CROSS-IT
Smart condition monitoring and prompt NDT assessment of large concrete bridge structures

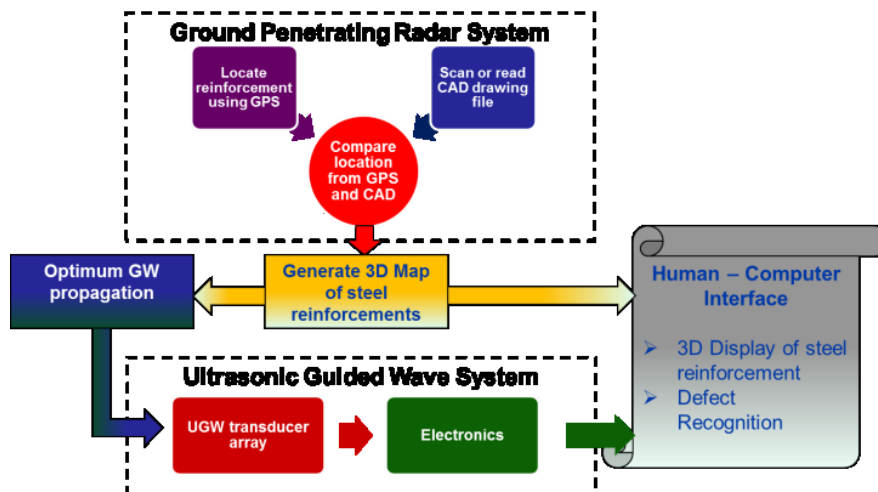## Summary of description of project context and objectives

Over the last 20 years half of all bridges built worldwide have been of a pre-stressed concrete design, with 25% being reinforced concrete and the remainder being made of steel construction. In the European Union (EU) there are approximately 300,000 concrete bridges with a reported replacement value of over €300 billion.

When concrete is used in bridges, tunnels and buildings, its load bearing capacity has to be increased by reinforcing it with steel bars and tendons. The failure of these large structures is normally due to corrosion of the internal steel reinforcement and tendons. This can be caused by normal age related degradation that can be triggered by water ingress into surface cracks resulting in corrosion.

The deterioration in bridges is exacerbated by the fact that axle loads have risen above those in operation when the bridges were designed, and this exposes these structures to stresses beyond their limits. Early signs of deterioration are often not seen and a high level of skill is required to distinguish signals from noise. At present there is no single non-destructive testing (NDT) technique capable of practical inspection of pre-stressed tendons throughout their length and existing NDT techniques such as visual inspection have major limitations. Bridge owners and operators therefore have a real need for improvements to present maintenance and Non-Destructive Testing (NDT) inspection practices for these structures.

The CROSS-IT project aims to develop a new technology to inspect concrete bridge structures for dangerous levels of age-related degradation, which could consist of cracks due to water ingress and corrosion of internal steel reinforcement. This development accommodates the following approach:

The technology is based on a hybrid system of Ground Penetrating Radar (GPR) and Ultrasonic Guided Waves (UGW), using the positioning advantages of GPR to locate the internal steel reinforcements, and UGW, to detect flaws and corrosion on those. The system will display the results as a visual 3D map on a dedicated laptop running a purpose designed program.

Description of work performed and main results

At the beginning of the project, with the advice of Atkins, the consortium has identified the test cases where the CROSS-IT project would be most beneficial to resolve the most critical problems within the concrete structures. The following tasks have been carried out throughout the development:

- Modelling of UGW in concrete and tendons and the discovery of the optimum propagation mode(s)
- Selection of UGW transducers to propagate the optimum mode(s) as determined from the modelling and experiments
- Training of a Neural Network for data analysis
- Software and hardware to combine the GPR and UGW signals and to display the results to the operator (advanced signal processing)

Final results and potential impacts

The successful implementation of the CROSS-IT system aims significant reduction in inspection time when compared with existing state of the art inspection techniques and due to the use of guided waves allow a much greater range of inspection from one single location than has ever been achieved. It also aims to minimise the need for corrective maintenance (back filling inspection holes) thus leading to a substantial decrease of the overall operational costs. This will revolutionise bridge inspection and maintenance procedures.

CROSS-IT is collaboration between the following organisations: TWI Ltd, National Technical University of Athens, Technology Assistance BCNA 2010 SL, INETEC-Institut za nuklearnu tehnologiju, ACUTECH Ltd, ATKINS. The project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 286981.

The project website, www.crossit-project.eu presents introductions to all CROSS-IT consortium members with links to their respective websites.