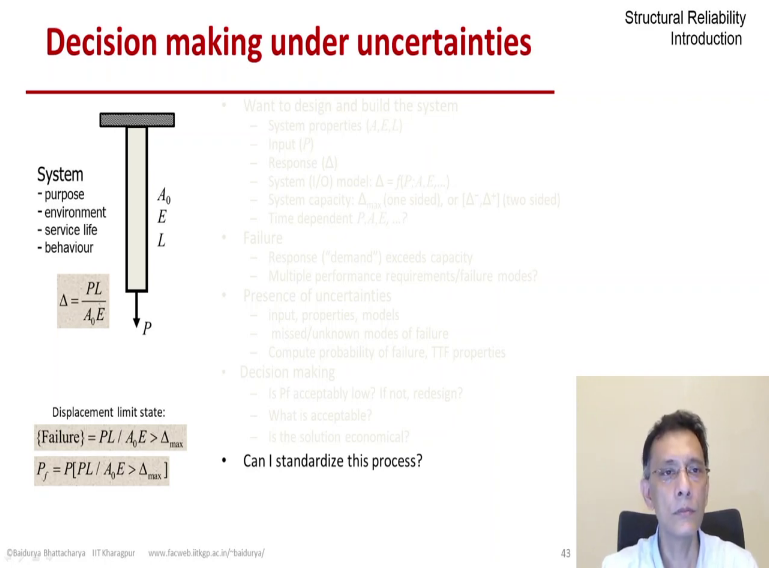
Structural Reliability
Prof. Baidurya Bhattacharya
Department of Civil Engineering
Indian Institute of Technology, Kharagpur

Lecture –08
Introduction (Part - 08)

(Refer Slide Time: 00:27)



Let us go back to the one slide that I described earlier in this lecture that captured the key features of this course. We have a structural system a simple prismatic bar subjected to actual tension in this case. In a more general case we could have instead an IC interconnect a gas turbine blade, an aircraft landing gear or a tall building with thousands of degrees of freedom subjected to seismic loads.

You know whichever it is we know the system its purpose the environment it will operate in its intended service life and how it is going to behave. So, we want to design and build the system and we have a good idea about its properties and inputs as I said. We know which responses we are interested in and we have a model that relates the inputs and the properties with the response and we have a good idea about what an acceptable response is.

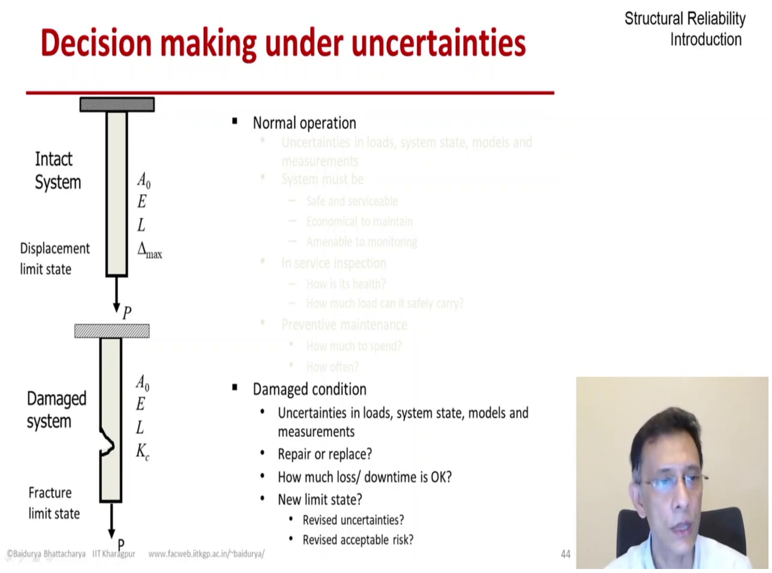
Now, some or all of these quantities could be time dependent in nature and because we know what the response is and what the acceptable response is we have a good idea about what constitutes failure. Now, our system does not have to have only one failure mode there could be multiple performance requirements. For example even in this very simple case there could be some torsion and loading and I would be worried about that.

If instead of tensile the force was compressive in nature I would be worried about buckling instead. So, I know what a failure mode there is and how to express them. Now, because of all the uncertainties that we are talking about in this problem in the inputs the properties the models of the system and something much more difficult if there are missed or unknown modes of failure there are ways of handling that.

And if I know the randomness is involved how to model the appropriate random variables or random fields and random processes I would be able to compute the probability of failure or the distribution of the time to failure and its various properties. So, with this information I should be able to take some decisions. Is the failure probability low enough if not then I would need to redesign is the solution economical and what would be an acceptable failure probability if I need to find that out that would require an additional analysis.

