Structural Health Monitoring (SHM)
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Lecture - 38
Part - 2: Long term SHM (Structural Health Monitoring)

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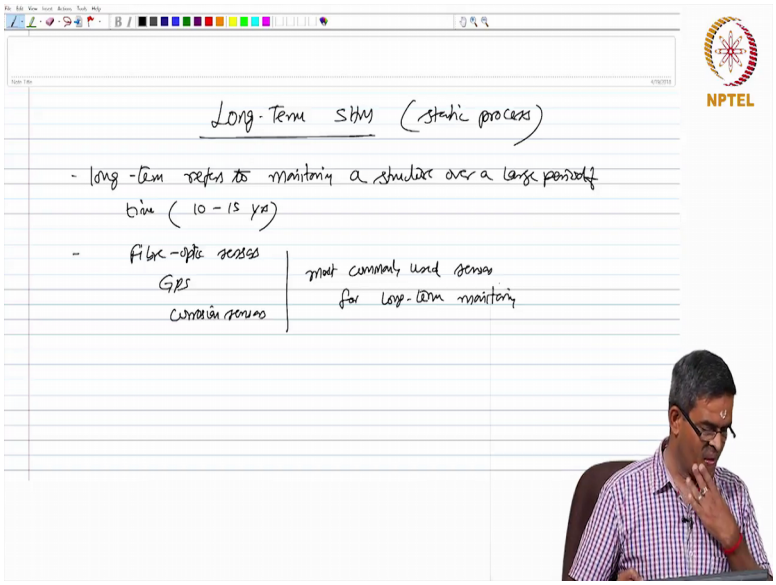

Let us now talk about long-term structural health monitoring essentially this is a static process. What do you mean be long-term? Long-term refers to monitoring a structure over a large period of time. This can anyway vary from 10 to 15 years. What kinds of sensors are being used for this kind of monitoring? People use fiber optic sensors, GPS, receivers and corrosion sensors. These are most commonly used sensors for long-term monitor.

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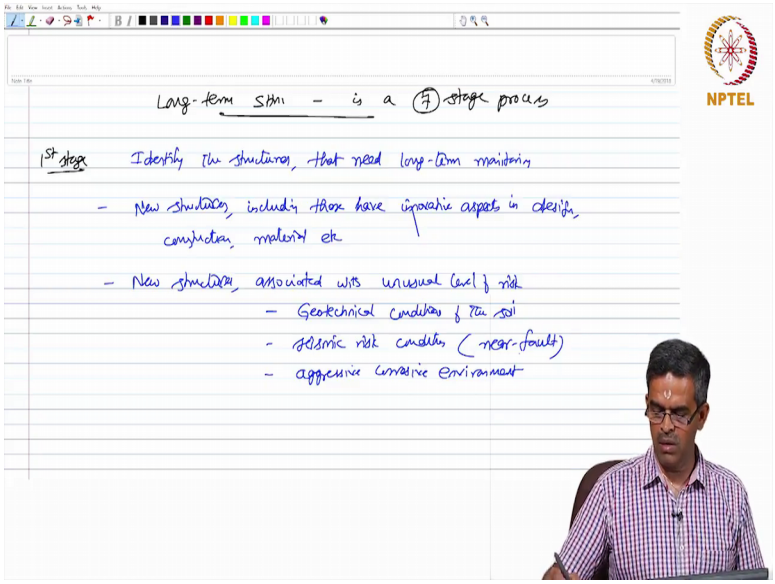

Now, long-term monitoring is a 7 stage process. The first stage is to identify the structures that need long-term monitoring. Generally, we do not do long-term monitoring for all kinds of structures, which structures should need long-term monitoring new structures including those have innovative aspects in design, construction, material etcetera they can be monitored.

Second could be new structures associated with unusual level of risk examples could be they have a special geotechnical conditions of the soil, where they are constructed. They can be or they must have been located in seismic risk conditions. For example, there can be an active fault nearby. It can be an aggressive corrosive environment. So, when structures are located under unusual level of risk then one can go for long-term monitoring.

