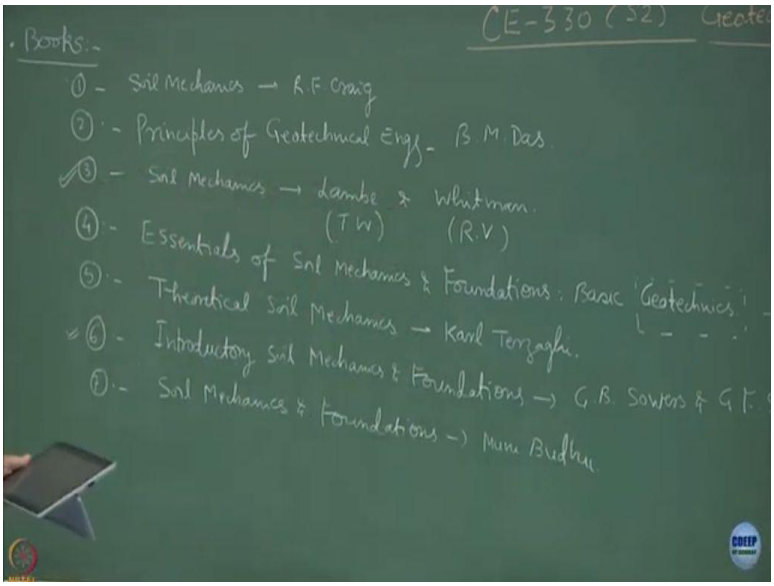

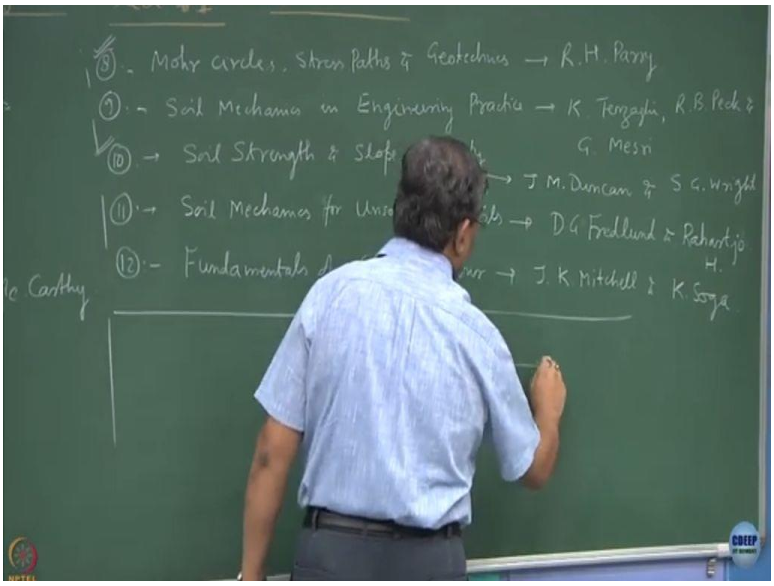

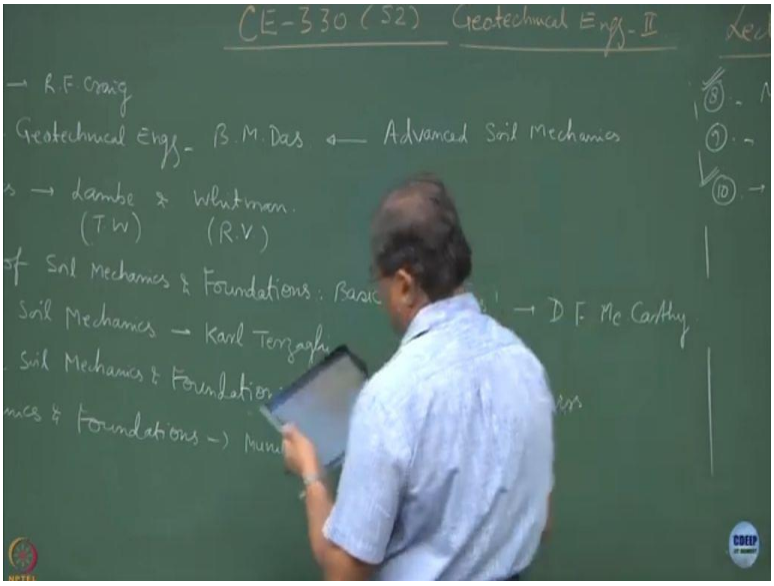

Let me begin with the books. The books which I have recommended for CE323 would still remain valid for this course. But, this course being a specialized course, I would suggest that whenever time permits, not during your undergraduate but even the later on, you should definitely go through the books particularly if you are going to be a civil engineer and a practicing engineer.

