Design of Steel Structures
Dr. Damodar Maity
Department of Civil Engineering
Indian Institute of Technology, Guwahati

Module - 06
Flexural Members
Lecture - 08
Design of Shear Connectors and Purlins

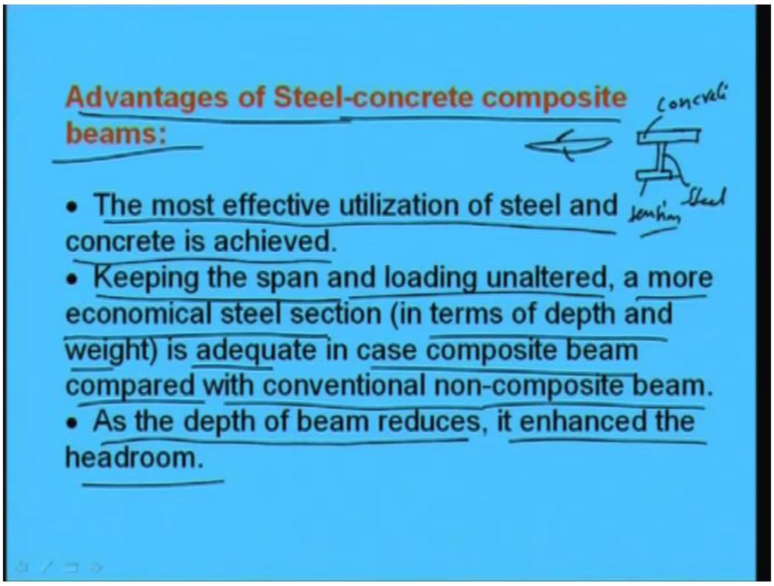
Hello, today I am going to discuss about the rest part of the design of shear connectors, then I will be going to discuss on purlins. In shear connector, last to last lecture I have discussed different aspects on the design, and the codal aspects on shear connectors. Shear connectors, we know, are used when 2 different types of materials are used, means as a composite section when we are going to use in a member, then shear connector would be required to join each other.

As I told in last to last lecture that we may we have to transform the section, we have to find out the I section or area in a transformed I, transformed area, all this you have to find out. So, how to find out all these things, I will demonstrate through the workout example through which it will be clear. Then, how shear connectors are going to design, how many number of shear connectors would be required to design such steel concrete composite beam, will be demonstrated.

So, at the first I will discuss about the composite beams, means composite members with special reference to composite beams. Why composite beams are advantageous, what are the advantages and what are the disadvantages, those things very little I will discuss here because I am just going to give you an small overview of the composite beams.

Composite structure is a separate things which will take 40 lecture atleast to cover the composite structure which is out of our syllabus. But, with having a small introduction to this, you will get interest and you may do at your own to find out some other type of design of composite members.

(Refer Slide Time: 03:04)

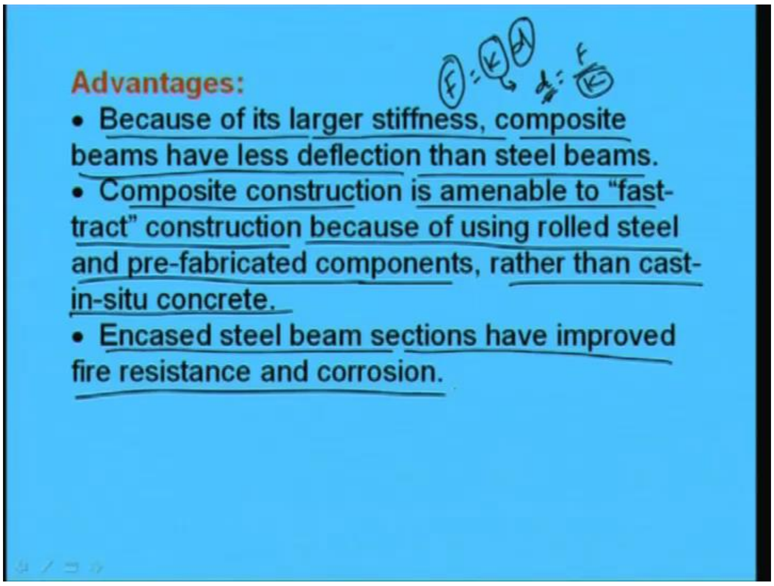


Now, let us see, what are the advantages of steel concrete composite beams? I have just written down here, just you can note that; one is the most effective utilization of steel and concrete is achieved, because if suppose there is a beam which is deflecting like this, then at the top the compression will develop and at the bottom tension will develop.

So, if we can make something like this say, this is concrete which is taking care the compression, and if this is steel which is taking care the this is steel which is taking care the tension because tension is developing here and compression is developing at the top. So, we can take the advantages of the property of the material and then we can make its utilize.

Second advantage is keeping the span and loading unaltered, a more economical steel section, in terms of depth and weight, is adequate in case of composite beam compared with conventional non-composite beam; means if we use steel concrete composite beam then we can find a more economical steel section. As the depth of beam reduces, it enhanced the headroom. So, with the use of steel concrete composite beam we can enhance the headroom.

(Refer Slide Time: 04:44)

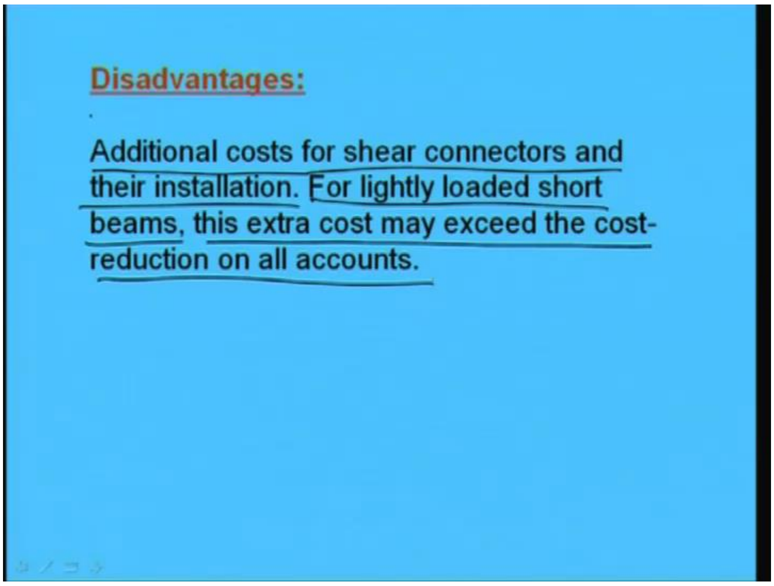


Another advantage is because of its larger stiffness, composite beams have less deflection than steel beams. So, as we know, the deflection depends of F is equal to k into d, where k is the stiffness, d is the displacement or deflection, F is a force. Now, if k is high, then definitely d will be less, because d is equal to F by k.

So, because of largest stiffness of the composite beam, what will happen, deflection will be less; that is why for a longer span if we can use composite beam, then we can restrict the deflection. That means restrict the deflection means, the codal permission is given; that is the span by 325 that deflection means that we can keep our deflection within that allowable deflection that is l by 325.

Composite construction is amenable to fast tract construction because of using rolled steel and pre-fabricated components, rather than cast-in-situ concrete. So, this is another advantage when we are going to use composite construction. Encased steel beam sections have improved fire resistance and corrosion; if the steel beams sections are is encased in the concrete, then definitely the fire resistance can be improved corrosion can be reduced; because we know the steel is can, means steel is if it is exposed to the air then the corrosion will take place. So, that can be reduced if we can use encased steel beam, like things.

(Refer Slide Time: 06:35)

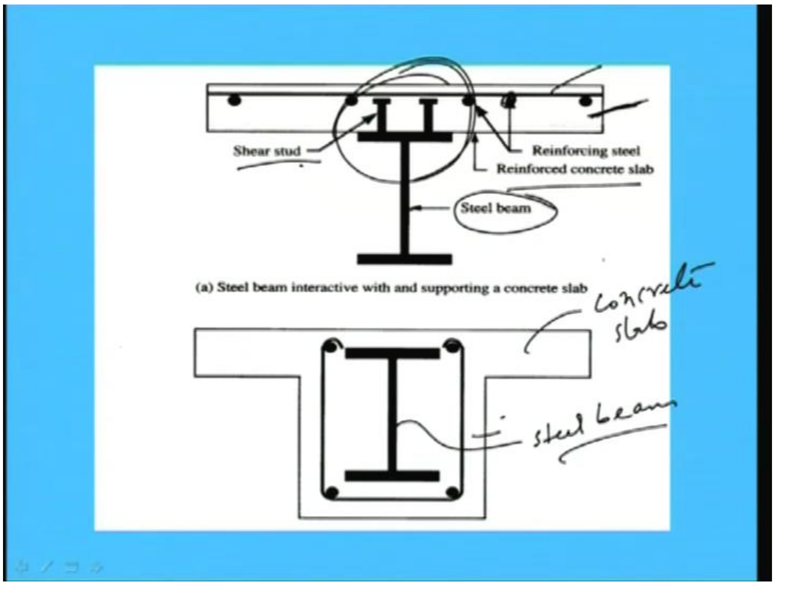


And now, when we are going to use steel concrete composite section we must know what are the disadvantages also; it is not that always we will get all advantages. So, if we know the disadvantages then we can think whether we will go for composite section or not. In case of steel beam, means steel concrete composite beam, the disadvantage is that additional cost for shear connectors and their installation is required. So, we have to use shear connectors for joining the steel concrete composite section properly. So, additional cost due to the shear connector will be required.

