Lighter-Than-Air Systems
Prof. Rajkumar S. Pant
Department of Aerospace Engineering
Indian Institute of Technology - Bombay

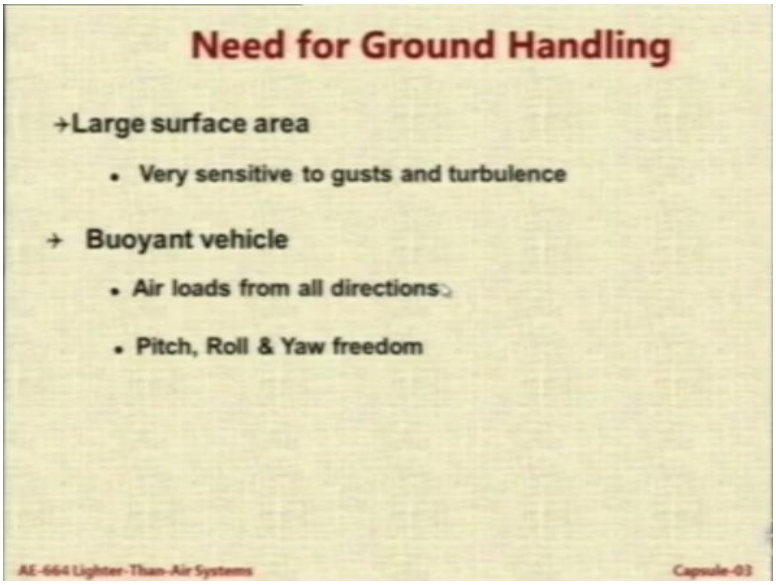
Lecture - 66
Need for Ground Handling

We know about LTA systems little bit by now. And we are also looked at how they are different from the heavier than air. Now one area which is a serious limitation of the LTA systems is the need for ground handling. This imposes not only extremely high cost, but also restricts the usability of these systems. You might say that airships and aerostats are simple and easy to fly, but then you need to also do something to handle them.

(Refer Slide Time: 01:04)

So, this is a collage of pictures taken from various sources, which shows the mooring masts used for various airships and aerostats. So, you can notice that essentially we are holding this platform from the nose. And in some cases such as in the bottom right, where you see the Zeppelin NT airship, you can see that in this case the mast is also a movable system. It is a truckmounted mast, so it can be taken away. So, apart from the massive size of the structure, you also need to have massive investment in terms of the ground handling.

(Refer Slide Time: 01:58)



So, why do we need ground handling in LTA systems As compared to HTA systems which need very little ground handling? Do you know for example what is the mechanism used to move a very heavy aircraft such as a 787 or Airbus A 380? If I want to move it from place A to place B on the ground, how do I do it? What is the mechanism used? No, APU is not used for that.

APU is basically used only to provide power for air conditioning, cooling, cooling of avionics systems, air conditioning, hydraulic system. There are simple tractors which have a link attached to them and you just attach this link to a hook in the nose landing gear. And an aircraft as big as 380 can be simply pushed or simply pulled by a tractor. It is very simple compared to what we would be seeing now.

The reason is that even though 747 or 380 have a very large surface area like airships. The weight is 350 tonnes or more. So therefore, it needs such a large amount of force to move it. For an LTA system even though it may be heavy, but it is a buoyant system. So, its net weight or effective weight is very less. So, in technical parlance what would be the net weight of an LTA system when it is parked on the ground? How much will be the net weight?

So you have heard of terms like static lift, net lift, buoyancy, weight, static lightness, static heaviness. So, using these please tell me what would be the apparent weight of a system which is standing on the ground?

"Professor – student conversation starts." Around 500 kg may be. No, I do not want numbers, I want the term. Static heaviness, correct. **"Professor – student conversation ends."**

So, the weight that will be read by a scale on the floor if you put an LTA system on it will be equal to its static heaviness and this can be 500 kg, 600 kg for a typical large airship. But the forces which will act on such a large body especially when the winds are reasonably high. They can easily exceed this 500 kg in the vertical direction and in the side direction of course there can be forces. So therefore you need something to hold it.

So LTA systems are very sensitive to gusts and turbulences. They respond to it much more. You do not see aircraf shaking and gust and turbulence when they are on the ground. They do shake and respond when they are in air because there there is a lift force acting which overcomes the weight. So, again, they come to a situation now almost zero net weight. Now if there is a gust acting on it, but they are very fast.

So they cut through the air much faster than the LTA systems and their dimensions compared to their total weight are also much smaller. So, a buoyant vehicle experiences loads from all directions. The most important and significant load is the side load, which will come because of the large surface area. And therefore you need to have a pitch your roll and your freedom that means freedom in nose up and down that is pitch.

