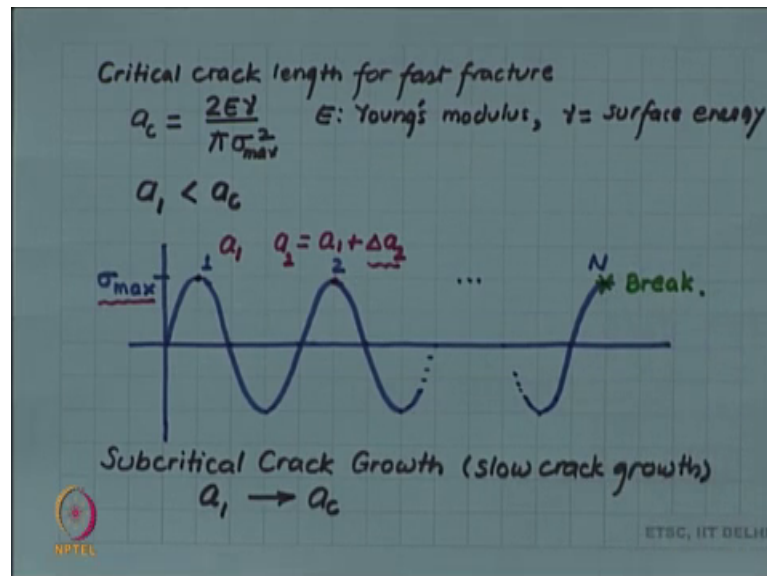


Introduction to Materials Science and Engineering
Prof. Rajesh Prasad
Department of Applied Mechanics
Indian Institute of Technology, Delhi

Lecture – 147
Sub-critical crack growth

(Refer Slide Time: 00:08)



So, let us now look at this cyclic loading and I have labeled the arrival of maxima, as the first maxima, second maxima and so on and as the cycling is going on, after on the Nth maximum the component breaks. There is a fracture. Now the question is when the sample did not break, when the component did not break in the first cycle, in the second cycle why the same component breaks at in the Nth cycle when the maximum stress is the same as in the first cycle or second cycle.

Let us look at it from Griffith's crack theory, which we have discussed. So, if sigma max is the load at which the component is operating, then we can find a critical crack length critical crack length, for fast fracture a c as 2E gamma by pi sigma max square, where E and gamma have the useful meaning E is the Young's modulus and gamma is surface energy.

Now, since the component did not fail on reaching this maximum stress this means that the existing crack length, the actual crack length a in the material let me call that a initial

or a_1 . So, a_1 is less than this critical crack size. So at σ_{max} a crack of length a_1 will not grow and a_1 is the crack length existing in the material.

So, since after unloading we are reloading again then this crack still will not grow. So, if we continue so on in the N th cycle also a crack of length a_1 should not have grown. This is fine, but what is being missed in this analysis that a_1 , the initial crack length a_1 will continue to grow with every cycle; this is called a Subcritical Crack Growth, subcritical crack growth, which means although the crack size was a_1 here, in the next cycle it had become $a_1 + \Delta a_2$.

So, there will be some increment of a crack length in each cycle. If these increment keep happening then you can see that after certain number of cycle a_1 would have grown to the length a_c . So, sub the crack growth from the initial crack length a_1 to the critical crack length a_c is called, the subcritical crack growth and this is the cause of the fatigue. This is not governed by this Griffith's criterion. This criterion tells that a crack of length a_c will grow in a fast fracture mode. There will be a very rapid crack growth, but a subcritical crack growth is a slow crack growth, but when the crack length will reach a_c , a fast fracture will take place and that is the end of the life of the component.