Aircraft Structure - 1
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Lecture-16
Wing Truss System

Welcome back to aircraft structures one course this is Professor Anup Ghosh from aerospace engineering department IIT Kharagpur. We are in the third week lectures this is the last lecture of the third week lecture 16 wing truss system.

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Today we will solve a small problem considering a wing truss even we would not call solve the total truss system a part of the truss system 3D truss system will be solving today. Introduction as a recapitulation what we have already done we have learned some history; we have learned how the structures are. The fabrication or to some extent details of aircraft structures; we have learned how load comes into the structure and we have learned what is load factor, ultimate load, limit load all those things we have solved problems.

How the wing experiences bending moment and shear force as well as fuselage experiences bending moment and shear force. And in last four lectures we have learned fast simple truss system and later on we have we have considered the problems of landing gear as a three dimensional truss structures or truss system.

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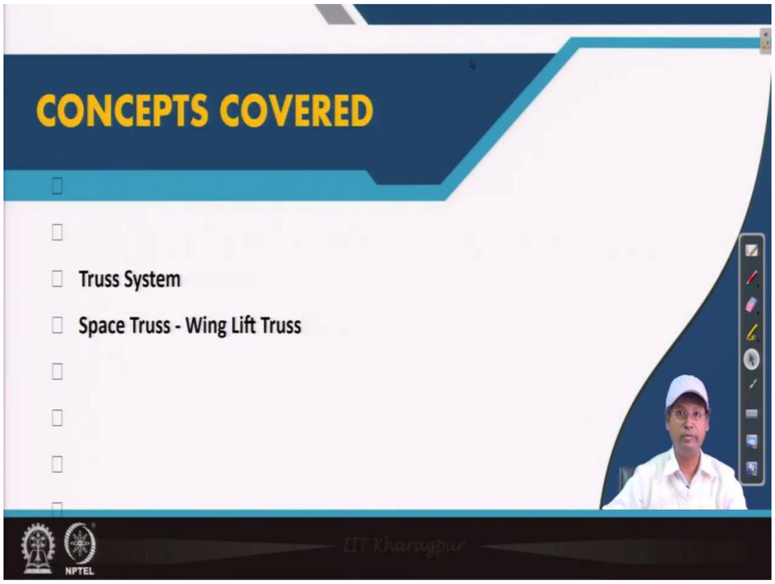

So, we will move forward to today with a wing lift trust, solving of wing lift truss. Let us see how it is done and how do we solve the problem.

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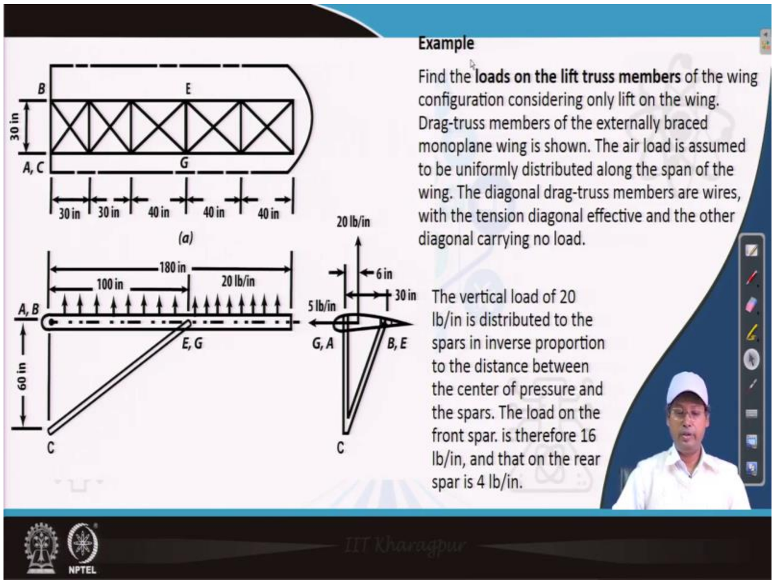

These types of wings are used for amateur aircrafts for various clubs by various clubs and for amateur flights. So, let us see how do we solve the beam truss. Find the loads on the lift truss members lift truss members are this two member truss this is a member lying on the plane which is if we better to have a direction this is Y direction this is X direction and the up direction that means this direction is Z direction so this is I think it is better to draw here Y this is X. So, we can say that this view what we see is on XZ and this view what we see is YZ with this consideration we will move forward to solve the problem.