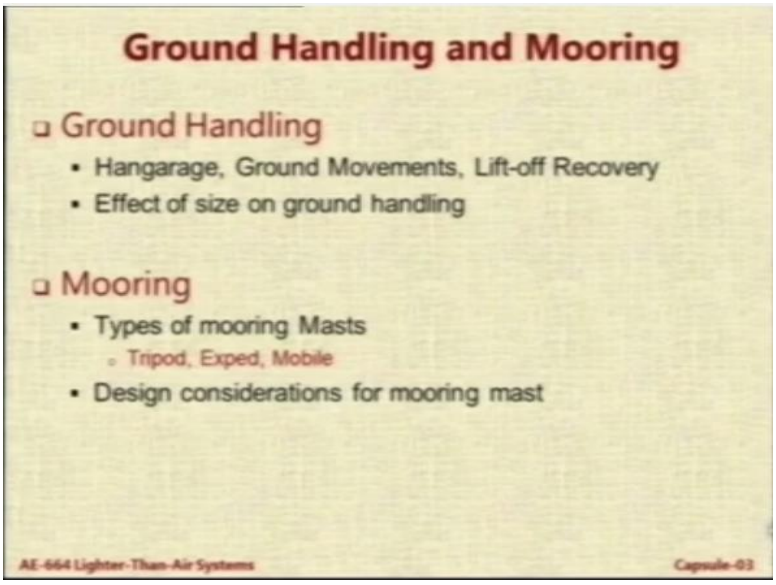
Nose rotation that is roll and yaw is nose left or right. This kind of you need to have some freedom in LTA system. If you constrain it, it will simply tear off. So ground handling is really a problem. And more than telling you what it is let us just have a look at a video from many years ago.

(**Video Starts: 06:26)** There is a website called Critical Past which talks about things which were in the past and looks at issues very critically. So the year is 1957 before even I was born, forget about you, right. And it just showcases what is meant by airship ground handling and you can see for yourself what the problems are. So observe very carefully. Then I am going to ask you questions based on purely what you have seen. **(Video Ends: 11:14)**

So, what we have seen in this film if you noticed as the airship was about to take off there were two vehicles on the sides which were moving. And the people on the ground were actually running and attaching cables to these vehicles. The idea was that these vehicles being little bit heavy will resist the motion of the airship to some extent and also they can be used to pull it. So there was a time in the past when ground handling of an airship involves 200 people, 250 people on the ground. I will show you one more video towards the end when we will see when

an actual actually airship came in to land how many people on the ground were required to safely operat it. So looking at now some specifics.

(Refer Slide Time: 12:14)

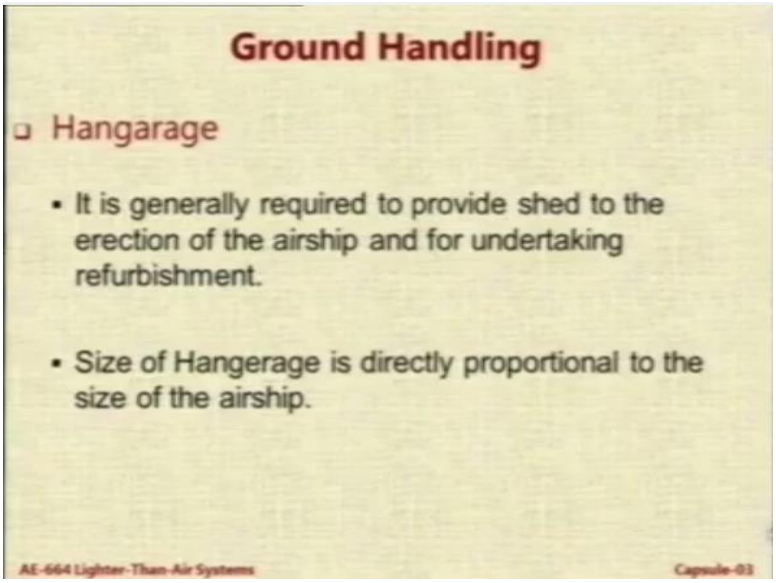


Ground handling means when we look at hangarage This can be a huge cost point in operating LTA systems. You need to create a hanger. So whenever you are making or operating LTA systems, be them aerostats or airships, you have to invest a lot in the ground infrastructure. And for airships, you need to have a reasonably sized hanger. Then there are ground movements bringing the vehicle inside the hangar, outside the hangar etc.

Lift-off recovery basically means takeoff or operating. Now, effect of size on ground handling is very evident. We know that larger the size of the airship bigger will be the hanger required and therefore the cost will go up. Then we have an activity called a mooring in which we basically attach the airship to a mast called as the mooring mast. There are various types of mooring masts, we will see them as we go in more detail.

The three main types are a simple tripod mast. There can be an exped mast or there can be a mobile mast which moves on vehicle and we will look at some design considerations for the mooring mast. We have to be very careful that when the airship is moving at low speeds in winds, we need to have sufficient control on it and also to ensure that the mast does not impose additional forces. The mast should be a facilitator, not the restrainer. It should not cause tearing of the envelope.

(Refer Slide Time: 14:03)



Now in ground hanlding hangarage or providing of the hanger is very important and a hanger as we all know is self evident. It is basically a shed. This shed can be used first to make the airship because when me make a small airships 5, 10, 15 meters you can do it inside a laboratory and then take it out. But suppose your airship itself is 150 meters, then where do we have a place? So you have to first customize the hanger and then make the airship inside the hanger.

So even to make airship of large size first thing you need to do is to build a hanger. Let us say the airship is already built we are now bringing to operate it you need for any refurbishment, for any installation, you need to do it. And obviously the size of the hanger will be connected directly to the size of the airship.