Structural Health Monitoring (SHM)
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Lecture – 07
Challenges in Structural Health Monitoring - Part 1

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Friends, welcome to the 4th lecture in module 1 on the course title Structural Health Monitoring. In this lecture, we will talk about the Challenges in Structural Health Monitoring in general as applied to various industries. Let us look into them in specific order, the foremost challenge in SHM industry is that, to develop and demonstrate the health monitoring technology, which can be useful to maintain the structural integrity with improved reliability and durability.

Friends, there are many techniques by which health monitoring can be done and being practiced in many industries all over the world. Undoubtedly, most of them are very successful as well. However, we all will agree at one point that developing a technology itself, which suits the specific application problem is one of the important and major challenge in the SHM scheme. The second issue is compared to non-destructive tests; unlike conventional entities, a single technology of health monitoring cannot be suitable for all applications. That makes it more challenging, it depends on various factors,

depends on the material, depends on the component geometry and identifiable damage scenarios of a given structural system.

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The third issue which is also an important challenge is that, outcome of the monitoring scheme should be reliable because, sometimes it may trigger an unwanted maintenance which is expensive. It may also sometimes creates spurious warnings, this should be avoided such situations generally degrades the confidence level on the strength of existing structure. The 4th issue is that optimization of structural design on the basis of acquired data through health monitoring. So, it is important that, this data which is acquired through SHM should be fairly accurate and robust.
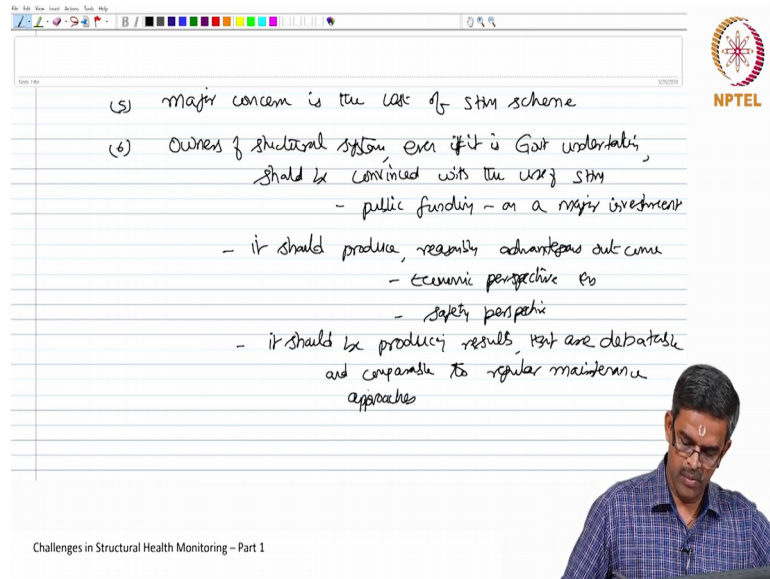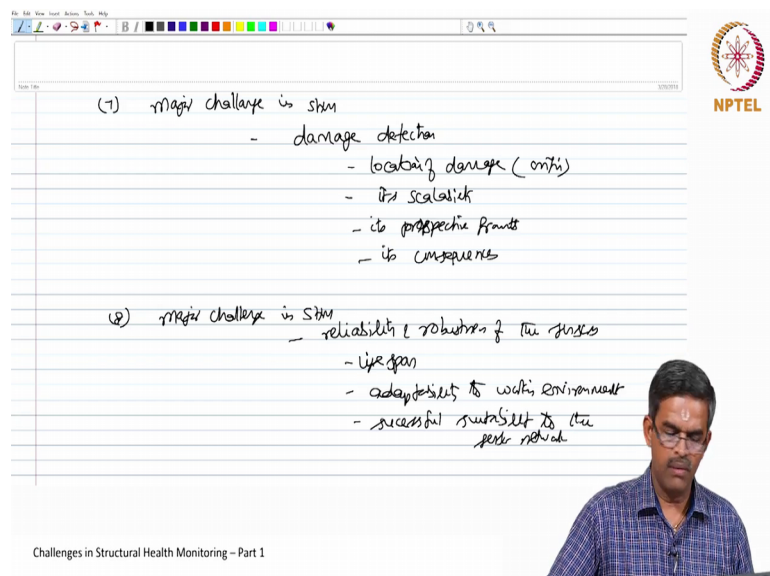
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The next challenge could be the major concern towards the cost of the whole scheme. The next every important factor, the owners of structural system, even if it is government undertaking should be convinced with the use of SHM because it invokes public funding on a major investment. Therefore, it should produce reasonably advantageous outcome in economic perspective, or at least in public safety. It should be producing results that are debatable and comparable to the regular maintenance approaches.
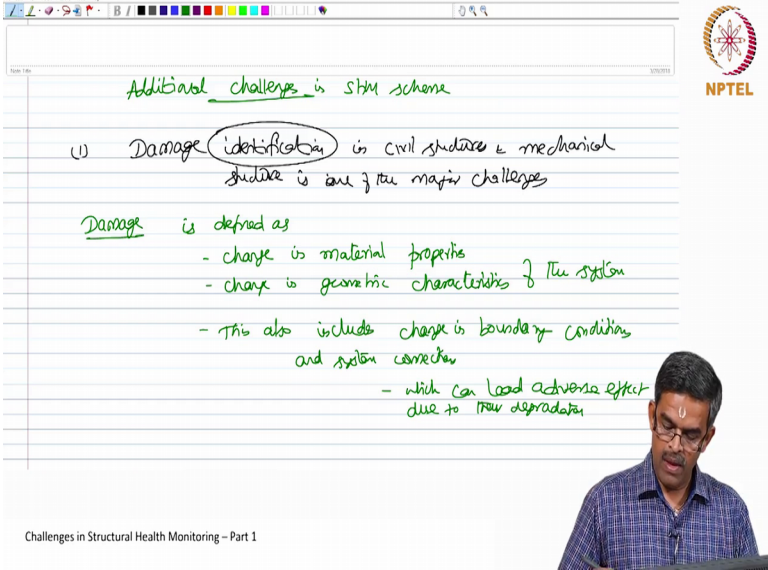
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The next major challenge in SHM is actually the damage detection itself; that is, location of damage, its origin, its scalability, its prospective growth and it is consequences. Other major challenge is again is reliability and robustness of the sensors, their lifespan, their adaptability to working environment. Successful suitability to the sensor network are all considered to be major challenges.

