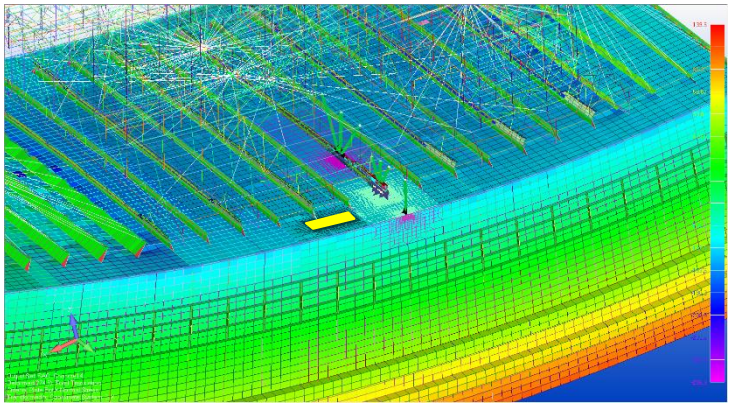
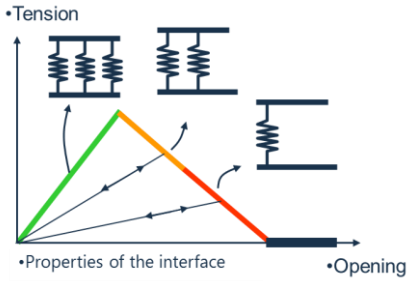
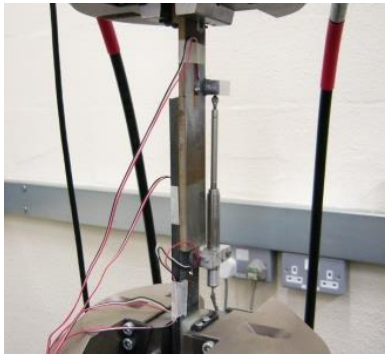
Strength Bond Offshore

Overpassing the technical limitations for the qualification of composite bonded repairs for offshore units.







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Strength Bond Offshore

Overpassing the technical limitations for the qualification of Composite bonded repairs for Offshore units.

Background and motivation

Bureau Veritas has initiated the Strength Bond JIP, on the assessment of bonded repairs for offshore units.

FPSO's have been around for the last 40 years, with a large development in the early 1990's. About two hundred are now operated around the world. The offshore environment is extremely severe to these steel structures that are required to operate 20 years without dry docking. Corrosion is a permanent threat to FPSO's and maintenance is a challenge.

When plate thickness has corroded down to the renewal criteria, it has to be repaired. However the current crop and renew repair techniques imply welding, thus:

- Emptying, cleaning and Inerting the surrounding tanks
- Opening a floating structure
- Rewelding the stiffeners, thus setting up large scaffoldings

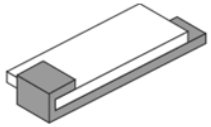
Mechanically, crop and renew repairs imply large costs and down time.

Composites and steel bonded repairs overcome these problems by being a non-intrusive and "cold" repair. It can be found surprising that such repairs have not been more developed in the industry. Offshore installation and durability are obvious problems to be treated. However, engineering face problems as basic as strength qualification. Analysis and design of a composite bonded repairs require tests that are delicate to translate to specific offshore design as there is a lack of guidance or reference. It makes difficult the qualification of a design of repair, and the evaluation of the safety margin.

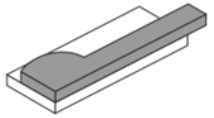
Actual status

Composite industry and engineers have developed best practices based on empirical feed-back. By nature, such methods give good results in a narrow range of designs and loading configurations around the empirical reference.