And, for lightly loaded short beams, this extra cost may exceed the cost reduction on all accounts; means, if the load is light or if the span is less, then unnecessarily we did not go for steel concrete composite because in that case the cost, overall cost will be increased because of the installation of shear connectors and other things. So, unless it is heavy load and longer span we do not need to go for composite.

So, we have to see where whether it is really required or not, on that basis we can find out that on the basis of requirement the sectional dimension and how much steel dimension is required; means, what is the dimension of the steel is required and what is the concrete is required on the basis of loading condition and the end condition of the beam.

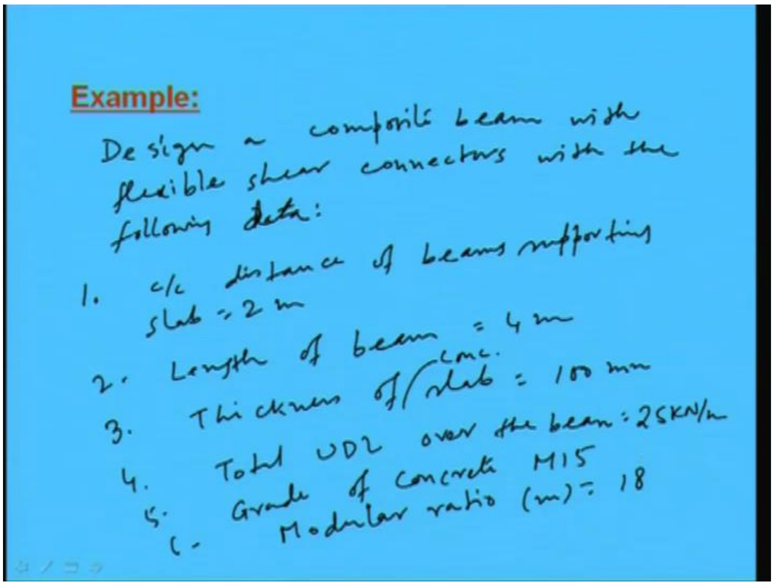
(Refer Slide Time: 08:23)



Now, this is some typical picture of steel concrete composite beam. Say, this is a concrete slab, this is reinforced concrete slab this one, and this is a steel beam. So, steel beam and concrete, concrete means RCC slab has been connected together through this shear connector. Then shear stood is here, it is given. These are the reinforcing bar; these are the steel bar in different direction. So, this is how the steel beam interact with the supporting concrete slab. So, this is how we have to design. This portion we have to design properly with the help of shear connectors.

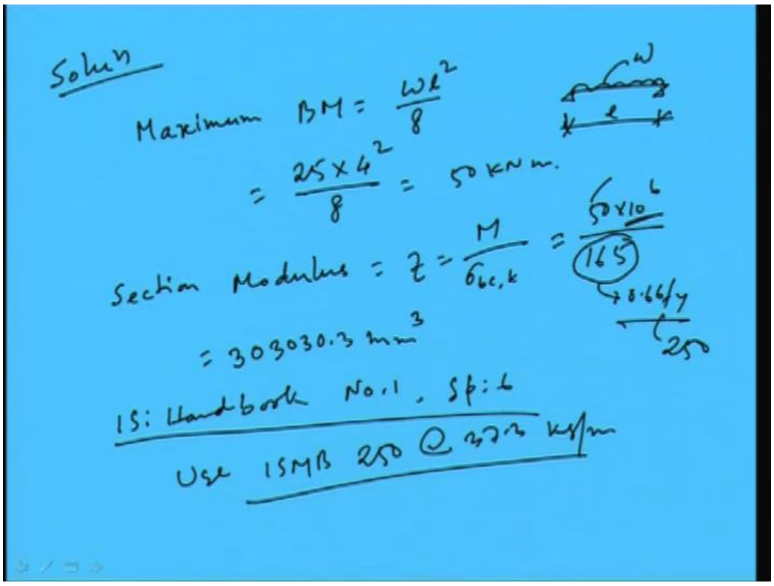
Another case of, if it is encased, steel beam is encased in the concrete; this is the concrete section, concrete slab; and this is the steel beam. So, this is another option through which the steel concrete composite beam maybe made. Both the section, these are the two different type of section; both the sections have their own merits and demerits. So, we are not going into details of all those. Only thing we should know that this type of things, means we use in the construction.

(Refer Slide Time: 09:54)



Now, I will go through one example through which we will be able to understand, how to find out the properties of different sections, how to combine those things, and how to analyze the steel concrete composite beam, then how to provide the shear connectors. Say, design a composite beam with flexible shear connectors with the following data. One is the center to center distance of beams supporting slab that is 2 meter. Then, length of beam means span say, 4 meter. Then, say, thickness of slab say let us consider 100 millimeter; thickness of slab means concrete slab. Then, say, uniform load, total uniform load, total UDL over the beam say, 25 kilo Newton per meter. Then, say, grade of concrete, let us use in M 15. And say, modular ratio say, is equal to 18. So, these are the data we have. So, let us solve the problem.

(Refer Slide Time: 12:40)



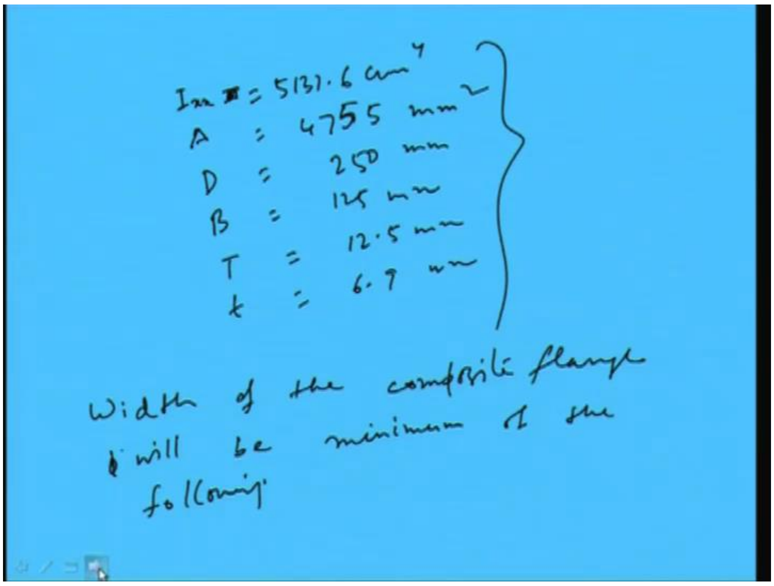
So, first what we will do? We will find out the maximum bending moment because from the maximum bending moment we can find out the section modulus. And maximum bending moment will be w l square by 8; as the end condition has not been given, so let us assume that it is a simply supported beam with having l span and w is there. So, if we put those value, w was given as 25 kilo Newton meter and l was 4; so this is becoming 50 kilo Newton meter.

So, we can find out the section modulus; section modulus will be z that will become M by sigma b c or sigma b t. Now, we do not know whether the beam is laterally supported or unsupported, but it is not 12, but when it is encased with, sorry; when it is a composite beam means when the slab of the concrete, concrete slab is connected with the beam we can assume that it is laterally supported.

So, sigma b c and sigma b t value will become 165, for f y 250. So, if we put the value, this is 50 kilo Newton, and then sigma b c is 165. This is for 0.66 f y as we know, and f y let us assume 250. So, if was assume f y value of 250, then this sigma b c will become 165; and this is 50 kilo Newton meter, so I am multiplying 10 to the 6 to make it Newton millimeter.

