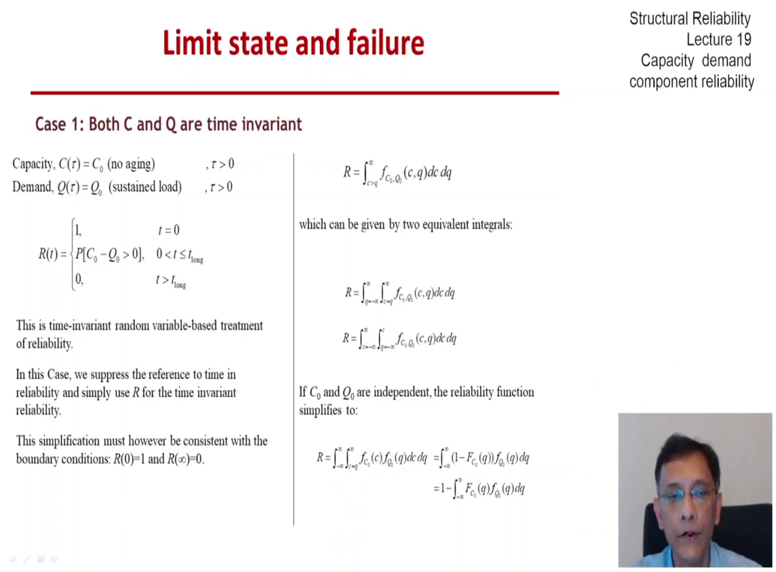
Structural Reliability
Prof. Baidurya Bhattacharya
Department of Civil Engineering
Indian Institute of Technology, Kharagpur

Lecture –156
Capacity Demand Component Reliability (Part 04)

(Refer Slide Time: 00:27)



Now a special case occurs in the overload type failure when the capacity is invariant to time. So, there is no explicit time dependence. So, we call that C 0 and the demand is also sustained in time there is no explicit time dependence. So, we call that Q 0. So, if our problem can be presented this way then essentially for the duration of interest we really do not have any drop in the reliability function.

So, just if we have to be consistent with the way that we have defined reliability so, far is that it starts from one and falls down to zero. Basically at just before the beginning of service reliability is one and then as soon as we put it into service all the loads are put and they are sustained the capacities do not change with time. So, it stays that way for a very long time that the t long is much longer than the service life of interest.

But even beyond that maybe the reliability falls quite fast down to zero but we are not really interested in that because this t long is way beyond our time interval of interest. So, this in effect is the time invariant random variable based treatment of reliability. So, that is the first case that we are going to look at this is case one which I mentioned a few slides ago. Now we completely suppress the reference to time and simply use reliability for the R for the time infant reliability.

And in many textbooks this is what we start the discussion with that we have a limited function that we have certain basic variables which define the limit state function and the limited function being negative is failure. So, we want to find the probability of that. So, that's the starting point in many structural drivers discussions i just wanted to give some build up to that. So, that is our case one and obviously we must keep in mind as I wrote in the equation at the top that R must start from one end must end at zero but the duration that we are interested in it is more or less invariant to time.

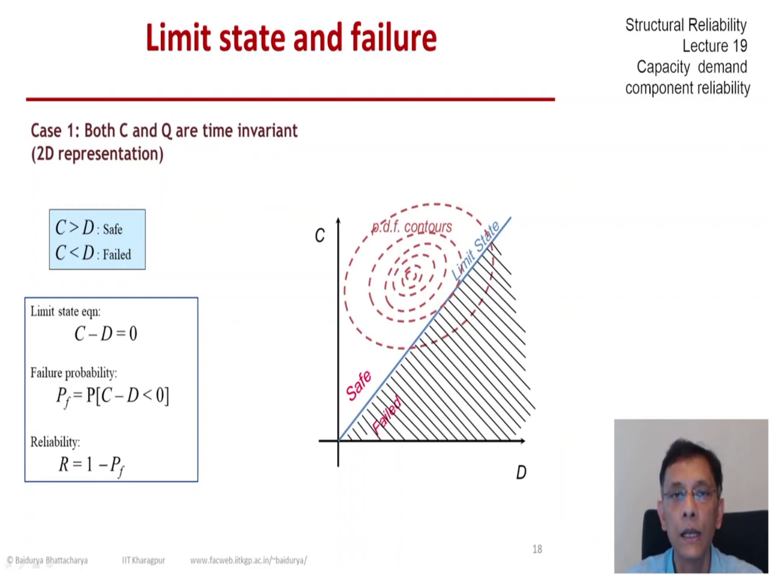
So, in this sort of situation we can find R from the joint density of C 0 and Q 0 what you see there is the joint density integrated over the domain specified as c greater than Q. So, all those regions of the basic variable space in which C exceeds Q are of interest to us and we want to find the probability content of those regions. Now we can give it in terms of two equivalent intervals we can we can set the limit on Q over the entire range of values.

But start C from Q and upward that would give one representation the other representation would be that we let C vary over all possible values but allow Q to take values all the way up to C and not beyond. So, either way; we have the same region defined and the probability content gives me the reliability. We hope that we can solve this if we know the joint probability density and we can integrate this either analytically or numerically more simplification would be possible if C 0 and Q 0 were independent.

And then the reliability function would simplify to because the joint density would be the product of the marginal densities and we could for each of the two equations above we can write that in terms of the CDF of one or the other. So, for the first equation it comes down to integral of 1 minus F c 0 as a function of Q times the density of all possible values of Q which can be further simplified as you see on the screen.

Or if we take the second approach we would describe this as the CDF of Q 0 evaluated at C and then weight that with the corresponding probability density of C and perform that over all possible values of C. So, in some sense it is the expectation of F Q 0 in terms of C. So, that would be that would be the analytical way of describing this two variable failure probability or reliability problem.

(Refer Slide Time: 06:13)



Pictorially speaking this can be represented as again we have C for capacity and now d for demand I hope that it is not confusing. So, C - D is the limit state function C - D equal to 0 is the limited equation. So, that failure probability is the probability in the region C less than t and that is what we see on the right. So, the PDF contours are the contours of the joint density function of C and D and then you have the failed region given by the dashed lines.

So, we would write we would compute the probability of that dashed region to find the P f or 1 - P f would be the reliability function. Let us now look at some examples and take the computation all the way to some numerical answers.