Structural Reliability
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Lecture –240
Target Reliabilities (Part - 03)

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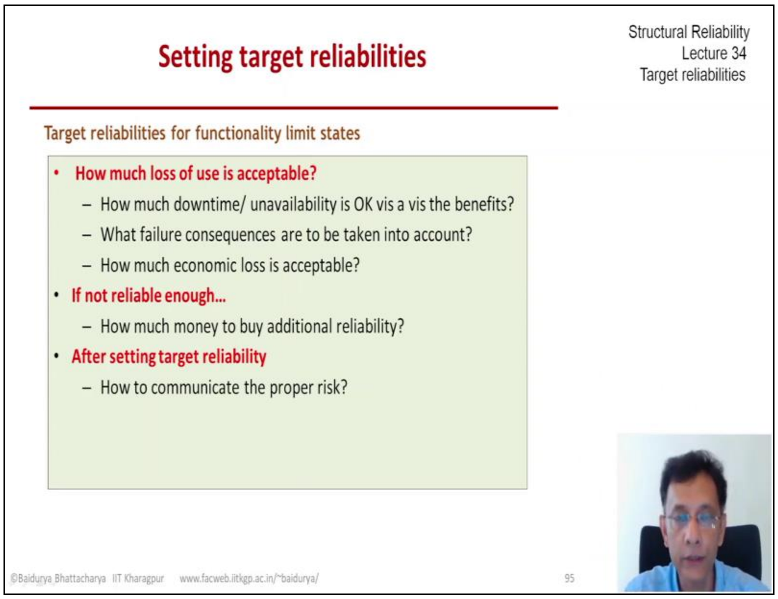

Thus we see that target reliabilities or their complement the maxim acceptable failure probabilities or the likelihoods or the rates at which we are willing to allow safety or more generally performance to be violated by our system or our structure in this particular case. So, obviously these target or maxim acceptable values would be tied to the consequences of the violation of these limits either safety limits or performance limits.

So, one logical question to start this discussion with is how to set target reliabilities is what happens if there is failure if there is non-compliance. So, what are the consequences? So, let us start with functionality limit states and the first question then would be how much loss of use is except acceptable. I use this term loss of views because we are talking about functionality and not loss of life or limp because we are not talking about ultimate type limit states which we will in the next slide.

So, then details such as how much downtime how much available how much unavailability is okay when compared to the benefits that we get when the system or the structure is performing as intended what failure consequences. So, that was our first question what failure consequences are to be taken into account and since we are talking about economic loss in the in this case of functionality limited states.

So, how much economic loss will be acceptable and then a related question is if I find that the item or the system or the structure is not reliable enough in that particular functionality. Then do I need to or am I willing to spend more to achieve the target that I want. And so, that would also be part of the decision making process part of setting the target reliability. And then after the target liability has been set the user or the owner of that system of that item should be made aware of what sort of likelihood that item has in not performing its functions as intended.

So, the word risk here is used in a technical term as we will see soon that risk is the product of consequence time solubility or more generally the expected consequence. So, that is target reliabilities for functionality limit states.

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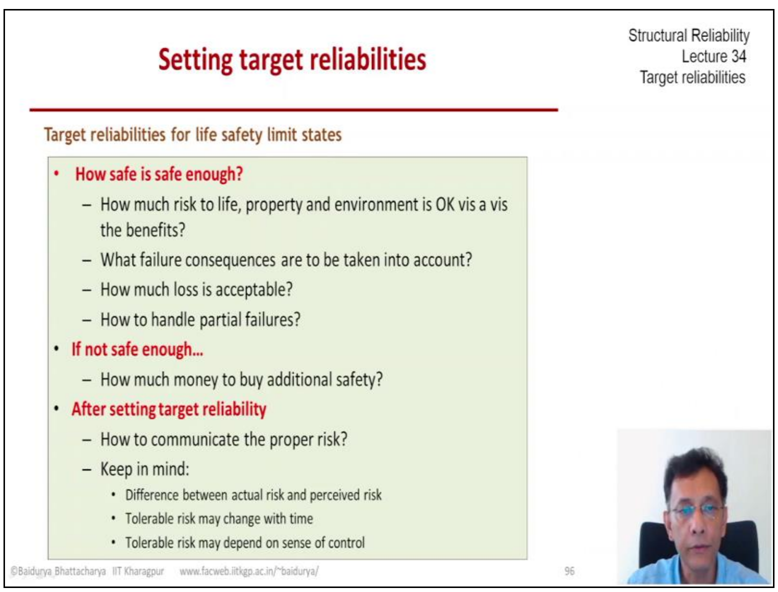

When we talk about life safety then obviously the question is central how safe is safe enough and we are talking about safety to life and limbs. So, how much risk to life to property to the environment are willing to accept because after all we are getting some benefits out of the activity the engineered system the structure that we are talking about. Again just as we did in the functionality or serviceability limit state what failure consequences are to be taken into account because that would determine quite possibly what the target reliability or maxim acceptable failure probability will be.