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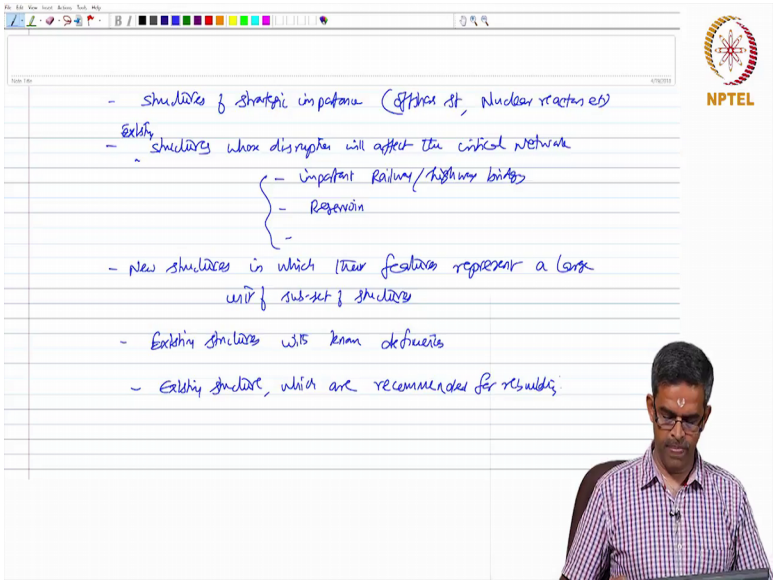

Structures of strategic importance like offshore structures, nuclear reactors etcetera can be going for long-term monitoring. Structures, we can say existing structures whose disruption will affect the critical network. For example, some important railway and highway bridges, reservoirs etcetera can be under long-term monitoring. New structures in which their features represent a large unit of subset of structures, existing structures can also be long-term monitored with known deficiencies, existing structures which are recommended for rebuilding can also belong to monitor.

So, friends before we apply long-term monitoring the primary question comes identify those structures which need long-term monitoring.

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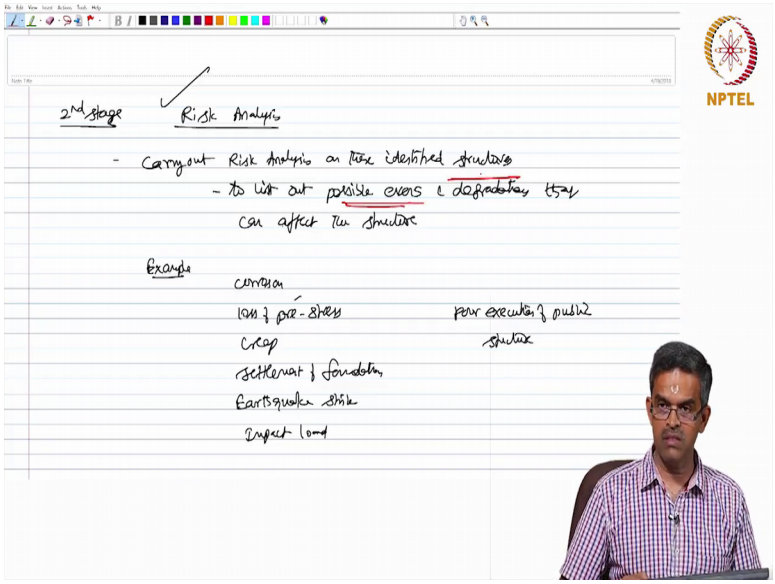

The second stage deals with risk analysis once we decide the types of structures which ought to be meant for long-term monitoring then one has to carry out risk analysis on these identified structures to list out possible events and degradations that can affect the structure. I can give some examples; let us say corrosion loss of pre stress in highway girders, presence of creap settlement of foundations, earthquake strike, impact load effects and above all poor execution of public structure.

So, let us carry out the risk analysis of these to identify what are the possible events and the degradation that can happen to these structures, that is the second stage before we plan for long-term structural health monitoring.

