

Composite Engineering and Product Guideline for Marine, Offshore, and Subsea Projects

Addressing the industry need for corrosion resistant, low maintenance solutions in brownfield and newbuild applications.



Bondstrand at the forefront

This interactive tool illustrates technical and commercial uses of Bondstrand™ nonmetallic composite solutions in project applications, which focus on cost savings driven by the many benefits of Bondstrand's engineering capabilities and composite products.

The offshore market has pushed the limits of technology innovation over the past several decades, propelled by operators' demands to **reduce total cost of ownership** while increasing safety and equipment performance over longer asset life expectancies.

Meeting these demands for over 65 years, Bondstrand is synonymous with longevity, superior corrosion resistance, weight savings, safety, and performance. Engineered to endure, this exceptional piping system solution has been the trusted glass reinforced epoxy (GRE) leader in the harshest of offshore environments—solving OPEX, corrosion and weight problems for new build projects, and safety, cost and practical challenges for brownfield projects.

Bondstrand has expanded its offerings, driven by years of successful project execution for brownfield and greenfield projects, case histories, and the need to develop new nonmetallic materials for future offshore assets. The solutions include composite pressure vessels, composite structures, subsea systems, engineering services, and our well-established piping systems.

Our aim is to focus Bondstrand's core value of Advanced Design and Advanced Manufacturing (ADAM) to an expanded offering addressing several industry challenges:

Click on each icon below to learn more.

Over 65 years of innovation

Click on each point to find out more about Bondstrand.



Bondstrand Products and Services

Click on each application for more information

Piping systems

Structural systems

Composite pressure vessel (CPV) systems

Engineering services

Subsea solutions



Addressing ROI and risk with ADAM

Escalating complexity and a need to improve capital efficiency is the norm in offshore assets. When these concepts relate to material selection there are a few features to consider:

Weight

Weight is directly associated with cost. As a constraining parameter, weight and most importantly excess weight can be a determining and/or contributing factor to cost over runs. Fiber-reinforced polymer (FRP) piping systems are a sixth of the weight of their metallic counterparts, and FRP structural components are a third of the weight.

[Click to view case study online »](#)

Minimal-maintenance, corrosion-resistant solutions

Asset life expectancy or asset life extensions and lowering maintenance costs usually contradict; the longer life expectancy, the higher the maintenance costs. This is not the case with FRP products; simply put, FRP products are not susceptible to corrosion, which is one of the main causes of maintenance costs with typical metallic products. With a rust-free design life of up to 40-years, FRP is ideal to avoid corrosion-based damage and subsequent maintenance costs.

[Click to view case study online »](#)

