

New fasteners: eco-friendly solution for offshore wind turbine tower

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10% of steel saved per tower !
No more studs or magnets

Introduction

Welding can be replaced by non-intrusive fastening solutions to secure cables and ladders inside the tower of offshore wind turbines. This makes the tower steel structure less susceptible to fatigue and allows reducing its thickness by up to 10%. Less steel means less CO₂ emissions - up to 100 tons of steel and 180 tons of CO₂ for a 20MW tower.

Magnets, made from rare earth, are sometimes used as non-intrusive fasteners. Bonded C-CLAW™ S300 fasteners from COLD PAD are stronger, cheaper, and safer. They are designed to last 35 years, holding up to 3tonnes (ultimate strength) and are protected from external environment thanks to a patented sealing system.



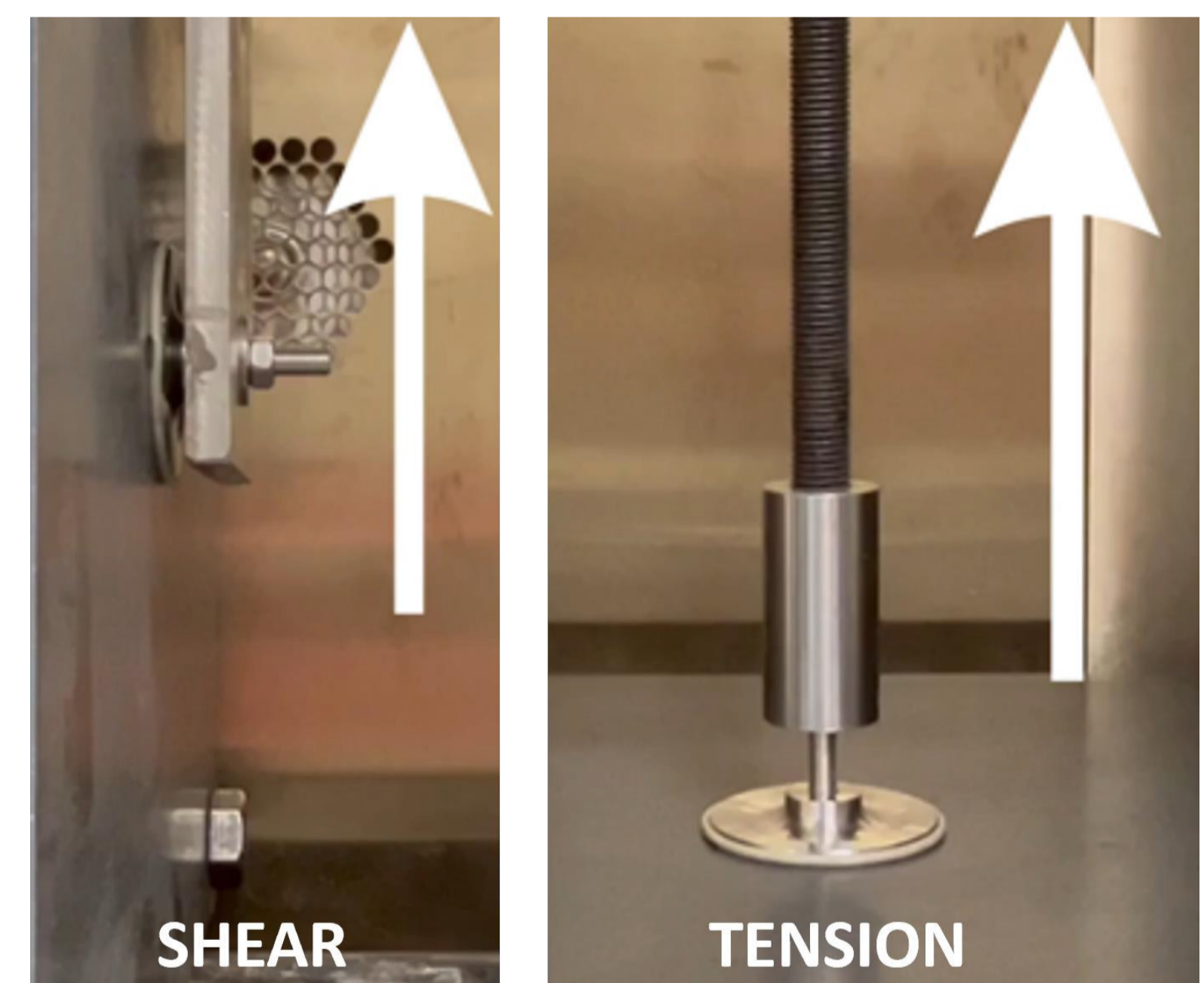
Bonded fastener and 340kg ultimate strength magnet

Method

Mechanical tests were performed on bonded fasteners to assess their structural performances with the following parameters:

- At least three samples per condition
- Two load directions (shear and tension)
- Several temperatures : -20°C, 0°C, 30°C, 50°C, 100°C
- Several substrate thicknesses : 5mm, 10mm and 20 mm.

Creep tests, cyclic loads & fatigue tests, tension tests after various extreme exposures have also been carried out.



Standard tests for bonded fasteners



Installation of a fastener with the automated tool

To ensure a fast, reliable and repeatable installation in any environment, including very humid areas like marine or offshore, a dedicated handheld installation tool was developed, for reliable performances.

Tests results

The predominant failure mode occurs in the stainless-steel threaded rod for loads surpassing 20 to 30kN.

All test results shown that, for a temperature range [-20°C;+100°C] and a substrate thickness range [5mm;20mm], the regulatory design capacity of the fastener is above 3kN. The regulatory design capacity has been derived from mechanical tests results using the Load and Resistance Factor Design (LRFD) approach prescribed in the DNV-ST-C501 standard. These results show the robustness of the fasteners with a safety factor that could be greater than 5.00.

| Load direction | Temperature | Regulatory strength (kN) |
|----------------|------------------|--------------------------|
| tension | -20°C ≤ T < 0°C | 3.8 |
| tension | 0°C ≤ T ≤ 50°C | 16.4 |
| tension | 50°C < T ≤ 70°C | 11.4 |
| tension | 70°C < T ≤ 100°C | 6.6 |
| shear | -20°C ≤ T < 50°C | 13.2 |
| shear | 50°C < T ≤ 70°C | 6.7 |
| shear | 70°C < T ≤ 100°C | 3.6 |

Short-term Regulatory capacities following LRFD approach prescribed in the DNV-ST-C501 standard that includes multiple safety factors