Structural Health Monitoring (SHM)
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Lecture - 02
Introduction to Structural Health Monitoring - Part 2

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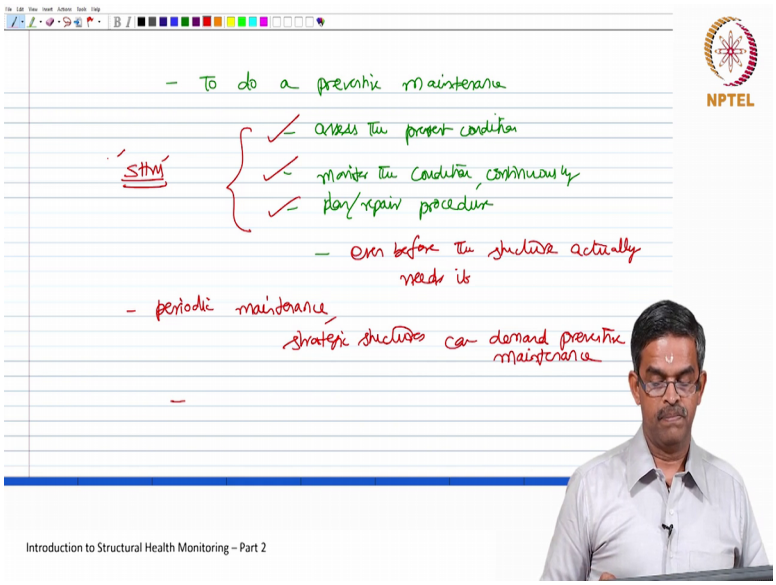

To do a preventive maintenance, one must assess the present condition. To assess the present condition one must monitor the condition continuously then one should plan the repair procedure even before the structure actually needs it.

So, instead of doing a periodic maintenance, strategic structures can demand a preventive maintenance. Preventive maintenance only possible when I monitor this, assess and then plan which is nothing, but structural health monitoring my dear friends.

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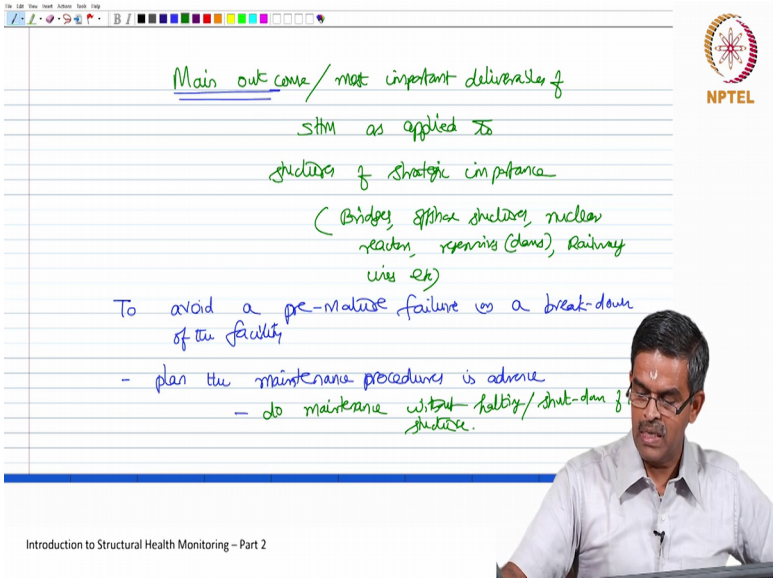

Therefore, main outcome one of the most important deliverable of SHM as applied to structures of strategic importance like bridges, offshore structures, nuclear reactors reservoirs this dams, railway lines, etcetera is to avoid a premature failure or a breakdown of the facility.

So, one of the main outcome of structural health monitoring is to ensure there is no premature failure of the structural system and structural system will never seek a breakdown in it is lifetime. So, you plan the maintenance procedures in advance and do maintenance without halting or shutting down of the structure. So, that is a very intelligent way of looking at it I can give a classical example.

