Shared Research Project

Engineered Composite Repairs

As a consequence of asset ageing, the extent and use of engineered composite repairs has increased dramatically over recent years.

It is now not uncommon to see examples on a range of both onshore and offshore structures, components and equipment. Such repairs present an attractive proposition both technically and financially. However, whilst in general the performance of such repairs has proven to be satisfactory, there continues to be uncertainty relating to their long-term integrity and performance. Whilst at the present time the majority of repairs are applied to non-safety related equipment, engineered composite repairs are increasingly applied to more onerous applications, some of which are considered to be safety critical.

HSE's Shared Research Programme supports external investment and collaboration in HSE's research portfolio. This allows resources and expertise to be shared for the benefit of all, through an appropriate range of commercial relationships, depending on the scale of activity and involvement.

These include:

Partnerships long term relationships with individual clients, who share key organizational objectives with HSE and covering a large suite of work, addressing joint topics of concern over a number of years;

Programmes centred on relevant cross-cutting themes, which impact both the regulator and regulated. Offered on a single or multi-client basis, programmes would run over a number of years and consist of a series of linked activities or projects around identified topic areas;

Projects these would have a defined aim and objectives and would be designed to address a specific research question in a clearly defined time frame. Projects would either be offered on an individual or multi-client basis; and

Research Club Memberships these would provide a mechanism to support smaller organisations and to increase the reach of the findings of research undertaken via the mechanisms described above as well as for the findings of HSE-specific research and HSE operational support activities.

By supporting the shared research approach, contributing partners will be able to help shape the focus of the research activity, gain ongoing access to emerging findings and have early sight of draft outputs.

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HSE has a long history of supporting science and research to address a range of cross-sector safety issues. In many cases, this has been delivered as a partnership between the regulator and industry via traditional Joint Industry Projects (JIPs). Recently, HSE has committed to delivering a Shared Research Programme that provides support funding for research addressing key health and safety related issues as identified by industry. HSE recognises the knowledge gaps associated with the long-term integrity of engineering composites and the asset integrity challenges operators currently face. Indeed, improved collaboration between operators, their supply chain and regulatory bodies has been identified as critical in maximising the economic recovery of the UKCS.

HSE proposes to lead a shared research programme aimed at improving our collective knowledge and understanding of the long-term integrity of engineered composite repairs.

Approach

In order to shape the shared research programme, HSE has held two scoping workshops in Aberdeen. These workshops were attended by operators, repair companies and regulatory bodies. Based on knowledge gaps identified during these workshops and subsequent discussions, a number of work streams have been identified as a series of distinct but interrelated work packages.

Inspection / Condition monitoring	Votes
Inspection techniques - life extension benefits	26
Not laminate. Steel / interface requires inspection, when does defect become through wall	15

External factors / response of laminate and bond	Votes
Chemical compatibility at different concentrations, temps, pressures etc..	3
Chemical resistance of different resin systems	4
Sufficient guidance to allow consistency of approach	1
Guidance on fire risk - assessment	12
Effect of mechanical 'damage' throughout lifetime of the wrap	9
MAH survivability bond and wrap impact, loading and fire	6
Effects of external conditions	0

Long term material performance	Votes
Line condition changes during life of repair MOC considerations	10
Sensitivity of variables in the design process, this may be well understood by the repair designers but needs to be better communicated to end users as they supply the input data	10
Long term loads	5
General understanding of limitations	17
Epoxy quality and testing for long term integrity - are current codes ok?	3
Quality of application say ten years ago vs 2 -3 years ago where understanding of QA/QC is better	7
Post service testing (destructive) performance of substrate i.e. how corrosion extends once perforation has occurred. Failure mode -> Warning signs	7

QA of installation	Votes
Competence of installer/assurance/ verification (e.g. independent scheme to ensure competence)	24
Installation competence and assurance of competence	1
Manufacturer's variables and long term reliability	3
Influence of installer competence on quality. When are 3rd party installers suitable and when should we revert to more experienced OEM.	8
Consistent compliance with application procedures	0

Knowledge gap raised by: Operator, Repair Supplier

The work packages present a top level overview of the work to be completed and the proposed deliverables. The technical detail of each work package will be defined and agreed on a collaborative basis via the steering committee which shall be formed when the project commences. The committee is expected to be a partnership of oil & gas operators, composite repair companies and the regulator (HSE), all of whom are key stakeholders in the application of composite repair technologies to ageing assets. In specific cases, where there are clear advantages to doing so, HSE may engage with external consultants to assist with the delivery of the work packages outlined in this proposal. This would be discussed and agreed, in advance, with the project partners.

Overview Of Technical Work Packages

Work Package 1: Quality Assurance and Integrity Management

The aim of this work package is to establish good practice with respect to quality assurance and on-going integrity management. It is anticipated that this will be identified through the sharing of knowledge and experience amongst the project partners as well as from reviewing existing company approaches and procedures.

All pertinent documentation will be reviewed on an independent and confidential basis, identifying good practice from the common features and justifiable approaches. This is likely to include several aspects, such as: repair selection process (composite solution vs alternatives); composite repair management system; installation considerations; approach to on-going integrity management and; decommissioning. In addition, where appropriate, good practice from other sectors will be identified and reviewed and its applicability to the offshore oil and gas sector considered.

It is anticipated that partners will be able to modify their existing procedures to reflect the good practice identified as part of the work package.

