

# Bondstrand Structural FRP Products for Subsea

In today's competitive environment, the weight and corrosion resistance benefits of Fiber Reinforced Polymer (FRP) can provide significant CAPEX and OPEX savings in subsea applications compared to conventional materials.

Bondstrand™ FRP structures typically weigh only 1/3 that of equivalent steel structures in air. This weight saving is magnified when immersed, where FRP weighs typically 1/6 that of steel. FRP materials do not require cathodic protection subsea, removing weight and costs associated with anodes and expensive paint systems required for metallics.

We design and manufacture a range of structural FRP products and solutions for subsea applications using high quality vinyl ester and isophthalic polyester resins, reinforced with continuous strand woven E-Glass reinforcements.

Our FRP laminates are engineered to ensure performance integrity is maintained when immersed over many years subsea and have been extensively tested in the laboratory and in service. We have unique FRP subsea ageing test data which allows us to efficiently design while providing assurance of uninterrupted performance over the specified design service life.

Our design team are highly experienced with FRP materials and utilise leading edge analysis and 3D CAD systems to produce solutions for our customers.

We use advanced resin infusion techniques for all our FRP fabrications, ensuring high performance and quality control. Our manufacturing facility features one of the industry's largest CNC installations capable of machining and tooling fabrications up to 30m long by 5m wide. This CNC capability ensures fast and accurate manufacturing, right first time.

## CAPEX cost reduction benefits:

- Lower lift weight in air and immersed
- Smaller, lower cost offshore installation vessels
- Reduced manufacturing costs for repeated complex items
- No cathodic protection required
- Eliminated complex surface preparation and painting costs associated with carbon steel

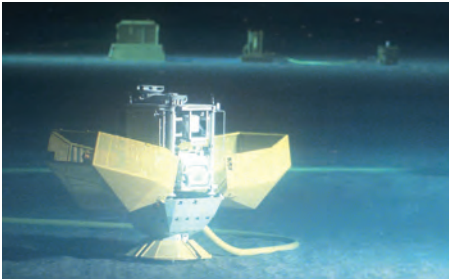
## OPEX cost reduction benefits:

- Smaller vessels required for intervention work
- Lighter subsea structures mean faster in-service removal for access
- Reduced risks to equipment damage associated with intervention operations
- No cathodic protection monitoring or works required



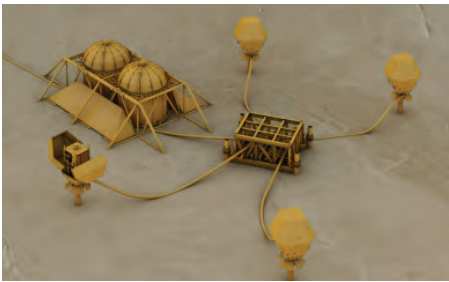
## Protection Products

Our FRP protection products are custom designed to prevent damage to valuable subsea infrastructure caused by dropped objects, fishing gear, or both. Our design team can model the required item in a 3D environment, then use analysis tools to apply specified loads and derive the optimal laminate design. Material partial factors are modified in accordance with our subsea ageing data to allow for the specified design life. Example applications include pipe covers, manifold hatches, cable or umbilical protection etc.



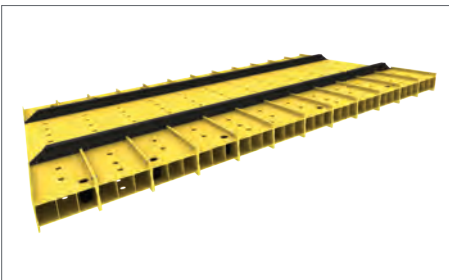
## Production Tree Protection - Cocoon and Shroud

Our Cocoon and Shroud product is specially designed to protect production or injection trees against dropped objects and fishing gear. Its unique design features direct connection to the tree flowbase which dramatically reduces the cost and time of installation. Its neat fitting design round the tree is designed to be snag-free in accordance with NORSOK U001, allowing easy retrieval of fishing gear in the event of an incursion and resulting in a much smaller, lower cost protection structure than conventional designs. Over 36 Cocoon and Shroud protection structures have been installed over the past 20 years in the UK North Sea.



## Manifold and Jacket Mudmats

Where weight is an issue, FRP mudmats will provide a significantly lower weight alternative to conventional steel plate. Our FRP mudmats are suitable for long term static loads backed up by our subsea ageing data. Our mudmats can also be provided with additional abrasion resistant surfaces if the structure is required to be allowed to move. Alternatively, we can profile the FRP mudmat to resist movement if required.



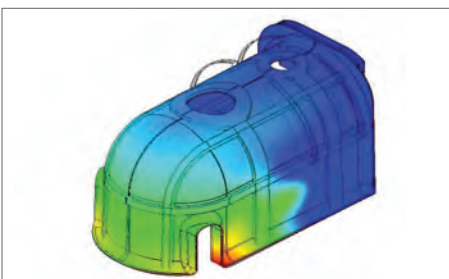
## Pipeline Mudmats

Where pipelines are laid on soft subsea ground, mudmats are sometimes required to prevent the pipe from sinking. We can design and supply FRP pipeline mudmats to meet specific project requirements such as pipe weights, ground conditions and multiple pipe scenarios.



## Custom OEM Solutions

We can also provide FRP solutions to be integrated into other subsea products. As an example, we recently engineered and manufactured the FRP enclosure for the Treatment Unit which is a key part of NOV's Seabox™ seawater treatment system. This sizable structure is approximately 8m x 2.8m x 2.8m, and contains the electrolysis anodes and cathodes, pumps, filters and control systems for the entire Seabox module. Its construction is complex, with many components, and required accurate manufacturing and assembly to ensure all the process equipment fitted correctly.



## Engineering and Design

Our team of engineers are specialists in the design of FRP structures and we can offer a complete service including concept design, analysis and calculations, detailed design and fabrication. We use the latest 3D CAD systems so we can integrate our solutions into the clients primary CAD model, backed up with skills and expertise to ensure our FRP solution will be delivered to clients requirements.