Computer Methods of Analysis of Offshore Structures
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Module - 03
Lecture - 04
Return Period & Stochastic Process (Part - 1)

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When you talk about computer methods of structural analysis applied to offshore structures, we all now understand that offshore structures encounter loads which belong to are originate from a stochastic process or a random process. In the previous few lectures we discussed about salient characteristics of random process importantly, one designer is interested to know what would be the period within which or after which a load amplitude will reoccur on a given structure, this is what we call as return period, Return period and stochastic process have a very close association. So, in lecture four now we will talk about return period and more details about stochastic process.

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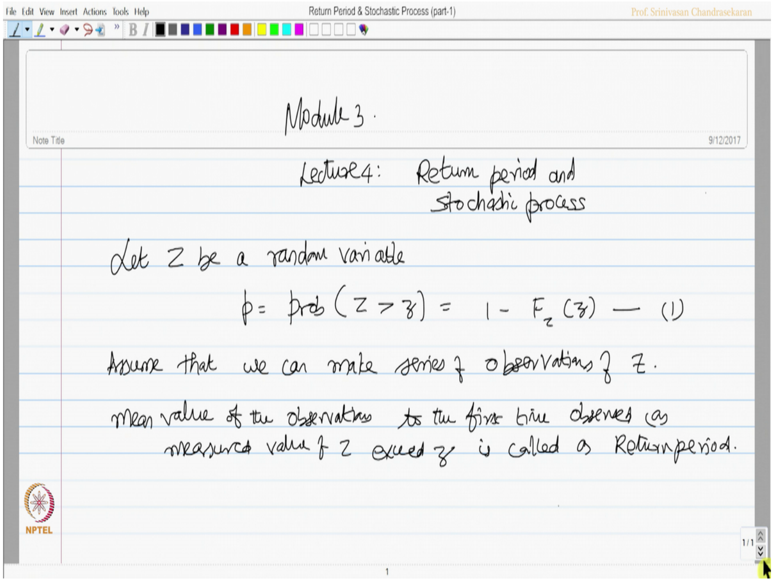

Let us say Z be a random variable, p be the probability of z exceeding z which can be simply given by 1 minus F z of z. I call this as equation 1.

Assume that we can make series of observations of z, now once you make series of observations mean value of the observations to the first time observed or maybe measured value of z exceeds z is called as return period.

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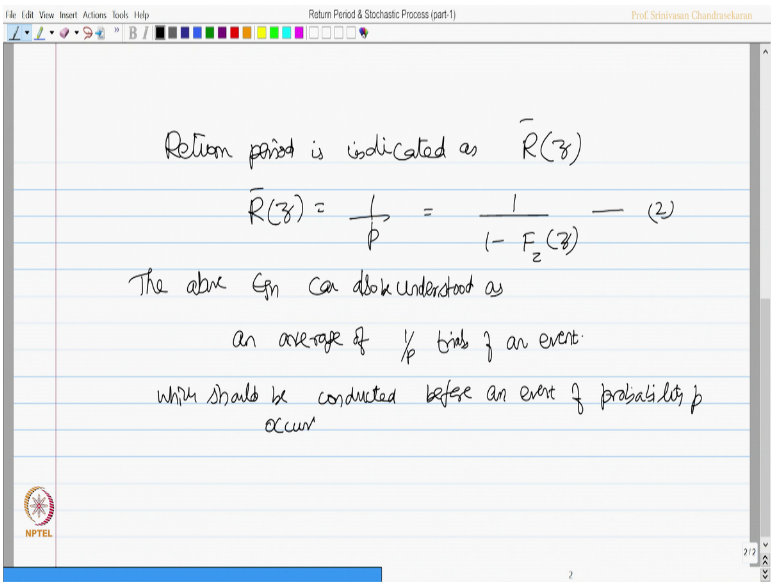

Let us elaborate this more in detail, return period is indicated as R bar of small z which is given by 1by probability which is 1 by 1 minus Fz of z equation number 2.

Now, the above equation can also be understood as an average of 1 over p trials of an event, this should be conducted before an event of probability p occurs.

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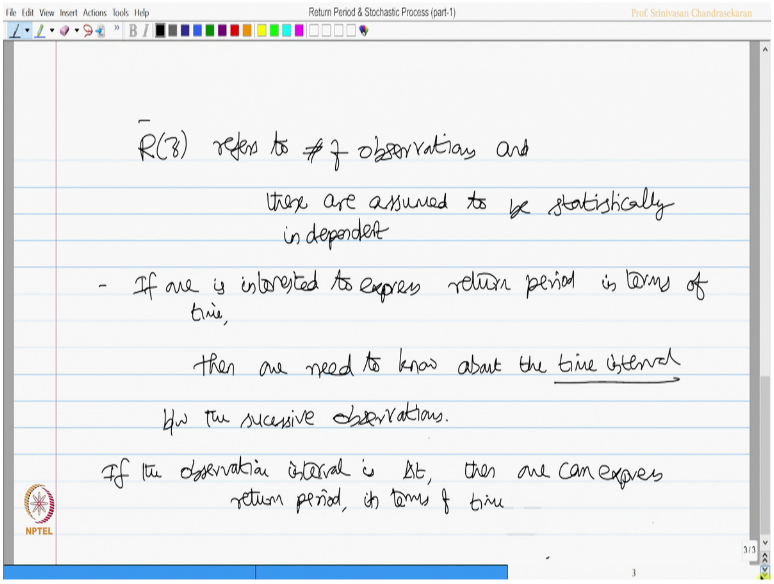

Now, R bar of z refers to the number of observations and these are assumed to be statistically independent that is an important statement.