Installation

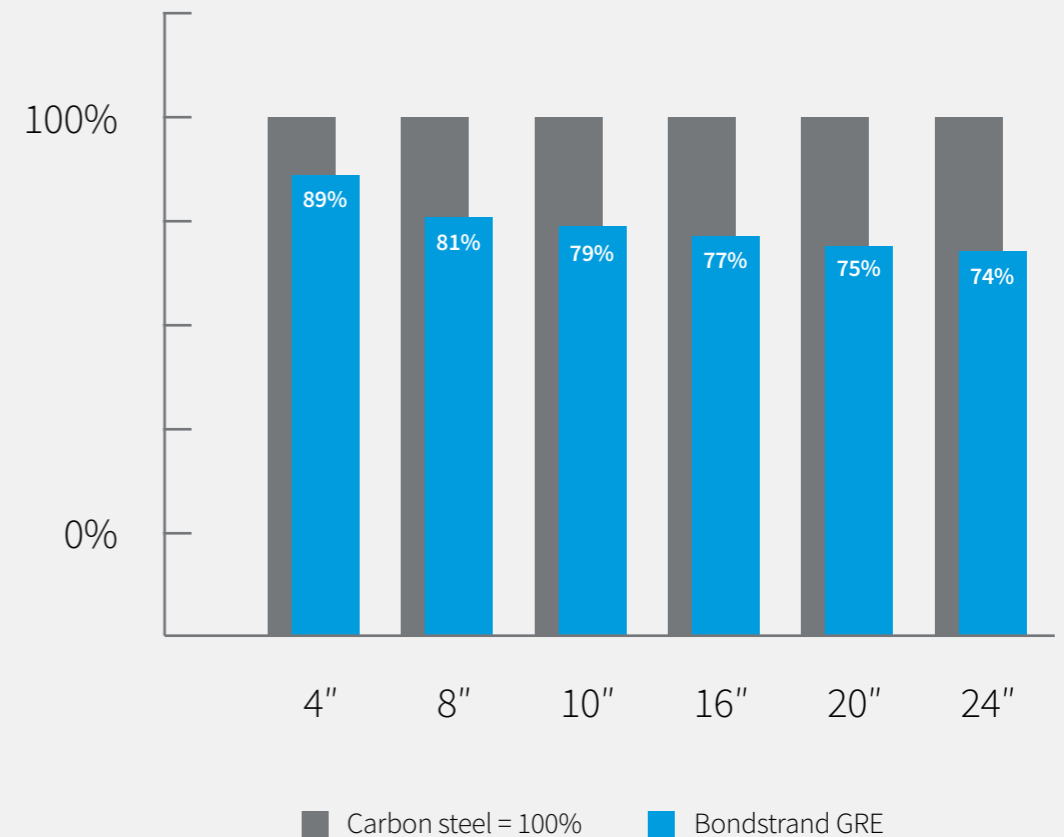
Effective installation means minimum on-site time and very low risk (no hot works required). Our capabilities in design, engineering, digital surveys, advanced and accurate manufacturing and installation all play key parts to reduce risk and installation time for both brownfield and greenfield projects. Contact us to discuss your installation or field service requirements.

Risk

Material selection driven by project drivers such as weight reduction needs proper assessment to reduce project risk. Early engagement for FRP design is important to determine proper **engineering analysis** and installation. Both are directly proportional to the success of achieving project drivers and reducing risk.

Installed cost per diameter of piping systems

Typical fire water, or cooling water system for offshore applications



Source based on internal data with European shipyard prices and steel



This section exemplifies with case studies how Bondstrand can help achieve better ROI based on weight and cost savings, corrosion control, increased safety, and longevity. All these features become project drivers.

Project drivers and benefits

- Weight reduction
- Corrosion control
- Increased safety
- Risk mitigation
- Low maintenance
- Lower total cost of ownership
- Installation
- Engineering

Project deliverables

- Structural systems
- Piping systems
- Composite pressure vessels
- Subsea systems
- Design and engineering

Corrosion in the oil and gas industry

The total annual cost of corrosion in the oil and gas production industry is estimated to be \$1.372 billion, broken down into \$589 million in surface pipeline and facility costs, \$463 million annually in downhole tubing expenses, and another \$320 million in capital expenditures related to corrosion.

It is widely recognized within the oil and gas industry that effective management of corrosion will contribute towards achieving the following benefits:

- Statutory or Corporate compliance with safety, health, and environmental policies
- Reduction in leaks
- Increased plant availability
- Reduction in unplanned maintenance
- Reduction in deferment costs

