Research work carried out in the area of NDT and SHM

Non Destructive Testing

Concrete is widely used for the construction of infrastructures such as bridges, power stations, dams, etc. In the hardened state concrete may contain defects such as voids/honeycombs, cracks etc. The presence of voids particularly in the cover zone of a reinforced concrete structure leads to early corrosion of the reinforcement. Non-destructive testing in reinforced concrete structure plays a very important role for the condition assessment of reinforced concrete structures. This includes identification of defects such as honeycombs, voids, cracks, etc., and, thickness measurement, location of reinforcements, ducts, etc., The Ground Penetrating Radar(GPR) technique is a very effective method for investigating the integrity of concrete, thickness measurement, reinforcement identification in concrete structures. The Ultrasonic Pulse Echo is a one-sided technique which can be used effectively for the thickness measurement, localization of reinforcement and ducts, and the characteristics of surface cracks. The Impact-Echo (IE) method is used to detect thickness, voids, honeycombing etc. of concrete and masonry structures. Software packages used for NDT data acquisition and analysis are dependent on the technique and manufacturer. Fusion algorithms based on the technique whether they are pixel level or feature level will come after pre-processing stage. Visualization of fused data and merging of input from different NDT devices is done in order to create user friendly visual output that can be directly used for on-site evaluation of building components condition. The overall objective of data fusion is to improve the information quality over that obtained from individual sources. Fusion techniques allow reinforcing redundant evidence and integrating complementary information to achieve a higher degree of certainty. Research work is done at CSIR-SERC to study the effectiveness of various advanced NDT methods in evaluating different features in RCC and PSC structures and also on the data fusion techniques.

Structural Health Monitoring

Structural health monitoring (SHM) and damage detection has become an important issue in many fields such as civil, mechanical and aerospace engineering. An SHM system would also allow operators to abandon schedule based maintenance and adopt a much more efficient condition-based maintenance. In the past two decades, the issues related to structural health monitoring (SHM) and damage detection in civil, mechanical and aerospace engineering infrastructure have been paid considerable attention by the research community.

The basic premise of an SHM system is that damage alters stiffness, mass or damping of a structure and in turn causes a change in its dynamic response. The complete health state of a structure can be determined based on presence, location, type and severity of damage (diagnostics) and estimation of remaining useful life (prognostics). Most of the vibration based methods use modal properties such as natural frequency, mode shapes, curvature of mode shapes, modal strain energy, etc. of a structure for damage detection. Another class of methods is based on time series or time- frequency analysis of data such as auto- regressive models, signal processing using wavelet,. Soft computing techniques like Artificial neural networks (ANN) and genetic algorithms have also been employed for damage diagnostics.

Since most of damage detection methods use structural responses directly, variations in the operational and/or environmental conditions may mask the changes in the dynamic response caused by structural damage. A methodology is needed to distinguish between variations in the dynamic response caused by damage and those due to changes in operational and/or environmental conditions. A physics-based model may be employed to predict response of healthy (baseline) structure over its operational range under various environmental conditions. However, reliable physics-based models are often very difficult or impossible to obtain for complex structures. A data-driven model may be created through experimental measurements of the baseline structure, but a very large database would be needed to create a model valid under various operational and environmental conditions.

Further sensor technologies have improved quite considerably in the last few years. Now most of the popular sensors are made of smart materials like PZT sensors (strain gauges or accelerometers, MEMS sensors, Nano sensors, fiber optic sensors and Bio sensors). Majority of the current SHM research is towards developing efficient strategies for remote health monitoring using wireless sensing. Several smart wireless senor networks are commercially available and several popular structures like Golden Gate bridge in California State of US have been monitored using these wireless sensors.

At CSIR-SERC research is carried out in the area of application of using different sensors for monitoring, issues related to wireless senor networks, damage diagnostic techniques using multivariate analysis like Principal component analysis, blind source separation techniques, time frequency analysis, time series models etc., specially catering to the recent sensor technologies like smart WSSN. Sensor management techniques like sensor fault detection algorithms, optimal sensor placement techniques etc. are also considered.