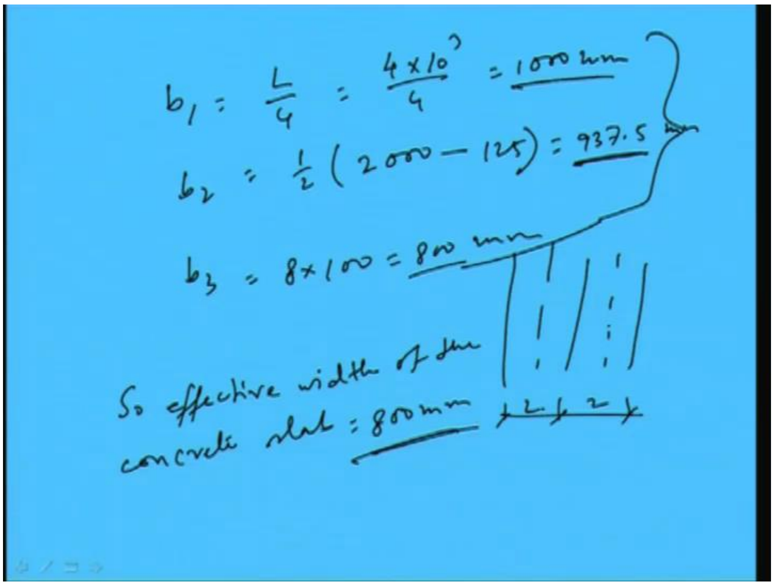
So, after calculating this we are going to get the value as say, 303030.3 millimeter cube. So, this is the value we are going to get. Now, from IS handbook number 1, that means SP 6, from there we can find out the appropriate section. So, let us use say ISMB 250 with an weight of 37.3 kg per meter. So, we are using ISMB 250. So, from this now we can find out the properties which we require.

(Refer Slide Time: 15:43)



That is say, I x x; this is given that is 5131.6 centimeter to the power 4. Area is given 4755 millimeter square. And, overall depth will become 250 because IS will be 250. And, width of the flange is 125 millimeter. Thickness of the flange is 12.5 millimeter. Thickness of the web is 6.9 millimeter. So, these are the things we can find out from the IS handbook that is SP 6. For ISMB 250 the corresponding properties can be write down. Now, what we will do now? We have to find out the width of the composite flange. And, that will be, it will be, width of the composite flange will be minimum of the following; as we know, that has to be decided from the spacing of the beam and other things.

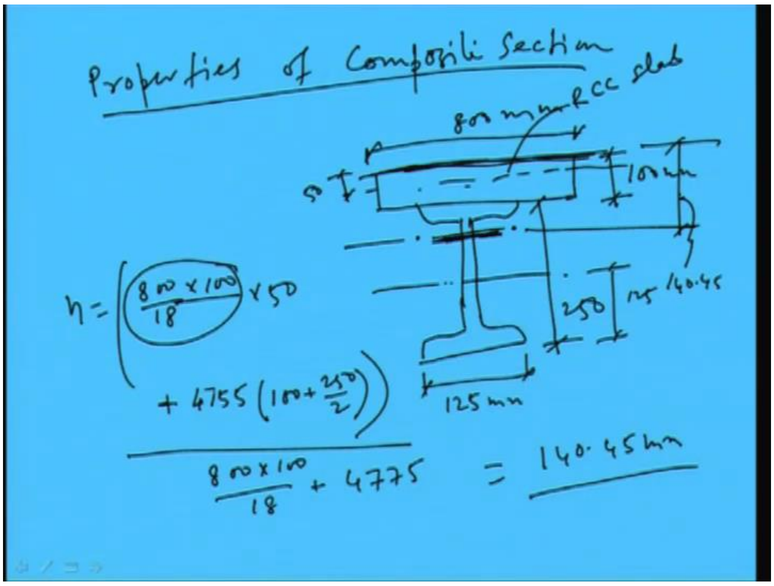
(Refer Slide Time: 17:22)



Like say this will be L by 4; it has to be. So, L was 4 into 10 cube by 4, and that is will becoming 1000 millimeter. And another, from another point of view that will be half of the spacing mean, center to center distance of beams supporting slab was 2 meter. So, 2 meter means 2000 millimeter minus, the b value is 125, the flange width. So, this is becoming 937.5 millimeter because if you see, the beams are placed like this. So, these are 2 meter.

Now, slab is there. So, either half of these two or another is b 3 that will be 8 into slab thickness that is 800 millimeter. So, out of these 3 we have to find out the minimum one. So, effective width will be, effective width of the concrete slab, this will become minimum of 100, 937.5 and 800. So, minimum is 800 millimeter. So, effective width of the concrete slab will become 800 millimeter.

(Refer Slide Time: 19:16)



So, now we have to find out the properties of composite section. So, how do we find out? Say, property can be find out, let us draw the figure. Say, this is the effective width which is 800 millimeter, we find out. This is concrete slab, RCC slab. Then, the beam is given; this is the steel beam. Now, this width is 125 millimeter. And other things are like this is given as 250 because ISMB, 250 we have used; and the slab thickness is given 100 millimeter. So, these are the properties we know.

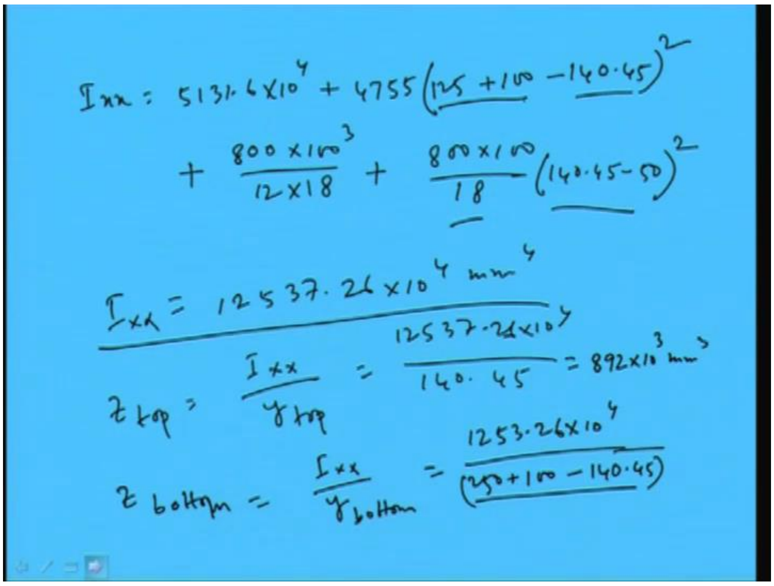
So, now we have to find out the combined properties, property of the combined section. So, first we have to find out where is the neutral axis depth, neutral axis depth of the composite section. We know neutral axis depth of the, this section is here, this concrete; and neutral axis depth of the steel beam is here at 125 from bottom; and here this will be 50 from top; and here this will be 125 from bottom.

Now, we have to find out the value of neutral axis say, n. So, if we take area about this top flange from here, then we can find out say, 800 into 100, the area by, 18, modular ratio I am making because I am finding out the values in terms of steel. So, the properties I am changing into steel. So, this is the transformed area, remember, of the concrete. So, into, this will become 50 because 50 is the CG distance plus, the area of I beam is 47, sorry, 4755 which was given in the IS handbook, into, 100 plus 250 by 2, that was 125.

So, area into CG distance by, so this is divided by, you can find out, 800 into 100 by 18 plus, 4775. So, from this we can find out the value of n. This will, finally will become 140.45 millimeter that is from top. So, neutral axis of the combined section is somewhere

here. This is, this will be 140.45. So, this is how we got the neutral axis. Now, we can find out I x x about this.

(Refer Slide Time: 23:25)



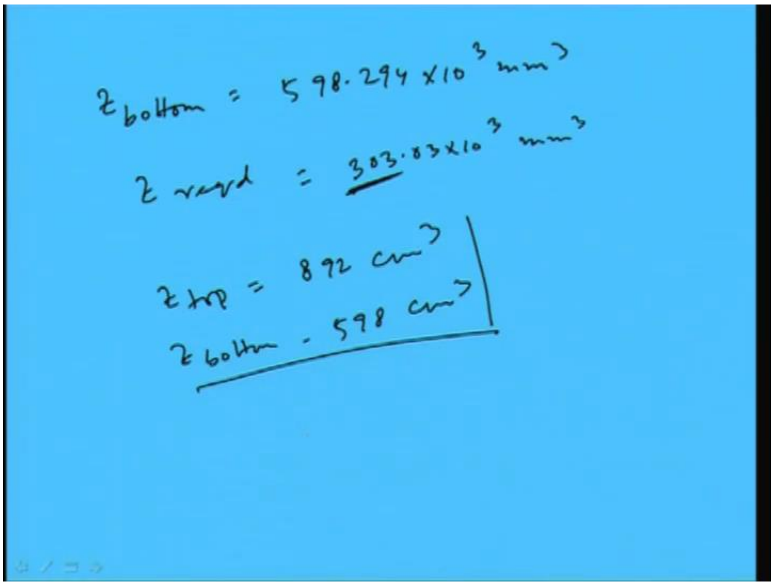
So, I x x will become 5131.6 that is the moment of inertia of the I section, into, 10 to the power 4 millimeter cube plus, A r square that is 4755 into r square, r square means this will be 125 plus 100 then minus, 140.45 because this is this will be the distance from here to here we have to transfer. So, we can find out total distance minus this. So, 125 plus 100 minus this, will be the distance between CG of individual I section and CG of combined I section; so A r square.

Then, this is the moment of inertia about the combined section plus, for steel, plus for, we will calculate for the concrete one. Concrete one will be 800 into 100 cube, b t cube by 12 into, modular ratio that is 18 because always you have to transform the section in terms of steel plus, A r square; that means, 800 into 100 by 18, into r square; r square means 140.45 minus 50 because this will become, this is 50, so this will become 140.45 minus 50 because this is 140.45.