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Let us see what are some additional challenges we have in structural health monitoring scheme. As we all agree being civil and structural engineers, damage identification in civil structures and mechanical structures both is one of the major challenges. For a given structural system identifying that is locating the damage itself requires lot of experience and lot of database comparison, to really understand or identify parameters causing such damage initiation.

Now, let us try to define what do we understand by damage. Damage actually is defined as change in material properties, change in geometric characteristics of the system. This of course, also includes change in boundary conditions and system connections, which can lead to adverse effects due to their degradation. How to handle them?

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The above complexities can be handled using non-destructive test tools. These tools are very helpful in identifying the damages at global level; that is, damages on the structure as a whole can be identified, but cannot be precisely located at the local level on each member, that is the most important challenge. When we consider structures like reinforced cement concrete structures, this problem is more serious due to increased complexities arising from embedment of reinforcement. One of the recent approach which can handle this problem is SPR, which is Statistical Pattern Recognition.

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Let us talk something more about damages, because location of damage is a very important concern in health monitoring. Damages generally start or generally initiate at material level, they are called either defects or flaw. Under certain loading conditions, these damages tend to propagate and they can result in system level damage. So, friends the main concern is not the system level damage it is the component level damage. It is very important to note that damages do not refer to loss of system functionality.

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If it is lost if the system functionality is lost, it is called as a failure. Please understand the difference between damage and failure. Then what do damages do? Damages prevent, the system to perform in it is optimal manner. So, one can now quickly compare a damage scenario and a failure scenario. Damage degrades the performance of the system. It does not affect system functionality completely of course, partially it effects whereas, failure is a total loss of functionality damages can be corrected, whereas, failure need to be mitigated. You have to reconstruct the system if it has failed.

So, monitoring is or SHM is to avoid failure, you cannot avoid damage. Damage inherent property of a system which is loss of functionality, which can happen due to material degradation, excessive loading, excessive deformation etcetera. So, damage cannot be prevented, but failure can be avoided, ok. So, health monitoring will help will address failure of a system, which is a total loss in functionality. Let us understand the difference.