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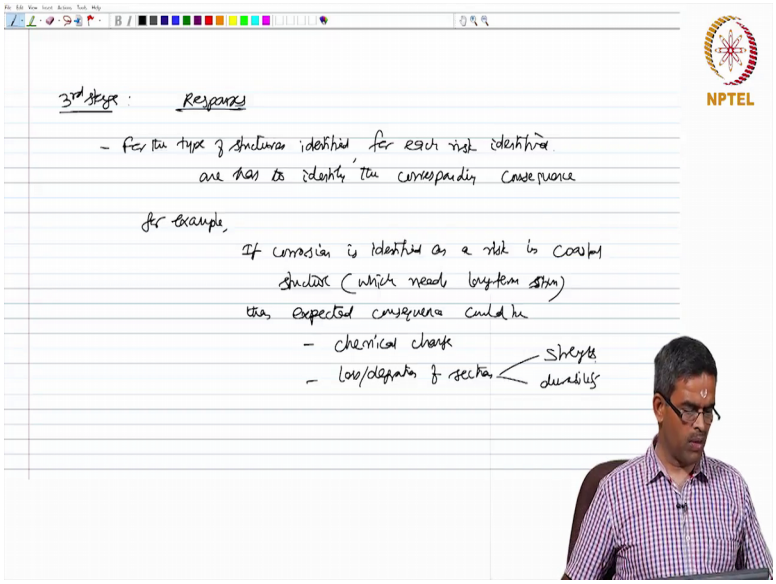

The third stage is to measure the responses for the type of structures identified for each risk identified in the previous step one has to identify the corresponding consequence. That is, for example, if corrosion is identified as a risk in coastal structure which needs a long-term health monitoring then expected consequence could be a chemical change and loss or degradation of section in terms of strength, in terms of durability that could be one of the consequence.

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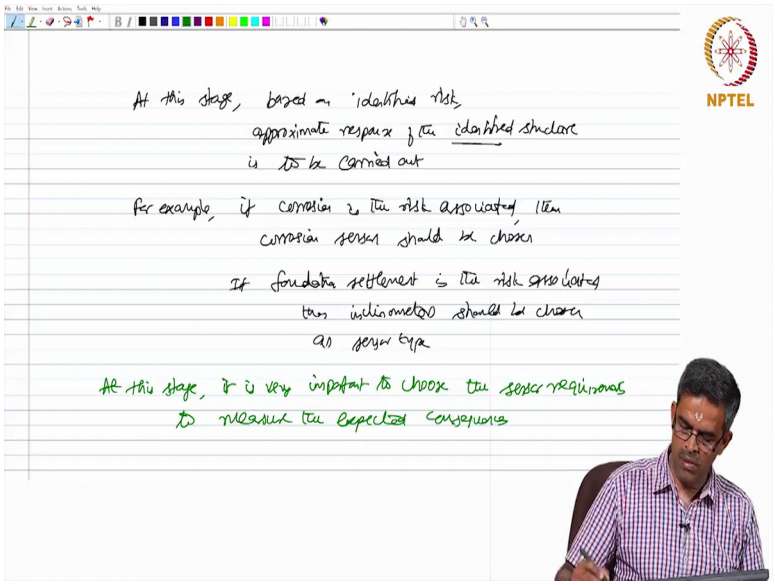

So, at this stage based on the identified risk approximate response of the structure of the identified structure is to be carried out. For example, if corrosion is the risk associated then corrosion sensors should be chosen if foundation settlement is the risk associated then inclinometers should be chosen as sensor type etcetera.

So friends, at this stage, it is very important to choose the sensor type I should say sensor requirements to measure the expected consequences.