So, this transfer has to done. So, this is becoming A into r square. So, if we calculate this value we will finally find out value as 12 to say, 12537.26 into 10 to the power 4 millimeter to the power 4. So, I x x we got. Now, we have to find out Z x x means Z. Here Z will be different because it is not at the center; so y top and y bottom will be different.

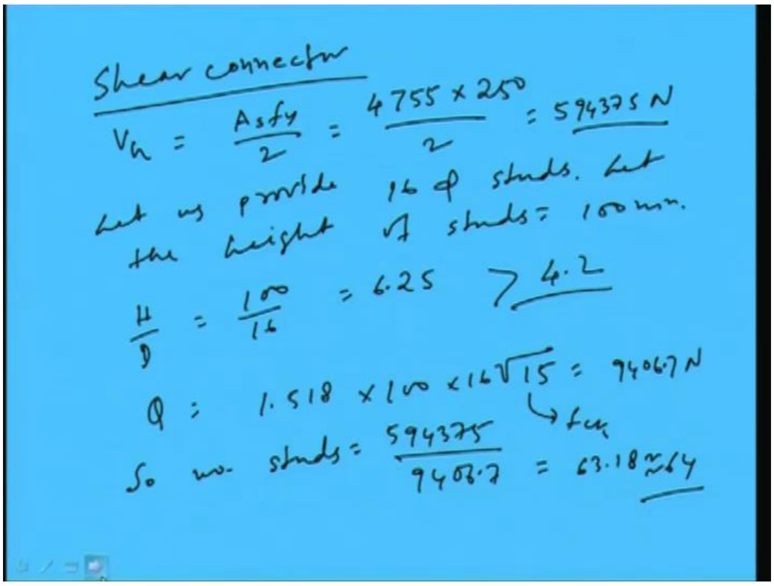
So, say, Z top will be I x x by y top. So, this will become, I x x is to this one, 10 to the 4 by y top; y top will be, from top the distance is 140.45 neutral axis distance, that is here given it is, this is the distance. So, after calculating this we will be getting value as 892 into 10 cube millimeter cube. Similarly, Z bottom will become I x x by y bottom. So, if we put those value, I x x is 12537.26 into 10 to the 4 by, y bottom; y bottom will become say, 250 plus 100 total depth minus, 140.45 that is the neutral axis depth from top. So, the distance will become this one.

(Refer Slide Time: 27:38)



So, if we calculate this value, so Z bottom will become 598.294 into 10 cube millimeter cube. And, Z required we have calculated earlier that is M by sigma b c or sigma b t that was 303.03 into 10 cube millimeter cube. So, this is all right because Z top is coming as 892 centimeter cube, and Z bottom is coming 598 centimeter cube. Now, required is 303 centimeter cube. So, this is quite ok. So, we can say that the section whatever we have chosen is quite ok from the moment point of view; that means the section whatever we have chosen is quite enough to carry the load which has been given.

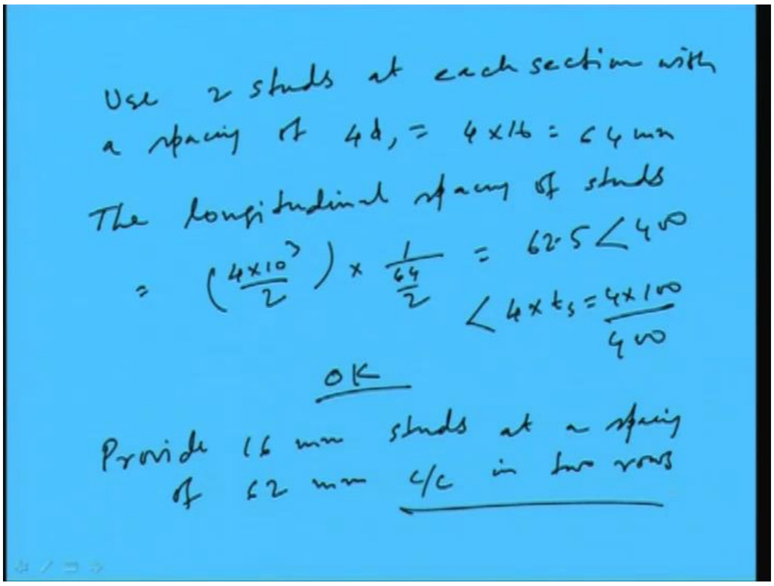
(Refer Slide Time: 28:54)



So, now what we will do? So, now shear connector. So, as we know V h will become A s f y by 2; so area was given 4755, and f y is 250 we are using; so this is becoming 594375 Newton. Now, let provide say, 16 mm diameter of studs, and let the height of studs is equal to say 100 mm. Let us use these two. Then we can the find the H by D ratio as 100 by 16 that is 6.25 which is greater than 4. 2, as per the codal provision it has to be greater than 4.2, so it is ok.

Now, Q will become 1.518 into, 100 into, 16 root over 15, this is the F c k value, the concrete we are going to use, this one. So, this is becoming 9406.7 Newton. So, number of studs will become 5, the total force is 594375 by 9406.7. So, if we make it that is coming 63.18 which can be made 64. So, number of studs will be required 64.

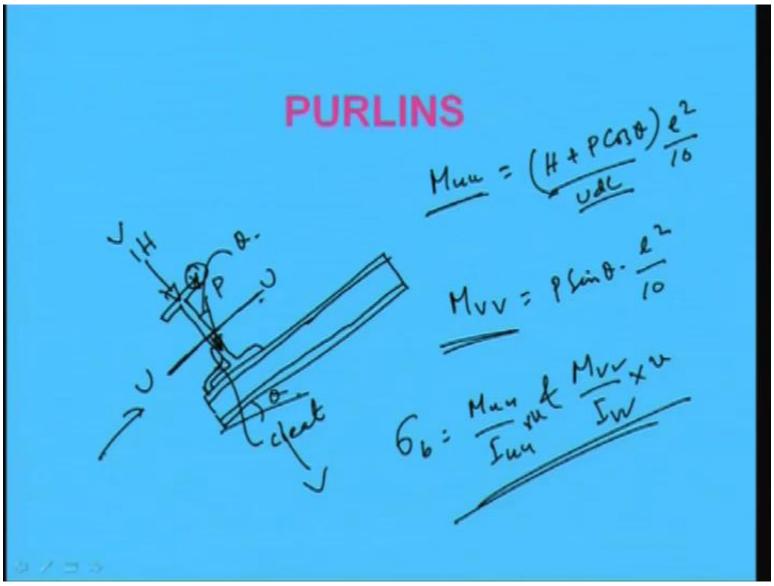
(Refer Slide Time: 31:11)



So, if we use say 2 studs in each section with a spacing of say 4 d, then this will become, so spacing will become 4 into 16, 64 millimeter. And, the longitudinal spacing of stud, this will become 4 into 10 cube by 2 into, 1 by 64 by 2; this is becoming 62.5 which is less than which has to be less than 4 into t s thickness of slab; so that will be 4 into thickness of slab is 100; so that is 400. So, this is less than 400 that means, this is ok.

So, we can say that provide say 16 millimeter studs at a spacing of say we are getting 62 millimeter center to center in 2 rows. So, in this way we can find out the values. So, a typical example I have gone through, through which we can find out a suitable section of the composite section. And then how to find out the number of studs or number of shear connectors for that particular case. So, in this way you can make it. I hope this example will be helpful for designing composite section for other cases.

(Refer Slide Time: 33:40)



Now, I will discuss about design aspects of purlin. Purlin, as we know, when the industrial sets are designed, the wind force coming into picture at a particular direction, from a particular direction it used to come. So, when we will be designing a purlin, what we will see? Purlin is basically a type of beam. We will see, it is a, means it is having 2 type of load - one is gravity load which is acting vertically, another is wind load which is coming from horizontally.

And again purlin is not about x x and y x, it has some slope. So, basically we have to change the loading direction, loading condition, then we have to find out what is the exact load coming vertically on the purlin, and then we have to design. Purlin may be used with the channel section or I section or angle section.

