Introduction to Materials Science and Engineering
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Lecture – 141
Stress Concentration

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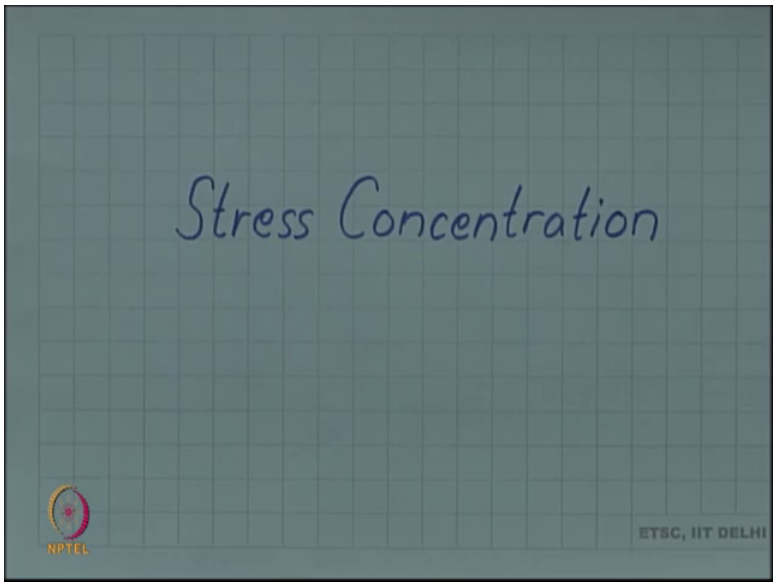

An important aspect of roll of crack in the fracture of material is the Stress Concentration caused by them. By stress concentration we mean the stress ahead at the crack tip.

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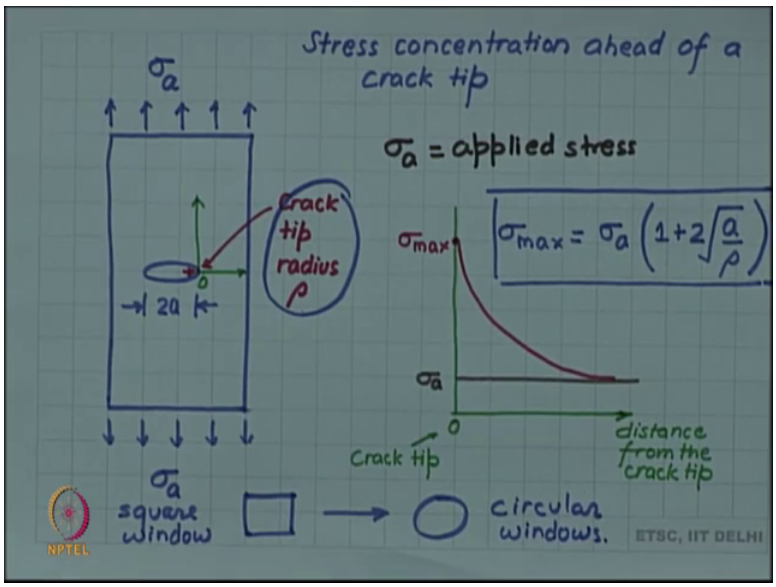

So, this is a crack in a body under an applied stress of sigma a. So, sigma a is the applied stress but if we look at the stress along this line starting from the crack tip and going away from that along this line and plot the stress on the y axis, let us do that. So, origin is at the crack tip and this is distance from the crack tip, then what you find is that if and let us say that this stress let me plot.

Let us say that this was the stress which was applied sigma a, but at the crack tip we will find that the stress is much higher than sigma a. So, stress variation ahead of the crack tip will be something like that. So, at the crack tip; we have a stress value sigma max which is many times higher than the applied stress, whereas, as we go away from the crack tip the effect of crack tip will be reduced and far away from the crack tip, we will be approaching the applied stress.

So, this can be the maximum stress is given by a simple formula which let us write that down. So, the maximum stress sigma max is equal to sigma applied times a stress concentration factor which is 1 plus 2 times square root of a by rho, where a is the half crack length as shown here and rho is the crack tip radius rho is the crack tip radius. So, this is a stress concentration formula which gives the maximum stress at the crack tip. So, although the applied stress may be much lower; the crack tip actually feels a much enhanced stress depending on the crack length and the crack tip radius.

Larger is the crack length more is the enhancement more is the stress concentration. Similarly a smaller is the crack tip radius that is sharper is the crack higher is the stress concentration that is why in engineering design sharp notches in the design has to be avoided. So, it is much better to have for example, in the aircraft industry a change took place from square windows to round windows.

Now, window is not a crack, but it still is an opening and there will be stress concentration around the window edge, but at the square corners the radius is very small. So, the concentration will be very high. So, initial failures were often noted at the corners of square window. So, gradually they went for circular or oval windows to reduce such a stress concentration.