SIMoNET – Newsletter March 2004

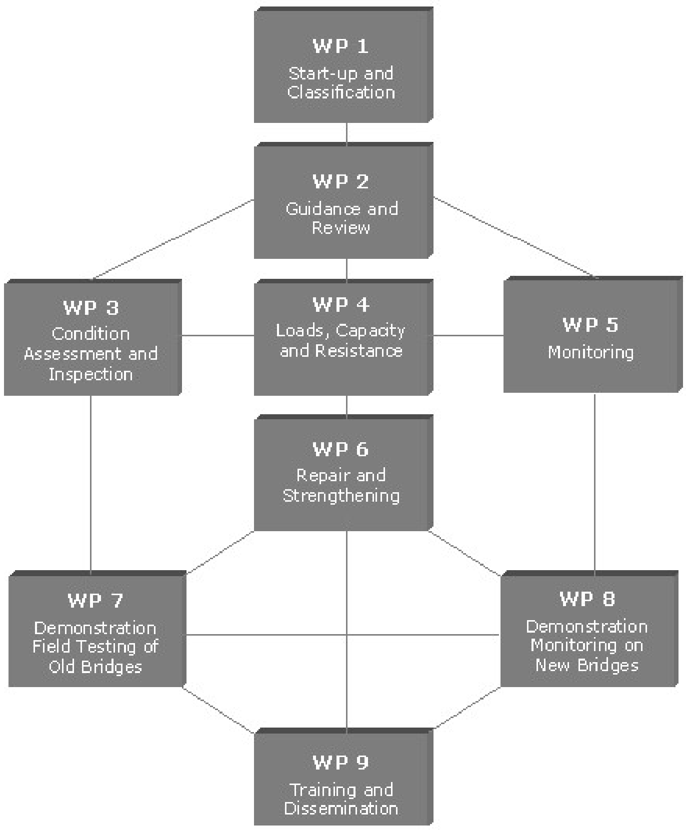
1. "Advanced polymer composites for structural applications in construction", ACIC 2004, to be held at University of Surrey, 20-22 April 2004. Sessions include:

- FRP Strengthening of Concrete and Masonry Structures
- FRP Strengthening of Metallic and Timber Structures
- Development of FRP Materials and Systems
- Analysis, Design and Testing
- Durability and Long Term Performance
- Certification, Inspection and Quality Assurance
- Case Studies

2. **Sustainable Bridges**

Sustainable bridges is the name of a €10m value EU 6th Framework Integrated Project that has just started. It is a project to assess and devise methods to improve the readiness of railway bridges to meet the EU's aim for a 30% increase in passenger and a trebling of freight rail traffic across Europe over the next thirty years.

The project is organised into a number of work packages as shown below:



More details can be obtained from the project web site www.sustainablebridges.net but Structural Integrity Monitoring will form an important piece of the work, with WP 5, led by EMPA (the Swiss Federal Institute for Materials Testing and Research) concentrating in this area.

Reasons for monitoring

Continuous monitoring with physical sensors has the potential to provide up to date information. Furthermore, it furnishes information about processes which changes in time like live loads, fatigue damage, vibrations, temperature etc. which are difficult to assess using other methods. A key feature of any effective monitoring system is its ability to perform autonomously a diagnostic of the state of health of a bridge. This offers the potential to perform inspections on demand, reducing significantly the inspection costs.

The goal of continuous monitoring is not to supersede traditional inspection but to optimise the inspection process with modern smart tools. This allows increasing the reliability of the obtained information, to reduce the human intervention as far as possible and to improve the benefit costs ratio. Civil engineering structures are mainly large and complex physical systems consisting of many heterogeneous components. Monitoring of all components with sensors is not economically or technologically feasible. Therefore, the monitoring process has to be restricted to a limited number of components. This can be achieved by identifying simple condition indicators and assessing these indicators by measurement. However, to achieve this goal at reasonable prices, a significant effort to standardize the monitoring process with regard to data acquisition, analysis and management is needed.

Research Objective

The objective of Work Package 5 is to develop and test an innovative, reliable and cost-effective technology for continuous monitoring of railway bridges. To achieve this goal the following key topics will be addressed.

- A **guideline** that defines a monitoring methodology addressing the specific needs of railway bridges. A guideline is essential to simplify and speed-up the planning and implementation of a monitoring system at sustainable costs. This methodology specifies the data acquisition, analysis and management process to cover the information demand that is needed to sustain an up to date assessment of the state of serviceability and safety of railway bridges. To be economically feasible, the monitoring process has to be restricted to as few structural elements as possible. The selection of these components and the sensor location has to be dictated by the objective to provide at any time a fast and reliable estimate of the state of health of a railway bridge.

