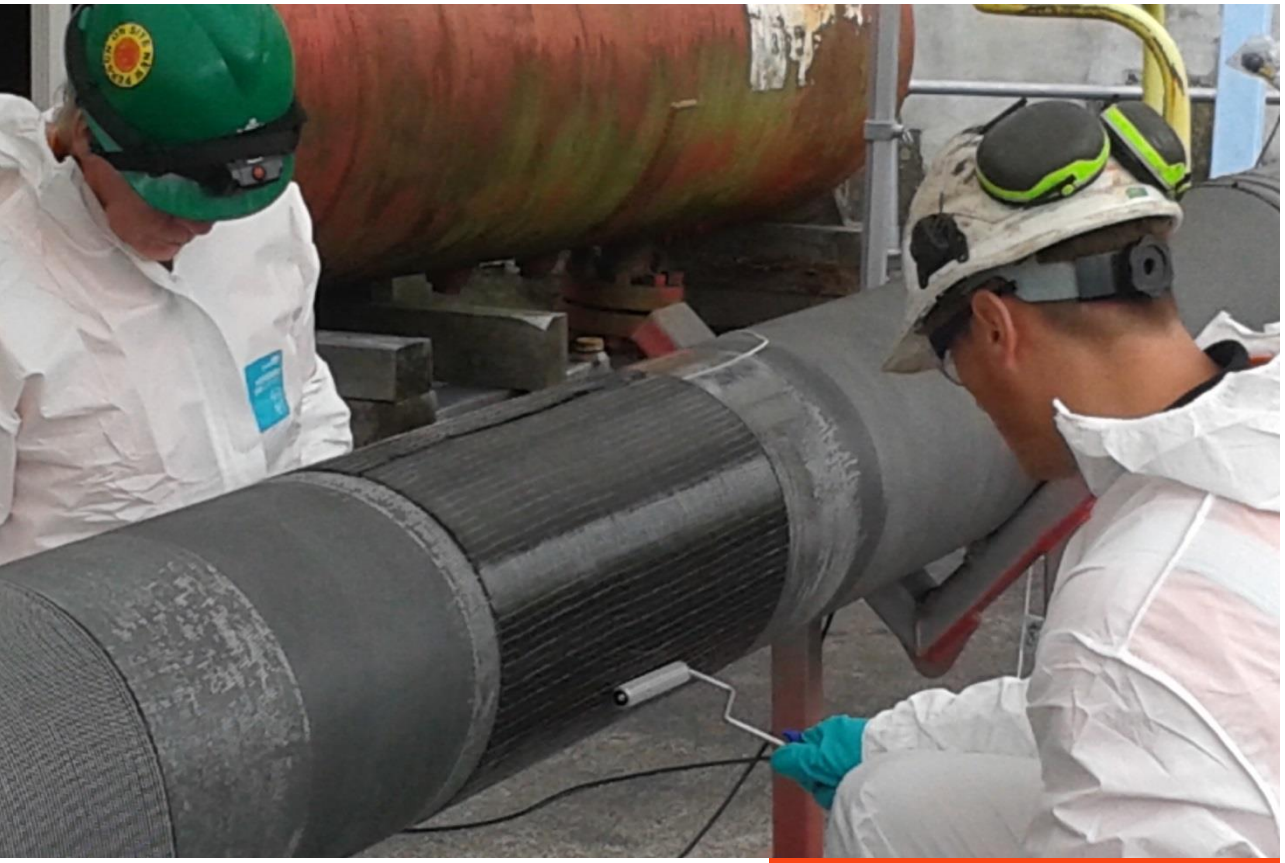

Composite repairs
A permanent pipe repair

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LCNI, October 2018

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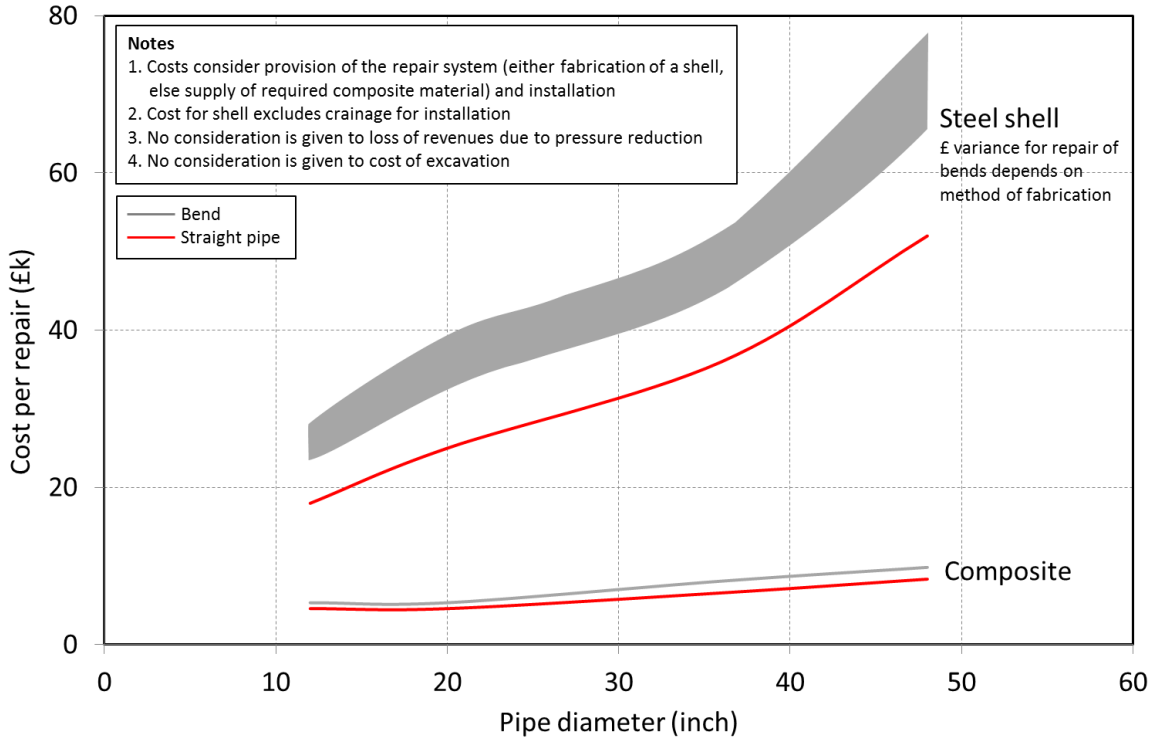
Why ‘Composite Repairs’?
A permanent repair for complex geometries

- To reduce the repair costs associated with complex geometries of above ground pipes lines both as an emergency repair system and as a permanent ‘long term’ repair solution

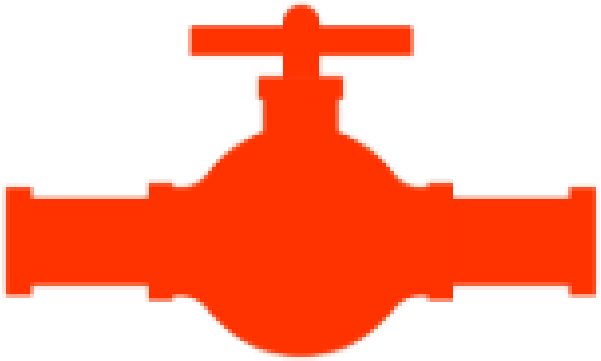
- Increase security of supply when emergencies arise.
- Established the effects of pressure during installation.



Why ‘Composite repairs’?
Meeting the challenge

Current repair solutions have long lead times, specially for complex geometries.

During the repair the piping streams would have had a pressure restriction enforced.



