SIMoNET

http://www.simonet.org.uk

# SIMoNET Structural Integrity Monitoring Network

## Report on 17th SIMoNET Meeting
## "Development of Sensors & SIM of Infrastructure"

## Held at UCL on April 8th 2008

### Introduction

Professor Dover introduced the seminar, welcoming those attending and briefly describing the background to the Simonet network.

### 1. Modern Built Environment Knowledge Transfer Network (MBE KTN) – Influence of SIM

**Philip Charles**
**Infrastructure Sector Manager, CIRIA**

Mr.Charles explained that the MBE KTN is a single national overarching network established to connect built environment stakeholders. The KTN is funded by Government through the Technology Strategy Board and managed by BRE. The delivery team is a consortium comprising BRE, BSRIA, CIRIA and Arup. Initially, the KTN is focusing on three industry sectors – offices, healthcare and infrastructure. Its challenge is to identify processes and technologies that have the potential to deliver a step-change in industry performance and client value in these sectors. For further details please visit the MBE KTN website at: www.mbektn.co.uk.

The presentation also introduced the MBE KTN in terms of his origins, its aims and objectives, who is involved and highlight some of the issues that its activities are tackling. It then discussed the challenges of and opportunities for structural integrity monitoring across the sectors of the MBE KTN – healthcare, offices and infrastructure covering building and civil assets respectively. These discussions will be in the context of the impact of climate change (with a focus on flooding) and life extension of structures, two of the key themes that CIRIA are leading on behalf of the KTN. The presenter then posed some questions that would stimulate discussions between the MBE KTN and SIMoNET communities and lead to opportunities for collaboration in the future.

### 2. Prognostic Damage Analysis of Vibrating Components

**Dr. Andrew Halfpenny**
**nCode International**

Dr. Halfpenny explained that vibration-induced failure of a component can arise through the long term exposure to fatigue damaging events or the application of an extreme amplitude shock. Many traditional applications of Structural Health Monitoring rely on diagnosing the presence of an emerging fault long before the onset of catastrophic failure. The direct 'Prognostic' approach is used when no measureable indication of failure can be obtained with sufficient reliability, timeliness or economy. The prognostic device monitors the vibration damage dosage throughout the life of a component and compares this with the original design certification. The device offers a comparison of the damage accumulated at an instance in time with respect to the design envelope. It also provides an estimate of residual life.

In order to assess the damage to a component, it is necessary to determine the stress on that component at the critical failure locations. The stress is dependent on the input vibration and dynamic response of the component and is often highly influenced by a particular natural frequency. The damage potential of a vibration input can be estimated for a component over a range of natural frequencies by plotting the potential damage versus natural frequency. This is called the fatigue damage spectrum and can be calculated in near-real time. An analogous approach is used to calculate the Shock Response Spectrum to compare the worst shock event with respect to the original design certification.

The presentation also described the analysis and presented several case studies where the analysis has been used to demonstrate vibration-induced damage on military land systems, aerospace vehicles and vibrating machinery. The incremental damage dosage values have also be used to correlate vibration tests with the real operational environment.

## 3. Non-contact defect detection in multilayer carbon composite materials using electric potential sensors and an a.c. potential drop method

**Dr. Robert Prance**
**Centre for Physical Electronics and Quantum Technology, University of Sussex**

A new non-destructive testing technique was described, a non-contact version of the well known a.c. potential drop method. Electric potential sensor technology (EPS), invented at Sussex, is capable of measuring, non-contact, the spatial electric potential associated with a sample via the displacement current, through capacitive coupling. This can be achieved due to the extremely high input impedance of the sensors, resulting in many cases in no loss of signal when compared with a contact voltage measurement. For laboratory samples an a.c. current is passed through the sample and the spatial potential above the surface monitored as a function of position. The presentation reported results from such a laboratory system and associated finite element simulations of the potential associated with simple defects in multilayer carbon composite materials. A full non-contact eight element imaging array with the excitation signal being induced inductively, as in eddy current testing, is under construction at Sussex.

## 4. Dynamic Monitoring of St Austell Fibre-Reinforced Polymer Footbridge

**Jonathan Shave**
**PB World**

Abstract awaited

## 5. Innovative monitoring technologies for underground infrastructure

**Prof. Kenichi Soga**
**University of Cambridge**

Professor Soga explained that one of the greatest challenges facing civil engineers in the 21st century is the stewardship of ageing civil engineering infrastructure. Nowhere is this more apparent than in their underground networks in the major cities around the world. Much of them were constructed more than half a century ago and there is widespread evidence of deterioration of this old infrastructure. The critical deterioration of civil infrastructure has driven the search for new methods of rehabilitation and repair by incorporating sensors and developing remote systems that would allow monitoring and diagnosis of possible problems occurring. Advances in the development of fibre optics, computer vision and micro-electro-mechanical sensors (MEMS) offer intriguing possibilities that can radically alter the paradigms underlying existing methods of condition assessment and monitoring. Future monitoring systems will undoubtedly comprise Wireless Sensor Networks (WSN) and will be designed around the capabilities of autonomous nodes. Each node in the network will integrate specific sensing capabilities with communication, data processing and power supply. The talk presented some of recent research at Cambridge in the area of innovative monitoring technologies.

## 6. Dynamic monitoring by interferometric radar

**Dr. Giovanni Alli**
**IDS Ingegneria Dei Sistemi (UK)**

Dr Alli described how satellite based radar interferometry has been used in the past 10 years to obtain measurements of slow land movements from space. IBIS is a new land based radar built on the same physical principles and can be used for closer range land movement monitoring (5 km) but also for measurements of vibrations of buildings and other engineering structures up to 50Hz. While the short range (up to 1km) accuracy of the instrument is far superior to commercially available laser instrumentation (0.01 mm) the system exploits naturally occurring radar scattering features across the structure to allow the measurement to be conducted without the need to access the structure itself. Furthermore, the system is largely immune to environmental conditions such as illumination, fog and precipitations.

A number of real life case studies were presented ranging from frequency analysis of wind turbines to modal reconstruction of bridge movements. Results obtained by IBIS were compared to those obtained using more standard technologies such as accelerometers and laser ranging devices.

## 7. New ACPD Instrumentation for On-Site Monitoring

**Dr Martin Lugg**
**TSC Inspection Systems**

Dr. Lugg introduced A.C. Potential Drop (ACPD) as a well-established technique for monitoring crack growth in laboratory fatigue testing. Use of the technique for on-site monitoring has been hindered, however, due to the weight of the equipment and its lack of ruggedness.

TSC Inspection Systems have been producing laboratory ACPD equipment for many years, as well as rugged a.c. field measurement testing equipment for defect detection and sizing on-site. This expertise has now been combined to produce a new IP54 rated ACPD multichannel instrument for on-site monitoring applications. Special sealed, magnetically-attached probes have also been produced that can be left in-situ at critical areas on (for example) metal-frame bridges, to allow such areas to be inspected periodically without removing the overlaying concrete.

## Conclusion

Professor Dover closed the seminar, thanking those who had presented and those attending and reminded attendees of the next seminar in the autumn.