Deliverables

- Table comparing approaches to key aspects of the QA process and ongoing integrity management
- Comprehensive report detailing how the requirements/ recommendations outlined in ISO 24817 are implemented
- Good practice document

Work Package 2: Inspection and the Criticality of Defects

The aim of this work package is to establish the capabilities and limitations of existing techniques for inspecting engineered composite repairs as well as conducting preliminary research into the criticality of defects. It is anticipated that this will take place in three phases. The first phase will include a state of the art literature review to identify the range of techniques available and their perceived capabilities and limitations. In addition, the review will summarise operational experience, informed by the project partners, literature and wider consultation.

Phase 2 will evaluate the capabilities of each technique. This will be established by inspecting test reference specimens, designed by the project partners, that incorporate a number of known defects at a range of locations, e.g. substrate, interface, composite. Test reference specimens could take the form of pipework, of varying diameters, including straight sections, t-pieces and bends. A range of techniques will be evaluated by inviting suppliers to inspect the reference test specimen(s) and report on the location and nature of any defects identified during the exercise.

In Phase 3, pipes with through-wall defects, that have subsequently been repaired, shall be pressurised to failure. A proportion of these pipes will have additional defects incorporated at various locations. The failure pressure of these specimens will then be compared to specimens without these defects in an attempt to establish their effect on performance. Whilst it is acknowledged that this exercise is non-exhaustive and only implies short term performance, such data does provide a valuable insight and may form the foundation for future work in this area.

Coupled with the Phase 1 literature review and operational experience/ perspective this programme of work will ultimately provide the project partners with a comprehensive assessment of the strengths, limitations and resolution of key inspection techniques, in particular, the ability to specify the most appropriate case-specific technique. The techniques will not only be evaluated from the perspective of what can be detected, but their feasibility of being employed and used in an operational environment will also be taken into consideration.

Deliverables

- A comprehensive report detailing the strengths, limitations and resolution of currently available inspection techniques along with an overview of operational experience/perspective to date
- A comprehensive report detailing the test reference specimen trials
- Inspection technique capability chart – quick lookup guide
- Report detailing preliminary work on the effect of defects on short-term performance

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Work Package 3: In-service Performance

The aim of this work package is to establish how the performance/ integrity of the repair system varies as a function of service life. It is anticipated that this work package will be split into two phases.

Phase 1 will include inspecting, examining and testing decommissioned repairs, the selection of which will be determined by the project partners. The repair system will be inspected with a range of appropriate inspection techniques (including visual) and residual properties established through testing. As appropriate, this data will then be analysed and used for comparative purposes, for example, against the values used in the original design.

Phase 2 will take the form of a report to include a literature review as well as an overview of operational experiences to date. This will draw on the outputs from the case studies detailed in Phase 1, and will also include information, data and operational experience pertinent to the in-service performance of a repair system (or elements thereof) in offshore oil and gas applications/environments.

Rather than research and investigate the effect of every single process parameter, the review will be tailored to address the key concerns/issues identified and agreed by the project partners. The output will be a highly focussed, sector specific report rather than taking the form of a generic degradation study. Failure data, where accessible, will be reviewed with a view to establishing the mode and any lessons learned to prevent reoccurrence.

Deliverables

- Comprehensive report containing a review of literature, data, experience, case studies, failure information pertaining to engineered composite repairs.
- Report – summary of case studies

Price and Duration

The total funding required for this programme of work is estimated at £800,000. It is therefore anticipated that with financial support from the Health and Safety Executive (HSE), each project sponsor would need to contribute between £50,000 and £75,000 dependant on the total number of partners. The final scope of work will be agreed once all expressions of interest have been received. The programme is anticipated to commence early in 2016 and take between 18-24 months to complete.

Work Package 4: Fire Performance

The aim of this task is to establish the fire performance of engineered composite repairs. HSE have already commissioned work on this topic and this is being undertaken by the Health and Safety Laboratory. Through- wall circular and slot defects have been incorporated into pipe test specimens which have subsequently been repaired. The test matrix includes carbon and glass reinforcement, high temperature and standard temperature epoxy resin systems and repairs of different thicknesses. The test specimens, complete with thermocouples, will be pressurised and subsequently exposed to a hydrocarbon pool fire. The cost of this work has not been included in this project proposal, but partners will have access to the results and any associated deliverables.

Deliverables

- Report detailing test specimens, test methodology and results

Work Package 5: Repair Installer Proficiency Scheme

The aim of this work package is to develop a competency framework that could be taken forward and adopted as a repair installer proficiency scheme. It is acknowledged that the repair of substrates using composite materials differs considerably from other repair techniques and the quality of the installation depends strongly on satisfactory craftsmanship. Whilst standards such as ISO 24817 detail installer qualification, including the basic skills/experience, training and validity aspects, these are considered to be the minimum requirements. Through partner dialogue and external consultation, a suggested repair installer proficiency scheme will be developed. Where appropriate, composite repair installer proficiency approaches used in other sectors shall be reviewed to establish whether there is scope for cross-sector knowledge transfer. In addition, schemes used elsewhere, e.g. for welding, shall be reviewed and where appropriate, concepts evaluated and developed such that they are relevant to the composite repair case.

Deliverables

- Report detailing proposed installer proficiency scheme with underpinning notes from partners and external parties.

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