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# Structural Health Monitoring of nuclear site structural facilities using Optimal Sensor Placement for damage detection and prediction of failure

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Nuclear reactors and associated structural facilities are designed to withstand various types of loadings including thermal, vibrational and fatigue etc. Despite meticulous design incorporations, these structures can be damaged during operation due to unforeseen scenarios and can cause imminent danger in retrospect of nuclear radiation leakages, loss of critical infrastructure and life. To avoid catastrophic outcomes, continuous structural health monitoring (SHM) of such structures ensure safety and efficient maintenance protocols. Finite Element Analysis (FEA) provides a valuable insight into structural performance during the design phase and can be validated through experimental twin. Optimal sensor placement to provide critical insight with reduced sensors can be cost effective. A successive full field estimation using a reduced FE model based on the OSP locations can be useful to visualize comprehensive structural behavior and assist in addressing the issues in sensor-less regions. A D-optimal (determinant optimization) method is shown to be used in tandem with System Equivalent Reduction Expansion Process (SEREP) for sensor placement and full field estimation of required measurand, respectively. Three test cases for simple structural elements such as beam and plate with various boundary conditions are shown to produce full field strain fields for the structures, when applied with an impact load to be later determined for its magnitude and location. The results produce fairly accurate reconstruction of the structural dynamic response when observed at different time instances/windows along with identification of impact magnitude and position. This concept is proposed to be extended to structures such a reactors, boilers, and piping in nuclear facilities to provide a detailed and comprehensive monitoring of these structures and to avoid damages and failure due to unknown cause(s) while in service and to identify their location and magnitude.

## Speaker Bio

**Primary author:** ARSHAD, Asad (College of Chemicals and Materials)

**Presenter:** MUHAMMAD BUTT, Asad

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