Structural Health Monitoring (SHM)
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Lecture - 01
Introduction to Structural Health Monitoring - Part 1

Friends, welcome to the course title Structural Health Monitoring which we abbreviate has SHM.

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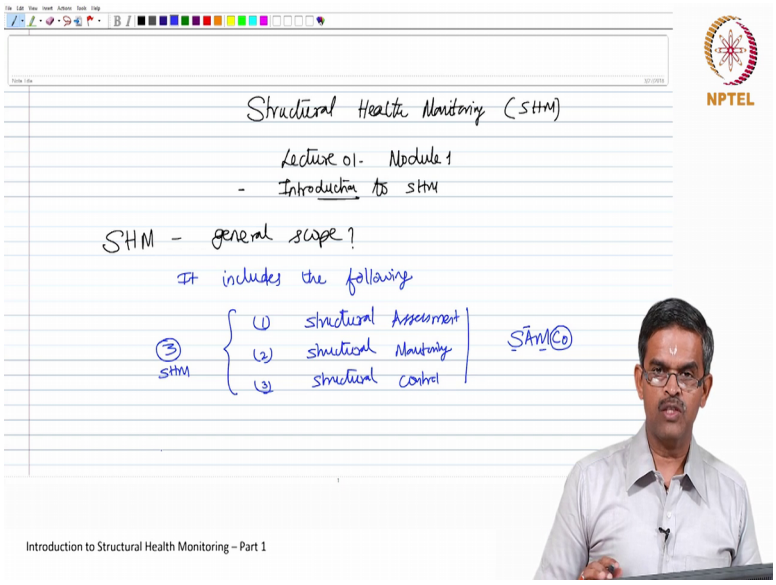

We will start with the lecture 1 in module 1. In this lecture, we will discuss about Introduction to Structural Health Monitoring. The foremost question comes what will be the general scope of SHM.

The general scope of SHM includes the following: Structural assessment, structural monitoring and structural control. This can also be abbreviated as SAMCo; structural assessment monitoring and control. So, friends one can see a very clearly, there are 3 components which are vital in SHM.

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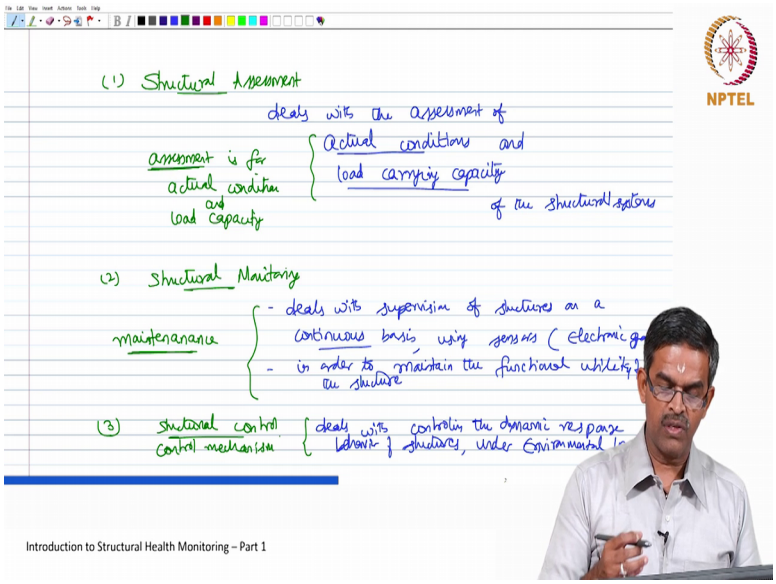

Let us first understand scope of each one of them separately. What do you mean by structural assessment? Structural assessment deals with the assessment of actual conditions and load carrying capacity of the structural systems. So, essentially the assessment is for the actual condition and load capacity, so that is the first objective of SHM. The second objective is structural monitoring.

Structural monitoring deals with supervision of structures on a continuous basis. So, friends, the moment we say supervision is done on continuous basis, one can realize that it will be done using sensors or some electronic gadgets. Why they are done? They are done in order to maintain the functional utility of the structure. Essentially in nutshell these deals with maintenance; so this is assessment, this is maintenance the third one is structural control.

Structural control deals with controlling the dynamic response behaviour of structures under various environmental loads. So, this deals with establishing your control mechanism. Let us ask a question priority of importance of 3-3 objectives, let us say priority.