So, the number one book I still would suggest is Soil Mechanics by Craig. There is another good book that is that is Principles of Geotechnical Engineering; this is by B. M. Das. There is another interesting book not for really undergraduates, but when you are practicing or if you really want wish to continue in geotechnical engineering.

Later on, you should refer to Soil Mechanics by Lambe and Whitman; this is T.W. Lambe and R.V. Whitman. It is an excellent book. Whenever time permits, please have a look at the chapters the way they have been introduced in this book. Another book on the subject would be essentials of Solid Mechanics and Foundations: the Basic Geotechnics. The word or the term which is normally used for geotechnical engineering in contemporary era is Geotechnics. That means the techniques related to a material which is of geological origin; geo is earth and techniques.

So, this includes everything. So, this is by McCarthy, a slightly advanced book Theoretical Soil Mechanics by Terzaghi. The next one is Introductory Soil Mechanics and Foundations; this is by Sowers and Sowers slightly advanced book. So, I would not really recommend you to go through this book at this stage; but you should be knowing that there are guys who have written books like this. Another good book would be Soil Mechanics and Foundations by Muniram Budhu. You might have to refer a book on some specific topic and Mohr Circle, Stress Paths and Geotechnics by R.H. Parry.

I will be beginning the discussion on this subject by linking the concepts of solid mechanics with the material, which is soils. And this is where this book will become very handy Mohr Circles, Stress Paths and Geotechnics; and the book is by R.H. Parry Richard Parry. There is another book Soil Mechanics in Engineering Practice by Karl Terzaghi, Peck and G. Mesri. Terzaghi, Peck, Hanson, Thondaman and then followed by Mesri; so, this is the linkage. These are the guys who started the subject.

Another interesting book, which you might have to refer to would be Soil Strength and Slope Stability. This is the book by J. Michelle Duncan and S.G. Wright. There is another version of Geotechnical Engineering book by B.M. Das; some of you would like to refer this. This is Advanced Soil Mechanics by B.M. Das. Those of you who are very seriously thinking of pursuing your careers in Geotechnics Soil Mechanics for unsaturated soils; normally, I would not be discussing the concepts of unsaturated soils in this subject. Because undergraduate level unsaturated soils is beyond the scope of the course.

But, because you have done capillarity and other things in the Basic Soil Mechanics; so, those of you who are very eager to understand how soil behave under their unsaturated state, this is the book. But, when we are solving problems related to slope stability and retention schemes, you will realize that the concepts of unsaturated soil mechanics will be utilized. Now, this is the book

by D.G. Fredlund and Rahartjois known as H. Rahartjo. There is another interesting book Fundamentals of Soil Behavior; and this is the book by J.K. Mitchell and K. Soga, very contemporary book.

And in case you want to pursue your career further, you should follow this book; because these are the guys who are really champions in their subject. Unfortunately, you will notice that I have not really listed any book by. Why? Yes, you are right. So, my suggestion to you will be please do not refer any of those books to save you from further difficulties. And the reason is very simple. These are the Bibles, original books. Most of other books and the derivatives are cut and paste. So, please do not consult any of the books which I have not referred here. You know why? Very slowly you will discover that our philosophies do not match.

So, when philosophies do not match that please do not follow the books which I have not listed over here. So, you continue with the R.F. Craig. I am sure you must have realized that is going to be a ocean of information and which is really beyond the timetable of undergraduates, agreed? So, what I suggest is unlike the previous course where you were tentative in attending lectures and not attending lecture; this course unless you attend the lectures, am sure you will not be able to follow much. Because I enjoy teaching this course as I said in my own style and it would be good for you to follow the lectures, come to the classes; stop me wherever you are thinking that you are not following things and have discussion.

