Lighter-Than-Air Systems
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Lecture - 64
Fabric Testing Machines – Part I

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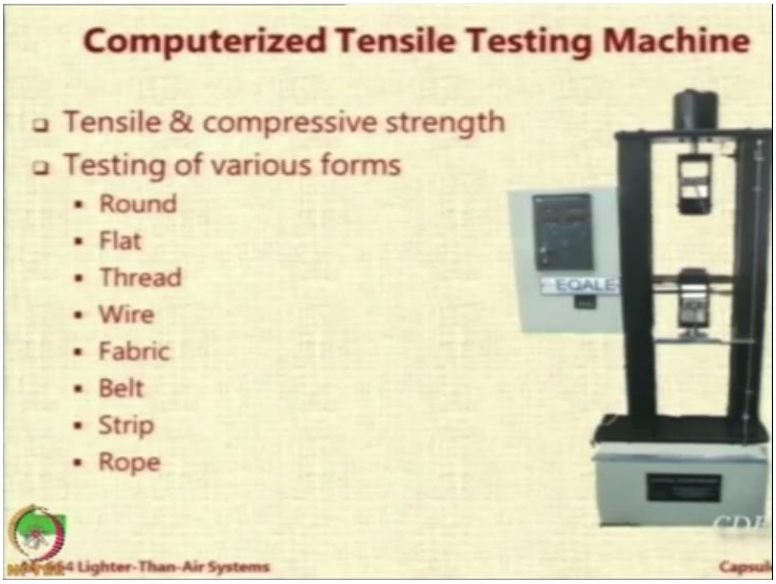

So finally, we will look at some work that we have done in our lab on characterizing these fabrics and for that some machines have been procured and installed in the LTA systems lab. So, I will just showcase to you these machines one by one. This is a machine that we have for dedicated machine, special purpose machine for testing the strength of ropes or fabrics. So, in the current configuration that you see the jaw that has been put, this is the jaw of the machine.

So, in between these two jaws you will attach the sample. This jaw is currently meant for cables. So, you will see there are some turnings in the particular that is if you take a close look at this you will find that it is meant for winding a rope. So, we use this machine for testing the braking strength of the tethers and the braking strength of the holding lines that we use in our airships.

If you want to test the strength of these ropes or these cables in a standard testing machine, you will not be able to do it because there are no jaws available to hold the material plus the range of this particular machine is in such a value where it can calculate the property. So, I think it

has got the braking strength of 200 kilograms and the lease count is also very low. So, this is used for tensile and compressive strength. And you can test various types of forms.

You can test round forms that means a round cross section cable. You can test flat cables. You can test threads. We use lot of threads in our airships. You can test wires. You can test fabric. You can test belts. You can test strips. You can test the ropes. So, all these can be tested in this particular machine. So, if you have any requirement, you can always visit it now. As part of this course, I am going to recommend that all of you should visit the lab one day.

And we will try to arrange a demonstration session for you in which the students will showcase to you the work that has been done. This is one special equipment around 3 and a half to 4 lacs is the cost of this machine.

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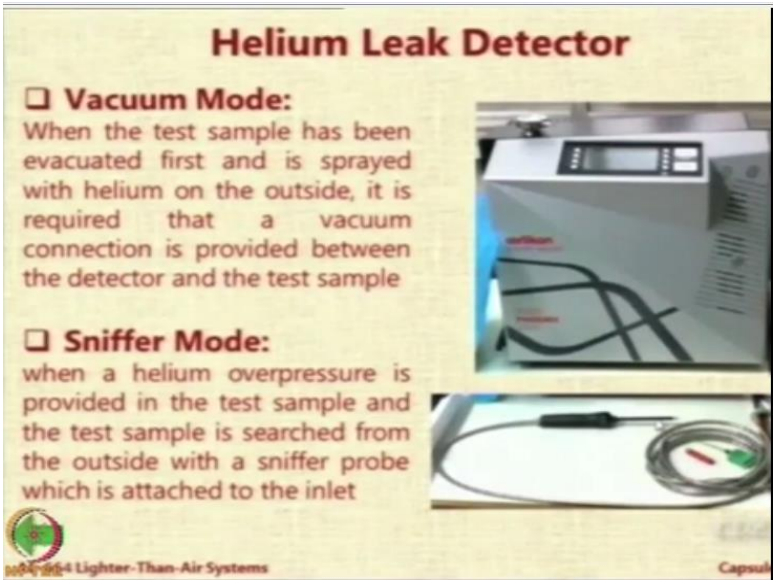

Then the next equipment which I want to showcase is a very special equipment is the Helium leak detector. So, as you know helium is one of our preferred LTA gases and leakage of helium can be disastrous from the point of view of cost and operational efficiency. So, let us say one of you makes a small airship or envelope for aerostat and now you have fabricated it, but how do we test it for leakages?