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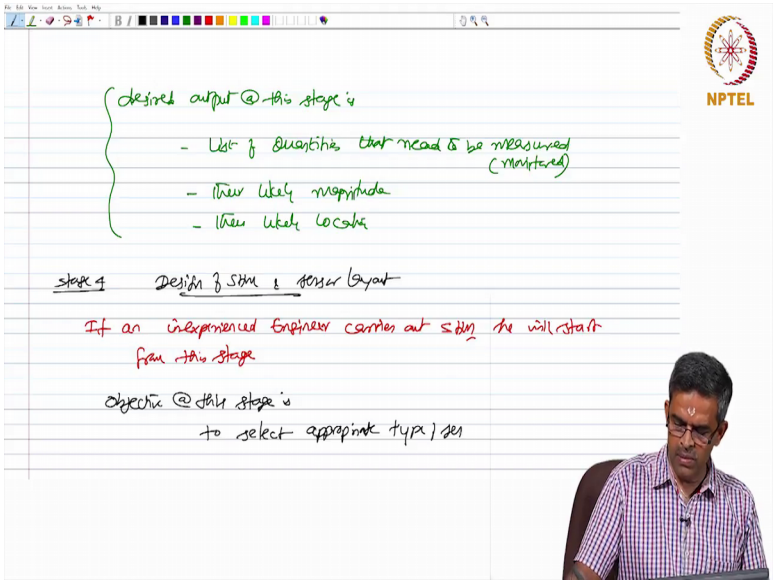

So, the desired output of this step or the desired output at this stage is list of quantities that need to be measured. In fact, I should say to be monitored, their likely magnitude and their likely location all should be known at this stage.

So, next is stage 4, which is dealing with design of a SHM and sensor layout. Now, friends, it is very important to note if an inexperienced engineer carries out health monitoring he actually will start from this stage. Please note: the previous three stages are very important to make the health monitoring system more efficient and successful objective at this stage is to select appropriate type of sensor.

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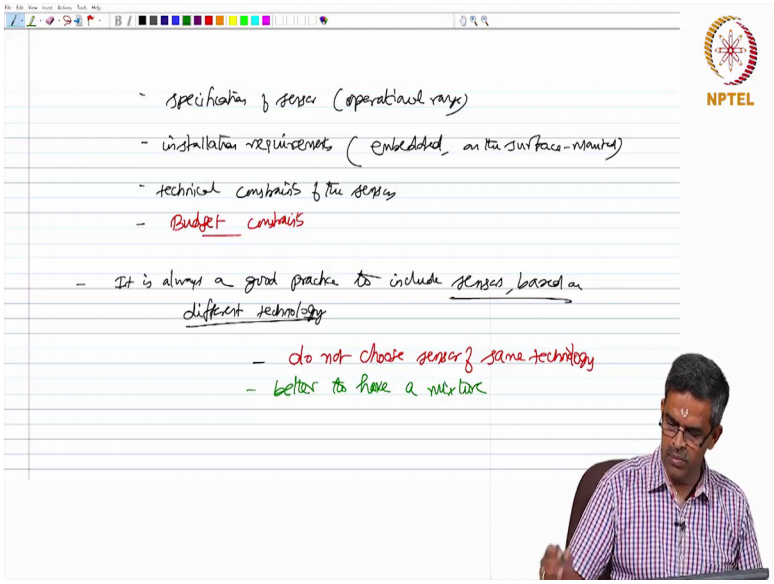

Specifications of sensor that is operational range, installation requirements of the sensor somebody some sensors can be embedded some can be on the surface mounted etcetera technical constraints of the sensors and most importantly the budget constraints. It is always a good practice to include sensors based on different technology that is very important. Do not choose a sensor of the same type it is always better to have a mixture.