On your own it would be very difficult for you to study this course. Because I will really venture into the philosophy of the material; and which normally you will not find written in books much. So, my suggestion is that apart from this lectures and participation in the class is very very important. So, my idea is when you are interacting, I tried to learn whatever is at the back of your mind. And as you introduce yourself just now, you come from different parts of the world, cities. The problems that you are facing are very different and typical; and for an individual it is not possible to visit all the places.

So, your questions are really going to help me as a researcher; forget about as a teacher, clear. So, as a researcher unless you come across new problems, you will not really learn much. So, my suggestion is please interact much as much as you can and related with wherever you visit. That is the way to study Soil Engineering-II; because the concepts are already with you. How to apply them where and how, and how much is an art. So, this is mostly a practice-oriented course. So, it

is the interface between fluid mechanics solid mechanics, what we call as soil mechanics application part. And then we will create several situations where you are going to use these concepts, is this fine?

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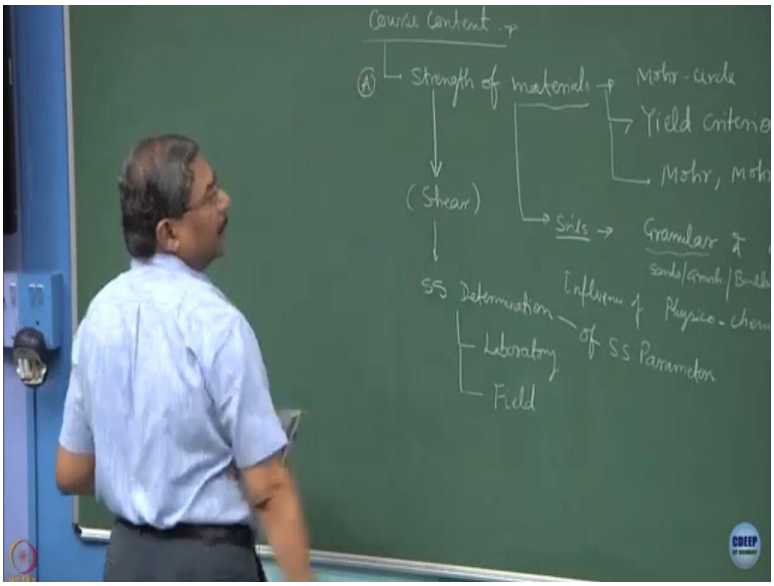

I will start a bit on the rigid body mechanics which you must have done in your engineering mechanics course applied to soils. Strength of materials I am sure you have done a course on this applied to soils. So, I will be initiating the discussion with Mohr-circle remember a bit of this or you have forgotten.

Brush your concepts though I will teach them in the class; because these are the basic tools which you will be utilizing in the entire course; so, concentrate more on this topic. Yield Criterion and then Mohr and Mohr-Coulomb Failure Criterion. I will be talking about the Strength of Soils as a material.

And as you know, we talk about two types of soils: the granular materials and cohesive. So, granular soils are the ones mostly sands and above that size inch. So, sands, gravels boulders et-cetera; and cohesive soils are the fine-grained soils. This is where we will be talking about the Influence of Physico-Chemical aspects on the strength of the materials, shear strength of the materials. We are mostly interested in shear strength determination of the soils. So, when I say strength, we normally do not talk about compressive strength or soils, we talk about the shear strength.

That means this course primarily deals with the material characteristics when material is getting sheared. The type of loading is shearing, not compressive. Because most of the problems in Geomechanics which we come across are the situations where there is a movement of the soil mass; so, we talked about the shear strength. We will talk about the shear strength determination; so, I normally write this as SS shear strength determination.

And when we talk about the shear strength determination, normally there are two techniques: the laboratory and the field. We call them as shear strength parameters. So, determination of shear strength parameters; this is going to be the first part of the course. The second part of the course would be application of shear strength theory.