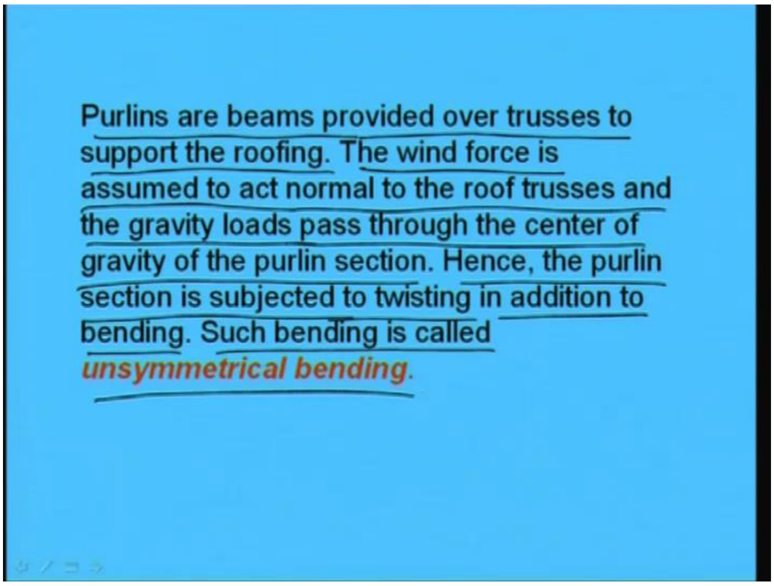
Let me draw a figure of purlin from which you will be able to clear how the load is acting on the purlin. Say, for an industrial building, say one I section is there. So, I sections we will work, would be acting like this. And here the, so cleat angle will be there; this is called cleat, to keep in a proper position. Now, one will come force from this direction, another is vertically because of the gravity load that is a P.

So, the slope 45 we have here, theta that will become here also theta; so with an angle of theta. Now, if we give some direction say this is u u axis and this is say v v axis. So, what we can do here, that M u can be find out from here. How do we find out M u? M u means in this direction we have to find out. So, what are the load is coming along this, that we have to find out.

That is, first is H, this is coming, and another is P, one component of P, that is P cos theta. So, this is the UDL load we have, perpendicular to u u axis, and then l square by 10. Purlins are considered continuous. So, accordingly, the coefficient 1 by 10 are used for calculating the moment. So, the moment will become M u u is equal to H plus P cos theta into l square by 10.

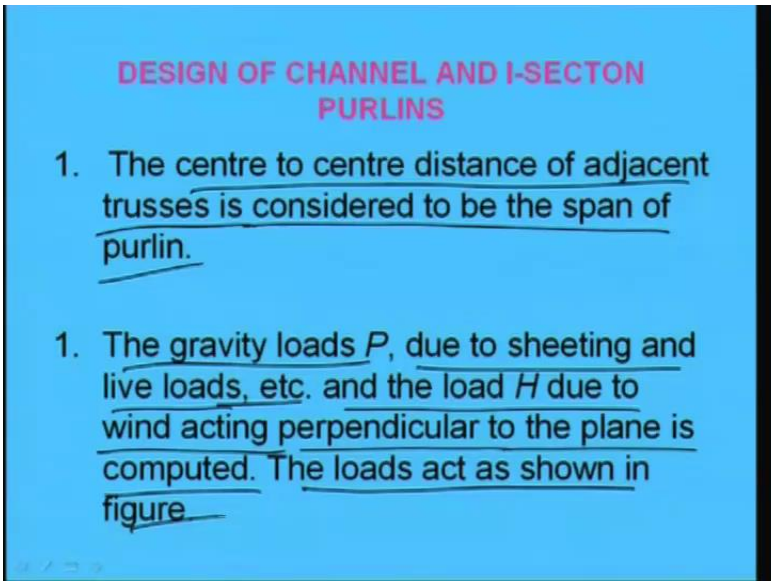
Similarly, M v v will become, there will be no component of H in this direction, so only component will be P sin theta; So, P sin theta into l square by 10. So, this is one sort of moment, another sort of moment is this. Now, when we are going to find out the stress at a point, say stress at a point here, what we will find out, say sigma b c or sigma b t, we have to find out for M u u and for M v v. So, here I have to find out I u u, and here also I have to find out I v v, then again the distance say u and v. So, it will be a combined stress. So, all these things how to calculate, I will just give an overview of this.

(Refer Slide Time: 38:13)



So, what I was telling, that purlins are beams provided over trusses to support the roofing. The wind force is assumed to act normal to the roof trusses and the gravity load pass through the center of gravity of the purlin section. Hence, the purlin section is subjected to twisting in addition to bending. Such bending is called unsymmetrical bending. So, chances means the unsymmetrical bending cases will happen, so I have to find out accordingly the stresses.

(Refer Slide Time: 38:59)

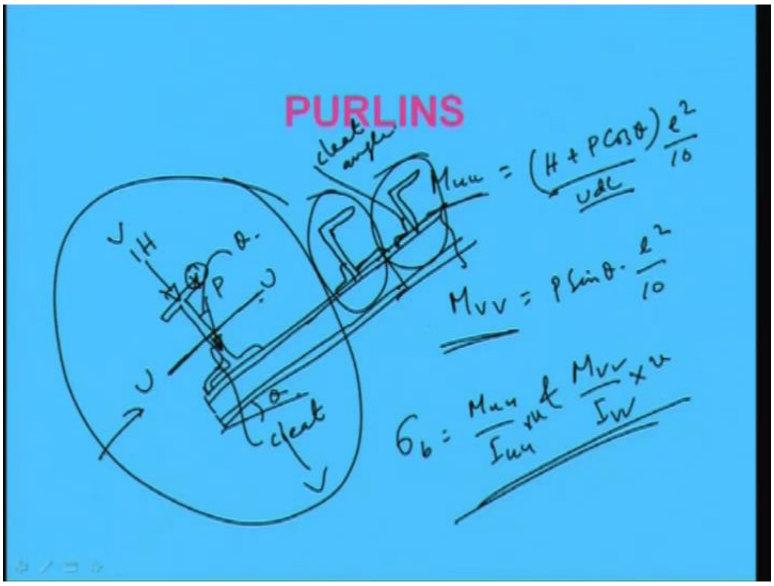


So, in short I will discuss about the design aspects of channel and I section, then the angle section. I will not take much time to discuss all these because if we gone to go for discussion then other things, other lectures we will not be able to complete. So, here I will just give an overview, so that the students can design the purlins at their own quick following procedures.

So, for designing, first what we will do, that the center to center distance of adjacent trusses is considered to be the span of purlin. So, we know that purlins are placed on truss. So, center to center distance of trusses will be considered as a span of the purlin.

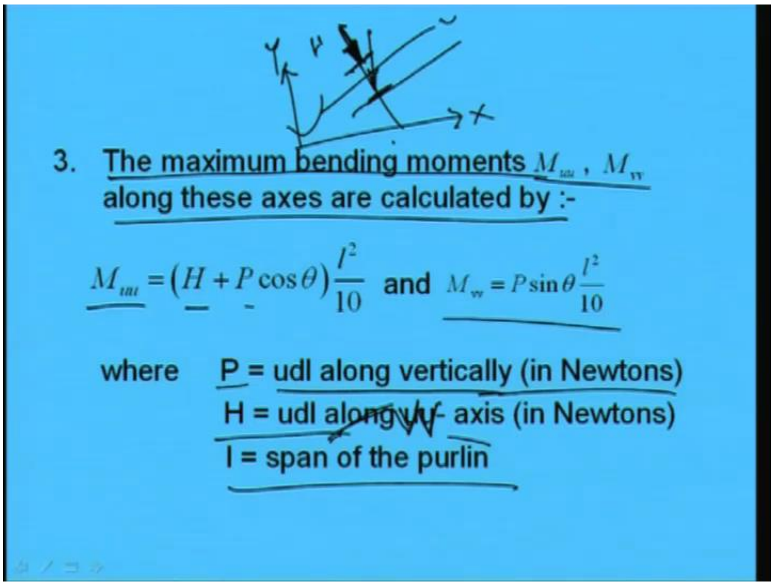
Then, the gravity loads P, due to sheeting and live loads, etcetera, and the load H due to wind acting perpendicular to the plane is computed. So, gravity load and the wind load will be computed in the purlin; how it is coming, at what angle, at what intensity it is coming, that we will calculate, and then we will find out the moment.

(Refer Slide Time: 40:25)



The loads act as shown in figure; that means, the figure we have shown here, where the load is acting, in this way load are acting. Other type of purlin if we see say, suppose if I extend here we will see say, if we use the channel section, so purlin will be like this, this is a purlin. And cleat angle will be given like this. Another is say angle section when we are going to use generally we provide like this, and cleat angle will be like this; these are cleat angle. So, these are also another sort of section which we are using for purlin. And, loads as we shown here in this way it will act.