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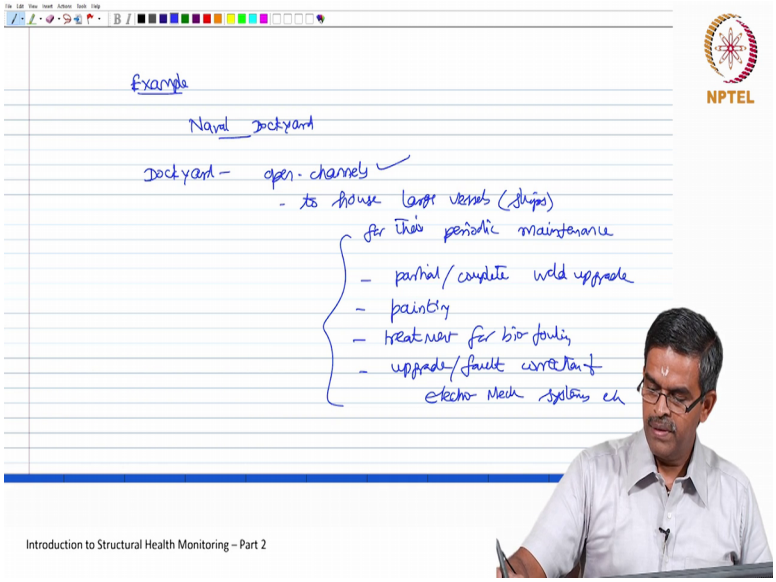

Let us take an example of a Naval Dockyard. Friends you all know that Dockyards are essentially open channels, which are constructed to house, large vessels let say ships for their periodic maintenance. Periodic maintenance could be partial or complete, weld upgrades, painting, treatment for bio fouling, upgrade, fault correction of electromechanical systems etcetera, there can be many job oriented demand in terms of vessels, which are brought down into an open channel which are called dockyards.

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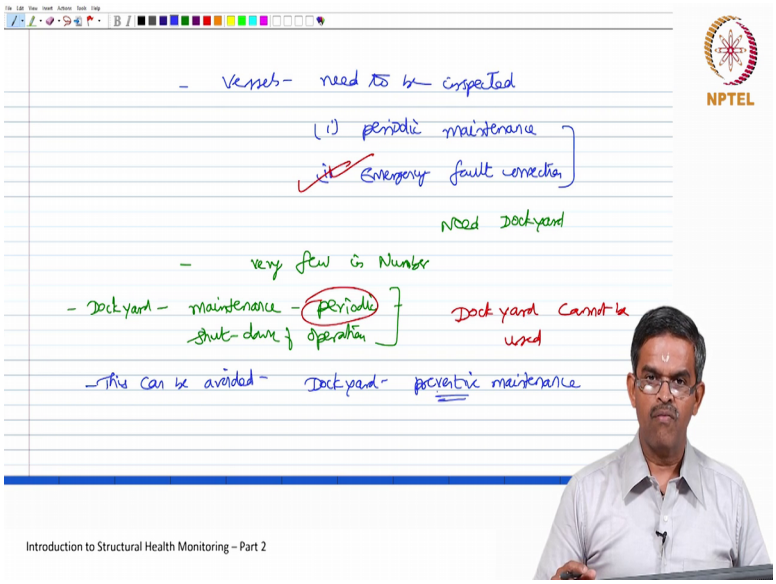

Now, navy operates on various kind of strategic vessels like submarines etcetera, these vessels need to be inspected. Inspection could be for a periodic maintenance, it can be on any emergency fault correction. So, they need a dockyard. Dockyards as far as India's concern operate be navy or very few number because they are expensive to maintain number 1 and number 2 you cannot allow the naval vessels to dock in any public dockyards.

So, having come to a point, if my dockyard is undergoing a maintenance which is a periodic maintenance, which demands shutdown of operation at that time had there been an emergency requirement of docking naval vessel. Now the dockyard cannot be used it reminds non-functional. So, the shutdown time cost by a periodic maintenance schedule on a dockyard or a structure of strategic importance deprive the basic utility value of the system itelf.