Oil and Gas “Rust”: An Evil Worse Than Depletion

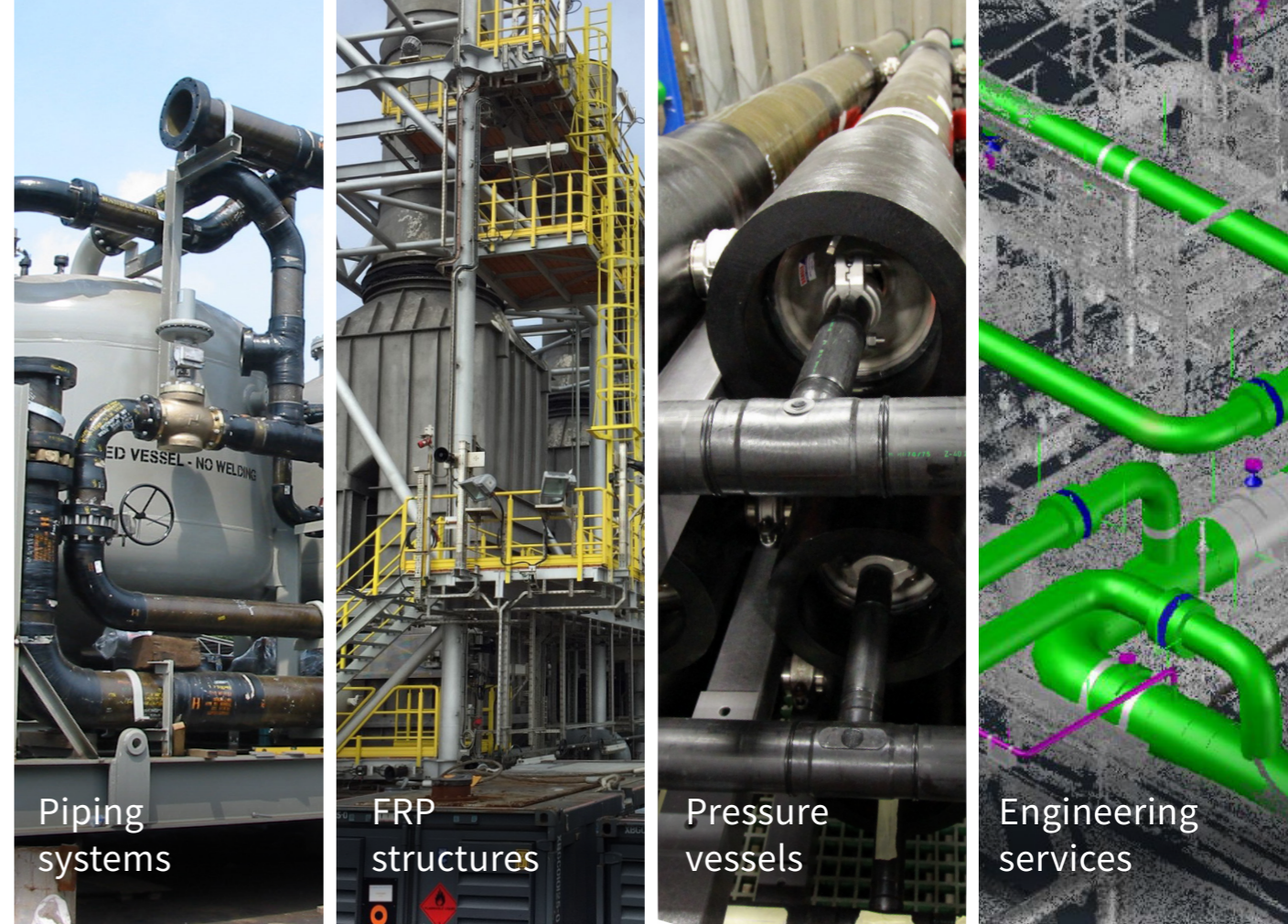
May 2008 Offshore Technology Conference (OTC) Presentation

Matthew R. Simmons, Chairman Emeritus, Simmons & Company International

Bondstrand- Moving forward together

Our goal is to aid in the acceleration and simplification of your complex projects, giving you a single point of contact for non metallic solutions for your brownfield and newbuild projects, while improving your ROI.

We recognize the demands of the environment, and we understand that risk mitigation, safety, and cost drive your projects. We want to help you move forward, bringing innovation, experience, knowledge, and a wider array of composite solutions to your offshore and marine challenges.