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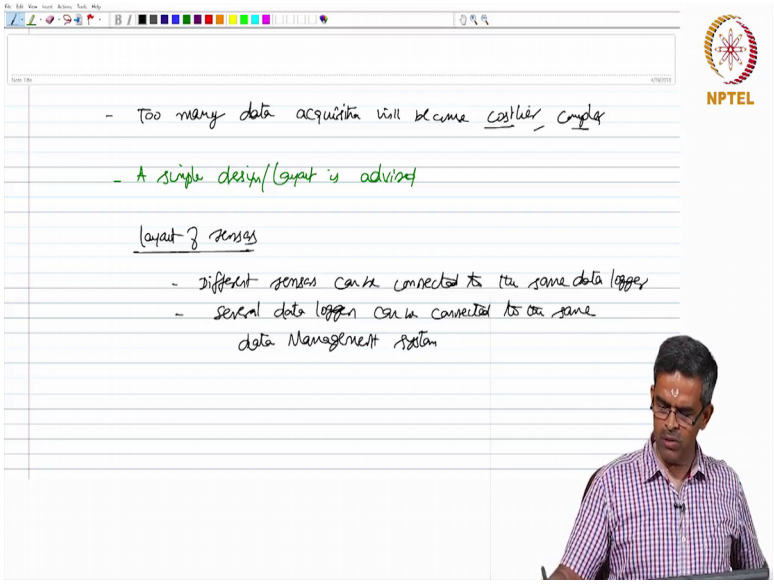

Further, too many data acquisition will become costlier, that is one part, will also become complex there is another issue. Therefore, a simple design or layout is advised.

Let us talk about layout of sensors. Now, interestingly different sensors can be connected to the same data logger, several data loggers can be connected to the same data management system.

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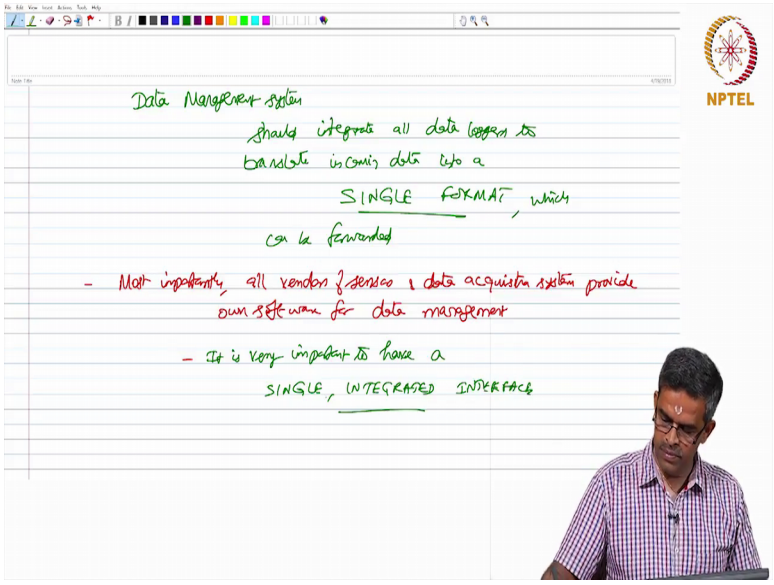

It is very important to note that data management system should integrate all data loggers to translate incoming data into a single format which can be forwarded. Most importantly, almost all vendors of sensors and data acquisition system provide their own software for data management.

So therefore, please note it is very important to have a single integrated interface.

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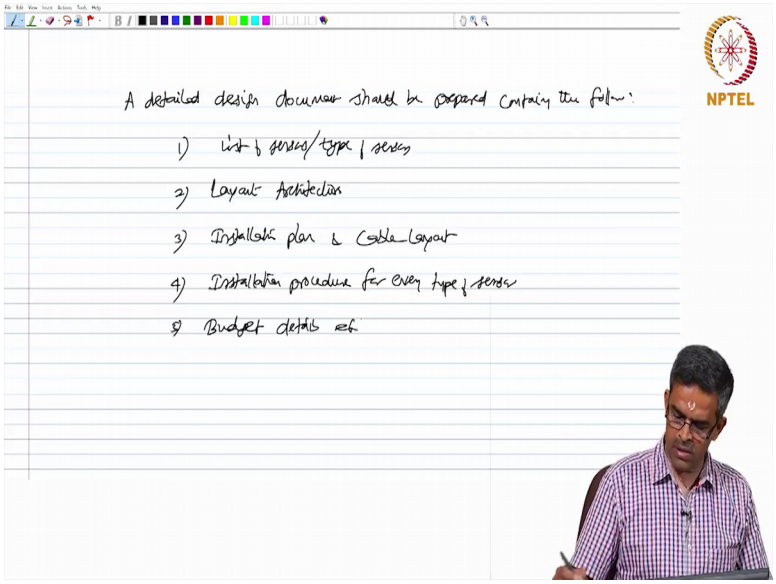

