The aim is to generate logical variations of the bridge model in SAP2000, extract modal results, calculate MAC, and then use these results to train an artificial intelligence model.

The first step would be to define input parameters, such as stiffness of members (E modulus), thickness of plates, boundary conditions of joints, and mass scale factors. Each parameter can be varied in a realistic range (for example, ±10–20% of baseline values) to represent uncertainties or potential damage scenarios.

The second step is to perform multiple modal analyses in SAP. For each variation, the natural frequencies and mode shapes will be calculated, and the shapes compared with the reference model (or experimental data) using the Modal Assurance Criterion (MAC). This will generate a dataset where inputs are parameter changes and outputs are modal results and MAC values.

The third step is to prepare the dataset for AI training. Inputs would be the numerical parameters, and outputs would be the frequencies and MAC values. In some cases, a global error index (such as the average of 1–MAC across key modes) could also be used. Preparing and managing this dataset will require some coding, but the focus remains on the engineering interpretation.

The next step is to apply machine learning models. Standard approaches such as regression algorithms, Random Forest, or a simple neural network can be tested. The purpose is to learn the relationship between parameter changes and modal properties, and then validate the predictions against additional FEM runs.

Finally, the results will be compared with the experimental accelerometer data. By adjusting SAP parameters, it should be possible to minimise the difference with the measured results (model updating). The AI model can then be tested to see if it correctly predicts the adjustments needed to match real behaviour. This would also demonstrate its value for identifying possible stiffness loss or damage locations.

The contribution of this article is to create a surrogate model: instead of running hundreds of computationally heavy FEM analyses, the AI model can predict MAC and frequency changes rapidly. This speeds up the model updating process and supports damage detection. The novelty lies in combining FEM, MAC, and AI into one workflow for structural model updating.