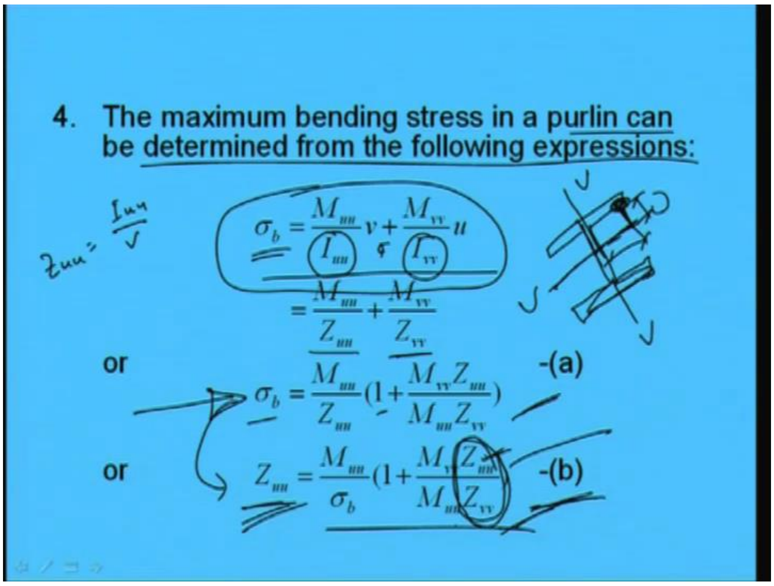
(Refer Slide Time: 41:23)



Now, next step is the maximum bending moments; the maximum bending moments M u u and M v v along this axis are calculated. What I have shown there that M u u will be equal to H plus P cos theta into l square by 10, and M v v will become P sin theta into l square by 10, where H is the, if purlin is provided here like this, so this is I section. We are considering H normal to this direction; we are assuming that wind force is coming normal to the purlin; So, H will be this one.

And, P, what is P? P will be the gravity load. So, always it will be downward means along y axis, global y axis if we make like this is; if it x and if it is y then global y axis. So, P is UDL along vertically, and H is UDL along u u axis means that axis in this, this is u u axis means not along, sorry, H will be along v v axis we can say, v v axis or perpendicular to u u axis And, l, l is the span of the purlin.

(Refer Slide Time: 42:49)



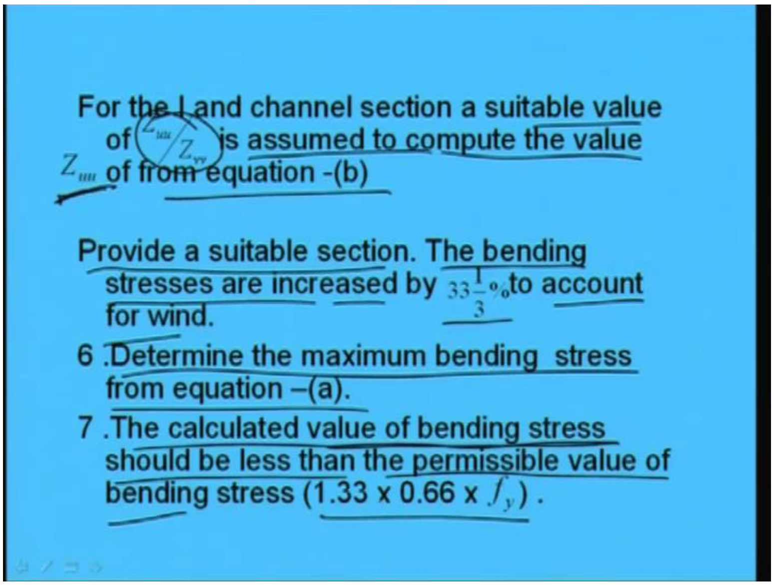
So, now we can find out the bending stress in a purlin which can be determined from this equation. As we know that if we have a section like this say, I section, sorry, this is the I section, now, suppose we are going to find out stress here, so what we will do? We have to find out what is the distance in this direction, and what is the distance in this direction, along u u and along v v, if this is u and if this v. And I have to find out I u u and I v v means, in globally we can say I x x and I y y which is given. So, for a particular section we know I u u and I v v we know which is given in SP 6. So, from there we can find out.

So, sigma b, the stress due to bending can be find out form this equation. Now, whether it will be minus or plus here that depends on the direction; Whether it will be developing tension or compression that depends on the direction of the forces, and where we are going to calculate it depends on that.

So, now, if I make in terms of section modulus I can write M u u by Z u u plus, M v v by Z v v because Z u u can be written as I u u by v because I u u is in this direction and v is in this direction where we are going to calculate. So, this is Z u u, this is Z v v. So, sigma b can be written in this way: M u u by Z u u if we take common, then M u u by Z u u into, 1 plus M v v Z u u by M u u Z v v. So, in this way we can find out sigma b, the bending stress at a particular point in the purlin.

Now, similarly Z u u also can be find out from this equation; that can be written in terms of this that is M u u by sigma b into, 1 plus M v v by M u u into, Z u u by Z v v; remember Z u u terms is here also. What we use to do? We use to consider a ratio of Z u u by Z v v, then we can find out the value of Z u u; it is a trial and error process.

(Refer Slide Time: 45:51)



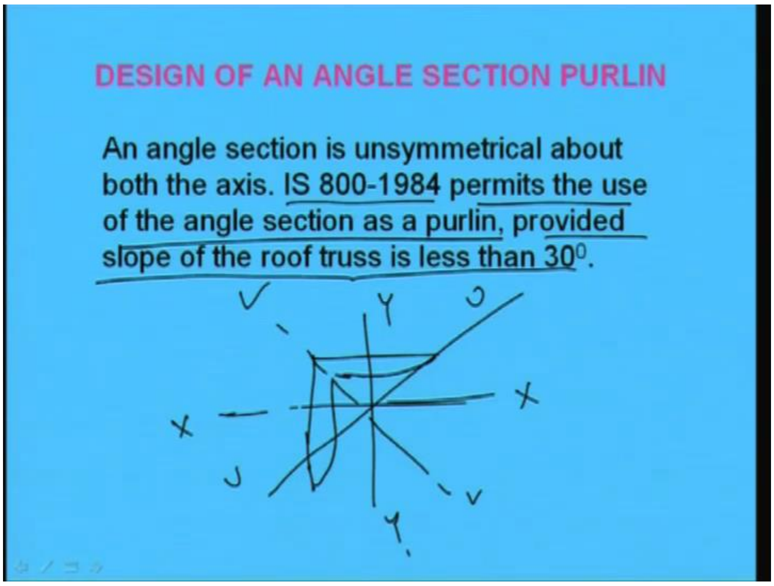
So, next what we will do? So, what I was telling that you see for the I and channel section a suitable value of Z u u by Z v v is assumed to compute the value of Z u u from equation b; equation b means this one. To find out a suitable section for channel and I say I, sorry, for channel and I section we can assume some ratio of Z u u by Z v v, then we can find out the value of Z u u.

Then, we can provide a suitable section. The bending stresses increases are increased by 33.33 percent to account for wind, that also we have to take care. Then, what we will do?

Then, we can find out the maximum bending stress from equation, a; maximum bending stress which is given in this equation that is M u u by Z u u into, 1 plus M v v Z u u by M u u Z v v. So, from this we can find out the maximum bending stress.

Then, what we will do? Then we will calculate the value of bending stress. The calculated value of bending stress should be less than the permissible value of bending stress which is this; permissible value of bending stress has been considered as 1.33 into 0.66 f y.

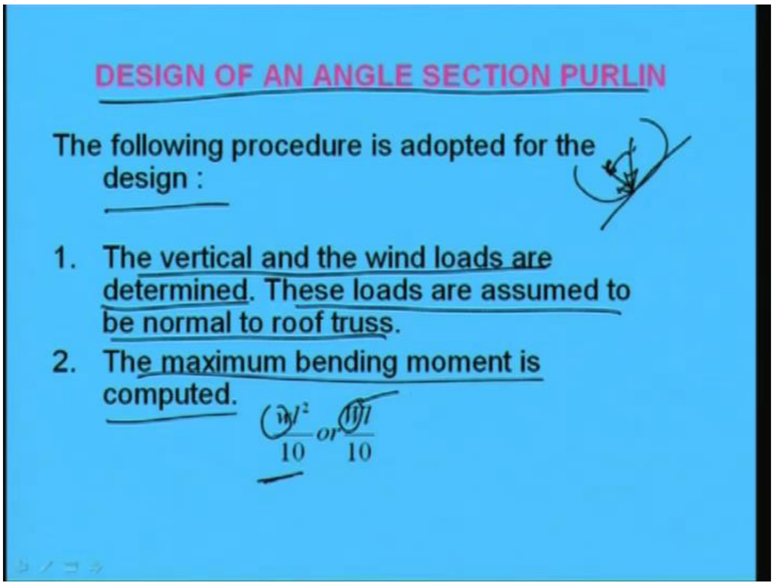
(Refer Slide Time: 47:36)



Now, similarly, we will discuss about the design of an angle section for using as a purlin. In angle section, it is an unsymmetrical section, so in both the directions the moment has to be calculated. In IS 800- 1984, it permits the use of angle section as a purlin, provided slope of the roof truss is less than 30 degree. So, if slope of the roof truss is less than 30 degree then IS means, IS code has permitted to use angle section also.