- Special efforts will be made to develop novel **optical fibre and MEMS-sensors**. For applications in railway bridges optical fibre sensors are very attractive because of their high immunity to electromagnetic fields, their long-term stability and their robustness in harsh environments. Micro-Electro-Mechanical-Systems (MEMS) are the first choice if there is a need for cheap, robust and small sensors. Monitoring systems with cheap sensors are essential for to be accepted by the industry. The activity is focused on the development of:

- a novel sensor sheet with embedded optical fibre sensors, able to detect, localize and monitor the opening of several cracks with just a single fibre.
- an optimised fibre optic Bragg grating sensor system for strain measurement on large structures
- an array of MEMS-sensors to track defects in terms of crack formation and propagation in concrete at real time using acoustic emission techniques.

- A reliable, scalable, flexible and time synchronized **local area communication infrastructure** between the sensors and the data acquisition system.

The communication infrastructure is based on a wireless local area network and has to support various physical sensors distributed over a wide area. Wireless sensor networks are appealing because on large and medium size bridges they are more economical than laying kilometres of conduits. This reduces significantly the installation costs of a monitoring system. In some applications, cabled sensors are impractical or produce high maintenance costs due to man-made or natural causes. The close sensors building the nodes of this network are equipped with data conditioners and analogue to digital converters to digitalize the sensor signals.

- A computer-aided automatic **smart data processing tool**. Automatic data processing is a key feature for a successful data management of a continuous monitoring process. The measurement of dynamic processes produces a large amount of data that has to be significantly reduced to be useful for further processing. The data reduction is done by a smart continuous analysis of the acquired data. This analysis is supported by an autonomous diagnostic and fault-detection methodology. To be able to detect abnormal state conditions, this methodology has to consider the effects of changing ambient and operational conditions on structural behaviour.

3. **"A new NDT technique for the railway industry: ACFM inspection of axles and rails", Dr Michael Smith, NDE Projects Manager, TSC Inspection Systems.**

Alternating Current Field Measurement (ACFM) has recently been introduced to the rail industry for the inspection of safety critical components. Originally researched by UCL and developed by TSC Inspection Systems, the technique has been in regular use in the offshore oil and gas industry for the inspection of surface cracking.

ACFM is an electromagnetic technique which can locate and size surface breaking defects in conductive materials and can operate through coatings. It offers the advantage of recording all inspection data and produces computerised reports. Three ACFM applications are being developed within the rail industry - the inspection of axles, bogie frames and the ACFM Walking Stick for the inspection of plain rails. Independent trials of comparative techniques have been carried out by the Engineering Link on axles and the results showed that ACFM outperformed MPI for detection and could also indicate the defect depth. Extensive testing by Bombardier Transportation and Network Rail has led to ACFM's acceptance within the rail industry.

4. Best Practice for the Procurement and Conduct of Non-destructive testing – Part 1: Manual Ultrasonic testing

HSE has published on its web site (http://www.hse.gov.uk/dst\NDT1.pdf) recommendations to improve the inspection of conventional pressurised equipment, developed by a drafting committee with representatives from industry and HSE. The document review current practice, identifies the need for additional requirements, in terms of defect type, component geometry, access, operator performance and the organisation and procurement of NDT. The document also addresses inspection improvements and component risk. A table listing 'additional measures' is appended indicating their need for three different levels of effectiveness, according to the reduction of probability of failure that it produces in particular cases. If the probability of failure is high then the inspection effectiveness should also be high (i.e. level 3). The additional measures listed relate to text sections, identifying the need for additional requirements. Additional parts to this Best Practice guide are being prepared.

5**. Overview of SAFERELNET**

SAFERELNET is a Thematic Network that brings together 67 partners (32 of which are from industry, 21 from universities and 14 from research institutes) drawn from 18 European countries with the common goal of improving safety and reliability of industrial products, systems and structures. Amongst the UK members include the Health & Safety Executive, Highways Agency and Network Rail.