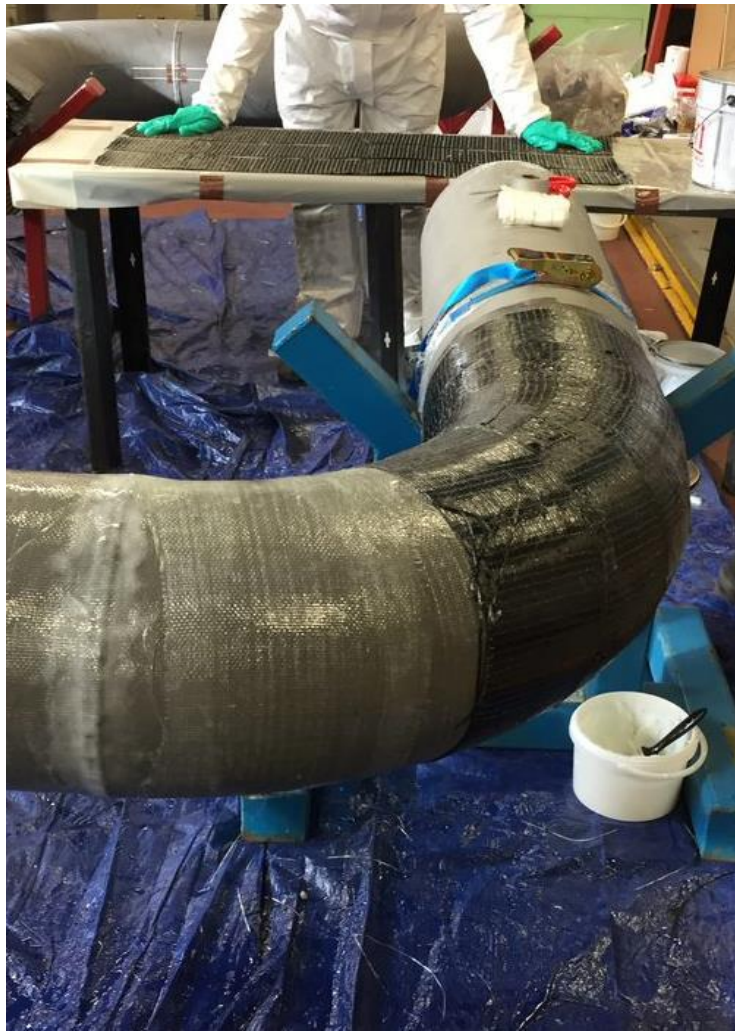
This creates big disruption to the network and customers.

What are ‘Composite repairs’?
Drawing on an existing technique

Composite repairs is tried and tested repair solution, use different distribution and transmition industries.

Offers significant savings compare to steel sleeves and cut out and replace techniques:

- No need for pressure reduction which reduce the loss in revenue.
- Security of supply, specially in emergencies where the system enable a quicker repair than a steel sleeve.
- Reduce impact on customers.

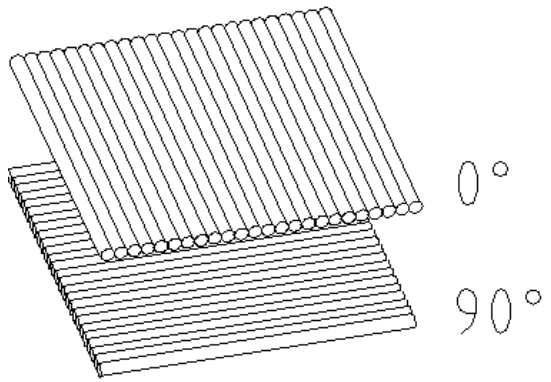


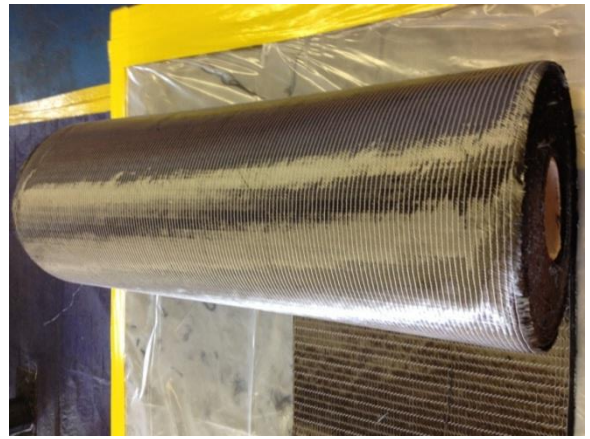
What are ‘Composite repairs’?
Understanding the technique

‘Bidirectional’ carbon fibre fabric designed to give strength in the hoop and axial directions

Can be applied to a range of geometries

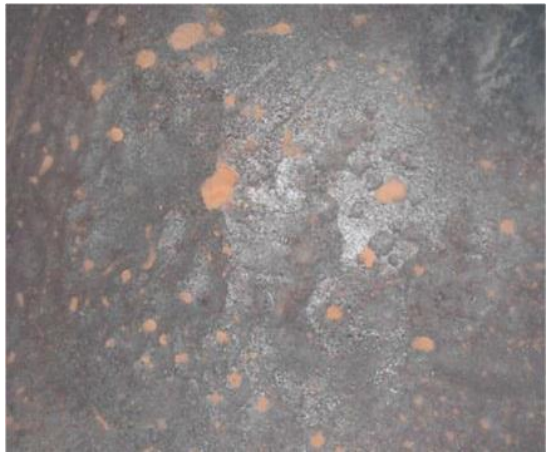
- No need for pressure reduction which reduce the loss in revenue.
- Security of supply, specially in emergencies where the system enable a quicker repair than a steel sleeve.
- Reduce impact on customers.





