Experimental Investigation of a Basalt Fiber Reinforced Composite toMetal Joint

Costache, Andrei; Glejbøl, K.; Sivebæk, Ion Marius; Berggreen, Christian

Publication date:
2015

Citation (APA):
Experimental Investigation of a Basalt Fiber Reinforced Composite to Metal Joint

A. COSTACHE¹,², K. GLEJBØL², I. M. SIVEBÆK¹, C. BERGGREEN¹
¹DTU Mechanical Engineering, ²National Oilwell Varco

CONTRIBUTION

This study investigates the possibility of anchoring a basalt fiber reinforced polymer (BFRP) in an aluminum grip [1] using dry friction. The pull-out force vs. clamping pressure will be investigated, together with the surface finish effect and wear pattern.

MODEL

A special test rig has been constructed, which can hold the grips and the specimen. This setup will be on one side attached to a load cell, and displacement is applied to the BFRP. A special system has been constructed, which can precisely record the clamping force via strain gages. It is thus possible to ensure uniform clamping pressure. A special test rig has been constructed, which can precisely record the clamping force via strain gages. It is thus possible to ensure uniform clamping pressure.

The displacement is recorded with digital image correlation. It is important to monitor the actual displacement of the specimen in the grips, in order to get the exact pull-out force when the BFRP slips.

DISPLACEMENT CALIBRATION

The displacement of three reference points that are tracked with DIC. A reference plane is used to remove unwanted rigid body movement.

The highest load that can be safely produced by the grip is the load at which point 3 starts to move.

TEST SETUP

configuration a  configuration b

Test configurations showing the BFRP specimen and clamp configuration. In configuration a the specimen does not extend outside of the grips. For configuration b, the specimen extends on both sides of the grip. Mechanical interlocking appears where the grips make local indentations in the specimen.

RESULTS

High density polypropylene (HPP) and high density polyethylene (HDPE) has been tested. This tests serve as a benchmark for the BFRP results. It is clear that the HPP is fairly close to the results in configuration a. This indicates that the friction is matrix dominated, even if there is some degree of fiber contact.

During a pull-out test the three tracking points displace at different rates. This effect is more apparent as the clamping force is increased. The maximum force at which the clamp fails is considered at the onset of displacement for the third point.

The two configurations have been tested at several clamping forces. Several repetitions have been done to achieve a statistical valid result. It is clear that there is a lot of scatter between the results. This is more obvious for the configuration where the specimen extends on both sides of the clamp. This behavior is due to the clamps digging into the BFRP.

Wear

flat grips sandblasted grips

The flat grips wear marks are localized towards the edges of the specimen. This indicates a small contact area. Fiber breakage is concentrated where the matrix delaminates. The sandblasted grips have produced more uniformly distributed wear, with smaller damage areas. Fibers are mostly intact.

FUTURE WORK

- Test for creep effects.
- Force control tests to estimate ultimate pull-out force in cyclic loading.
- Improved geometry

REFERENCES


CONTACT INFORMATION

Andrei Costache / DTU Mechanical Engineering
+45 45251391 / andcos@mek.dtu.dk

ACKNOWLEDGMENT

The guidance and support from Kristian Glejbøl, from National Oilwell Varco, Subsea Production Systems, as well as the economic support from the Danish Agency for Science, Technology and Innovation are gratefully acknowledged.