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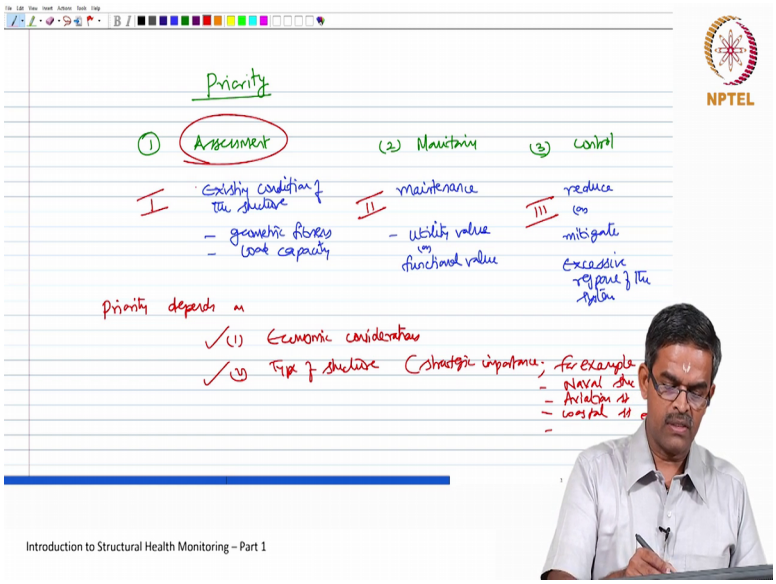

What are the 3 objectives? Assessment, which talks about preparation of existing condition of the structure in terms of it is geometric fitness and load capacity.

The second one is monitoring which is more or less related to maintenance, which establishes the utility value or functional value. The third one is the control, which aims to reduce or mitigate excessive response of the system.

What we are now attempting to see in this slide is, out of these 3 main functions of structural health monitoring, which will be of foremost importance to us. Of course, the priority depends on 2 factors. One of course the economic consideration, 2 what type of structure we looking for; if it is a structure of a strategic importance for example, naval structures, aviation structures, coastal structures, etcetera.

So, depending upon the type of the structure, and of course, the economic considerations which drive the whole concept of application of SHM in structural engineering one can decide the priority. Concerning a normal type of structure under a given normal budgetary considerations, assessing the condition of the structural system is very important. If you want to make an effective design, then one can do for the control exercise, but prior to that maintaining the utility value of the structure is also equally important. And third of course comes intelligent design using smart structures.

So, if you look at the chronological order of priority of applications of these objectives in structural health monitoring, the foremost objective comes assessment. Once you assess you will exactly know the existing condition of the structure. Now there is a very interesting question asked what exactly SHM deals with in terms of it is critical summary.

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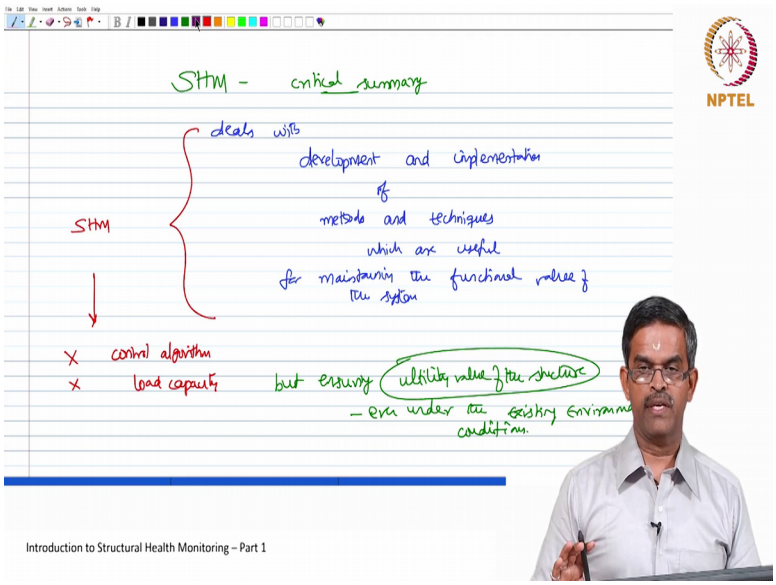

What all SHM can cover, very interesting; SHM actually deals with development and implementation of methods and techniques which are useful for maintaining the functional value of the system.

So, one can say very clearly here, that the main objective of health monitoring is actually not exercising your control algorithm. Not exercising assessment of load capacity, but ensuring the functional utility value of the structure, even under the existing environmental conditions. I will come to the point what will happen if these conditions change.

