Computer Methods of Analysis of Offshore Structures

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Module - 03
Lecture - 06
Fatigue Damage 1 (Part - 2)

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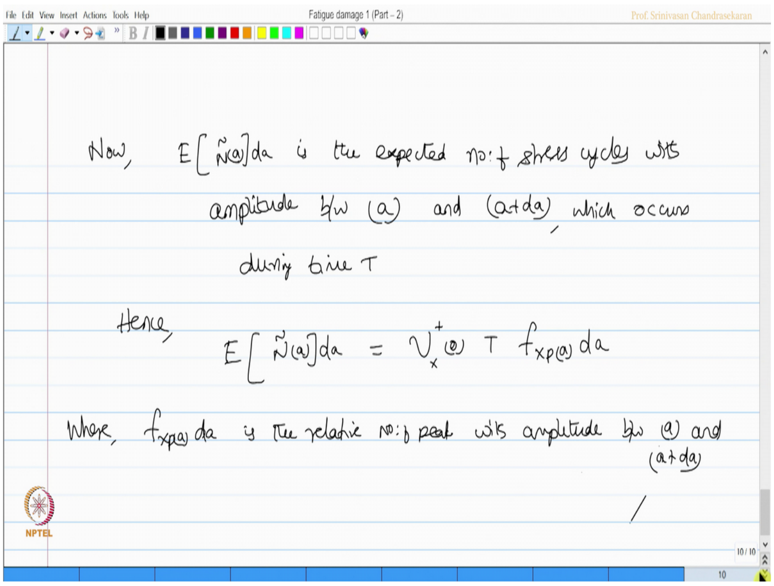

Now, the expected value of N tilde a d a is actually the expected number of stress cycles with amplitude between a and a plus d a, which occurs during time t hence the expected value of n tilde a d a is now expressed as V x plus of 0 t f x p a d a where f x p a d a is the relative number of peaks with amplitude between a and a plus d a.

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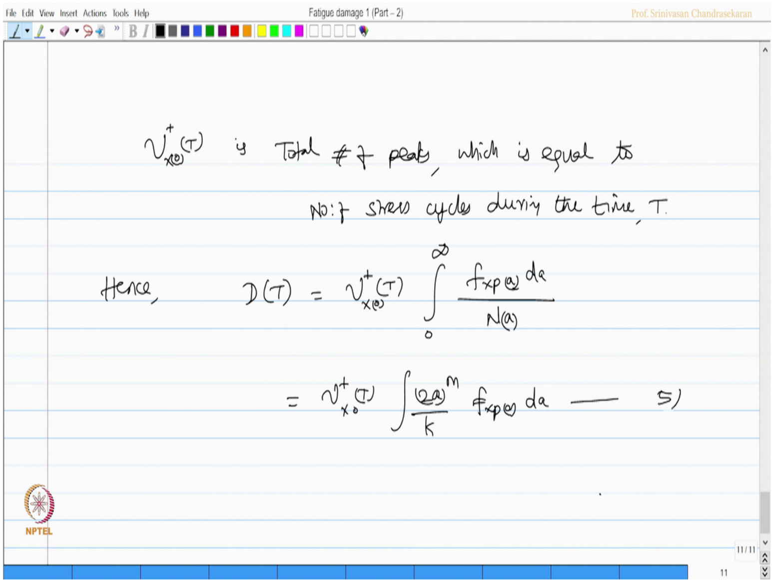

V x 0 plus T is the total number of peaks which is equal to the number of stress cycles during the time T. Therefore, d of T is V x 0 T, integral 0 to infinity f x p a d a by N of a which expressed as V x 0 T internal 2 a to the power m by K f x p a d a I call this as equation 5.

