



SAFEJOINT INDUSTRY WORKSHOP

The SAFEJOINT Industry Workshop took place in Athens, Greece on the 3rd and 4th July 2014.

The workshop was well attended with a combination of formal presentations and a dedicated discussion session at the end of each topic. This successfully encouraged discussion from both academia and industry with many opinions and suggestions about the way forward for these joining technologies and the needs of industry. The presentations from the workshop can be downloaded from the SAFEJOINT website at www.safejoint.net or by emailing belinda.fairbairn@ncl.ac.uk

The progress of the SAFEJOINT project to Month 18 were presented with current results and the way forward for the next 18 months to the end of the project.

This edition of the newsletter will detail a round-up of the issues raised by the workshop discussion in each topic area:

Session 1—Metal to Composite joining

The first session was designed to showcase the developments on dissimilar material joining by SAFEJOINT and two other similar projects concerned with joining technologies, YBRIDIO and PMJoin. The response from the delegates during the discussion session was positive overall on the new technologies been presented and the diverse applications addressed by the three projects. A representative from the Rail Industry stated that this level of information and innovation presented will be of interest directly to the potential for these technologies to be taken up by industry in the medium term.

Some of the industry representatives present debated whether a lap shear specimen is the best approach as different applications require different configurations, although it does always exhibit best performance. A discussion ensued and it became apparent that indeed adhesive bond strength varies with different loading configurations.

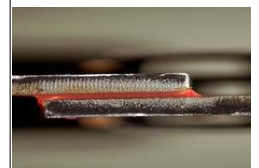
OCTOBER 2014

Inside Edition 4:

- Focus on the SAFEJOINT Workshop



The SAFEJOINT Project is part-funded by the European Commission (EC) FP7 Programme



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Session 1—Metal to Composite joining—continued/.....

The remaining discussions in session 1 were mainly concerned with explanatory details of aspects of the work presented. One of the questions that arose was that of the cost of new technologies. It was explained that the approaches in the three projects do not require any significant capital expenditure and could be easily incorporated into existing operations where adhesive bonding is already in use. The consortia of all projects are well aware of the commercial demands of industry and they aim to achieve a step change in adhesive bonding performance without any significant cost penalties.

Session 2—Modelling of dissimilar material joints

The topics covered in session 2 were:

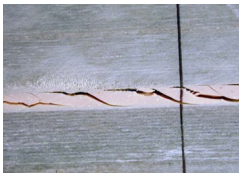
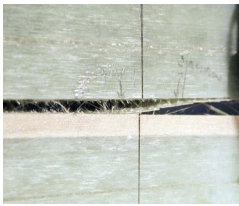
- *· Failure modes in composite joints: a finite element study.*
- *· “Mixed adhesive joints”*
- *· Integrated modelling of 6xxx series friction stir welds: from thermal cycles to mechanical performances.*

Session 3—NDE of Dissimilar Joints

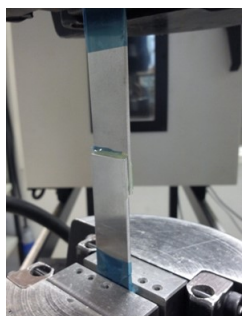
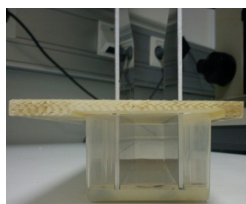
- *Ultrasonic NDT of dissimilar joints*
- *Development of Piezoelectric sensors*

The open discussions at the end of the presentations of session 2 & 3 started with the work on functionally graded adhesives also drew significant interest focusing on the effect of (or degree of) mixing of the adhesives once they have been placed at the joint. The level of improvement achievable on the adhesive joints performance through this technique has been also analysed in detail, viewed in terms of the stresses distribution along a lap shear joint. In addition, the effect of the temperature on these solutions has been discussed. It was also mentioned that the embedded strain sensor technology developed within SAFEJOINT aiming to provide quantitative information of the stress distribution within a joint and help optimise the placement of graded adhesives.