This can be avoided if the dockyard undergoes a preventive maintenance. So, it is not maintained periodically, but it is maintained in a very pre-planned preventive manner. So, that the dockyard always remains functional even during critical ageing, even in the critical environmental conditions; however, the utility value can be slightly decreased in terms of it is operational capacity, but however, no complete shutdown will ever happen for the dockyards.

So friends preventive maintenance is far advantages compared to a periodic maintenance. To do a preventive maintenance we need to assess monitor continuously to obtain the current condition and then plan for the type of maintenance, which may have to do for those kind of structures.

Having said this let us quickly compare the structural health monitoring and a human body analogy.

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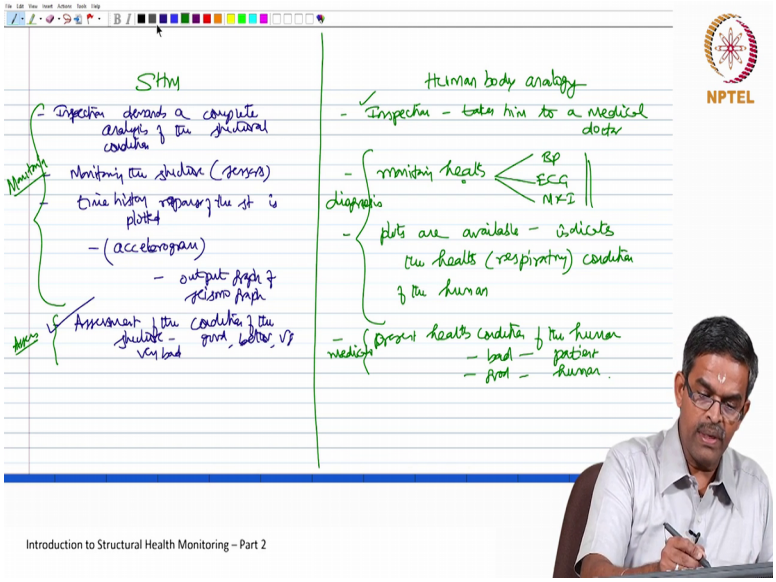

When a human fall sick he goes to a doctor so, he volunteers himself to go to a doctor or his parents, neighbours, friends, well wishers take him to the doctor. So, essentially inspection takes into the doctor to a medical doctor. Similarly, inspection demands a complete analogy or analysis of the structural condition, which can be done by monitoring the structure. In this case it can be done by monitoring his health, there are many ways blood pressure, ECG, electrocardiogram etcetera MRI whatever may be a situation demands as per the advice of a medical doctor his health can be monitored on a continuous basis.

Here monitoring is essentially done using sensors. Once sensors respond to the behaviour of the structure, the time history response of the structure is plotted accelerogram can be one example. Accelerogram is essentially output graph of seismograph equipment. So, in this case you can always see when you undergo electrocardiogram, there are plots again available, which indicates the health condition let us say respiratory condition of the human. Please understand we are not still calling the human as a patient because the human is not sick; he is being inspected and diagnosed. So this is what we call as diagnosis in medical term, this what we call as monitoring in SHM term.

While monitoring the output could be you result in assessment of the condition of the structure saying that whether it is good, better, very good, very bad, whatever may be the

indication you want to make you essentially come to a conclusion about the present condition of the structure which we call as assessment.

Similarly, after the diagnosis you come to a conclusion the present health condition of the human. If the health condition is bad he is admitted as a patient, if the health condition is good then he is recommended as a human and advice to continue certain medicines. So this is what we call as medication, this is what we call as assessment.

Once assessment is complete, then one can recommend certain control algorithms to reduce or completely mitigate the undesired responses of the structure.