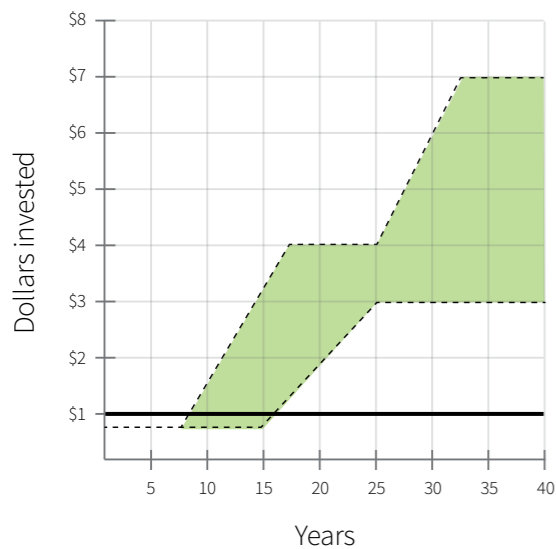
Piping systems

FRP structures

Pressure vessels

Engineering services

Investment over the life of a project: FRP versus steel



- For every dollar invested in FRP, 3 to 7 times more would have to be spent on steel over the life of the project.
- FRP is 30 to 75% lighter than steel.
- Variable depending on corrosion area, and product type i.e. piping, pressure vessels, structures.

— FRP investment line
 ■ Steel cost over \$1 of FRP invested

Source based on internal NOV data

*Steel costs are conservatively estimated to demonstrate long-term investment comparison, dependent on corrosion areas and product types.

To find out more about the potential of Bondstrand, [watch this short animation online](#) »

Main benefits of composite materials



Lower total cost of ownership



Good fire performance and UV resistance



Highly corrosion resistant



Durable/long service life



Lightweight
(1/3 to 1/6 weight of steel)



Qualified and approved – extensively used in industry for decades



Offsite build for fast track site installation



Unlimited applications opportunities – from wastewater to warships



Low conductivity/
electromagnetic transparency

Solutions like no other

Working with operators and engineering houses around the globe, we've worked on everything from FPSO and FLNG vessels to submarines and drillships, saving millions of dollars, and hundreds of thousands of pounds in weight.

Download one of the below case studies to discover more.



Our composite systems saved more than **700 tonnes** in weight for BP Clair Ridge's fixed platform in the North Sea, UK.

Piping systems

We design and build high-performance Bondstrand GRE pipes, fittings, and systems to the specific requirements of offshore and shipboard piping.

Design solutions include elevated external pressure resistance for in-tank piping; electrical conductivity for hazardous areas; low smoke and toxicity for confined spaces and passageways; and fire endurance for fire-suppression systems. Full engineering support is available for system design, stress analysis, material take off and spool prefabrication.

Our products are proven to meet the demanding requirements and regulations associated with the marine and offshore market, whether on fixed, floating, or custom-designed facilities. Bondstrand provides end users with versatile alternatives to traditional materials, and is the preferred product of choice to combat corrosion, reduce weight, and minimize maintenance in the harshest environments, including: all seawater and freshwater processes, drain and vent applications, fire protection systems, deck drains and more.

Our engineers and fabricators design and manufacture pipe and fittings, incorporating a variety of mechanical and bonded systems to ensure precise installation, optimum performance, and unmatched ease of assembly. This makes our products ideal for a vast range of applications, including:

- Sea water systems
- Firewater systems
- Cooling water
- Produced water
- Sanitary systems
- Drain lines
- Column piping
- Potable water
- Ballast piping
- Sounding tubes
- Vent lines
- Scrubbers
- Sodium hypochlorite
- Caissons
- Grey water
- Accommodation piping

Supporting documents:

