Structural Reliability
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Lecture –135
Component Reliability - Time Defined (Part - 14)

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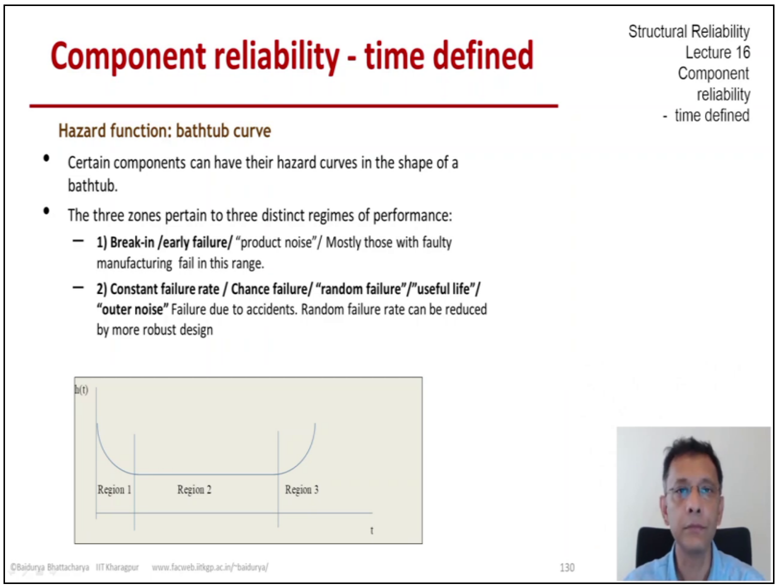

In the course of this lecture we have mentioned the term bathtub a few times. So, what does it really mean? Simply speaking it is a hazard function whose shape looks like that of a bathtub. So, whether looking from the side or from the end it kind of looks like this and that is why the name comes from. So, many types of components exhibit this sort of hazard curve where we can identify three distinct regions.

So, there is the first region which is decreasing and then it kind of becomes flat and stays flat for a while and then it again starts increasing. So, these three regions pertain to three distinct regimes of performance. So, the first region is variously termed the break-in part or the only failure region product noise. So, and these come from various disciplines but they basically mean that it is early failures those that had some manufacturing defect they kind of burn out very early on in fact a very common method of quality control is to actually identify.

These faulty items through some early through some tests and they are never shipped out. The next one is the we have mentioned many times is the constant failure rate region which is also the useful life region where failure is random. So, the random failure region chance failure region the outer noise as opposed to the product noise. So, it is basically a failure caused by external events shocks or other sort of random accidents which are not in the control of the manufacturer and that is the region that we like to extend as much as possible.

Because that is that is low maintenance that is most productive and that has the lowest failure rate for such items. And then once the useful life nears its end the product can still function but then damage accumulates to the point that the longer the item survives the more likely it is to fail. So, it is clearly an aging phenomenon that that kicks in that starts showing and that is that is a common phenomenon even for living organisms when various age-related issues catch up then the death becomes more and more likely with advancing age.

So, these are the three regions that we often see and together they are called the bathtub curve.

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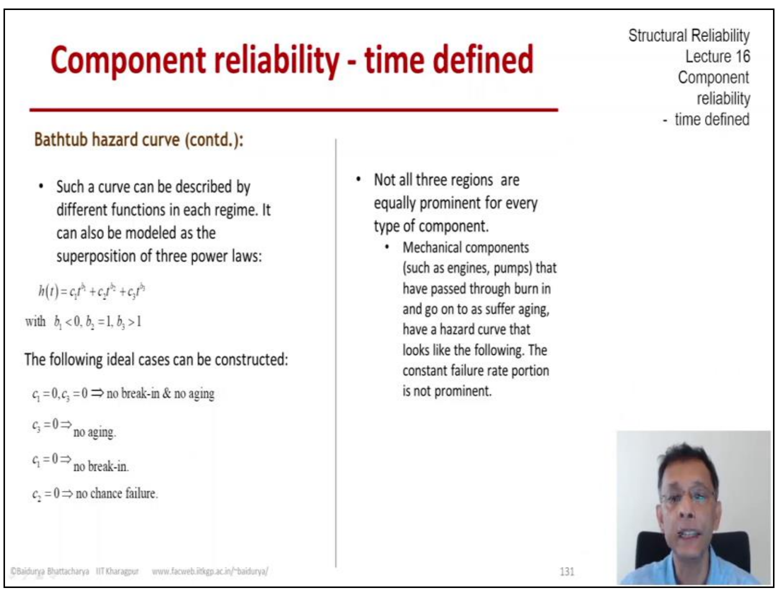

Now through an equation we can describe this by you know having different functional forms in three different regimes we can also more conveniently describe this as a superposition of 3 power laws one which is the decreasing type one which is the constant type and one which is the increasing type. So, b 1 less than zero b 2 equal to one and b three greater than one and depends how you choose them and how you choose c 1, c 2 and c 3 would determine the relative importance the relative contribution of these three behaviours to the composite hazard curve.

And now we can look at some of the limiting cases. So, when c 1 and c 3 are 0 then there is no break and no aging. So, we have the constant failure rate the ideal exponential time to failure when c 3 is 0 then we eliminate aging when c 1 is 0 there is no early break-in period and when c 2 is 0 then there is no chance failure no random failure it is either breaking type failure or aging type failure. Now just to repeat what I said before not every component exhibits this sort of behaviour this is idealized.

Some components can even eliminate the constant failure rate regime where after an initial break-in period it is aging and aging and aging all the way through for such a system this is what the hazard function would look like.