**Computer Methods of Analysis of Offshore Structures**
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**Module - 03**
**Lecture - 06**
**Fatigue Damage 1 (Part - 1)**

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Friends, let us continue with the discussion on module 3, where we are discussing about the stochastic process.

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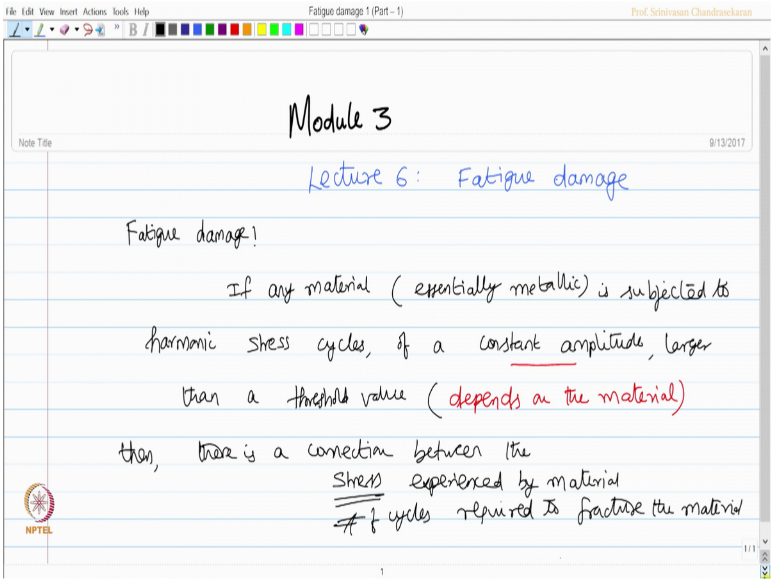


In lecture 6, today we will talk about Fatigue damage estimates which is one of the important methodology of estimating failure phenomenon in complaint offshore structures. Now, let us try to understand what do we mean by fatigue if any material essentially it is metallic is subjected to harmonic stress cycles of a constant amplitude which is larger than a threshold value the threshold value actually depends on the material because every material has a threshold value of acceptance of stress value.

So, if any material is subjected to harmonic stress cycles of a constant amplitude, which is larger than a threshold value then, there is a connection between the stress experienced by the material and the number of cycles which is required to fracture the material. So, a relationship is between the stress experienced by the material and the number of cycles required to fracture the material.

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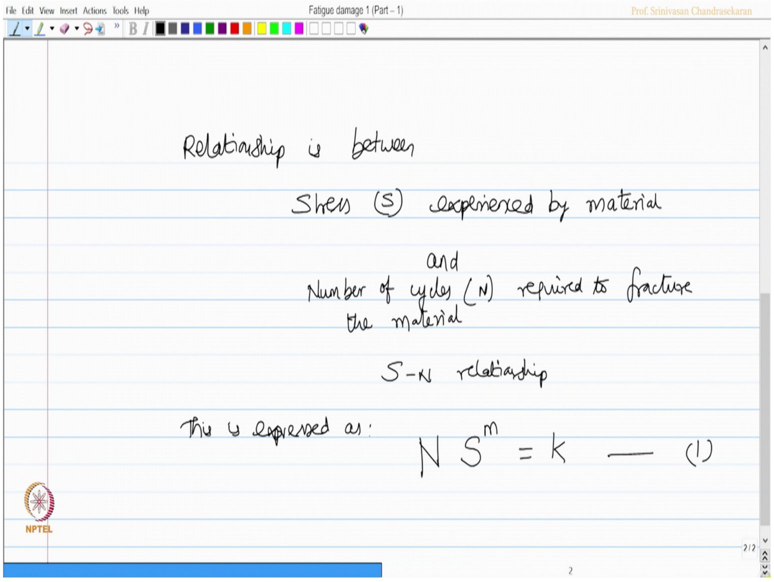


We call this relationship as S-N relationship this is expressed as N S to the power m is k I call this is equation number 1.

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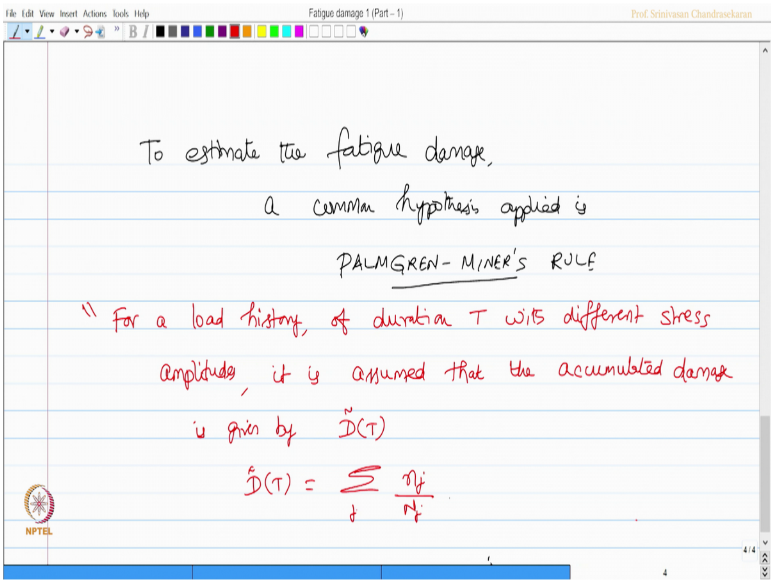


