Lighter than Air Systems
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Module No # 02
Lecture No # 07
Tethered Aerostat systems

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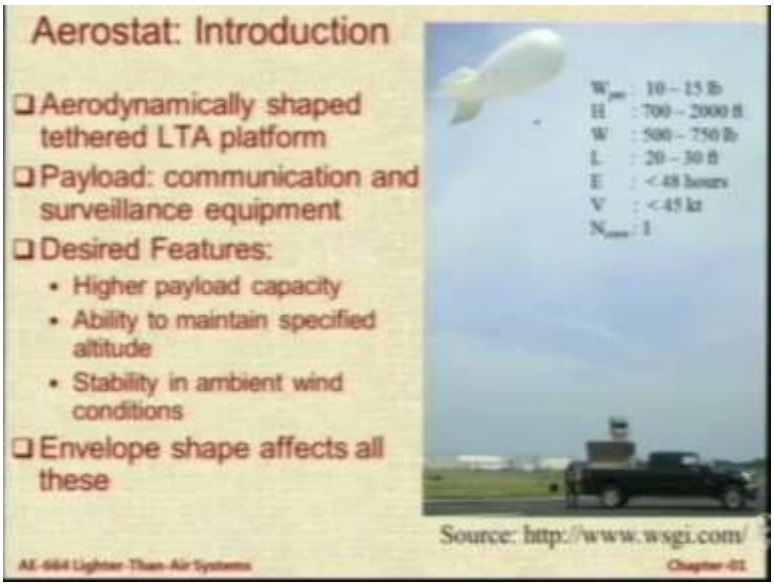

Let us move on to the next system. This system is not exciting or as dramatic as airship because it is just a balloon which is tethered to the ground. But even though it is tethered to the ground it can be made use for very interesting and far reaching applications. So this is the photograph of a small portable airship which is launched from back of the pickup truck ok. So what is this basically an aero dynamically shaped tethered LTA platform.

So it is not a vehicle, it is not an aircraft it is a platform because it is expected and desired to remain stationery. So one huge degree of freedom we have removed. The payload that can be mounted on this is again limited by your imagination more of people use it for either communication equipment or for surveillance equipment. Now what are the desired feature of a good aerostat for a given size we should be able to carry the largest amount of payload.

It is like just like any other aeronautical system we should have high payload fraction. It should be able to maintain a specified altitude on its own without any great intervention. And once it maintains its position it should remain stable that means as the wind direction changes or

disturbances occur it should on it own align itself and not demonstrate a continuous motion which will basically distracted from its application.

Now all of these are effected by the envelope shape. And hence the sizing of the envelope the shaping of the envelope and very accurate calculation of the size location and type and shape of the fins that you see on the back is an important exercise. We have to learn all these things as part of this course ok. So this particular aerostat as an example can carry around 10 to 15 pounds of payload at a height of 700 to 2000 feet.

And it is not very long it is probably easily fit into these room. But it can remain upto 48 hours. Now my question to you is should it not remain endlessly why there should be 48 hour limit or so for this particular system. So what do you think is the reason due to which 48 yes I would also encourage people to speak their names because we are still new to each other. Sowmya, you from which department are you? Nanotechnology ok.

So might because of the leakage of the gas contain inside over a period of time the precisely the reason. If we are able to make an envelopes which have got little or no leakage ok then actually there is no limit to endurance. But typically fabrics have a particular leak rate and that introduces a limit to how many hours you can keep it without popping up. In this case it is around 48 hours which is good enough if you want to do if you want to have a system for around 2 days to do surveillance just one deployment and it is there.

Interestingly it can withstand winds of around 45 knots which become almost 90 kilometer per hour approximately. And it just need one crew member who is standing below you can say. So it is a single man operation or a single woman operation and it can be easily deployed. And the same person can even drive the vehicle and take it around.

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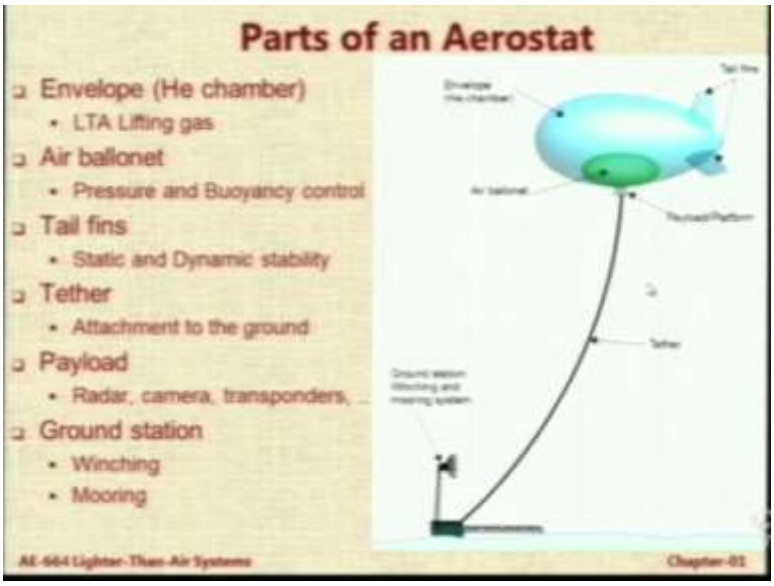

Alright let us look at what are the key parts of the aerostat. So the first and most important part obviously is the envelope. Here we say the helium chamber because we are assuming that helium will be used but it could also contain hydrogen or any other lifting gas. So it is basically the one that contains the liquid gas so it is nothing but the container, it is nothing but the envelope to carry a given volume of gas.