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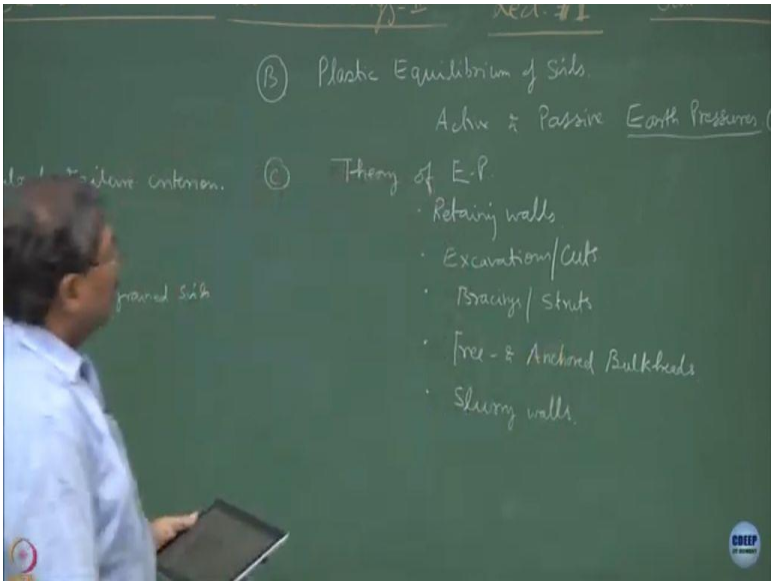

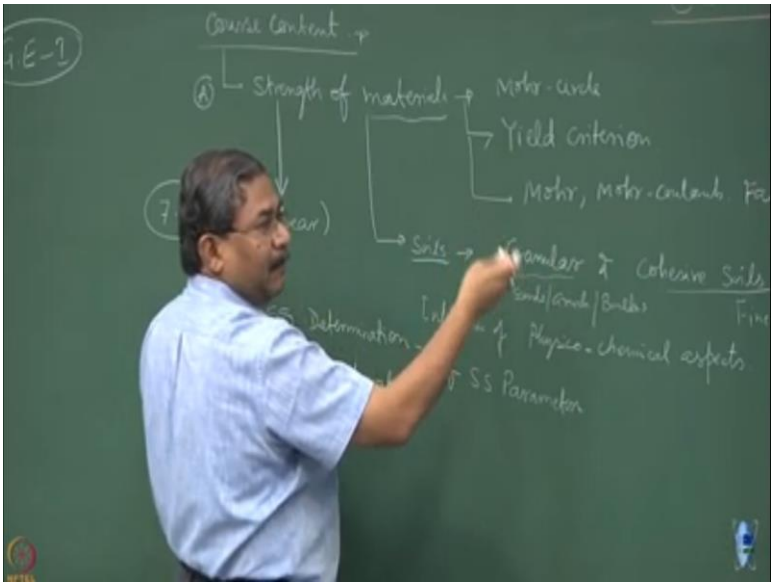

So, as far as shear strength theory is concerned, I tend to spend about 7 to 8 lectures on this to be conservative side 7 to 10. This is the plastic equilibrium; that means we are stepping out of the elastic zone; and we are talking about the plastic equilibrium of the soils. Application of shear strength theory number one and this is where we will be talking about active and passive pressures as a part of this would be. But, you can say as C-part would be further applications to theory of earth pressure. Here we will be discussing several example problems as retaining walls, excavations.

We will be talking about bracings and cuts, struts; sorry struts will not come here. Excavation and cuts can be put together, bracings and struts support systems. We are discussing about free

and anchored bulkheads, slurry walls; this is going to consume quite a bit time. This is going to be an exhaustive course. And the D-part would be the last and final would be stability of slopes.

So, what I would like to convey here is having studied the shear strength aspects of the material, how to utilize them; case study number one in general, plastic equilibrium in soil with different applications, real life situations. The second is stability of slopes; normally we talk about instability. So, the way I would teach this course or the topic is I will be talking about instability; because an engineer is more concerned about when something is going to fail and how to stop it. Soil Mechanics or Geotechnical Engineering-II will stop here.

And the next semester you are going to do application of shear strength that is the foundation security. So, now the journey is going to be up to this point fourth year first semester you are going to do foundations of different types, shallow foundation, Deep-foundation, pile foundations, anchors, marine structures, moorings, floating foundation, what not.

So, truly speaking, the compartments are like this Geotechnical Engineering-I was the Introduction to the Material. Its mechanistic point of view, when I share what happens, when I confined what happens, when I apply stress what happens, when I strain it what happens, how the material behaves, and then applications. So, this is going to be dedicated course at PG level; each of these chapters is going to be a dedicated course. And remember that this is a subject which I practiced. So, there is a professional interest also.