So, SHM talks about essentially maintain utility value. This is where most of the countries and most of the policy and planning guidelines, pay attention towards maintaining the functional value of critical structures, and they call that as health monitoring.

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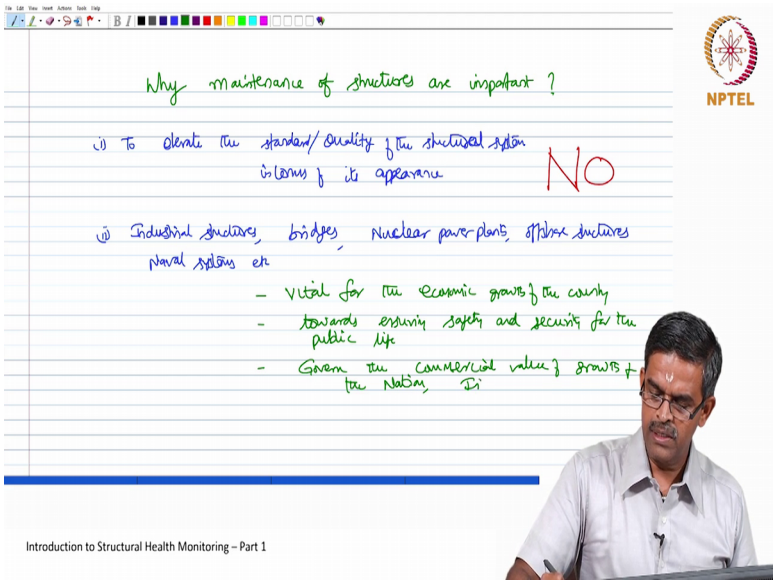

Having said this, a fundamental question can come in mind, why maintenance of structures are important.

Why do we maintain structures? Once the structures are constructed, and they are commissioned and handed over to the client, the client started using the structure, maybe a bridge, maybe a utility building, maybe any public building. Why do we have to maintain them? A very rough view of maintenance is to elevate the standard or quality of the structural system in terms of it is appearance; is this reason why we maintain structures. The answer is no. This is not the reason why we maintain structures.

If we talk about industrial structures, bridges, buildings of strategic importance like nuclear power plants, offshore structures, navel systems etcetera, the foremost issue is they are vital for the economic growth of the country. They are also important towards ensuring safety and security for the public life. Further they govern the commercial value of growth of the nation in international market.

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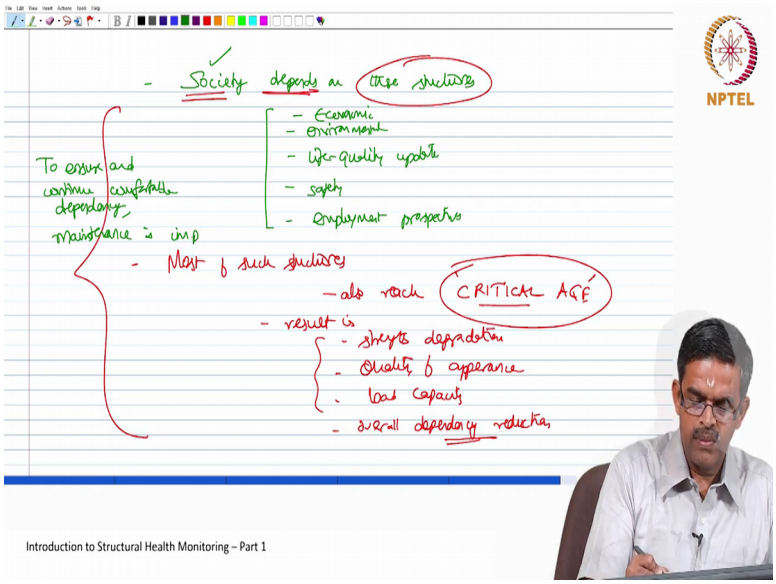

Further society, essentially depends on these structures for various reasons for economic, environment, life quality updates, safety and of course, employment perspectives. So, there is a heavy dependence on these structures with a society itself, public depends on these structures.

But unfortunately, most of the structures also reach what we call as critical aging, which can result in strength, degradation, quality of appearance, load capacity and overall dependency reduction. Please understand friends, aging can lead to reduction in dependency, whereas, society depends on these structures.

Now, to ensure and continue a comfortable dependency of the structures maintenance is important.