So, one way of testing for leakages is go to the swimming pool and dip it in the water just like the tire punctures are checked by the cycle mechanics. So, you fill it with air and the air will bubble out from the leakages. Now, do you think we can use this technique for our LTA fabrics? Why not? What is the problem?

"Professor – student conversation starts." There will be so large point force that we will not be able to. I am using air. So if we dip it in water there will be a large buyonant force which made of this, so it will be very difficult to keep it in place inside water. That is very right. You will require a huge amount of manpower to push a large envelope full of air because remember the buoyancy force will not come from the weight of the air, it will come from the weight of the water displaced and the weight of the water displaced will be quite high.

What is the weight of 1 meter cube of water? One ton imagine. This is one reason. Any other reason? Why a cycle mechanic can use but we cannot use? Suppose I make a small balloon which you can push inside let us say. I still cannot use it very efficiently for LTA systems leak detection why? I mean what do you say? It is not visible. There may not always have a suitable large body of water there. Yeah.

So I am saying that now the airship is only 1 meter in length and swimming pool is available, so still there is a problem. That is one problem. The fabric normally not, LTA fabrics normally are not supposed to soak water, they are supposed to repel or resist water. So if I use for example PVC, there will be no problem. Raincoats are made up of PVC. So nothing will happen, water will repel. **"Professor – student conversation ends."**

The problem is that a typical LTA system is under low pressure. A cycle tube is under very high pressure. So the air is gushing out when you put it. In an LTA system if you put it on a very high pressure it will tear, it is not designed for very high pressure right. The pressure inside is only a little bit more than outside. So, what will happen is if you push the airship in the swimming pool by the hydrostatic pressure of the water it will just cave inside.

It will cave inside and that will resist the air to come out. So, resistance of air to water. So, you will see some bubble somewhere but it will be difficult to locate. So we cannot use. So can you think of some other method of using? Can you think of some other method by which you can determine leakages in an inflated envelope? Now those from the LTA lab who know let do not tell what it is, think about it.

You have made an airship envelope of let us say 5 meter length. You have filled it with air. The shape looks okay. But there could be minor leaks at some places. How do you find out? Think about. It is difficult as we tried it out. We tried with agarbatti and dhoop flames inside.

So, first of all it is not easy. You can generate, see the dhoop is something that creates a lot of smoke and it is easily available in the market.

So, you can put a pump which will suck the products of burning that dhoop stick and you can put it inside the envelope. After some time the whole thing smells of dhoop. So odour is very difficult. Now, in which place you have a larger concentration of dhoop you need a very nice nose for it, it is very difficult. So we tried, we failed. Anything else?
"Professor – student conversation starts" Color. color dye? You mean liquid? Color gas? So you are saying that we take a gas which is colored and we fill the envelope with colored gas and then we look for places from where it comes out. You will notice that the rate at which the gas comes out is very small. So therefore color dyes also may not work very well except when there is a big leak. If there is a big leak, you can see it. "**Professor – student conversation ends."**

Then you need a special kind of a gas where there is accumulation, you are assuming that the color will accumulate at the hole. It does not happen. It just comes out. So we have tried all those things. That is why I am very confident. Anything else? And just looking at the practical situation. Now you are stuck somewhere in some college you are going doing a demonstration.

Now where do you get the color gas? Are you going to carry with you? You might say okay, I know some chemicals if you burn them, it gives yellow colored gas. Then you pump that gas inside, so it is not very straightforward. Think of something else. Which is much cheaper and much practicable, think about it. You have to use some innovation. Let me give you a couple of minutes to think. In the meantime, I am going to locate a picture of our testing and show it to you.

So think about it. Take a time, take some time. So there is a method called as a soap bubble method in which what we will do is now first thing is you are assuming that the liquid will be only at the joints that is not necessary. It is quite possible that the fabric itself has got a small hairline or a small spot where it leaks. So do not assume that the leakage will happen only at that point. And the method which you suggested is possible.

I am not saying it is not possible, but it is not really very, it is very cumbersome.

“Professor -student conversation starts.” Sir we can take the envelope in the hot air and over the time look for infra red and we can record. Very exotic solution. So, you fill it with hot air and then you wait, look you are somewhere else, you are not in your lab. Think of a simple method which can be implemented in the laboratory.

The beauty of solutions which work are that they are simple. Think of simpler solutions. So, think of very simple solutions which can be implemented. Remember anything that detects the leakage by looking at or sensing the gas or air which comes out is not going to work practically because the rate at which it comes out is very small if the leakage is small. The pressure inside is less. If you pressurize it too much, you are stretching the fabric.

I will not permit it because you will create a tear. If there is a very small pinhole, you may pressurize and pull it blow it more. So, in the process you will give me 10 more holes, I do not want that. So, no brute force methods. Something else that can be sensed. You can drop a film of water, it is not easy to drop it, but let us say if I drop if I have a rope with bucket and that bucket is mode and the water is slowly falling, the rate at which the gas is coming out is very less.