A further point that was raised was that of “kissing bonds”, namely bonds that appear sound (no void detected) but they are of significantly reduced strength as a result of contamination, environmental degradation or poor surface preparation of the joint. It was explained that at present this is not possible with current techniques. It was mentioned though that the thin film strain sensor technology developed in SAFEJOINT may be able to detect that but the sensors cannot provide information on the “global” condition of the joint.



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The SAFEJOINT partner KTU presented some images of dissimilar metal joints developed within SAFEJOINT utilising a new technique “ultrasonic microscopy” demonstrating that the detection of both defects as well as the distribution of nanoparticles in the weld of dissimilar metals. This technique is an invaluable tool for both inspection and weld quality, the latter allowing for the optimisation of the welding process.



A question was raised on the environmental degradation of the joints. All projects are aware of the issue and work is underway addressing this issue. However, it is not expected to encounter any environmental degradation effects dissimilar to those of existing bonded joints as the process is dominated by the adhesive resin properties.

Session 4—Environmental degradation of dissimilar material joints

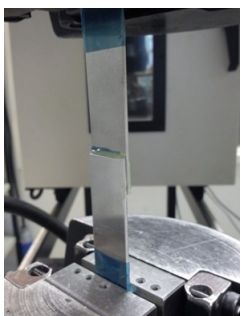
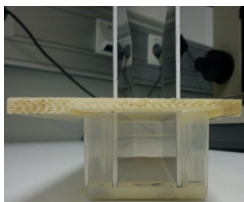
The topics covered in this session took place on Day 2 of the workshop:

- *· Environmental impact on elastic adhesive joints in marine applications*
- *· Degradation of adhesive joints*
- *· The effects of pre-bond and after-bond contamination on the fracture toughness of adhesively bonded joints*

The outcomes of the Open Discussion were:

There are tools and procedures for assessing the long term performance of bonded joints and those are addressed within SAFEJOINT. The discussion was already made on the previous day and it was re-iterated that the performance of bonded joints developed in SAFEJOINT, YBRIDIO and PMJOINT should not display behaviours overly dissimilar to existing bonded joints. The controlling factor is the moisture diffusion in the adhesive resins. In terms of dissimilar metal joints, the effect of environmental degradation (corrosion) is addressed through an innovative idea of incorporating in the weld pool nanocontainers that include corrosion inhibitors. This work is currently underway but preliminary results look promising.

The issue of contamination of joint surfaces (from lubricants, fuels etc) prior to bonding was also discussed as it is in the majority of cases the most important problem affecting the integrity of bonded joints and is related to the manufacturing procedures of the joints. It is a problem that requires extensive training of personnel manufacturing those joints who are not always aware of the implications of inadequate surface preparation and cleanliness. This is also the source of “kissing bonds” for which the development of some type of NDE method needs to be developed. This problem is currently addressed in the standards by a combination of bonding and bolting of dissimilar materials for safety critical structures and components in the transportation industry.



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Session 5—Dissimilar metal joints

The final session of the workshop was facilitated by Simon Frost of Walker Associates who is a member of the SAFEJOINT Industry Advisory Group titled Dissimilar metal joints. There were 2 topics covered in this final slot:

- Microstructure and mechanical properties of Al-to-steel welds performed by friction melt bonding.
- Micro structural and mechanical study of AA 5083 and AA 6082 friction stir welds reinforced with SiC, TiC and CNTs .

The discussion that ensued focused mainly on clarifications of the techniques presented including the issue of corrosion for aluminium to steel joints and the means of avoiding galvanic cells being set up.

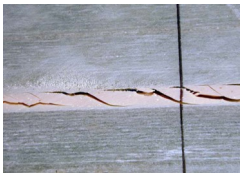
The main issue affecting this type of work concerned NDE inspection and environmental degradation. The SAFEJOINT partner KTU presented some images of dissimilar metal joints developed within SAFEJOINT utilising a new technique “ultrasonic microscopy ” demonstrating that the detection of both defects as well as the distribution of nanoparticles in the weld of dissimilar metals. This technique is an invaluable tool for both inspection and weld quality, the latter allowing for the optimisation of the welding process.

