Design of Structures II

Lecture 1

Concrete

Concrete means the mixed proportion of cement, fine aggregate, coarse aggregate with the design or what is cement ratio? What is cement ratio? Which is normally designed based on some IS method or any other method which are available. Now here this concrete otherwise called as plain concrete cement shortly called as PCC. This concrete is again reinforced with materials like plastics, wood, steel many other material which are available in the mock guide. The concrete which is called as reinforced cement concrete. Shortly it is called as RCC. But nowadays here we are using steel is the only material in the case of reinforced cement concrete. There are certain reasons behind it. What are the reasons for using steel is the only material in the case of reinforced cement concrete. There are only the technical reasons. There are three technical reasons for using steel is the only material in the case of reinforced cement concrete structures. For example first one for example when we have a simply supported beam which is supported at its ends. Now it is subjected to some kind of forces. What will happen this beam will be formed like this? It means that the topmost layer shorten in its length and also it is subjected to a maximum compressive stress. And the bottom most layer elongates in its length maximum and it is also subjected to maximum tensile stress. And there is a layer i.e called as a neutral layer which has neither compression nor tension and the axis process through the neutral layer is called as neutral axis. It means that the layer above the neutral layers are subjected to the compressive stress and the layer below the neutral layer subjected to tensile stress. We all know that concrete is very strong in compression. So the layers above the neutral layers are entirely taken care of by the concrete. What about the layers below the neutral layer which are subjected to tensile stress. So here the concrete is very weak in tension that's we all know that if the concrete is allowed to take any tensile stress what will happen there is a crack which is formed. So it's not supposed to take any tensile stress we need to provide certain alternative material that is used to resist the tensile stress. That material should have more tensile stress than the any other material which are available in the market. Here we have found that steel is the only material which has more tensile strength than that of other materials. So this is the first reason for using steel is the only material in the case of RCC structures. This is the one. What is the second reason? We all know that due to change in temperature. The concrete will elongate or shorten in its length due to

change in temperature. What about when we have used the material i.e. steel in the RCC. Steel should also elongate and or shorten along with the concrete. So here the scientist found that the coefficient of thermal expansion of steel is almost same as that of concrete. So when it is almost same as that of concrete and steel should also elongate shorten in its length along with the concrete. This is the second reason for using steel as a material in the case of RCC. What is the third reason? When it is normal in as RCC is called as the composite structures. The structures which has more than one material called as the composite structures. So here we have use the steel as a material that is there are two materials one is concrete another one is steel. So here when it starts behaving like a composite structure there should be a perfect bond between them otherwise it will act separately. Here also they have found that there is a perfect bond between the concrete and steel. So these are all the three reasons for using steel as a only material in the case of RCC structures. The first reason is it has more tensile strength. Second reason the coefficient of thermal expansion of steel is almost same has that of concrete. And third reason and there is a perfect bond between them. So these are reasons which are using steel as a only material for in the case of concrete structures.

Next one is I have already told that what is cement ratio? What do you mean by what is cement ratio? i.e. Amount of water divided by weight of cement. Now how to calculate amount of water for a particular branch of concrete. Normally in the particular batch of concrete mainly depends on one bag of cement. So weight of 1 bag of cement is normally we all know that is 50 kg. If the water cement ratio for particular grade of cement. Normally the concretes are graded like M15 and M20, M25, M30 like that. So here for normally in the case of RCC structures the minimum grade of concrete should be uses M20 grade. It starts from M20 grade concrete as per IS56 2000. So for example if water cement ratio which has been design by the method for M20 grade concrete as 0.5. So now to calculate amount of water required for a particular batch of concrete. So water cement ratio water divided by cement is equal to 0.5. the water is equal to 0.5 into the weight of cement that is 50 kg that is equal to 25 litres. This is the way of calculating amount of water for a particular batch of concrete, a particular for 50 kg of the concrete. So here we have seen what do you mean by concrete? Then what do you mean by reinforced cement concrete? What are the reasons for using steel as a only material in the case of reinforced cement concrete? What do you mean by water cement ratio? How to calculate the amount of water for particular batch of concrete for the various grades of steel. Now here we have discussed about the grade of concrete. The grade of concretes are graded like M15, M20, M25, M30, M35 like that. So here M

refers to mixed proportion or it is called as Mix. What does the numerals refer to? i.e. 35 for example. The 35 is here is called as characteristic compressive strength of concrete in Newton per millimetre^2. That is the characteristic compressive strength .but in the case of steel there are two main grades of steel one is mild steel and another one is high yield strength deformed bars we are having FA415 and FA500. So here the 415 refers to the characteristic tensile strength of steel. Here in the case of M35 that is the concrete 35 refers to characteristic strength of concrete. So here generally it is denoted by characteristics strength of materials. What do you mean by characteristic strength of materials? As per IS456:2000 characteristic strength of materials below which not more than 5% test results are expected to fail. What does it mean? What is the reason behind it? Why they prescribed not more than first 5% of test results may be expected to fail. In the case of reinforced cement concrete, there are two different cases. One is strength of materials. Another one is loads on the structures. Here we are using two different materials one is concrete another one is steel. We all know that what about the strength of concrete. The strength of concrete which is subjected to wider change of variations by so here the concrete mainly depends on workmanship so the strength of concrete normally subjected to wider change of variations which is due to the workmanship but it's not like in the case of steel. The steel is manufactured and strict quality control in the factory. Now it come to the loads of the structure. Now two different loads one is live load and another one is dead load. The dead load we can easily estimate i.e. the dead load can be accurately measure once we know the thickness of the member and also its own heat weight of the material. But it's not like in the case of live loads. live loads are subjected to wide range of variation. So here in the case of materials as well as the load which are subjected to wider change of variation. They cannot exist minimum value of strength of material maximum load on the structures. There is always probability that the strength should be always must be very less than the prescribed strength of the materials or the structures. So IS codes allow certain % of testers would be expected to fail?So here as per IS456 they allow for not more than 5% of the testers may be expected to fail due to these two reasons i.e. strength of material and loads on the structures subjected to widest range of variations. So they define like the characteristic strength of materials below which not more than 5% of test results may be expected to fail. So this is about the characteristics of strength of materials. Now we have the concepts of methods of design. So far we have seen what do you mean by concrete? What is meant by reinforced cement concrete? What are the reasons for using steel is only material in the case of reinforced cement concrete structures? What is cement ratio? And how to calculate the amount of water for particular batch of