Suppose if one is interested to express return period in terms of time, then one need to know about the time interval between the successive observations. If the observation interval is delta t then one can express return period in terms of time which can be given by Rz is delta t R bar z which I call equation 3.

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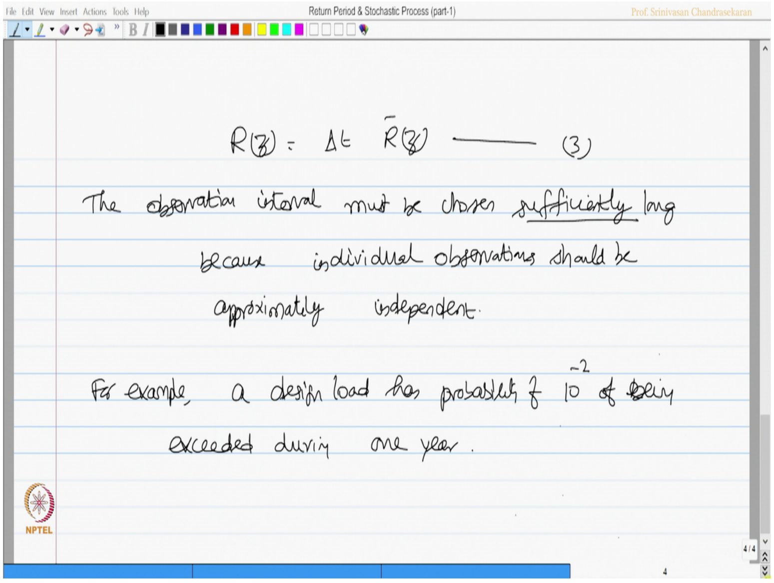

Interestingly the observation interval must be chosen sufficiently long that is an important statement why because, individual observations should be approximately independent. Let us apply this for an example case and see what happens. Let us take for example; a design load has probability of 10 power minus 2 of being exceeded during one year.

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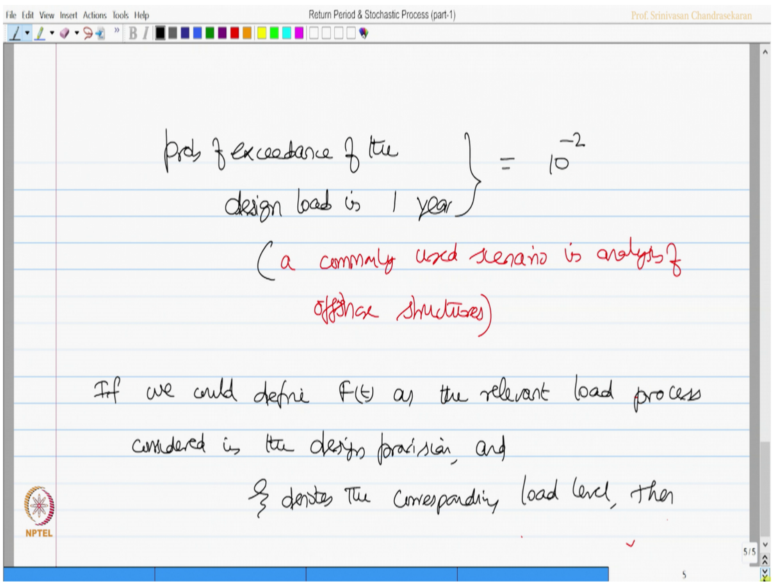

So, probability of exceedance of the design load in one year is taken as 10 power minus 2, which is a commonly used scenario in analysis of offshore structures. Suppose if we could define F of t as the relevant load process, which is considered in the design provision and zeta denotes the corresponding load level.

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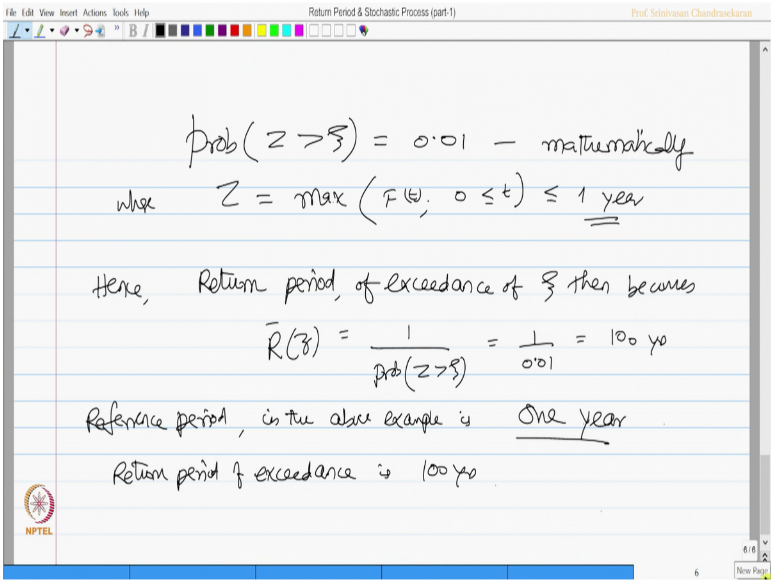

Then probability of zeta z exceeding zeta is 0.01 mathematically is it not where z is now the maximum of F of t, 0 less than or equal to t less than or equal to one year.