So, you will not have so much pressure that the bubble will be formed. That is why as I said any sensor that detects leakage by capturing or sensing the air coming out may not practically work in a normal situation. Of course, what we do? Look, I will show you what we do. So, in our helium leak detector or the system that I showed you, what we do is there are two methods. There is something called as a vacuum mode.

In a vacuum mode basically so you can detect the presence of helium. So this is a sniffer. You can see the probe here. This is a probe. You connect this to the machine and then you take the probe and now you can move it at the locations where you expect leakage. If helium is coming out, this fellow will sniff it and it will tell you that there is a leakage coming and this is a sniffer mode. But for this I must fill it with helium and let us say there is leak at three places.

So helium is slowly coming out of that place. First thing is it is so humanly difficult task to go all over the envelope with the probe, very difficult. Try to do it 15 feet length envelope, one and a half meters dia, just go all over the envelope you will be bored to death. It will take you

3-4 hoursby the time the gas will leak. So so for using this method for leak detection means you should be prepared to be patient and then suppose you miss it.

So leakage is there, but you missed it. So it can be done, but not recommended. But our engineers came up with a very ingenious method which can be used anywhere. It does not require anything other than what is available in a typical hostel. I will give you a hint. In a typical hostel room, you have some things. You have a desk, you have a table lamp, you have a computer, you have calculator, laptop bag, scale, pens, that is it. This is what they use and they can detect the leak. Any hints? So let me show it to you.

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We use what is called as visual leak detection method. So what we do is on one side of the envelope we illuminate with the table lamp. you can see Vishal is holding a hand held table lamp, made the room dark. On one side put a table lamp or a big illuminating bulb. On the other side the whole team starts looking. Now light is something that can come outside the hole. If there is a pinhole, you will see star like illumination points.

So on the bottom left is a zoom, 10 times zoom of one of the holes. So, by visually inspecting the envelope, you can find pinholes. This works beautifully and we have used it and this was suggested by some students who work in the lab when I gave them this problem. We tried all the methods you mentioned. We tried soap film method, nothing is happening, full lab became dirty, slippery. Then someone said swimming pool cheltehain.

They went to swimming pool. Then they said they all became completely wet and the balloon would keep bobbing up and they said sir there is no leak, we are only leaking. Then we tried all sorts of things the agarbatti dhoop everything. Ultimately one wise chap said why not use light and then we tried it, it works. So, to give a technical name it is called as the reverse elimination method.

Actually it is nothing but putting a light source on one side, making the room dark and observing, using human eye as a sensor observing on. It works very beautifully for small pinhole leaks even when you are in the field. So I can show you one image. This picture is the laboratory, but I can show you one more picture where we know, it may be in this.

(Video Starts: 17:01) So when we went to Manali. At that time there is one picture here I think Yeah, you can see this is in the lab. This is the leak zoomed. And then this is Manali. We go there. We do our testing. There we go. **(Video Ends: 17:17)**

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In Manali, we did the illumination using the lamp that they gave us. This was a small hanger and like typical IITians, we work in the night because we have to fly early morning. The best time to fly typically is 6 am to 7 am when the winds are less that is the best time to fly. So we worked all night and around 2 o'clock or so you can see on the left side there are two students looking for leaks, on the right side there is a lamp. But this time we are doing it with gas.

So whether you have gas inside or air it does not matter, light will still pass through.

“Professor – student conversation starts.” Yes. Sir working that transparent. we cannot use this method. I do not think this will be working so No polythene material will show up, the leak will show up. The problem is you must have seen in our videos, I showed you some video of a black colored airship, it could not work in that. **“Professor – student conversation ends.”**

So, that was one drawback of this black. That is a very good fabric by the way, it was 95, I think 121 GSM. It was given to us by a company for testing that is this fabric good for your airship? And there was a dual degree project by a student. He made the airship from that, very good, small airship a 4 meter length gave us around 1 kg of net lift. So it is very good, lightweight. But the problem is that fabric.

It could also be sealed by RF sealing, so we could use our machine, but the problem is that we could not use our illumination method to calculate to find the leaks. So, therefore that envelope is available in the lab. It has many leaks and no one is able to find the leaks. The only thing available is our helium, but that is very expensive. So, this is coming back now to the other equipment.

So, by the way this helium detector is seventeen and a half lakh rupees, just this one small equipment and the trolley is another half a lakh with 30,000 rupees. The sniffers are coming for around 5000-8000 rupees. So, very expensive item and I cannot take it with me to someplace. So, it can only be used for those situations where we are desperate. We have some location and now we want to pinpoint exactly where we can search very minutely.

What we normally do is in locations where you get a leak it with a red colored circle so that we know that this is a prone area. We patch it up, but there could be. However, if it comes somewhere else, this method is very cumbersome. Hence, it is not used.