cement. Then what do you mean by grades of concrete and grades of steel. And the case of grades of concrete we have seen what do you mean by M? the numerous refers to the numerous refers to so here the numerous refers to characteristic strength of materials a characteristics as per IS456 they defined like characteristics strength of materials below which not more than 5% of the test results expected to fail. Then we have also seen why they have allowed certain percentage of test results may be expected to fail. This is only due to the variation in strength of materials and the load on the structures.

Methods of Design

Now we move onto the concepts of methods of design. There are three different methods which are used to design the structures. They are predicted one is working stress design method. Second one is ultimate load design method. Third one is limit state design method. Before that here we are going to have the working stress method. Before that what do you mean by stress? How to explain the stress? The stress when the material is subjected to any kind of forces. The force that try to change their shape of the materials. We all know that the material which consists of many number of molecules or particles. So the particles or molecules which constitute the material of the body which tries to resist the change in the shape of the body. So as the resistance increases, the deformation increases. When the full resistance to the external force is settled, the deformation stops or the bod is not able to develop any resistance to the external force, the deformation goes on continuing upto the failure. So the resistance to the deformation per unit area of the body is called as stress and the corresponding deformation i.e. the change in deformation per unit length of the body is called as strain. Now here we have seen working stress. We have seen what do you mean by stress? Stress is when I external system of forces which is acting on the body try to change the shape of the body. The particles are molecules which constitute the body which resist the change in the shape of the body. So the resistance increase, the deformation increases. When the resistance to the external force is set up, the deformation stops. If the body is not able to develop full resistance to the external force, the deformation goes on continuing upto the failure. So the resistance per unit area of the body is called stress. And the corresponding deformation per unit length of the body is called the strain. Now we come to what do you mean by working stress? Before that what do you mean by ultimate stress? Before that what do you mean by ultimate load? The load at which the material can sustain before breaking is called ultimate load. And the corresponding stress is called as ultimate stress. But in practice, the material are any structured which has not subjected to ultimate stress. One it is reaches the ultimate load or the stress it starts failure. So the actual value of the

stress is kept much less than the ultimate load and it always well within the elastic limit. So the maximum value of the load to which the material can be actually subjected is known as working load. And the corresponding stress is called is working stress. So here, there is a difference between what is meant by working load and ultimate load? Working and ultimate stress.

So ultimate load means the load at which the material can sustain before breaking. And the corresponding stress is called the ultimate stress. Normally in practice, materials which are not subjected to ultimate load. The actual value of the load is kept much less than the maximum value of the load i.e. much less than that ultimate load and it always should be well within the elastic limit. So the actual value of the load or the maximum value of the load to which the material can be actually subjected is known as working load. And the corresponding stress here it is called as working stress. So here I have told that there is an elastic limit. What do you mean by elastic limit? Before that what do you mean by elasticity? The property of the material to return back to its original position after the removal of external force is called as elasticity. And the removal of external forces, the stress can completely disappear. But deformation need not fully disappear. So the limiting value of the load that can be found upto with the deformation can completely disappear on the unloading. So the loaded corresponding to that limiting value of the load is called elastic limit. So here this method which is mainly talk about material which is subjected with the elastic limit and talks about the elasticity property of the elasticity or thus this material has normally upto the elastic limit. This method is otherwise called as elastic design method. This method is always called as elastic design method due to material which has subjected only upto its elastic limit. So they consider the material only upto the elasticity. So here another one is modular ratio. The modular ratio which is normally denoted by m. This is the another well known mechanics they have used. Now here, when we talk about the ultimate stress, the working stress method, when we go about the ratio i.e. ultimate stress divided by working stress i.e. called as factor of safety. What about the factor of safety we used in the case of working stress method. For example, in the case of concrete, the concretes are graded like M20,M25, something like that. The working stress of M15 great concrete is 5 and factors of safety are given in the table.

This method which is normally failed to give the maximum load under structure, serviceability and exact economy in design an idea of reserve strength of member. And also the actual stresses developed in the structure at the working loads which is completely differ from the theoretical value. This is the second reason for this failure of working stress method. And here the reason

behind is the assumption the concrete is assumed design, elastic material perfectly it is not correct and the contrary it is more complex material. So this is something introduction about the working stress method. Then they found the ultimate load design method. In the case of ultimate load design method but in the case of working stress design method. They have taken concrete as a plastic material but here they have consider inelastic and plastic behaviour of concrete and steel. And here the loads are normally multiplied by the factor of safety to arrive the ultimate load and also the ultimate stresses developed in the concrete and steel are known real values. Anyway that however the deflection cracking effects were not considered under working loads, working conditions in the case of ultimate load design method. So this method only used to check the ultimate load under structure after designing with the help of working stress method to give the idea of real factor of safety of structure. So this is about a ultimate load design method.