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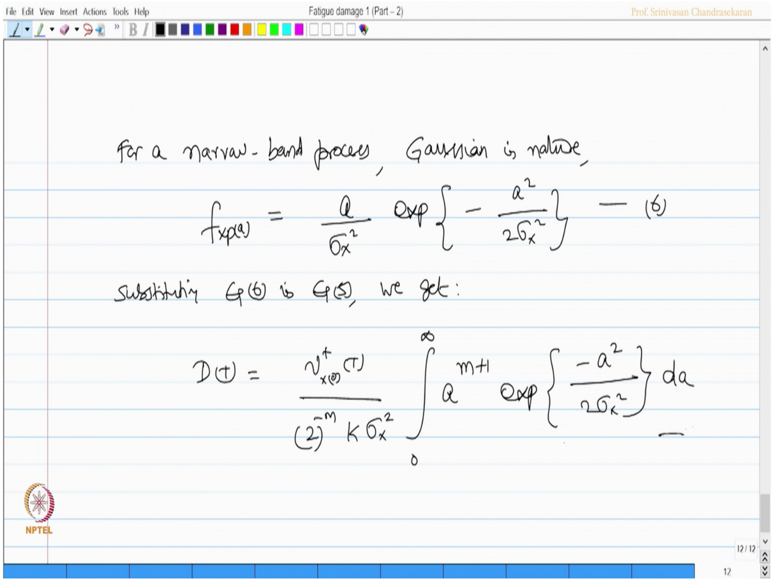

For a narrow - band process, which is also Gaussian in nature f x p of a is given by a by sigma x square exponential minus a square by 2 sigma x square now substituting that value in question 5. So, substituting equation 6 in equation 5, we get D of T is V x 0 by 2 minus m K sigma x square integral 0 to infinity, a m plus 1 exponential minus a square by 2 sigma x square d a. I call this as equation number 7.

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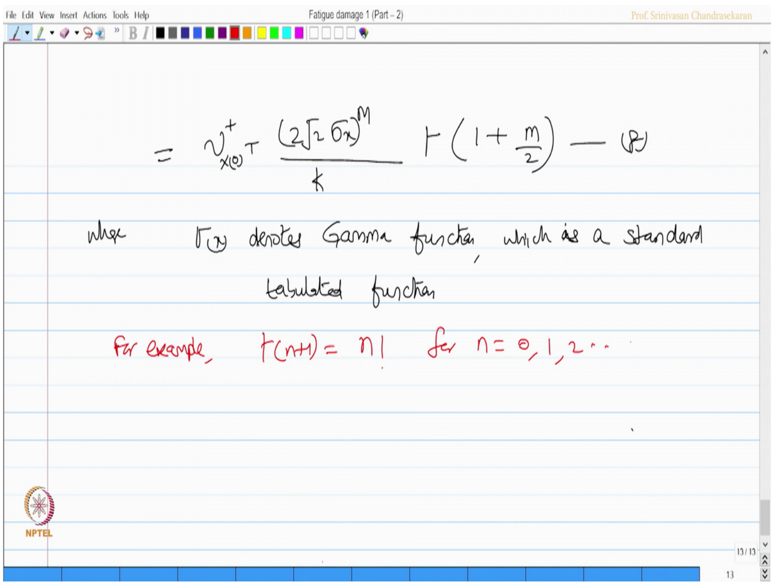

Which can be simplified as V x 0 T 2 root 2 sigma x m by K gamma function 1 plus m by 2, where gamma x denotes a Gamma function, which is a standard tabulated function whose values are available in the statistical table. For example, you want to find gamma n plus 1 is n factorial for n equals 0 comma 1 comma 2 and so on.