Find the loads on the lift truss members of the wing configuration considering all lift on the wing. Drag truss this truss system is the drag truss system, drag truss members of the externally braced monoplane wing is shown this is the external brush members these things we are supposed to find out. The air load is assumed to be uniformly distributed along the span of the wing the air load is uniformly distributed as it is mentioned it is 20 pound per inch along the length.

The diagonal drag truss members are wires these members are wires with the tension diagonal effective and the other diagonal carrying no load. So, only one is under tension whereas the other side is not is not having any tension the vertical load 20 pound per inch is distributed to the spar in inverse proportion to the distance between the centre of the pressure and the spars. These are the two spars this is one spar and this is the other spar.

So this member is joined to this spar CG and this member the CE is joining or supporting this part BE this CG is sub supporting the AG spar and CE is supporting the BE spar the load on the front is therefore 16 pound per inch it is assumed as mentioned here inversely proportional. So, that is the reason the front spar is carrying 14 pound per inch and the rear spar is carrying 4 pound per inch. So, let us see how do we solve the problem or find out member loads in the member CG as well as CE that is our task we are supposed to find out the member force are in CG and CE.

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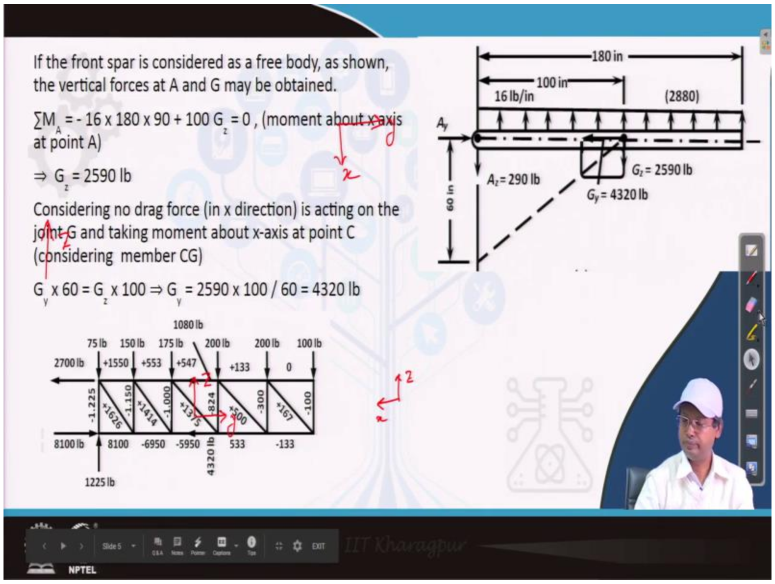

Here we have the front or the front spar where as it is already discussed 16 pound per inch load is distributed uniformly this distance is 10 inch this is the total 180 inch and we have a member that is from C to G this is the point G the front spar is considered as a free body as shown the vertical forces at A and G may be obtained with respect to a moment of summation of moment at with point A and minus what do we consider is that we are considering the free body of the member of the member CG 16 in into the total load coming.

Considering this member about point A we are taking moment so this 180 the CG is at 90 distance, 16 is the UDL uniformly distributed load concentration and the vertical load G is acting there that is to support so from that way moment about X-axis at Point A moment about X-axis about point A we are considering and that gives us the load CG as 2590 pound considering no drag force in X Direction is acting on the joint G.

So if we consider this joint G and taking moment about X-axis at Point C considering the member CG what we will get is that this is 60 and this is 100 this is 60 inch this is 100 inch and the two forces are acting one is downward as G_z and the other force acting here as G_y. So, if we solve this in this direction we have the opposite acting to moment and from there we get that G_y is equals to 4320 pound.

This is the complete solution of the drag brace we will discuss this again but here it is to note that this 4320 pound which is coming to on the member CG that is also acting in the this direction as 4320 pound here and this the other force will discuss in the next slide.