So, how much loss is acceptable how to handle partial failures since we are talking about life safety there could be are we talking about ultimate there could be stages of such collapse or such failure. Again a similar question is as we did in serviceability is if it is not safe enough if we found that the existing reliability is not safe enough and we need to increase the target. How much money should be spent to invest.

So, that we achieve additional safety. And then it is even more important than was the case for functionality limit state in life safety we need to communicate the proper risk and that is an important job because of engineering when it interfaces with society this sort of communication is very important and one needs to keep in mind when making this communication is that there are differences between the actual risk and perceived risk, risk again being used in here in the technical sense that it's the expected consequence.

And there are reasons why such differences exist and even if the risk is tolerable now it may not be tolerable in the future people's expectations change people the public may expect the engineered systems the structures to perform even better failure may be even more unacceptable in the future when presumably society becomes more affluent and expectations increase. And this idea of tolerable risk which we will come to later is also affected by one's sense of control.

So, if the activity is undertaken voluntarily or if the person has the sense that they can make a difference in the outcome then the tolerable risk might actually be much higher and that in turn would change what an acceptable reliability is. So, all of these things need to be considered for setting target reliabilities.

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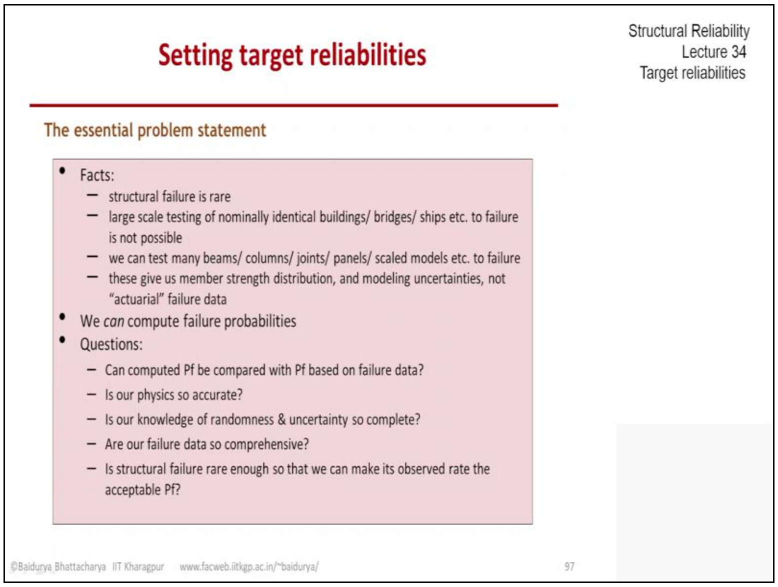

But even before this there are some essential problems that we need to address when we talk about certain target reliabilities for structural systems and structural components and I have listed them here. We have discussed stated realize these facts throughout this course. So, let us list them one by one there are three or four of them that I would like to present in this manner is first structural failure is rare.

So, that we have we understand that we have almost taken that as a given and we would like structural failures to remain rare if not become rarer. The other fact that we also realized through this course is that large-scale testing that is some is the bedrock of many reliability programs but for structures for buildings bridges ships. Testing of nominally identical units to failure is not possible that is also something we understood and we agree.

We can however test components subsystems, beams, columns, joints, slabs, panels, even scale models to failure but what we get through that through those tests is we get the member strength distribution if we like we can get modeling uncertainties but what they do not give us such lab tests are the actuarial failure data. So, real observed failure data are not obtained from lab tests even if performed in large numbers.

But we can compute failure probabilities that's what we have spent a good amount of time in this course and we are confident that we can compute failure probabilities of components and systems. But then there are questions and these are what I call the essential questions the essential problem statement. Is can the computed failure probability be compared and verified with the failure probability based on failure data can we compare them are they done on the same basis.

Because is this is a question that needs to be answered if we can compare is our physics. So, accurate because we are doing physics based approach to failure physics based computation of failure probabilities limit states and so on. So, is our physics. So, accurate that if we can actually compute the failure probability and whatever the answer comes we can compare with failure probabilities coming from failure data actual field data observed data and see if they are satisfactory or not is our physics.

So, accurate is our knowledge of randomness and uncertainty. So, complete because that is the other part of the knowledge that we are using along with the physics in computing failure probabilities and if we are able to compare the completed Pf with the observed Pf then that observed Pf based on failure data are the failure data. So, comprehensive in other words are the failure data. So, representative that we can compare a computed Pf with it and decide if the computed Pf is good enough or not.

Finally we go back to the first question at the top of this slide structural failure is rare okay but is it rare enough that we can make the observed Pf the acceptable standard.