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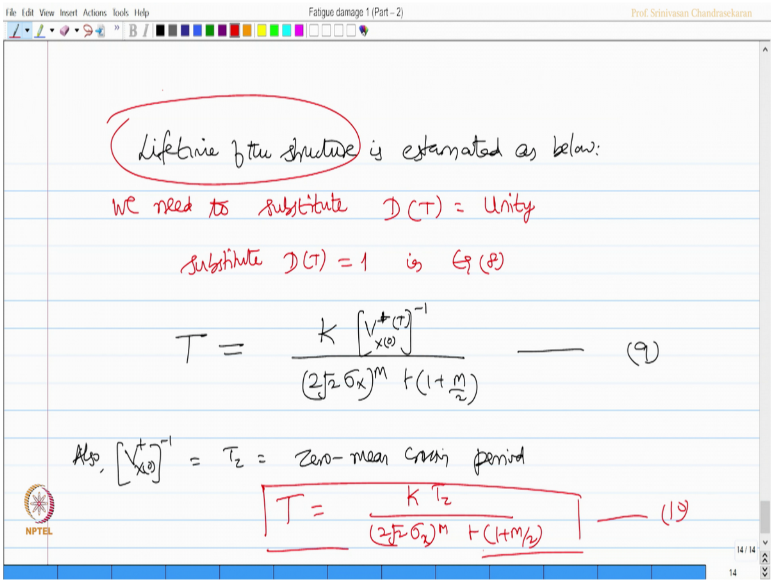

After, estimating the cumulative damage one is interested to know how to estimate the Life time of the structure it can be estimated as below, it is very simple we need to substitute D of T as unity that is the hypothesis. So, substitute D of T as one in equation 8. In equation 8, is what we see here substitute this value equals 1. So, I should say then in that case because equation 8 involves T, I am interested to find out t I substitute this equal to 1 and find T.

So, by readjusting I can write the equation for T as, K V x 0 T 2 root 2 sigma x to the power m gamma function 1 plus m by 2 equation 9, also V x 0 inverse there is an inverse sign here, is actually T z which is called 0 mean crossing period and now t which is the life time estimate is given by K T z 2 root 2 sigma x m gamma 1 plus m by 2. So, this is my equation forgetting the Lifetime estimate of the structure.

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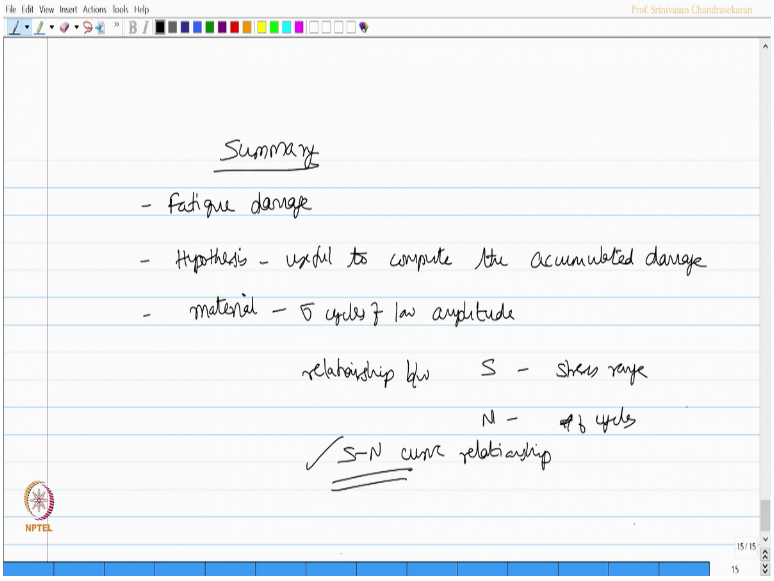

So friends, let us look at the summary what we learnt in this lecture. We understood how to compute the fatigue damage, what is the hypothesis which is used to compute the accumulated damage when the material is subjected to stress cycles of low amplitude you can establish a relationship between the stress range S and the number of the cycles N which is famously called S-N curve relationship. This relationship is available for variety of marine steel in offshore structures in various International course.

So, in the next lecture we will take up an application example problem and try to estimate the fatigue damage given on different members based upon the material capacity. We will do couple of problems with an application problem in offshore structure. We will also discuss the computer code, how to estimate this damage using a simple procedure.

Thank you very much.