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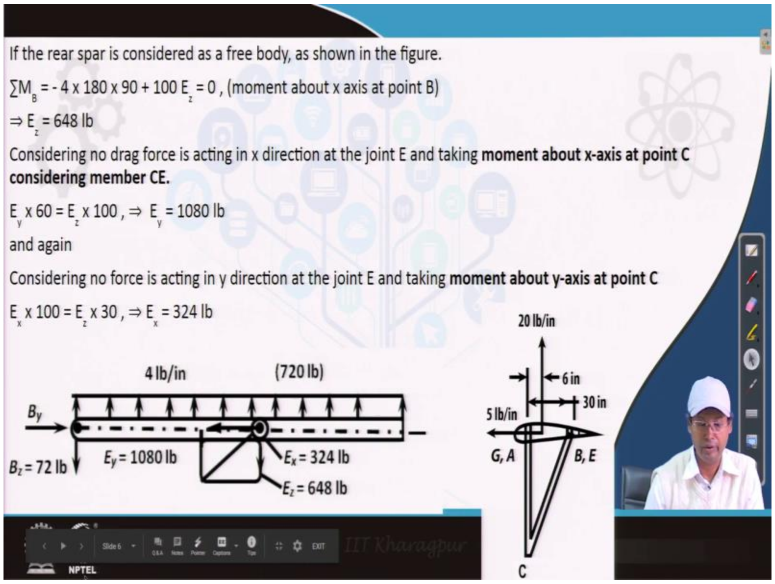

So, in this slide what do we have if the rear spar is considered as a free body as shown in the figure M_B are the moment about X-axis at point B if we consider what do we have like the previous one we have solid the load intensity changes otherwise there is not much change in this equation it is similar to that. So, we get the force E_z, E_z is 648 pound as it is shown here. Considering no drag force is acting in X direction at the joint E and taking moment about X-axis at Point C considering member CE this member CE but we have similar way as we have seen in the last one that CE here also we have this force and this force this is equals to E_z and this is E_y.

And then accordingly what we can find out that E_y is equals to 1020 pound this is C this is E one more force is there but it is in the same line of x-direction that is why E_z is not considered and again considering no force is acting in y direction at the joint E and taking moment about Y axis at Point C what we can find out that E_x multiplied by 100 in the other plane if we consider E_x multiplied by 100 and E_z multiplied by 30 and we get the E_x value.

So this is a similar visualization like this and we get the value of 324 and this 324 contribution we will see in the this is the force 324 acting towards from the board towards me and that value is 324 here it is acting. So, we need to consider the other direction moment to find out that. So, with this consideration or both the members CG and CE are found out in case of CG there is no force in the X direction whereas for the CE there is a force in the X direction.

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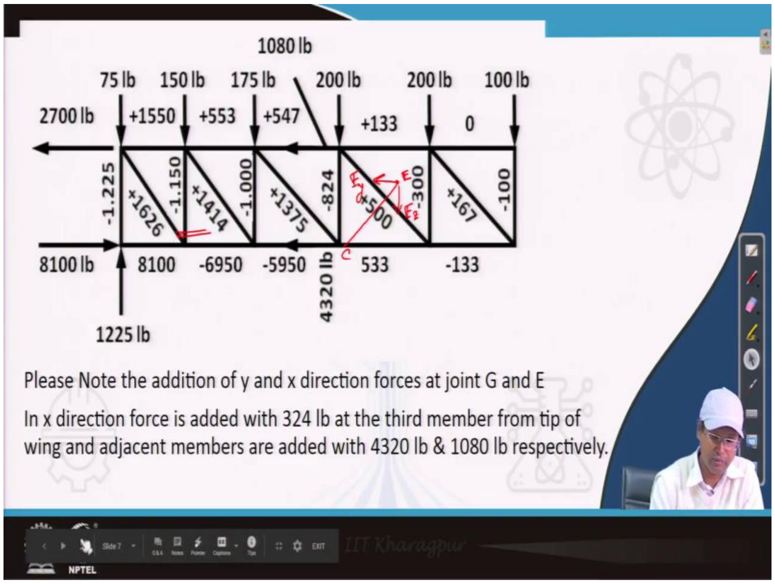

With this understanding we also come to the last figure where as we as we have mentioned in the last slide the found out force of G is shown here and that 324 is getting added up here. See this is 100, 100 + 200 gives 300 then 200 plus this gives the -824 found in this vertical member. So, that is the reason that E_x this direction force which is 324 is added up and increases the drag member force. So, with those force combinations as it is drag members are there you can easily solve the answer is also given.