Bondstrand 2400 Series

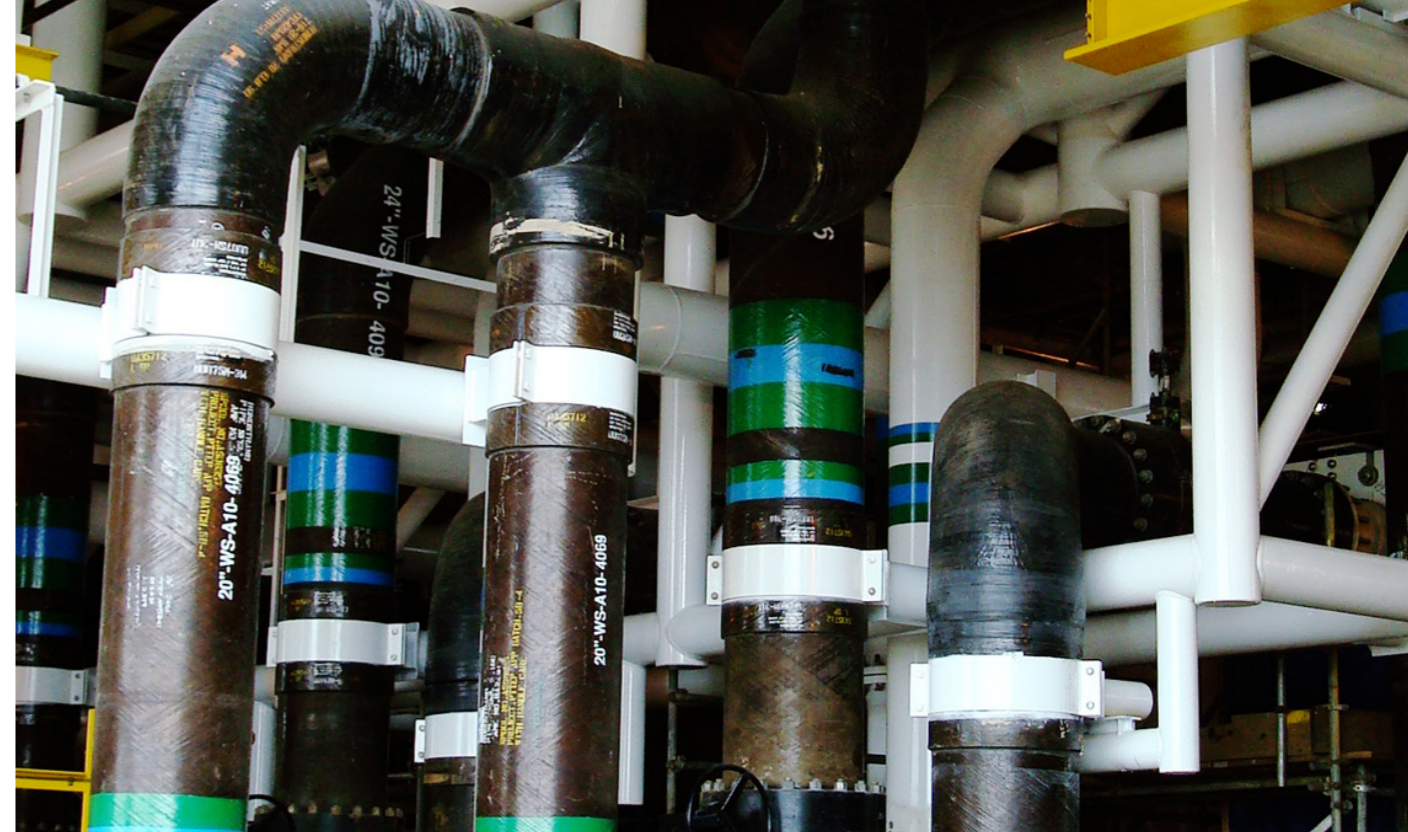
Bondstrand FP Series

Bondstrand LD Series

Bondstrand Retrofit Applications

Bondstrand 2000M/7000M for Marine & Offshore

Bondstrand Glassfiber Reinforced Epoxy Piping Systems



Beyond composite piping, we also offer design consultancy, technical services, and engineering solutions.