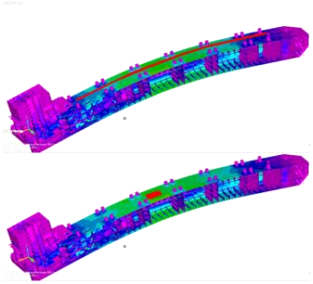
Moreover the common practice in bond engineering is to reduce by design the stress at the edges of the bond line (figure beside):



It can be done by enlarging the bonded part out of the stressed area or ensuring at no peel can affect the bond edge.



Such practices can not be applied on a common FPSO repairs where hull girder stress can not be avoided at the edges of a patch (figure below).

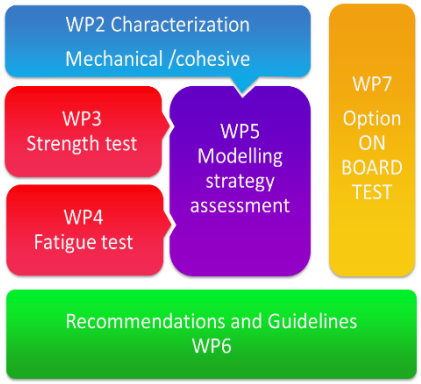


Also, the classical method applied in bonding consists in applying large safety factors between the strength obtained by empirical means, and the loads. This necessitates to have laboratory or on-board tests to evaluate the strength. From then on, qualification of each new design and repair configuration becomes a very long and complicate process.

Objective and scope of work

Based on the experience gathered during the last 20 years, in research or certification of bonded repairs and composite projects, Bureau Veritas has initiated the present Strength Bond Offshore JIP to overpass the Ilimitation to qualification of bonded repairs. The JIP is part of a larger project and will be followed by a second phase on bonded repair durability. Bureau Veritas is already engaged in other research projects on this subject that will benefit the future phase 2 of Strength Bond offshore. **A clear objective of the JIP is to enable a first level of certification of bonded repairs.**

The baseline of the JIP is to carry out a large test campaign with test set-ups dedicated to offshore repairs. Various repair designs differing from a referent case will be tested in order to reach two key milestones:



Investigate sensitivity of strength to typical parameters such as loading type, surface preparation, patch edge shape, substrate flatness…

Validate the robustness of failure modelling criteria. This is crucial and can only be reached by assessing a various range of designs, loading configurations, etc…

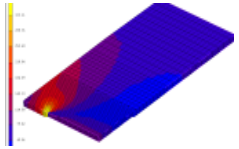
The workflow of the project is articulated between characterization and strength tests, to be compared to a large modelling work investigating the failure predictions techniques.

Fatigue tests are to be performed as it is a necessary step to enable qualification of bonded repairs.

An optional on board test would allow the partner to gather results on strength, mid-term results on durability and fatigue, and prepare longer term results for the following phase. In the meantime it constitutes a demonstrator of the installation capabilities.

Improvements

Definition of precise failure criteria will allow the evaluation of the margin between the strength and the regulatory loads, hence definition of safety factors. Hence, bonded repairs design can follow classical offshore engineering routines.



Approval of design will not require systematic tests and its duration will be shortened to allow acceptable time frames.

Project deliverables

Strength Bond Offshore is to be reported with deliverables all along the work packages. Deliverables on characterization, strength and fatigue tests are to be produced. The modelling WP will produce specific deliverables on techniques and results discussions. However **the main product of the project is a practical guideline on offshore bonded repair strength evaluation**. The guideline will present:

- Strength sensitivity of typical offshore repairs to the main design and installation parameters
- Typical and representative fatigue strength results
- Comparison of the robustness and accuracy of each failure modelling strategy

Schedule

The project started in **March 2019** and is currently in a 1-year extension. JIP progress meetings are held biannually during the FPSO JIP week.

Budget and participation fees

The total budget is 500 k€ to 600 k€ with options. Participation Fee is set to 120 k€ for Oil major companies and 60 k€ for other societies

Organization and contact

Bureau Veritas will act as JIP manager. All participants will be represented in the Strength Bond user group, with meetings every 6 months.

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