Structural Reliability
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Lecture –219
Capacity Demand Systems Reliability (Part 10)

In our lectures on structural systems reliability, so, far we have looked at the series configuration whether it be a non-redundant structure which would fail if any one of its members fail or it be a structure with multiple failure modes and the structure fails if any of those modes occur or a situation of dual or multiple performance levels or multiple load combinations. And in each of these situations we ended up with a series configuration.

In this last lecture on systems reliability we are going to look at parallel and other active load sharing redundant systems. Let us see what interesting feature these sorts of systems have.

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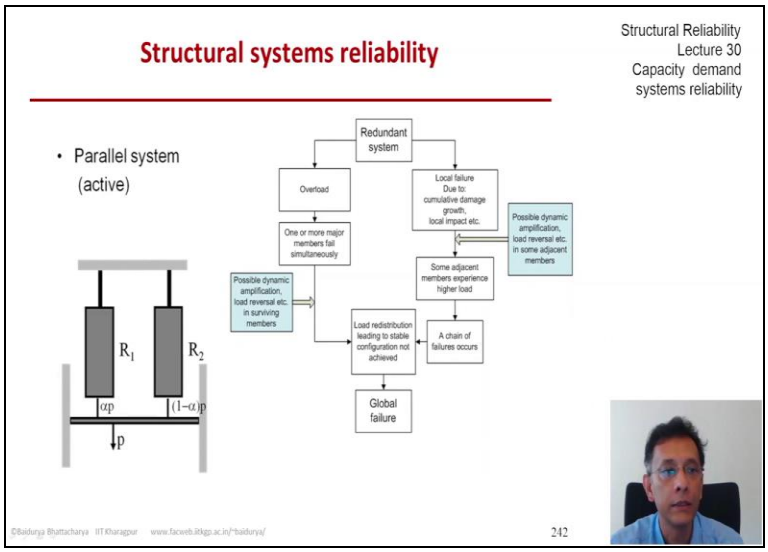

So, what you see on the left is an active parallel system again the simplest possible situation where we have two members loaded by a common load P and the load is shared by 2 not necessarily equally in this particular situation for equilibrium we have P balanced by alpha P in the left member and one minus alpha P in the right member as long as both members are intact. Now this system itself we understand that if one of these two members fail it does not fail automatically provided the remaining member the surviving member is able to pick up the slack.

So, we have a redundant system in hand and in this particular example this is an active parallel system. So, let us see what are the issues of such a redundant system? So, let us walk through the flowchart on the right. So, we have discussed that a structure may fail under overload or under cumulative damage. So, let us see what the overload would do to the failure of a redundant structural system.

So, if there is suddenly a huge massive load on part of a structure then one or more major members or subsystems can fail and almost simultaneously without any chance of warning or redistribution. And while that happen it is possible that there could be dynamic amplification there could be load reversals and such in the surviving members and if it is not possible to reach a stable configuration after this massive damage with load redistribution among the surviving members then we would have global failure.

On the other branch we could have for the redundant system a local failure this local failure could involve one member two members due to cumulative damage for example a member may have increasing corrosion or increasing crack size and then finally it is not able to take that load under normal operating loads and there is that local failure. Then due to this failure we could have just like in the earlier case in the left branch there could be dynamic amplification there could be load reversal in some of the nearby members.

And then these members would experience higher loads and which might or might not be arrested. So, if it is not arrested then a chain of failure occurs and again to a point that we cannot have a stable configuration formed and leading to global failure. So, a CD system does not have this complication or luxury if I may use the word any member failure any single logical element failure means the entire system has failed but if we have a redundant you….