To control the pressure inside the envelope and to ensure that the envelope does not reach breaking point due to stretching because of the change in temperature in or because of any other reason which causes stretch in the envelope? We have a relieving system called as the air ballonet. Please note the t in this word is silence. So it is called as air ballonet. So it is actually a small air bag inside the gas bag.

And by controlling intentionally the volume of this air bag that means by taking out the air or taking in the air in this gas bag you can control the volume available for the helium or hydrogen or a LTA gas inside to expand or contract. So we use it essentially for buoyancy control and stress relieving the envelope. Then we have a payload platform now in this sketch we have shown pay load directly attached to the envelope and we have shown it below the ballonet, but it could be actually anywhere on the body of the aerostat.

And in many cases such as the picture which I showed you ahead the payload is mounted not on the envelope but at a particular place called as a confluence point below the aerostat. So the payload

or the equipment that you want to carry could be directly on the balloon if the local loads can be handled by the envelope materials or else you can delete that by mounting it on a point called as a confluence point.

And then the connection between the envelope and the ground is this tether. In this case we have shown some type of a catenary profile because we are expecting it to be under high wind conditions. But there is one serious mistake in this figure. I do not know whether you can make out. What do you think is not correct at least conceptually in this particular figure? At the ground yes the tether will be connected to something on the ground.

In this case they have shown of winching and mooring system. Not necessary I mean you can have various kinds of system. The sketch shows a system which has a small you know cup like thing to hold the nose etc. But one can mount it anywhere as it is conceptual sketch. What is it? Just a minute Amir you were saying something. That can happen if the wind is very high.

When you fly a kite for example in a high wind condition this is the kind of profile you see for even the kite. So the tether can remain in high winds in this particular shape. Yes you had a point yes your name Ashish yes why should face opposite. So it is actually facing opposite the wind that is right. The wind if the wind is from left to right then that is the right direction in which it is facing.

Why should if face opposite to the wind? It should not it is remaining stationery. So the best way to remain stationary is to face the wind and use the fins at the back because as the wind direction changes the fin will bring you back. This is called a weather cocking. So the direction is right. Yes Jagadeesh. That is a conceptual sketches as I said the tether is connected to the envelope it may not be there it may be some other.

I know this is the conceptual sketch I agree there is something more fundamental which is wrong. Yes Suneera yes can be the payload can be on the balloon as I said. It can be on the balloon or it can be below anything else? Ok fine. So basically what we wanted to show was a 3 tail configuration with the third one hidden because it is behind. This one is actually a top fin it may seems to you as something it is incline towards to you as actually it meant to be vertical.

I will tell you the problem is with the angle that the aerostat envelope is shown. Actually if there is wind it will trend to some angle of attack. It will not remain horizontal the balloon will actually acquire some equilibrium angle ok. So I will correct this figure I have the correct figure I do not know how it is wrong figure has come here. It is made by one of our M Tech student and I had told him that it has to be corrected.

But it is my mistake I put the wrong figure in the presentation. Ok yes it could be but in that case the tethered will not be so much catenary when there is a catenary position we normally expected to trim at some angle. But you are right I could alter the center of gravity and create a situation where the trimmed angle is kind of 0. But normally that is not the case ok. So let us go ahead the tail fins that are mounted behind in are essentially for static and dynamic stability.

Ok now there are 2 words here static stability and dynamic stability. So the aerospace engineers among you I am sure you will appreciate the difference between the meaning of static and dynamic stability. But for the benefit of others who may not know or for those who have forgotten let us have brief idea about what is meant by static stability? What is meant by dynamic stability? And what is the difference between them.

So; any volunteers to explain the difference between these two terms. Do not worry about aerostat talk about aircraft in general. We have the same things apply here. What is meant by static stability of an aircraft or a system. Suneera you want to try? So what you said is if a force is applied on the system it will return back to the original position no this is not static stability. This is of course if this happens the system is statically stable but something less also is acceptable.

Ok so this is not the requirement this is more than the requirement. What do you think is the minimum requirement for a system to be statically stable ok. So you do not have to use many new terms to explain it. Basically you should say if a system is equilibrium and if some unbalanced for acts on it or an external force acts on it. What is the tendency of the system? Under the option of this external force if the response of the system natural response without any intervention is to tend towards the original position rather than going away then it is statically stable ok.

It may not lead to stability so what may happen is if I disturb the system if I take it let us say away it should tend to come back it may exceed and gone the other side. It is still statically stable ok. But then as Hrithik mention over the period of time normally we except the oscillation to slowly reduce and it should actually come back to the position that is dynamic stability. So dynamic stability is what happens in the end does it actually come back.