What are ‘Composite repairs’?
Experience to Date

- Pressures up to 345barg
- Temperatures from -90 to +210^{o}C
- Live and offline repairs
- Wide range of geometry
- PRCI project to demonstrate suitability for long term service
- 3 defect depths (40%, 60% and 75%)
- Burst test completed after 1, 2 and 3 years burial



Project scope
Advancing towards a permanent repair

Practicalities

- Complements the work of PRCI and the HSL.

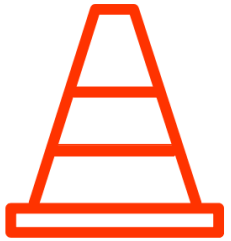
- Extend the scope of T/PM/P/25 to other complex geometries

- Establish the effects of pressure during installation.

Safety post installation

-Training and competence is key.

An in-house written scheme of competence.

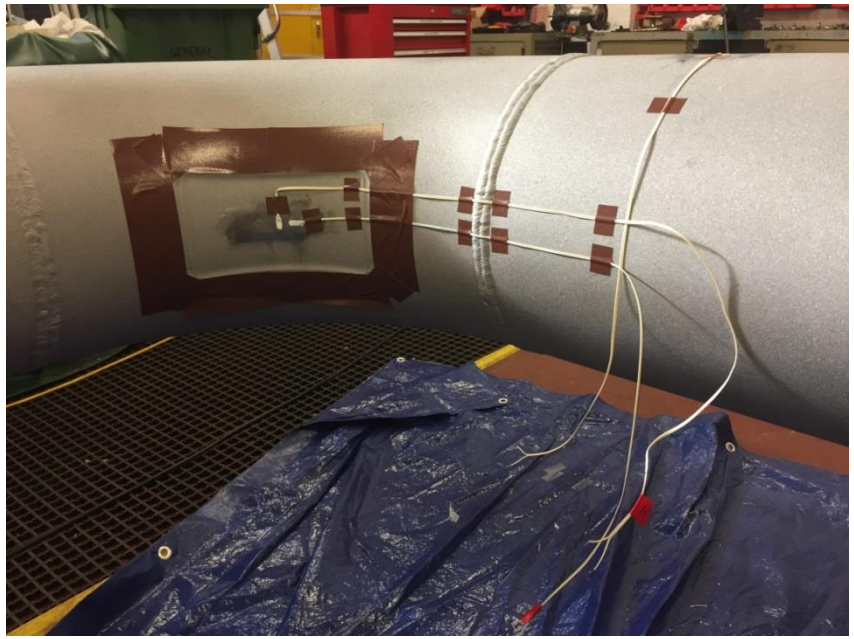


Testing programme

- DNVGL
- Debonding, flexibility, stiffness and environmental variables.

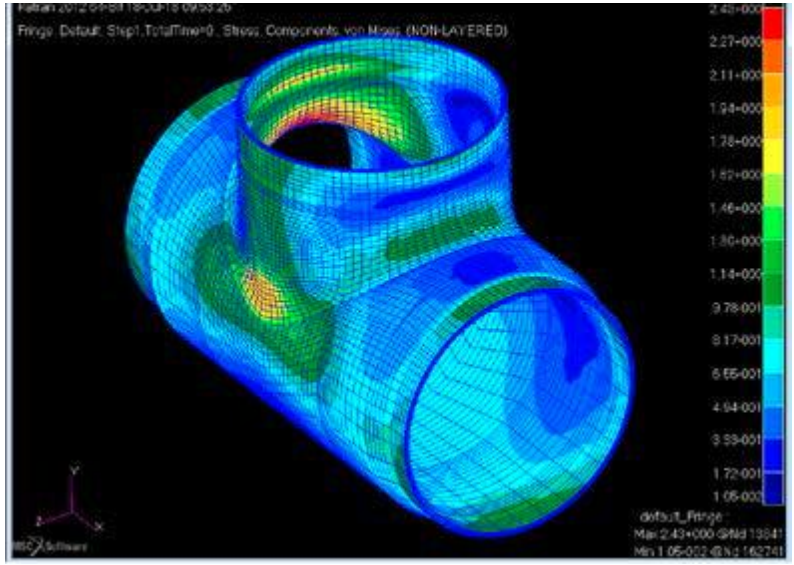
Fast tracking… testing

Yard and lab trials
Working with DNVGL



Practicalities

- GAP analysis to understand the missing parts between PRCI/EPRG/APGA studies.