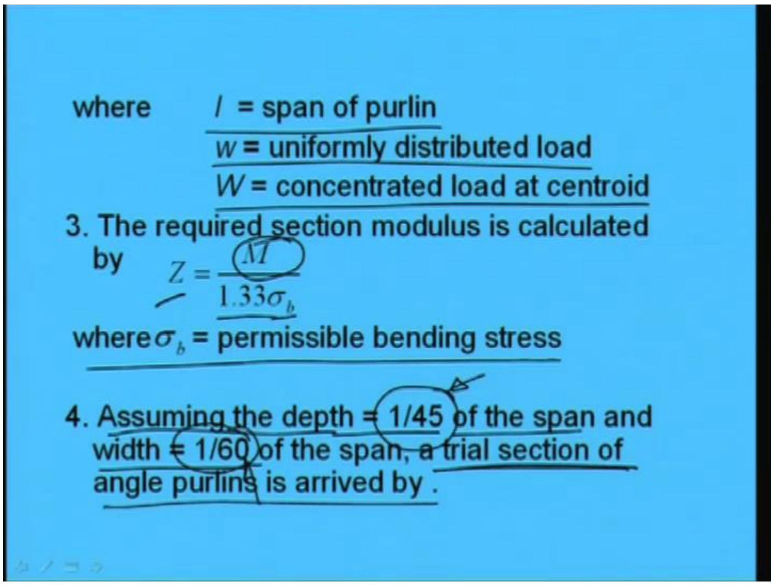
So, angle section means if we see say, if I see the angle section the complication we will be understanding that, if you see in globally say this is x x and this is y y. And, so bending may come in this direction also which is v v, and bending may come in this direction also, u u. So, because loading is not in a, from particular direction, loading is in 2 direction means we can make it in perpendicular to that section, and along that section. So, the unsymmetrical bending will occur that is why we have to take care accordingly.

(Refer Slide Time: 49:08)



Now, design of an angle section purlin. So, following procedure is adopted for design; the procedures similar way we can discuss; that is, the vertical and wind loads are determined. First, in means, first we will find out the wind load and the vertical load due to self weight and other imposed loads. Then these loads are assumed to be normal to the roofs; if roof is there then wind load is assumed to be normal to the roof, and vertical load will always be there. So, we have to take the component of that. And then after taking component of that we can find out the maximum bending moment which is w l square by 10 or W l by 10 where w is UDL load, and this W may be used as concentrated load that is given here.

(Refer Slide Time: 50:05)

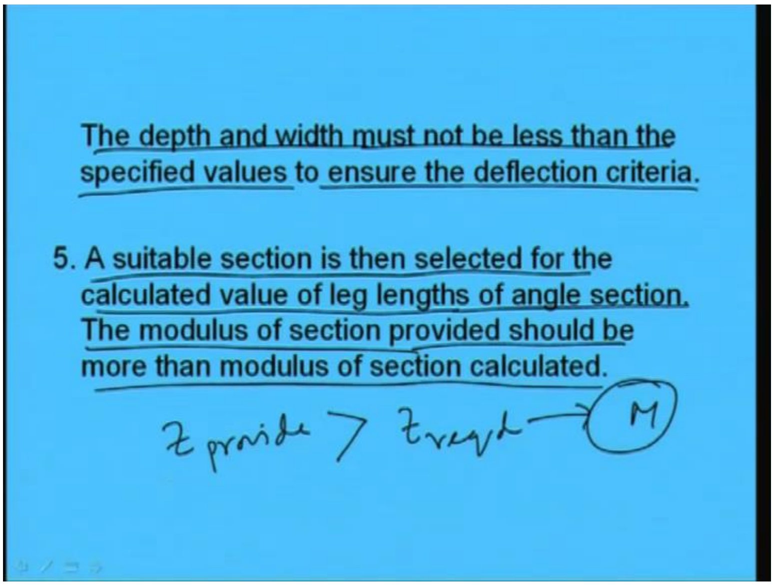


W is the concentrated load at centroid, and this w is the uniformly distributed load, and l is the span of purlin. So, in this way we can calculate the value of maximum bending moment. The moment we calculate the maximum bending moment we can find out the required section modulus.

The required section modulus will become, M by 1.33 sigma b, where sigma b is the permissible bending stress. So, required section modulus when we are going to get on the basis of maximum bending moment then we can find out a suitable section. The suitable section can be find out from IS handbook that is SP 6, whether we will go for equal or unequal that depends on the designers experience and the requirement; what is the slope, how it is, so on that basis we have to decide.

Now, assuming the depth as 1 by 45 of the span and width as 1 by 60 of the span, a trial section of the angle purlins is arrived. So, how do we arrive the trial section of angle purlin? That is, we may assume depth approximately as 1 by 45 and width we can assume approximately 1 by 60 of the span. So, the moment we find out this approximate depth and approximate width then we can find out a trial section of the angle purlins.

(Refer Slide Time: 52:03)

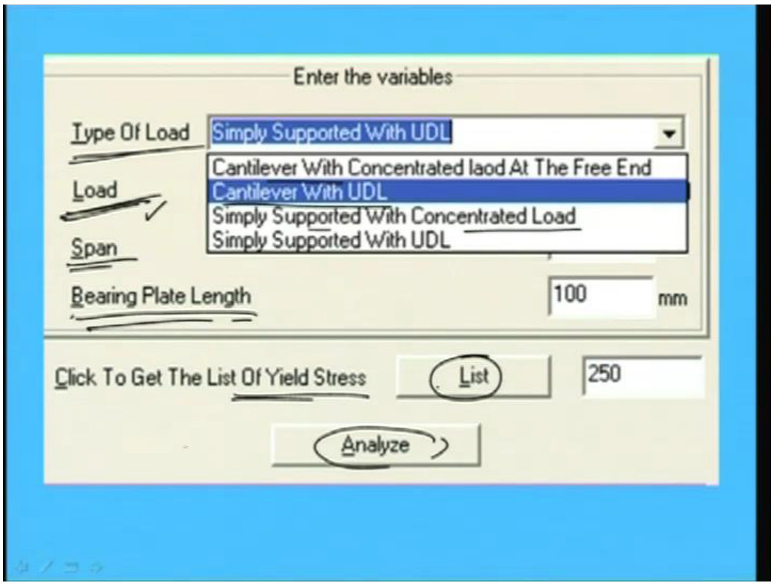


So, depth and width must not be less than the specified values to ensure the deflection criteria. Now, in codal provision the deflection criteria is given. So, we have to ensure that also, that the depth and width must not be less than the specified values.

Then a suitable section is then selected for the calculated value of leg lengths of angle section. The modulus of section provided should be more than the modulus of section calculated. Modulus of section provided means Z provide, definitely has to greater than the required, Z required which is calculated from the moment; and this we have provided. So, in this basis we can design the purlin.

Now, I will demonstrate a software very quickly which has been developed by my students. The objective of demonstrating this software is to show how quickly one can design a beam. Another thing is, if you see this software then you will be able to design at your own; you will be able to develop the software thinking in mind that in this way one can develop a software easily.

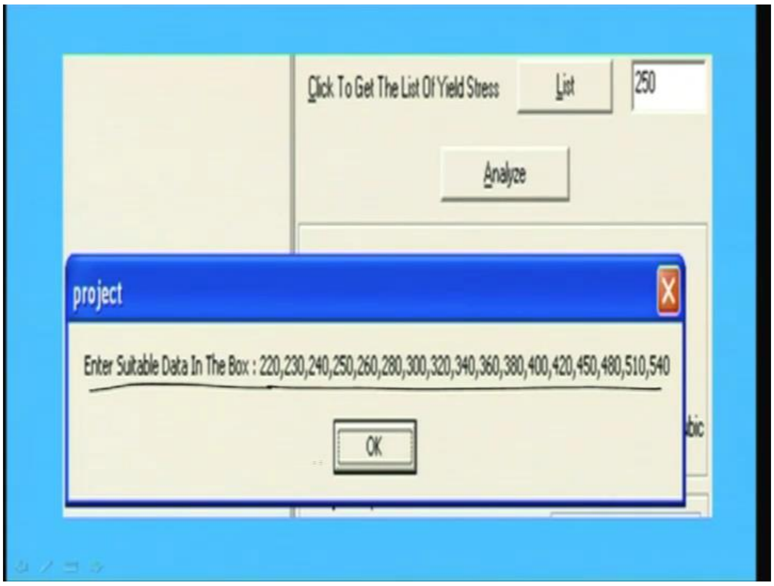
(Refer Slide Time: 53:40)



So, in the software what we have done? The first one user has been made where the type of the load has to be told; type of load, and of course their end condition. Like different conditions are there which has not been, I am not able to show here because of shortage of space. Let us say, suppose cantilever with concentrated load at the free end, Cantilever with UDL, Simply supported with concentrated load at the center, Simply supported with UDL, that means all the possible cases which we have discussed earlier those has been taken care in type of load.