Static stability is does it tend to come back or not. Say we should have both in aerostat. We should have static stability that means we should have a tendency of it to automatically reacts to someway that it tends to comeback and not only that over the period of time or a recently periods of time we want it to actually also comeback. Not keep on oscillating for whole life. So the tail fins help in both and their size is from both the consideration.

The tether is basically a cable which attaches the envelope to the ground and the payload is what you as a user mount on to the system either on the envelope or at a point below it. At the ground station it is something that helps in 2 things in winching and mooring. So what is the meaning of winching and what is the meaning of mooring? And how are they different. Can someone try to explain? What comes to your mind winching and mooring? Yes your name? Kiran.

The winching is the process of holding in the place and what is mooring? Ok so it is not correct. Actually mooring is the holding in a particular place and the winching is basically a raising or layering to the desired location. So a winch is system which pulls or pushes to intentionally changes the location and a mooring system is the one where you attach it when you do not want it to move.

So you have to have a winching system for the up lowering and raising and lowering and a mooring system to hold it when you do not want. For example when you want to leave the aerostat on the ground for some reason for couple of hour you do not want it to keep moving around you want it to be moored around the ground.

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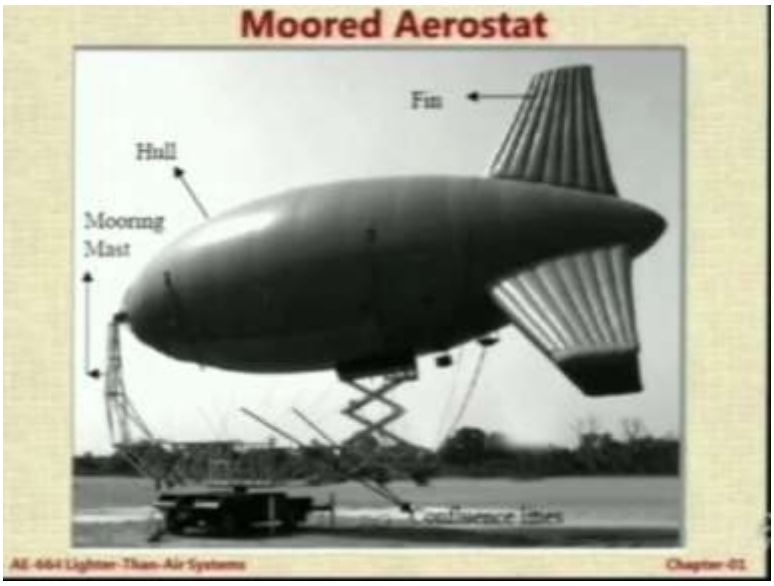

Ok this is the Moored aerostat developed in India by ADRDE laboratory called as Aerial Delivery Research and Development Establishment in Agra. So pioneering institute or lab in the country which; has done work in the area of LTA systems. Mostly they have worked in aerostat by now I believe they are also starting to work on airships. So this is one of the first aerostats. So you can see that there is this hull or envelope.

Now hull and envelope are interchangeable word. They come from the aerospace lineage and which comes from the ship lineage or naval lineage. Hull basically the body. So hull is as same as anonymous with the envelope. You have fins on the back and notice the fins are quite large in size in aerostats. And then you have this Mooring mast and here you have the system called winching it up and down.

And then we also see something called as confluence line which are basically line which are then attached together. I am sure when you fly kites you will remember when you flew kites that we attach a single tether to the kite with 2 ropes towards the end which are properly sized ok. The angle between the 2 ropes is actually done. How is the angle between the 2 ropes? As children when you flew kites did some one teach you how to do Kanni.

So we hold the knot it should be it should hit the top portion at the top attachment point and the bottom attachment point. So that 2 of them should be the same length which means 45 degree angle that gives the best characteristics. But there were few who are quite enthusiast if I want to

have highly maneuverable kite what should I do? I was taught by my senior that there should be 1 inch or 1 figure width more on the top that give you more maneuverable kite.

If the wind conditions are very poor and you are going to basically fly by giving it a constant jerk then the bottom should be longer than the top. So these are the few things you learn. Similarly there are confluence lines which are used to attach the envelope to the tether to which and the length of these lines and their orientation helps in deciding the stability characteristics. You will study this when we come to stability of aerostat.

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This is one of the recent aerostats developed by the same laboratory. And this photograph was taken at the aero India show. So you can see that there is very neat winching and mooring system developed instantly by LnT in Powai. And then you have this envelope and here you can see the payload is mounted in this case directly onto the envelope ok. So let see there is very interesting news..

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Ok now these particular aerostat 17 crore rupees that they mention. Please note the bulk of the money has gone in the radar development or cost of the radar is much more than the aerostat ok. My guess would be that the aerostat system everything together will be not more than 4 to 5 crores and the remaining money will be for the radar ok. But the whole system is what is important not

just the balloon ok. So now we have NDTV confirmation that aerostat are available and made in India.