In the end I might also be interested to standardize the process because if I have to do this over and over again that would be an excessive demand on my time and resources. So, if there was a design guide that would work most of the time in similar situations then that would be something I would be interested in as well. Now this is about design of a system that is yet to be built.

(Refer Slide Time: 04:25)



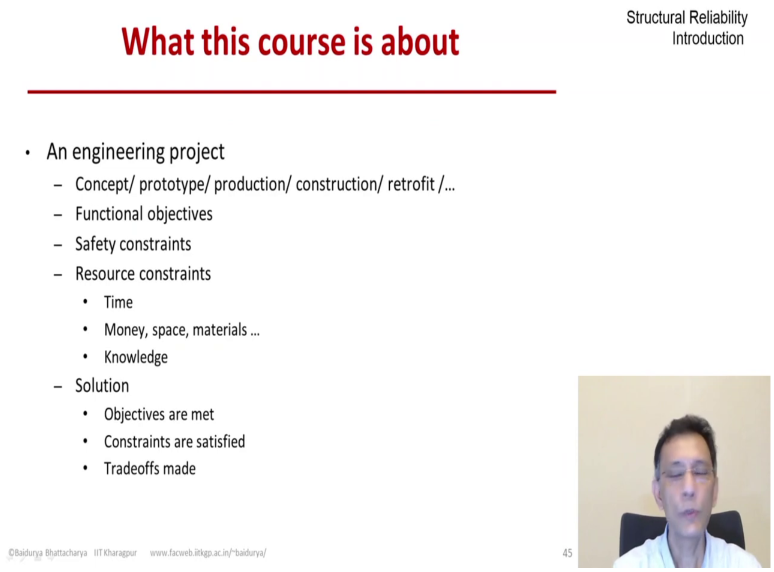
But once we have an existing structure some of the concerns and questions are different the structure is already in place and the best model of the structure is the structure itself. The uncertainties are there but now, I am able to do some non-destructive measurements. So maybe the nature and magnitude of the uncertainties are different compared to before. And I would now, be interested in this existing system that it remains safe and serviceable it is cost effective to maintain.

And it lends itself to monitoring because I would be interested in the questions is how is its health and how much load it can carry and for which I might need to do some systematic in-service inspection. If I am worried about something that might go wrong in the future that would bring me under preventive maintenance and I would like to know how much to spend what to fix and how often to undertake such maintenance activities.

Now, these are all concerns that are relevant for the intact system under normal conditions. What would happen if the system gets damaged for some reason and then I would have different sets of questions and concerns. Do I repair it or do I replace it? In either case how much loss or how much downtime would be acceptable. Are there new limit states that are of concern here? For example I now, might be interested in the fracture limit state which I was not before.

And because in these new conditions a new damage condition I might have different expectations from this damage structure I might have different acceptable failure probabilities and I might also have a revised estimate of the uncertainties involved.

(Refer Slide Time: 06:27)



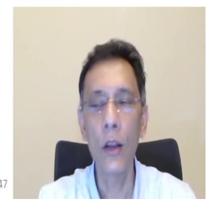
So, putting all of that together an engineering project which could just be the concept definition or working through the steps through prototype production or construction or retrofitting. In any of these cases I would have a set of functional objectives to meet and there would be constraints that we have already talked about. And in the end I should be able to provide a solution in which the objectives are met the constraints are satisfied and whatever trade-offs need to be made they are made.

In light of all that we have been discussing in this lecture it would be appropriate to actually restate the last three points of this slide and which I am now, adding in red font and restate that the objectives are met most of the time the constraints are satisfied most of the time and the trade-offs that are made are acceptable.

(Refer Slide Time: 08:11)

Contents

		Weekly Course Plan
PART A: BASICS	**Week 1** Pre-requisites	Introduction and overview. Review of basic probability. Random variables, probability laws, common probability distributions – origins and interrelations. Simple one variable example problems.
	Week 2 Random variables	Functions of random variables. Joint probability distributions, conditional distributions. Joint Normal distribution. Concepts of stochastic process. Simple one- and multi- variable example problems.
	Week 3 Monte Carlo simulations	Introduction to Monte Carlo simulations Generation of samples from various discrete and continuous distributions, generation of dependent samples Variance reduction techniques Examples: simple coding problems



So, with these thoughts let us look at once again the contents of the first part of our course and as you can see the first step was to model and estimate the uncertainties. So, the next 5 lectures we are going to spend on the theory of probability and random variables. Thank you and see you there.