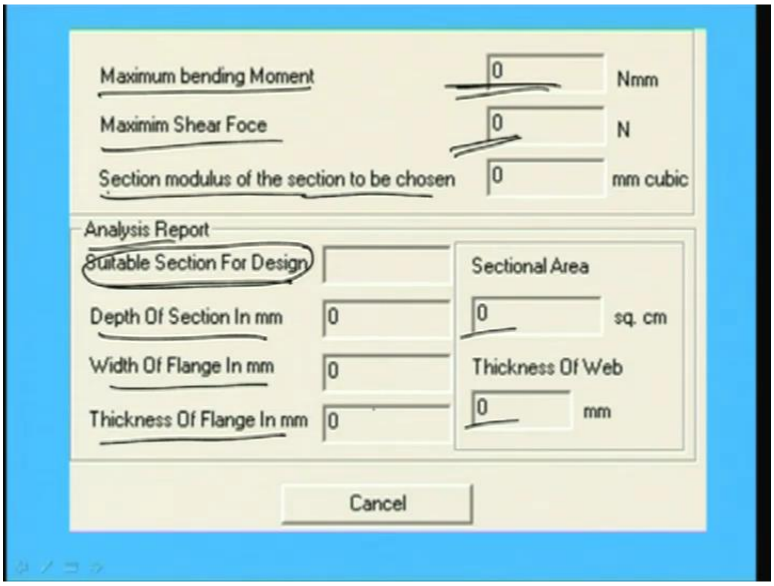
Then, sorry, then the load, load means when we are going to tell type of load, after that what we can show the, what is the load? Whether UDL, if it is UDL, then what is the magnitude; if it is concentrate, then what is the magnitude, and where it is? Then the span length, then bearing plate length, bearing plate length we will give. Then, what is the yield stress? Yield stress list is given, when you click this you will get yield stress and then you have to analyze. So, these are the input which has to be means, which is required for designing of a beam.

(Refer Slide Time: 55:01)



So, after that what we will do? Here you see, just I am showing; when list I am asking to show, they are showing the list; what are the available type of steel we have; so on that list we can choose a certain type of steel.

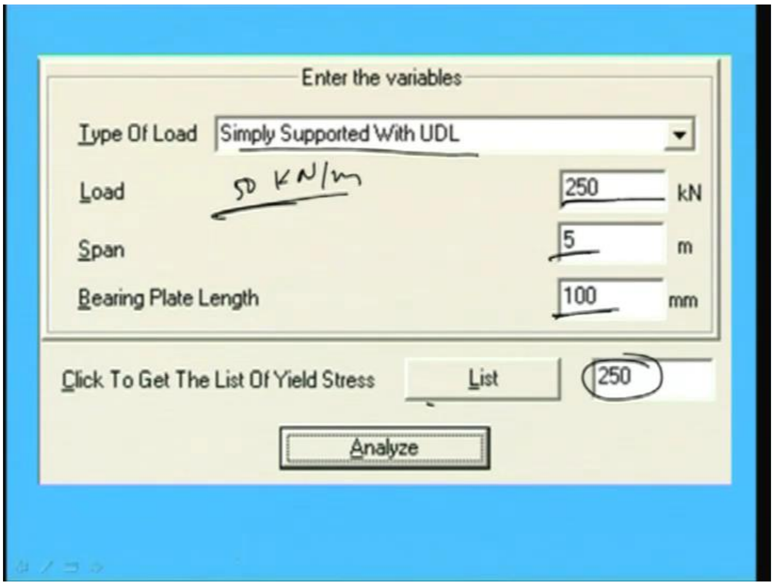
(Refer Slide Time: 55:19)



And, these are the results which you will get means, what will be the maximum bending moment, what will be the maximum shear force, and what will be the section modulus of the section to be chosen. Means, from the load span and end condition you can find out the maximum bending moment, and this we will display here, and you can check means user when are using they can check also step by step whether the software is giving correctly the results or not. Then, analysis report you will get, that suitable section for design means it will take the suitable section from the IS code automatically where the data of IS code, that means, SP 6 data has been entered in the program and stored there.

Then depth of section what is required, width of flange what is required, thickness of flange what is it means what is there, means the details of the section which has been chosen, sectional area, thickness everything has been chosen. Now, you see; so from this we can find out with a fraction of second means fraction of minute, the result of the design of a beam.

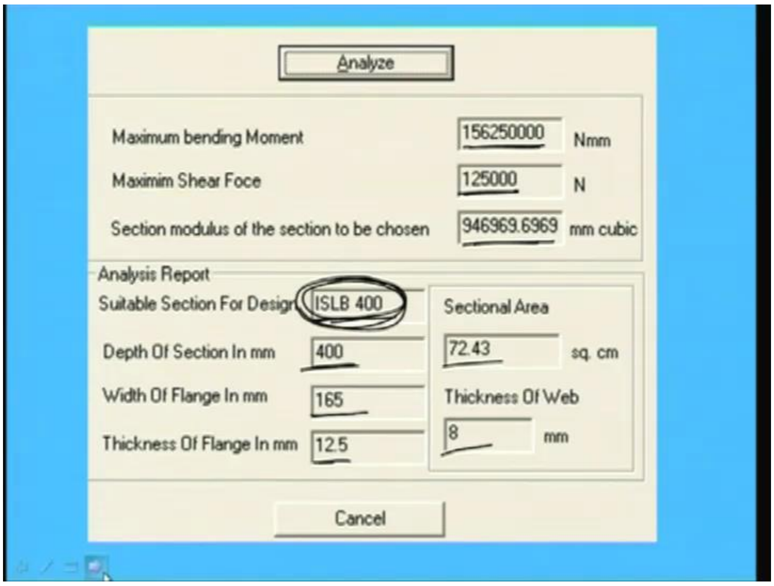
(Refer Slide Time: 56:41)



So, what are the input we will be giving? That say, this problem I have going to, sorry, again this slide I am. So, now I will demonstrate the example which I have solved in my earlier lecture. In one earlier lecture I have solved with the problem that is simply supported beam with UDL load; if you remember that was given 50, load was given 50 kilo Newton per meter length.

So, total load will be, over the span will be 250 kilo Newton. Then span is 5 meter, and bearing plate length was given 100 millimeter. If you have attended that class then you must have seen that these are the data which we had. Now, from list also we have chosen f y as 250. Then, the moment we have taking here, we will get the results.

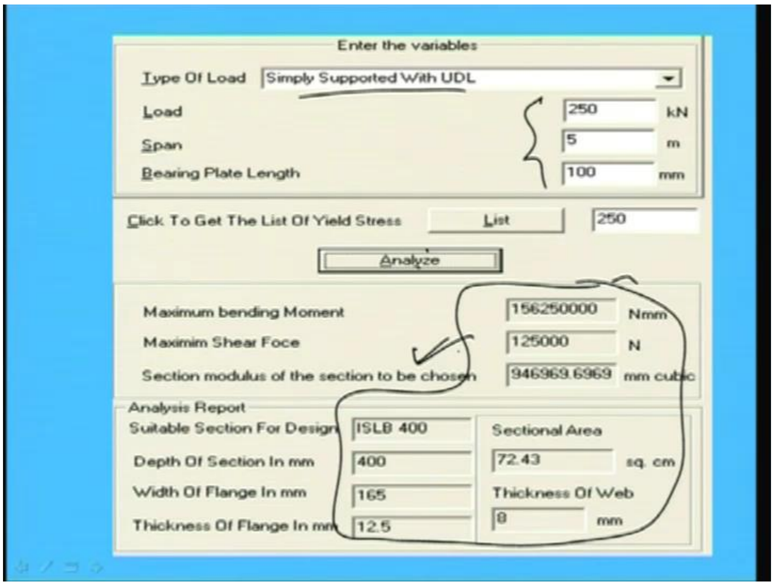
(Refer Slide Time: 57:38)



So, results will be like this. When we are clicking in analyze you will get the maximum bending moment is developing this, maximum shear force is developing this. and required section modulus is this. Now, from this we are going to choose ISLB 400, means the computer programming itself is going to choose a suitable section which is ISLB 400.

And, the details of the section properties has been given like what is the depth of section, what is the width of the flange, thickness of flange, and sectional area, and thickness of web. And remember, when the report is giving means, when analysis result is giving and telling that ISLB 400, it is checking all the steps then only it is giving the final results. So, this is how we can use. It is a very simple software we have developed, through which one can design a beam.

(Refer Slide Time: 58:38)



The whole thing can be shown here. You see, the simply supported beam with UDL load with this data. And, when we are clicking analyze, we will get all the required data here. So, in this way one can be done.

The purpose of showing the software is as I told that the students can develop at their own similar type of software where the input is very less; only thing is, in background the lot of checks has to be done which was discussed. Now, after checking, finally you will get this result. Now, if we go through manually then we may not get the economic one, the most suitable one, but in software we will make the logic in such a way that economic one we will get.

So, in today's lecture, what we have seen? First we have discussed about the design aspects of composite beam member, and we have gone through one workout example through which we have seen how to find out a suitable section and how to find out the shear connectors details.

Then, we have seen very briefly the purlin aspects, means purlin, design of a purlin in case of I section and channel section, and in case of angle section also, what are the difference here, we have just given an overview; then which can calculate a suitable section to withstand that much load with that end condition and make. So, with this I like to conclude today's lecture.

Thank you very much for your patience.