A detailed design document should be prepared at this stage containing the following; 1 – list of sensors and type of sensors, 2 – layout architecture, 3 – installation plan and cable layout in case of wired sensors, fourth your detailed documentation about installation procedure for every type of sensor, then the budget details etcetera. So, this is the outcome of this stage.

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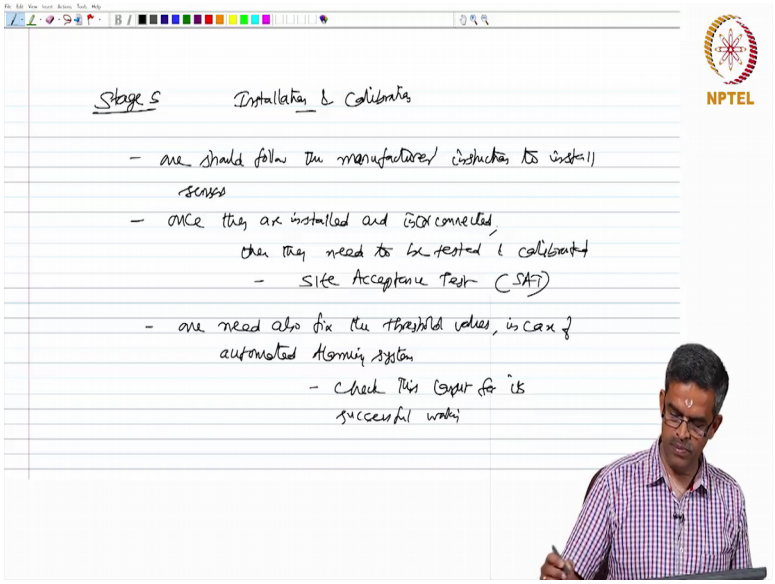

The next of course, is the stage 5, which talks about installation and calibration. One should follow the manufacturer's instruction to install sensors. Once they are installed

and interconnected then they need to be tested and calibrated. This is what we call as Site Acceptance Test, a SAT should be conducted to check the efficient working of sensors. To do this one need to also fix the threshold values in case of automated alarming systems. Therefore, check this layout for its successful working.

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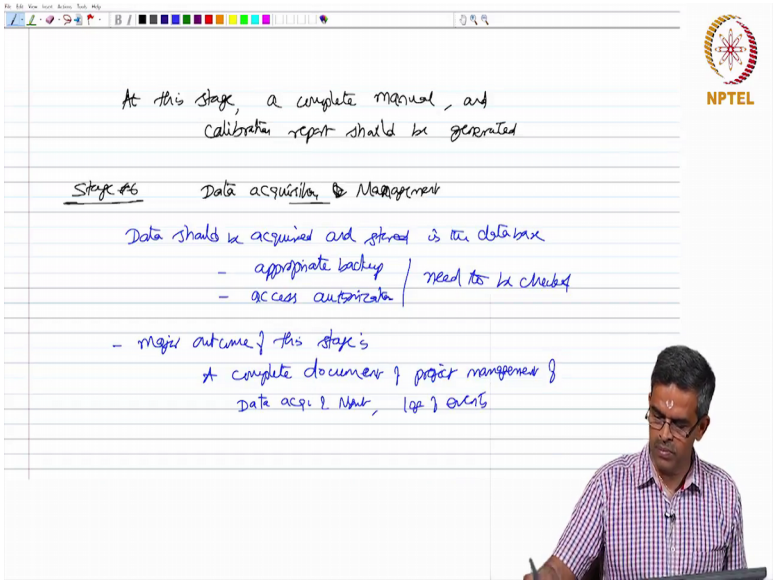

So, at this stage a complete manual and calibration report should be generated.

