

# Measurements for Materials Systems (MMS)

## MMS13 – Assessment and Criticality of Defects and Damage in Materials Systems

## MMS15 – Interactive Knowledge Base (IKB) on NDE and Design of Composites

### Minutes of 5<sup>th</sup> Industrial Advisory Group Meeting

Thursday 15<sup>th</sup> July 2004

Rooms CS6/CS7 - Module 9, National Physical Laboratory

#### Attendees

Gordon Bishop	NetComposites	Richard Lee	AEAT
Ajay Kapadia	VT-Halmatic	Bob Lewin	Rolls-Royce
Graham Sims	NPL	Rod Martin	MERL (pm)
Kevin Fraser	Imes Ltd	Nigel Evans	Insys
Roger Davidson	CTG	Mike Gower	NPL
Mark Stone	AEAT	Martin Wall	AEAT
Graeme Hughes	HSE	Fadhil Habib	BAE Systems
Anne Birt	QinetiQ	Robert Smith	QinetiQ
Brian Thompson	SP Systems	Stephen Bowron	MERL (am)
Nick McCormick	NPL (pm)		

#### Apologies

Steve Austen (RNLI), Shayz Ikram (L.O.T. – Oriel Ltd.), Sam Luke (Mouchel-Parkman), Keith McClaghlin (Advanced-NDT), Stephen Wyatt (Quo-Tec Ltd), Sue Panteny (Faraday Advance), Andreas Obst (ESA), Roger Gregory (LTI)

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#### 1. Welcome and introduction

Mike Gower (MG) welcomed members of the joint IAG to NPL for the fifth MMS13/15 IAG meeting. He then went through the meeting agenda and asked if anyone had any issues with the minutes from the last IAG meeting. No issues were raised and the minutes were accepted. MG asked if members would briefly introduce themselves to the group.

#### 2. Project progress

##### 2.1 MMS13

MG gave a brief overview of the MMS13 objectives, project structure and current status/progress of the live tasks. He stated that work on Tasks 1-6 had now been completed and the only tasks that were currently live were the case study and dissemination tasks. He also updated IAG members on the outputs that had been produced from the MMS13 project so far.

MG then went on to present the test work that had been undertaken as part of the materials characterisation task. He reported that all the base and Mode I & II testing (undertaken by MERL) of the materials supplied by VT/Halmatic had now been completed. Key findings from the base materials characterisation work were presented and are detailed in MG's presentation that is posted at [www.mms15.com](http://www.mms15.com).

MG then briefly described the tests that had been carried out on two ultra high modulus (UHM) CFRP materials used for bonded over-wrap repairs for stiffening and/or repair of

ageing bridge structures. The tensile strength, modulus of elasticity and strain to failure of the materials were determined according to BS EN ISO 527-5, ASTM D3039 and BS EN 2561. Both materials were supplied from DML Composites along with a nominal 1mm thick glass fibre-reinforced end tabbing material. Two batches of tests were undertaken using two different end tab materials; (i) the DML supplied 1 mm thick material and (ii) 2 mm thick Tufnol®. The work was undertaken to provide a suitable methodology for the measurement of tensile modulus for UHM materials. MG reported that during the tests it was noted that when the hydraulic grips were used to clamp specimens with the 1 mm thick end tab material, even at low gripping pressures, cracking could be heard. When the 2 mm thick end tab material specimens were tested there was no acoustic emission. The strength and failure strain results for the 2 mm thick end tabbed specimens were considerably larger than for the specimens tested with 1 mm thick tabs. He stated that it is recommended that for future tests, 2 mm thick tabs (of uniform thickness) be used as they offer far greater protection to the specimen when gripped. As expected there was no difference between values of tensile modulus for the 1 and 2 mm thick end tabbed specimens. There was in general fairly high scatter in the tensile strength results and low scatter for the modulus results (less than 5%).

*Nigel Evans (NE) asked how the specimen end-tab design was important to the actual properties of the material during application. MG replied that the use of 1 mm thick GRP end-tab material offered reduced protection to the test material during loading and that premature failure was initiated in or near to the end-tab regions due to damage introduced during gripping. Use of thicker, homogeneous end-tabs prevented gripping damage and premature failure was avoided. Therefore a more representative value for tensile strength was achieved.*

Stephen Bowron (SB) presented an overview of the test methodology and results of the static and fatigue Mode I and II tests. SB stated that for both material formats and for both delamination modes, significant fibre bridging was observed. In fatigue, this was taken into account (during data reduction) by multiplying the fatigue G data by  $G_{IC}/G_{IR}$  for the Mode I data or by  $G_{IIC}/G_{IIR}$  for the Mode II data.  $G_{IR}$  and  $G_{IIR}$  were determined from the respective static R-curves by curve-fitting. Paris Law relationships were used on the original data and the data corrected for fibre bridging. By correcting for fibre bridging, threshold G levels for producing a crack growth rate of  $1 \times 10^{-7}$  mm/cycle were calculated for use in situations where no fibre bridging is anticipated. SB's presentation can be viewed at [www.mms15.com](http://www.mms15.com).