SAFERELNET promotes networking and dissemination activities amongst its members and with the industry but is not a research and development project. It bases its work on the results of research and development activities carried out by its members combined with those in published literature. One of the main functions of the Network is therefore to provide a forum for exchange of ideas and experiences amongst its members with a view to stimulate transfer of technology between industrial sectors and between countries. Specific objectives of the Network with reference to the assessment and management of safety and reliability of industrial products, systems and structures include:

- Review of current practice in different countries and different industrial sectors with a view to identify "best practice";
- Review of the state-of-the-art to identify emerging ideas and solutions which hold promise for practical implementation;
- Identify gaps in practice in different industrial sectors and countries considering:

  Industrial problems for which there are no satisfactory technical solutions,

  Gaps between practice and research,

Gaps in the level of technology used between countries,

Gaps in the level of technology used between industrial sectors;

- Promote ways and means for addressing the identified gaps by:

  Developing Best Practice Guidance Documents for application to industrial problems,

  Stimulating transfer of technology between industrial sectors and countries,

  Identifying priority areas for research to respond to industrial needs, and promoting the initiation/coordination of research projects in these areas,

  Providing recommendations to code committees and regulatory bodies,

  Developing systems and technical information for use in training and education,

  Dissemination of SAFERELNET results through industrial workshops, discussions with industry forums, publications, web site, newsletters etc.;

- Collaboration with other national and European Networks in areas of synergy;
- Promote harmonisation and standardisation of techniques, methods and management systems where disparate practices exist between systems, industries and countries.

Scope

The scope of the Network covers in principle all types of industrial plant, equipment, structural systems, buildings and other civil engineering facilities. The focus will be on safety-critical systems in the following industrial sectors:

- Oil & Gas production facilities,
- Process industries,
- Power (nuclear, conventional, renewable energy),
- Shipbuilding and Maritime Transport,
- Surface Transport (Road and Rail),
- Buildings.

Deliverables

The main outputs and deliverables from SAFERELNET include:

- A unified risk management framework defining requirements for Safety Management Systems, quality assurance, performance assessment, training and competency, and systems for risk prevention, control and mitigation;
- A Framework Document presenting a unified methodology for risk assessment combining Quantitative Risk Analysis, Human & Organisational Factor Analysis and Structural Reliability Analysis;
- A Framework Document for maintenance management of plant equipment and structural systems. This requires an integration of techniques such as Risk-Based

Inspection and Maintenance (RBIM), Reliability Centred Maintenance (RCM), Availability-Reliability-Maintainability (ARM), etc.;

- A Framework Document for Re-assessment and Life Extension of industrial plant and infrastructure systems considering safety and economics;
- Documents showing the application of the above to specific industrial sectors;
- Prototype Internet-based systems for distance learning of safety and reliability;
- Recommendations to code committees and regulatory bodies in formulating safety requirements;
- State-of-the-art reports on a number of specific areas of topical research;
- Case studies and benchmark studies.

Benefits

The main benefits of the Network are:

- the building up of a common view about the most recent research work in safety and reliability, in particular the identification of the current, “good” and “best” practices in the industry;
- the identification research work with the potential for industrial application;
- the transfer of technology to NAS countries;
- raising awareness of industry across Europe about “best” practices and emerging trends;
- unified framework contributing to the harmonisation process on application of safety and reliability in Europe;
- exchange of knowledge and transfer of technology among different technological areas, industries and countries.

Progress report on Safrelnet – activities in 2003

- Third SAFERELNET General Meeting, 19-20-21 May, Copenhagen
- Workshop on Acceptable Safety Levels, 19 May, Copenhagen
- Workshop on Integration of Risk and Reliability. 21 May, Copenhagen
- Network Steering Committee Meeting 22, 23 September, Denmark
- Workshop on Integrated Risk Assessment, 22 September, Denmark
- Fourth SAFERELNET General Meeting, 30th and 31st October, London
- SAFERELNET Industry Workshop, 29th October, London
- Workshop on Inspection Planning, 30th October, London
- Workshop on Maintenance Planning, 30th October, London
- Extended WP3 Technical Meeting, 30th October, London
- Workshop on Risk Management, 31st October, London

More information available on: http://mar.ist.utl.pt/saferelnet/structure.asp

6. **ASRANet - 2nd International Colloquium,5-7th July 2004**, **Barcelona, Spain**

Session Themes:

Structural Risk Management + Human &Operational Factors
Computational Methods in ASA and SRA
Management of Deteriorating Structures
Risk Based Inspection and Maintenance Planning
Risk Acceptance Criteria and Assessment for Accidental Events
Seismic Risk and Reliability Assessment
Probabilistic Load Modelling
Reliability Based Design, Optimisation & Codes
Integration of Structural Analysis, Risk and Reliability
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