Lighter-Than-Air Systems
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Lecture - 25
Static Lift Prediction Part I

So, today's talk is going to be quite different from what you are seen so far. Today, we start doing our analytical calculations and there will be 2 or 3 such presentation. So, that today will look at only the prediction of static lift. And then we will look at in the next presentation estimating how static lift variation can be estimated. So, this presentation has been made from the reference textbook.

One of the reference text book for this course by John Taylor and we have the author's permission to freely use the book for this course. So I am thankful to John for permitting us to use the book. The material covered today is going to be part is based on three or four chapters of that particular book first. So, let us first look at the basics. I hope all of you remember what is meant by gross static lift. So can someone help me by starting. How will you define gross static lift of an LTA system?

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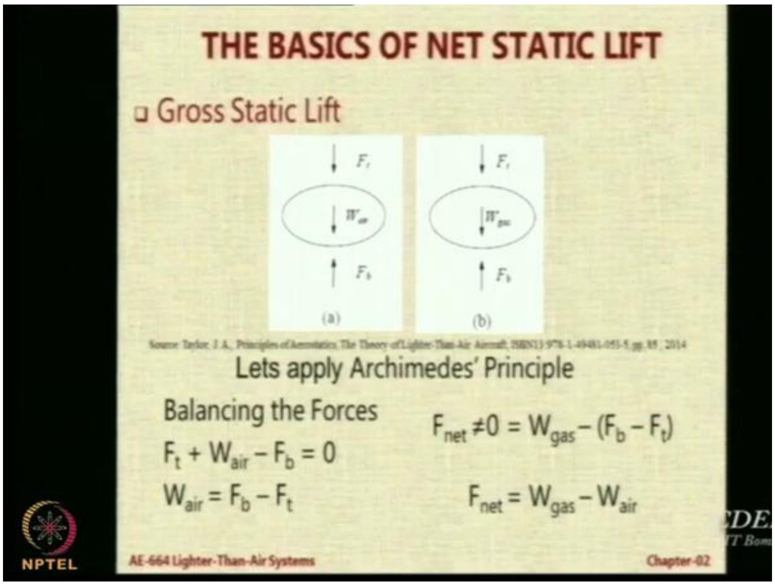

So, anyone of you, gross means total complete and static lift means because of buoyancy. So gross static lift imagine there is a small bubble of air in the atmosphere is not a balloon. This is a bubble of extremely low weight. So we ignore the weight of the bubble. This bubble is stationary in the air. So therefore that is the upward force of buoyancy acting on it that will be on the bottom. There will be Force acting on the top of the bubble because of the ambient pressure.

So every bubble is taken to higher altitude the value of F_t will keep on reducing. OK then there is weight of the air of the bubble. So since the bubble is in equilibrium because it is a bubble of air in air it cannot be under any dynamic condition static lift prediction. So, therefore if you apply Archimedes' principle you can easily say that the force F_t plus the mass will be equal and opposite to the force of buoyancy.

And hence weight of the air can be considered to be the difference between the buoyancy force and the pressure acting. Now this is weight of the air inside the bubble. Let us repeat the same thing, now we have a bubble of gas identical dimension. But now will it be in equilibrium? It will not be because the weight of the fluid displaced is not same is not equal to the weight of the gas, gas is lighter.

So this is going to rise up. As it rises up the force F_t will fall because of ambient pressure reducing. So, it is not the net force is not zero there is some net force and that net force will be weight of the gas plus the pressure acting minus the force acting. So therefore the net force will be the gas weight minus the air weight. Actually this F_t is a difference between the pressure acting on top and pressure acting in the bottom.

But if you are assuming that the bubble is in free atmosphere, and it is basically enclosed. Then the pressure acting the pressure acting on this bubble is only going to be the pressure that is because of the column of the air above this particular bubble. So, therefore when it is in the equillibrium force acting from the top will be just becaue of the pressure acting on the bubble because of atmosphere.

Why, agreed as I said the air bubble is not in the equilibrium it is air bubble inside air. The gas bubble is not in equillibrium therefore it is rising that is because the forces are imbalanced. And the net force acting on the gas bubble is exactly what we are looking at, which is the difference in the weight of the gas minus weight of the air. I understand what you are saying. But if there is a enclosed column of Air which is in equilibrium.

I understand that you are talking about the atmospheric effect that is as we go up. There is some pressure below some pressure up but if there is an air bubble which is in equilibrium then because of the weight of all the air above it in the atmosphere there will be a force acting on that bubble. That is what I am saying that is this F_t force from the bottom then there is a weight of the bubble and then there is the force F_t we take the equillinrium and equate the forces.

F_t is negligible as compared to; that will depend on at what altitude this air bubble is in equilibrium. So we are trying to bring in this concept by saying that if there is air bubble in equilibrium. The three forces which will be acting are as follows. So where $F_t = 0$? No is the same air, it is the same air I am not putting gas inside. I am taking an atmosphere which consists of general air.

The density of the air will change from various altitude to altitude therefore at any particular altitude I capture some gas some air, weightless enclosure let us say ok it is a bubble. Infinitesimally thin membrane which captures this control volume. So, the pressure on the atmosphere acting on the bubble will be balanced by the force acting. And if it is in equilibrium then the downward forces will be equal to the upward forces.

I am not calling it is as a buoyant forces or something and I am saying the forces acting will be in equilibrium. The buoyant force will come only when you have a gas. It cannot happen then how will there be equillibrium? See understand one thing we are trying to bring the concept of buoyancy by showing that there is no force if it is there in air in air and there is some force if there is gas in air.

So I am not commenting on the numerical value of any of these forces. I am just saying that if there is a bubble stationary then the air inside the bubble has displaced the air outside both have the same mass. Then you are right there is no bouyancy but now when I replace; this is only for illustration purpose that now when I replace I can I replace that air inside with gas then there is going to be an update force?

Suppose we go ahead and look at now two important concept. Now, this is the gross lift. So the gross lift is basically difference in the weight of the displaced air and the gas.