Richard Lee (RL) presented work that had been carried out by AEAT on the production of a draft procedural guide that will act as the pre-cursor to the electronic web-based Good Practice Guide (GPG) for the assessment and criticality of defects and damage in material systems. The draft guide will be finalised by the end of 2004 with input from the case studies and industrial feedback. RL also presented relevant data from recent cross-industry meetings focussing on composites, in particular, the final meeting of the EU Composit network attended in Bristol (<http://www.compositn.net/>). RL also mentioned that a proposal for a cross-sector collaborative project under the title of ACLAIM (Advanced Composite Life Assessment and Integrity Management), was to be submitted to the DTI Technology Programme. He stated that the main partners would be AEAT (project lead), NPL and Mitsui Babcock Ltd. and that the project intended to develop a framework for assessing the integrity of advanced composite structures over the complete life cycle through an integrated approach to structural health management. (N.B. It was announced in November 2004 that the ACLAIM project partners were successful in securing funding for this project)

## 2.2 MMS15

Martin Wall (MW) gave an overview of the IKB on NDE of composites (MMS15). He began by providing a review of some of the key features of the IKB and then gave details of progress made since the last meeting and on the shared notice board for MMS13/15. There had been a significant increase in the amount of content and software improvements.

A demonstration was given of the current version of the Interactive Knowledge Base (IKB) accessible via the URL [http://www.netcomposites.com//ikb/default\\_v2.asp](http://www.netcomposites.com//ikb/default_v2.asp) on the NetComposites site. To avoid confusion this would be the main point of access for IAG members. A development version on the AEAT server is also available with password access; this is used to trial content and software improvements prior to uploading to the NC site. Both versions of the IKB can be accessed via the members area of the mms15 website [www.mms15.com](http://www.mms15.com). To help IAG users, MW agreed to produce a simple user guide for the IKB.

Gordon Bishop (GB) NetComposites presented and demonstrate the new user interface they were developing to integrate with the IKB. This has drop-down menus and connects with the style of the NetComposites site. The user interface has the familiar feel of web applications in the left hand menu with a horizontal menu-bar giving structured access to the IKB information for individual NDE techniques. Robert Smith (RS) and Anne Birt (AS) described Qinetiq's involvement in the project both in providing NDE data and in the validation of data and rankings in the IKB.

MW gave a demonstration of the software module for recommending an NDE technique (RAT). The software itself was still under development. This included a score editor that allowed the questions and answers to be modified as well as allow rankings for different techniques to be compared.

There was a discussion of the benefits of the *Recommend* feature. Ajay Kapadia (AK) could see this being valuable in manufacture to identify the best NDE solution to resolve production problems. The response time to make decisions in manufacture is often very short with NDE expertise being brought in at short notice. Therefore, the recommendations needed to be robust and reliable. There was a general discussion about the benefits of giving guidance in general, in case this was applied inappropriately by inexperienced users. The IAG recommended that appropriate caveats were included so users were clear on the scope of the guidance.

Another main topic of discussion was the balance needed between expert assessment and the suppliers of the technology. Suppliers had an intimate knowledge of their technology particular defect capabilities, so their input was valuable. Conversely this could give a more favoured assessment of the technology than may be found in practical situations. To avoid potential conflicts an audit process is required and the basis of this should be documented for users.

The IAG agreed they the technique selection (RAT) tool is an important part of the IKB and should be retained, with all efforts taken to ensure it is robust and reliable. It was agreed that a meeting be held between the MMS15 partners to draw up a documented strategy for the ranking process and how this would be validated. This would give users greater confidence in using the result. Validation of the IKB content was also discussed. As well as internal review by the project partners, it was hoped the IAG would also participate in the validation. This would help ensure the content is correct and in the right location.

Action MW to arrange a meeting with QQ and NC to define the strategy for scoring of techniques within the recommend feature and validation of the IKB

MW reported on recent case studies including an application of laser shearography to GRP train cabs and further studies on composite overwrap repairs. IAG members were encouraged to make relevant case studies, data examples and procedures available to be included in the IKB. A brief overview was given of recently developed computer models for simulating radiographic and ultrasonic C-scan inspections and predicting reliability (POD). A copy of the presentations has been placed on the MMS15/mms13 website.

### **3. Presentations on Performance Programme (2004-2007) Projects**

During the afternoon session, Nick McCormick (NM), Graham Sims (GS) and MG gave brief presentations on three projects that form part of the Department of Trade and Industry (DTI) funded Performance Programme that started in April 2004 and is due to finish in March 2007. The Performance programme is the follow on programme to Measurements for Materials Systems (MMS). The projects presented were:

- Project B3: A Tool to Predict Lifetime for Composites Subjected to Environmental/Fatigue Damage (NM)
- Project F4: Accelerated Ageing Protocol for Service of Polymer Materials in Hostile Conditions (GS)
- Project F12: Development of Test Methods for Determining the Criticality of Defects in Composite Material Systems Under Long-Term Loading (MG)

MG stated that these projects would share the same industrial advisory group due to the common theme of material degradation and damage criticality. It is intended that the MMS13/15 IAG would form the basis of this IAG. More details on these projects can be found at [http://www.npl.co.uk/performance/project\\_list.html](http://www.npl.co.uk/performance/project_list.html). GS then gave a brief overview of the work currently being undertaken in the 2004/2005 Materials Interim Programme.

N.B. All the presentations given at the IAG meeting (covering MMS13/15 progress) are available at [www.mms15.com](http://www.mms15.com).

### **5. Date of next meeting**

The final joint MMS13/15 IAG meeting will be held on the *24<sup>th</sup> of February 2005* at NPL. An agenda will be sent out to members in due course.