Because the probability of exceedance of this value of 10 power minus 2 is for one year; hence return period of exceedance of zeta then becomes R bar of z 1 by probability of z exceeding zeta is 1 by .01 which is 100 years. So, the reference period in the above example is one year and return period of exceedance is 100 years.

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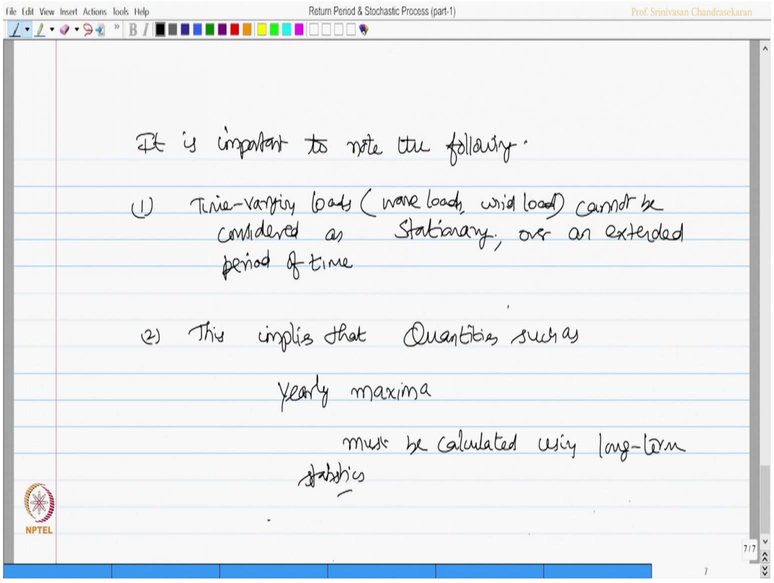

Friends it is important to note the following time varying loads like wave loads wind loads etcetera cannot be considered as stationary over an extended period of time therefore, this implies that quantities such as yearly maxima must be calculated using what we call long term statistics.

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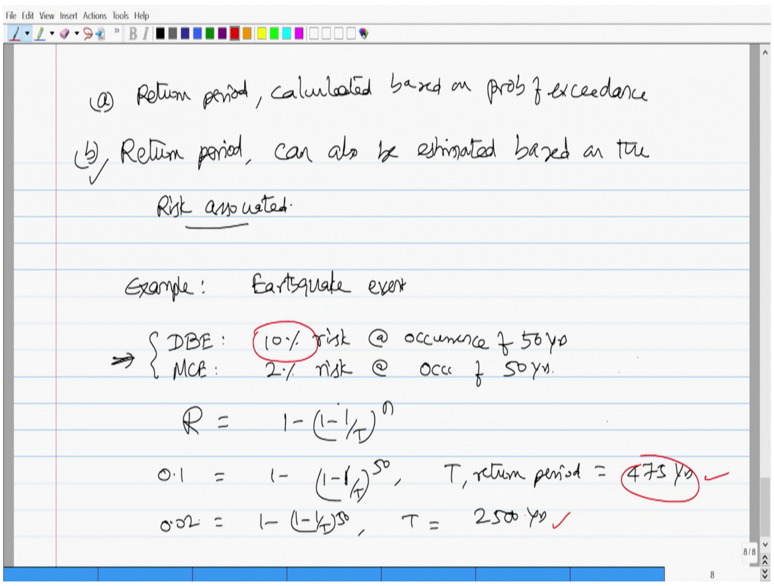

One can also estimate return period can also be estimated based on the risk associated that is a second component. What you have learnt in the first component was return period calculated based on probability of exceedance. Let us now see how to estimate return period based on risk associated, we will take an example of an earthquake event. Let us say there are different levels of earthquake considered for design of strategic structures like offshore structures design basis earthquake, which has got t10 percent risk at occurrence of about 50 years. Maximum credible earthquake which is 2 percent risk at occurrence of 50 years.

So, now, I want to estimate return period based upon the risk level. So, return period can be given as 1 minus 1 minus 1 by T to the power n. So, let us substitute the risk is 0.1 that is 10 percent 1 minus 1 by T to the power 50 which amounts T the return period as 475 years. Similarly for 2 percent risk 1 minus 1 over T of 50 which gives me T as 2500 years. So, friends these example simply illustrates depending upon the risk admittance in a given design return period can be as close or as far away as 2500 years.