So, in this case N denotes the number of cycles to fracture the material, S denotes the stress range that is very interesting it is not a single value at which the material fracture, but there is a range m and k are actually material constants. Usually, m varies anywhere from 3 to 5 for marine steel, we will talk about this slightly later in more detail. We estimate the fatigue damage a common hypothesis applied in the literature is Palmgren - Miner’s Rule.

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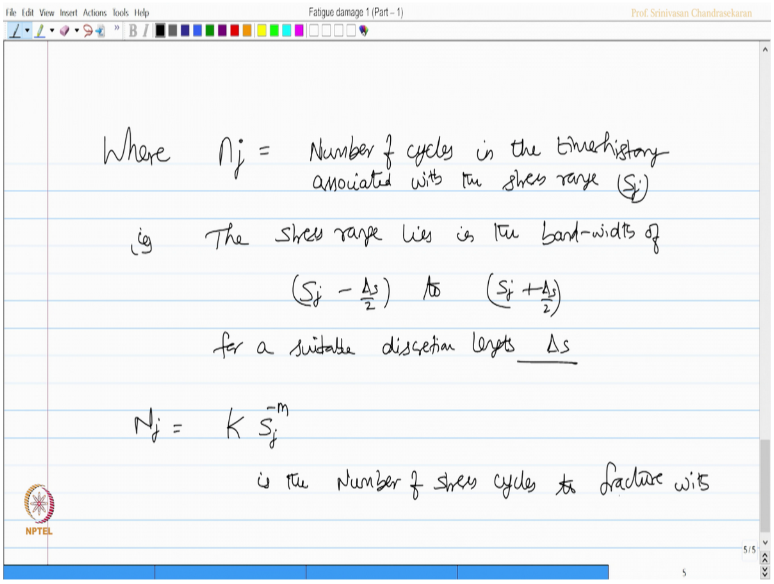


What is this rule state? This rule states that for a load history of duration t with different stress amplitudes, it is assumed that the accumulated damage is given by D T which is summation of n j to capital N J is summation equation 2, Where the n j is number of cycles in the time history associated with the stress range S j, that is the stress range lies in the bandwidth of S j minus delta s by 2 to S j plus delta s by 2 for a suitable discretion length delta s, capital N J is actually equal to K S j minus m which is the number of stress cycles to fracture with stress range S j, fracture is assumed to occur when the following condition is satisfied.

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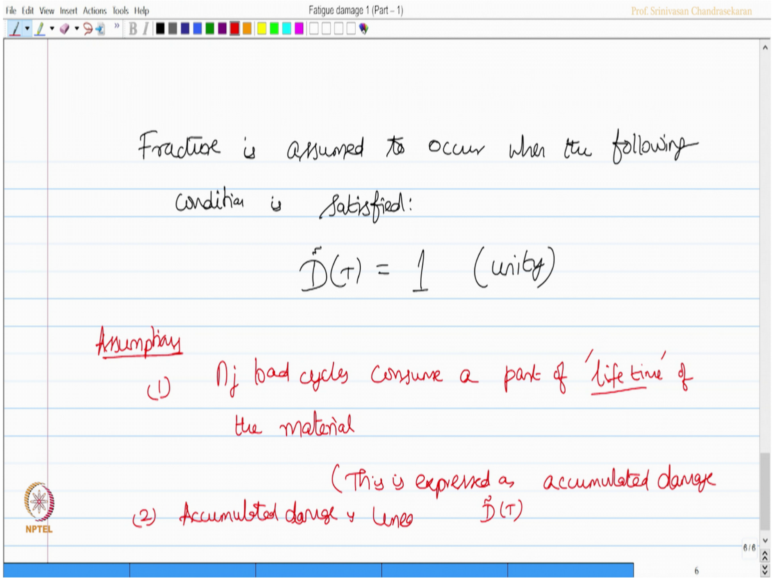


It says that, it should be equal to unity the above hypothesis an assumption it says that that n j load cycles consumes a part of the 'lifetime' of the material. This is expressed as accumulated damage which is D T, the second assumption it says that the accumulated damage in this model is linear.