Installation

- Each repair has been installed according to Management Procedure T/PM/P/25, which is based on SO-24817)

Yard and lab trials
Scope of testing programme

- Long term performance of composite systems for range of geometries.
- Identify restrictions on remaining life of piping system.
- Potential for debonding (e.g., if pipework is depressurised).

- Potential use for buried pipelines and piping systems, consideration to;
  - Long term adhesion
  - Cathodic disbonding
  - Adhesion of pipeline maintenance coatings

Fast tracking… testing results

Initial results
What have we learned so far

Testing for possible debonding due to pressure reductions / depressurisation;

- Results: Successful tests; no loss of adhesion of debonding, despite severity of testing

Fatigue testing of bends;

- Results: Testing confirms suitability of the repair system as a permanent repair method for metal loss damage affecting a bend/elbow

Initial results
What have we learned so far

Assessment of environmental variables on the integrity of the repair

- Results: Although there is a reduction in adhesion over the long term, when subject to the wide ranging conditions, the test results show that the repair system maintains good adhesion, achieving the acceptance criterion of 1000psi.

Fast tracking… what next

Remaining testing
What have we learned so far

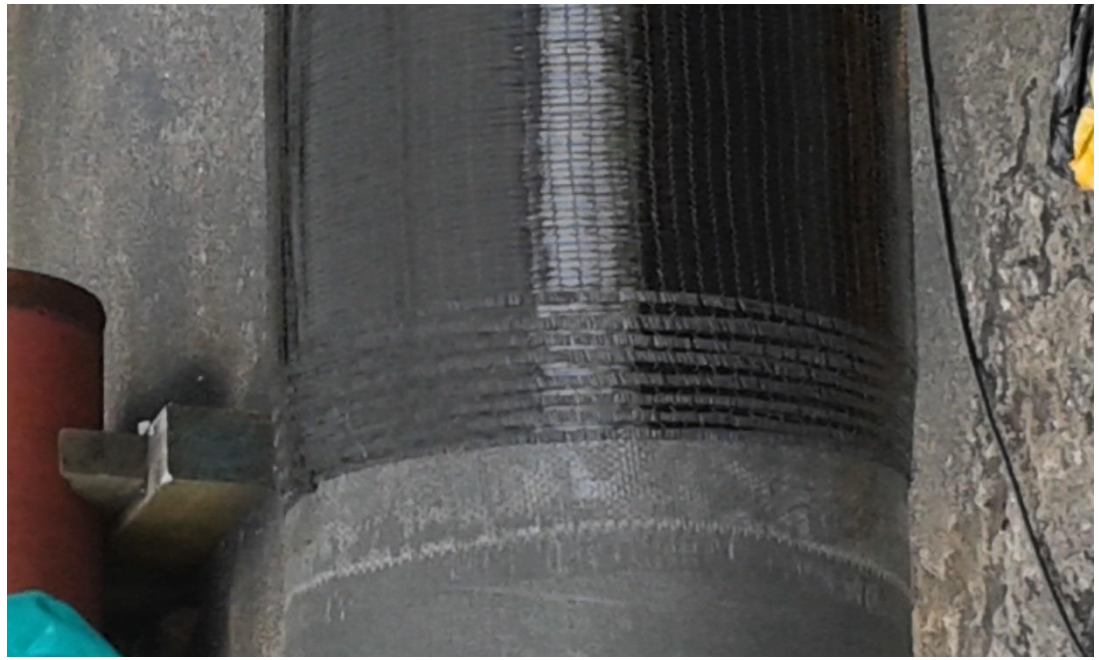
Tees – Static and fatigue tests

- Static tests.
- First fatigue test.
- Second fatigue.
- 4 off static tests; pressurised to failure (else a maximum).
- 2 off fatigue tests, each test comprising 2 Tees.

Remaining testing
What have we learned so far

Tees – Stiffness and flexibility

- 6” and 12”, configuration determined from previous stages.
- Test procedure, before and after application of Composite Repair;
- Determine SCFs for internal pressure, in-plane and out-of-plane bending and torsion.
- Compare to determine effect



To summarise….

Thank you

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