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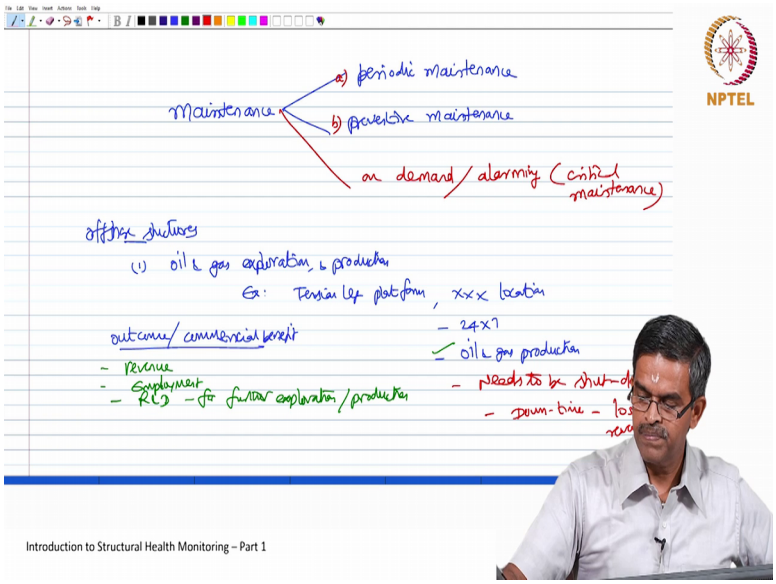

The moment I say maintenance, there are 2 ways I can attempt to do maintenance. One periodic maintenance, other is preventive maintenance. The third one is more alarming maintenance only on demand, or when the system becomes very alarming what we call as critical maintenance. This is very dangerous; we do not start maintaining a structure once the structure reaches a critical stage. Because then recovery of strength of the structure is very, very difficult.

When you look at the objective of periodic and preventive maintenance, let us apply and take an example to discuss this. Let us talk about offshore structures, let us talk about platforms are used for oil and gas exploration and drilling exploration and production. Let us take an example of a tension leg platform located in xxx location, working round the clock towards oil and gas production.

Now, the outcome or commercial benefit of this structure could be revenue. Because it is exploring oil and gas and oil gas is sold in the market, two high tech employment and constant research and development for further exploration and production. Imagine that this structure needs to be shut down because of some maintenance. So, the period of shutdown is what technically called as downtime will lead to loss of revenue. One does not expect a revenue loss of these structures.

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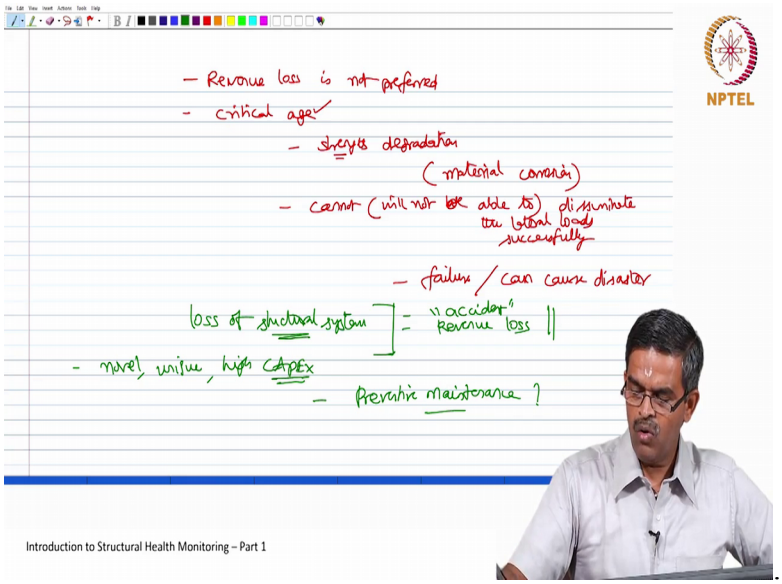

So, revenue loss is not preferred, one; 2 the structures are reaching critical age there is a strength degradation, there can be many reasons as you all agree this can be essentially due to material corrosion in sea. As a result, when the structure reaches a specific age, the strength loss happens and the structure cannot, let us say will not be able to disseminate the lateral loads successfully.

So, there is going to be a structural failure, which can cause a disaster. For all you care it can be called as an accident. For all you know, it is going to be a revenue loss, but what I am bothered more is not these 2. I am bothered more is loss of the structural system itself. So, these structures which are of very novel, very unique and high investment cannot be afford to be lost. So, instead of doing a periodic maintenance I must do what is called a preventive maintenance. Now the question comes, how do you do a preventive maintenance.