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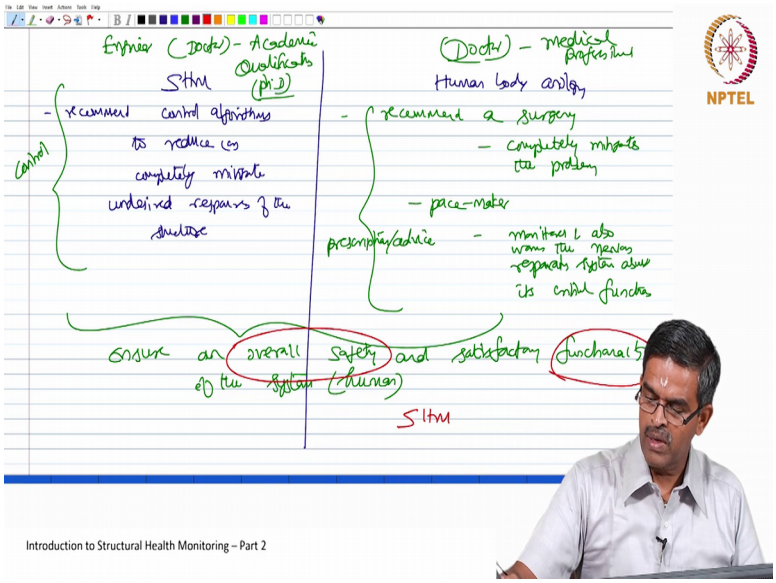

Here also similar thing is done based on the diagnosis and assessment, one can always recommend a surgery, which completely mitigates the problem or one can recommend a pacemaker for example, for a heart problem; which continuously monitors and also warms the nervous system or the respiratory system about its critical functioning. So, this is what we call as prescription or advice here we call this as control.

So, on the total if you look at comparing these 2, both of them ensures and overall safety and satisfactory functionality of the system or the human. Of course, this done by a doctor who is a medical professional and this is done by an engineer, who is also a doctor, but by academic profession; which we call as PhD. So, essentially both of them

follow the same analogy, you monitor, assess and then recommend control strategies; which can essentially ensure the overall safety and continuous functionality of the system. So, that is the main objective what we assume as SHM.

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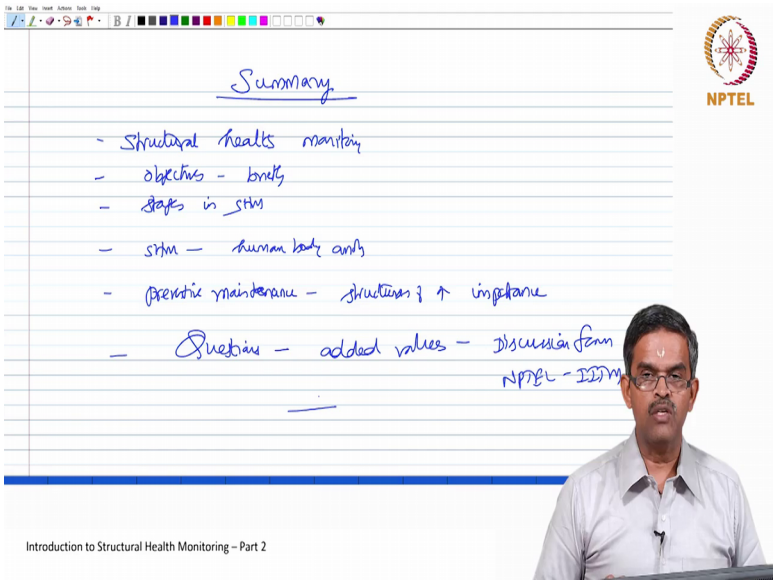

So, friends let us quickly see the summary what we learnt in this lecture, we understood what is meant by structural, health monitoring, what are the essential objectives briefly, what are the various stages in health monitoring, how health monitoring compares with human body analogy and what is the advantage of preventive maintenance compared to a routine maintenance especially when done for structures of high importance.

Hope you enjoyed the lecture we will be happy to take any questions or any added values of your suggestions through the discussion form of NPTEL IIT Madras.

Thank you very much see you in the next lecture bye.