So you can solve the problem and find out the forces please note the addition of Y and X direction forces at joint G and E in X Direction force is added 324 in X Direction force is added with 324 pound at the third member from tip of the wing and the adjacent members are added with 4320 pound and 1080 pound respectively. This is the 1080 pound as it is shown so with those member forces added we are supposed to solve the drag truss of the wing.

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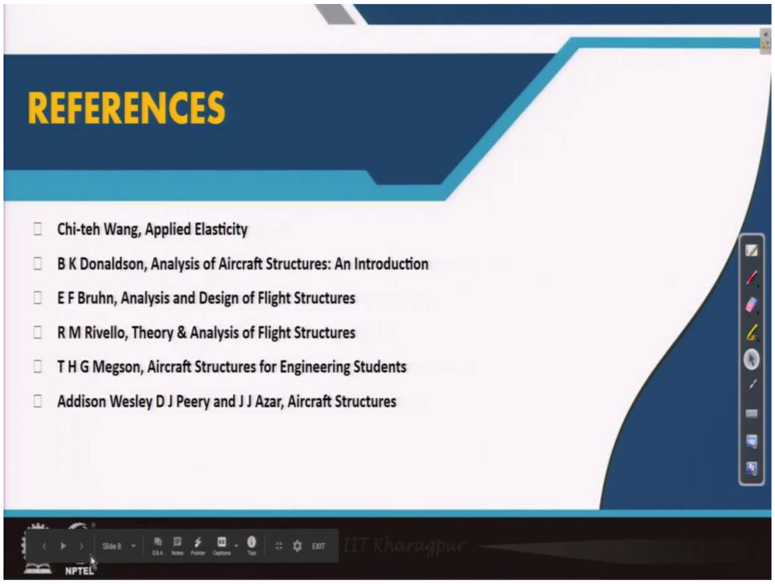

With this we conclude the third week lecture series and with help of the space structure system.

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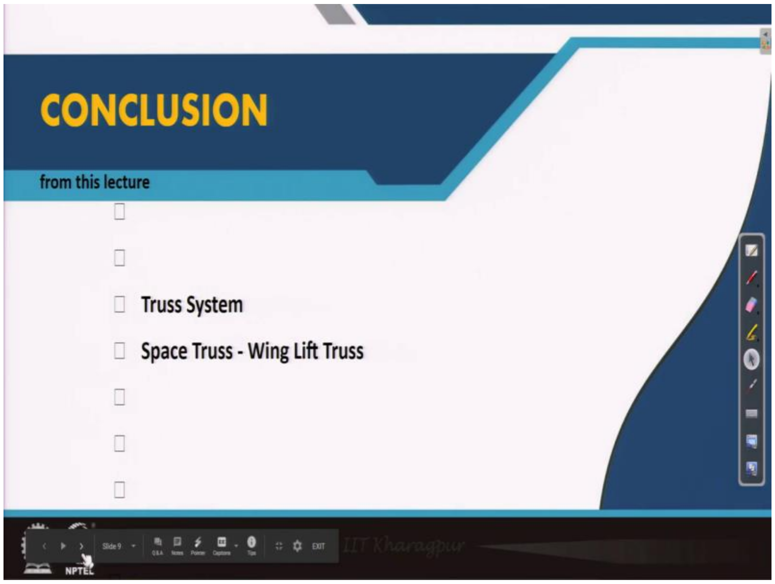

We have solved a few problems of aerospace or aerospace structures there are many more problems to solve but with this introduction I hope you will be able to attempt the day-to-day problems of aircraft structures and will be so solve those problems for further analysis. So, with this I thank you for attending the last lecture of third week will start a new topic in the fourth week, thank you for attending the lecture.