Workshop Round-up

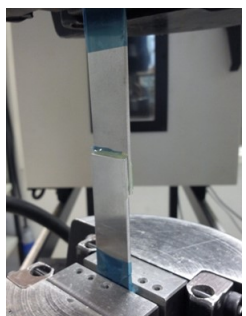
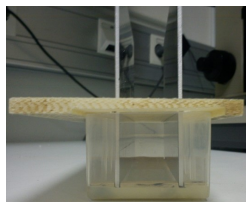
The second day of the workshop was rounded-up with a general discussion forum facilitated by SAFEJOINT Coordinator, George Kotsikos about the Industry perspective, needs, comment and input on the future direction of research in dissimilar material joining followed by a round-up of discussions and points raised throughout the workshop.

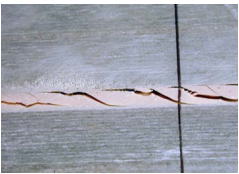
The main issue that was raised is the need to comply with certification rules for each transport mode application, as they define the performance requirements for any newly developed technologies. For example in the aeronautics industry the rules of certification of bonded structures are well defined by the certification Authorities (FAA and EASA). Any new technology must comply with these certification rules as fully described in the Advisory Circular related to this topic. A representative from the aeronautics industry, suggested the certification rules for bonded structures should be considered as a guideline to comply with for any new joining/bonding technologies, from an early stage in the development.

However, it was also pointed out that the surface transport sector (rail, marine, automotive) albeit having to abide by certification rules, is not as strict in its design rules as aeronautics. Notably for those industries, the issues of ability to reliably inspect the condition of the joints, long term structural integrity and environmental degradation are deemed important.

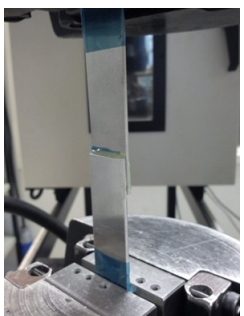
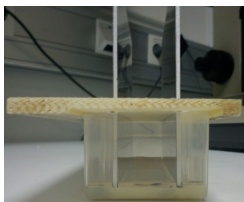


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Perhaps the most important issue for land transport is cost. Any developed techniques through SAFEJOINT have to be comparable in cost to existing methodologies for manufacture and inspection.

Another issue mentioned in one of the sessions on the previous day was reiterated at the general discussion session and deals with the ability to detect “weak bonds” (or “kissing bonds”) as there is currently no detection techniques able to assess this type of defect in bonded joints and can be the source of premature failures and the main contributor of uncertainty over the adoption of purely bonded joints which are really the goal for efficient lightweight designs.

The main conclusion that was drawn at the end of the round-up session is that any joining technique would be acceptable if it is accompanied by:

- precise manufacturing rules
- reproducibility of the bond
- detailed and reliable inspection techniques
- reliable through life structural integrity monitoring
- methodologies to determine residual strength (or remaining life) of a joint following the detection of damage; and
- prediction of long-term performance of the joints.

What is important for all the previous points is that the degree of uncertainty must be extremely low and similar to the levels for existing joining techniques such as riveting or bolting.

SAFEJOINT—FINAL CONFERENCE

A final Conference is being held in 2015, which will bring together the research and practical solutions developed through the SAFEJOINT project. The findings of the project will be presented as well as the latest developments from around Europe and internationally. The purpose of the Conference is to disseminate the knowledge generated from the SAFEJOINT project and will be a forum for discussion on the market uptake of the technologies developed and also encourage industry to adopt these techniques.

The date and venue for the Conference will be advertised in the SAFEJOINT newsletter and on the SAFEJOINT website.