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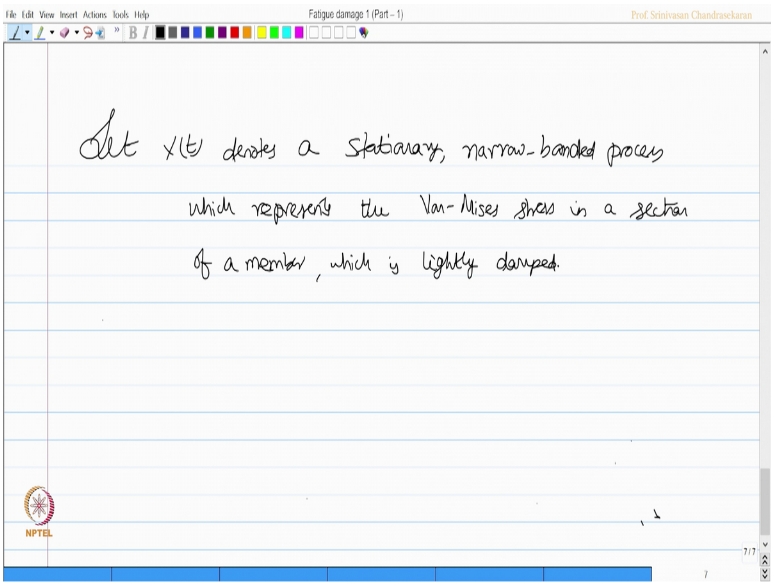


Let us say that the X of t is a response time history which denotes as stationary, narrow banded process which represents the Van - Mises stresses in a section of a member which is lightly damped.

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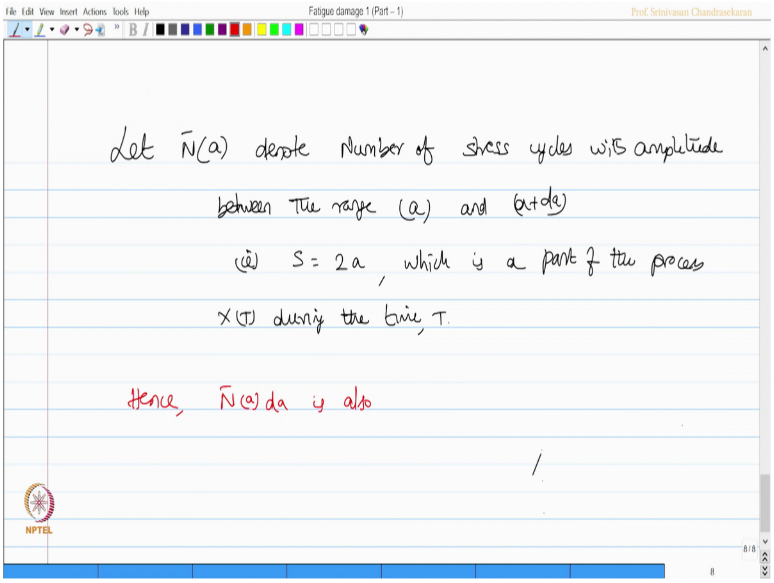


So, to start with we assume that X of T is a 0 mean process in that case, let N bar of a denote the number of stress cycles with amplitude between the range a and a plus d a that is S is going to be now equal to 2 a which is a part of the process X of T during the time T. Therefore, friends we now understand that N bar a d a is also a random variable.

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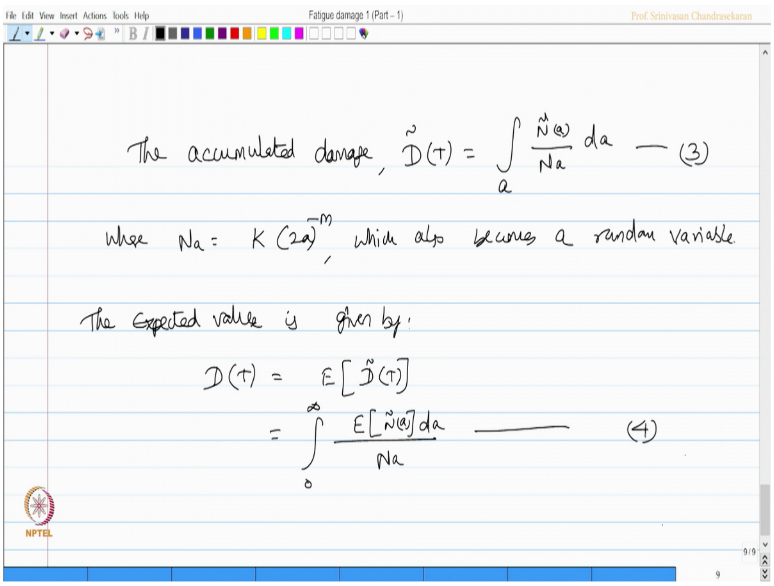


The accumulated damage, as given by the existing hypothesis is followed by the same equation call equation number 3, where N a is K stress range to the power of this load, which also becomes a random variable the expected value is given by D of t the expected value of this which is further said as integral 0 to infinity expected value of N tilde a d a by N a which I say as equation 4.