Stage number 6, is data acquisition and management. Data should be acquired and stored in the database. It should have an appropriate backup, it should also have an access authorization; this need to be checked. The major outcome of this stage is a complete document of the project management of data acquisition and management with log of events.

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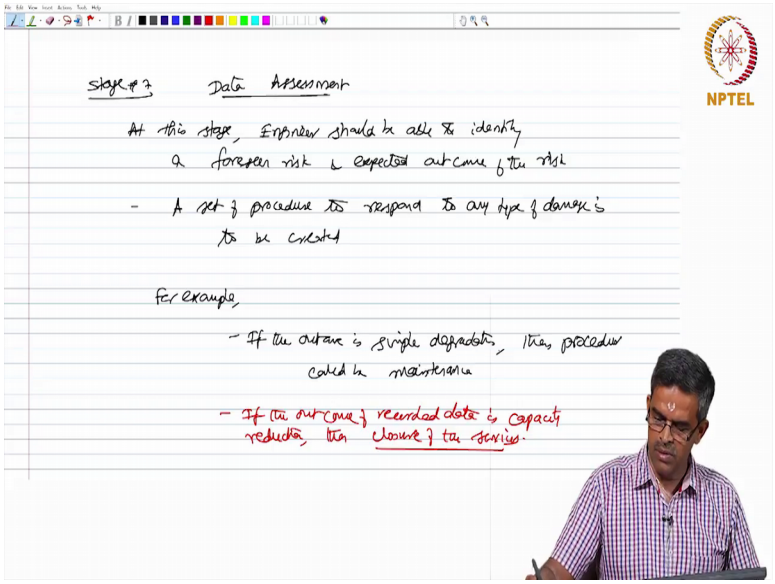

The last could be stage 7, which is essentially data assessment. The engineer should be able to identify a foreseen risk and expected outcome of the risk. A set of procedure to respond to any type of damage is to be created. For example, if the outcome is a simple degradation then procedure could be maintenance. If the outcome of recorded data capacity reduction, then there should be closure of the services of the system should be recommended.

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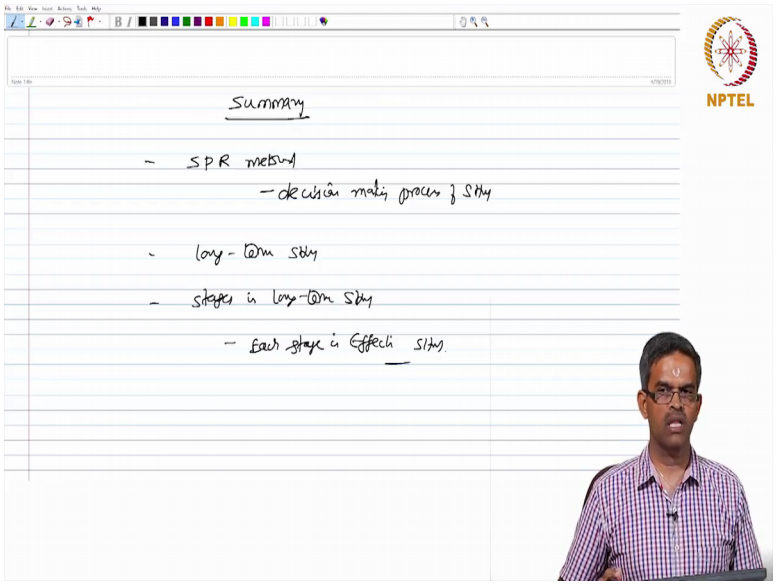

So, friends, in this lecture we learned a statistical pattern recognition method which is useful in decision making process of structural health monitoring. We have also seen what do we understand by long-term monitoring, what are the different stages in long-term structural health monitoring and how each stage is important in effective health monitoring.

Friends, I hope you follow the lecture and understand them very well. In the next lecture, we will talk about non destructive evaluation methods and techniques which are useful for health monitoring measurements.

Thank you very much and bye.