We select the ideal manufacturing process for each product application, including:

- Reciprocal filament winding
- Centrifugal casting
- Dual-angle continuous filament winding
- Chopped-hoop continuous winding
- Filament-wound and compression-molded fittings

Certs and approvals:

American Bureau of Shipping (ABS), American Petroleum Institute (API), American Society of Mechanical Engineers (ASME), ASTM International, DET Norske Veritas (DNV), International Maritime Organization (IMO), International Organization for Standards (ISO), NSF International, United States Coast Guard (USCG), United States Department of Defense (Military Specifications), are just a few examples of our commitment to regulatory compliance.



Structural systems

Where there's a challenge with weight, corrosion, or access, we have a composite structural answer.

Composite materials are a lightweight, corrosion-proof alternative to steel, reducing installation and maintenance costs and ensuring longevity—in some cases, lasting for up to 50 years of operation. We solve the problems inherent in using traditional materials for tough applications and harsh environments, providing our customers with an economic advantage that endures.

Based on the structural problems you experience in your projects, we can work with you to create a viable, long-lasting FRP solution, through Advanced Design and Advanced Manufacturing (ADAM). Whether you're looking for a robust handrail that challenges steel, that won't corrode, and has a continuous top grip, a specially designed access system, composite windwalls, custom offshore structures (including equipment supports, mud tanks, and drag chain structural support), we have the design and manufacturing capability to turn your concept into a reality.

We use standardized components to create a structural solution that will reduce your cost of ownership. Structural products include:

- MARRS™ Offshore handrail systems
- Ladders and gates
- Grating and flooring
- Platforms, stairs, and walkways
- Impact protection systems

Download the flyer below to discover more.



4000 linear m of MARRS offshore handrails, installed on the BP Clair Ridge Platform, North Sea, UK.

Composite pressure vessels

Engineered, tested, and manufactured in-house, our composite pressure vessels are designed to meet specific project requirements while adhering to internationally recognized pressure vessel standards.

Manufactured using high-quality resin transfer molded and filament-wound fiber glass components, and available in a range of sizes and pressure ratings, our pressure vessels provide the ultimate longevity in the harshest of environments and provide the ideal corrosion-resistant alternative to metallic equivalents.

Our pressure vessels are manufactured from Bondstrand piping, which has been extensively used in offshore applications for the last 50 years. Manufactured using high-quality glass and epoxy resin, and available from 4- to 60-inch diameter, our FRP composite pressure vessels provide a lightweight and corrosion-resistant alternative to metallic pressure vessels—designed to extend asset life, and also outlast the asset.

Download the flyer below to discover more.

With our proprietary technology, Ershigs can manufacture custom industrial plastic composite tanks, built to your exact project specifications, providing the highest quality of corrosion resistant products. Read more [here](#).



Large diameter ASME X pressure vessels installed on the skid, for BP Clair Ridge.

Vessel Type	Description	Typical Applications	Design Codes
Vessel Type 1	Small diameter, high pressure, up to 8-in. diameter, pressure up to 1200 psi (85 barg), up to 9 metres long.	Reverse Osmosis (RO)	ASME X (PED requirement for Europe)
Vessel Type 2	Large diameter, low pressure, using existing range of Bondstrand pipe, up to 60-in. diameter, pressure up to 145 psi (10 barg), up to 11 metres long.	Seawater filtration including ultrafiltration, cartilage filtration, multimedia filtration and coarse filtration, fresh water, chemical injection, utility and supply systems.	ASME X and DNVGL-ST-C501
Vessel Type 3	Large diameter, low pressure, using existing range of Bondstrand pipe with filament wound domed ends. Pressures up to 360psi = 24barg for vessels up to 24"; 290psi = 20barg up to =36"; and 145psi = 10barg 40" - 60", up to 11 meters long.	Seawater filtration including ultrafiltration, cartilage filtration, multimedia filtration and coarse filtration, fresh water, chemical injection, utility and supply systems.	ASME X and DNVGL-ST-C501

Engineering services

Our Engineering Services Department (ESD) provides expert technical services and design consultancy for Bondstrand FRP composite structures, GRE pipe systems, and composite pressure vessels, using the latest software programs and our 50 plus years of experience.

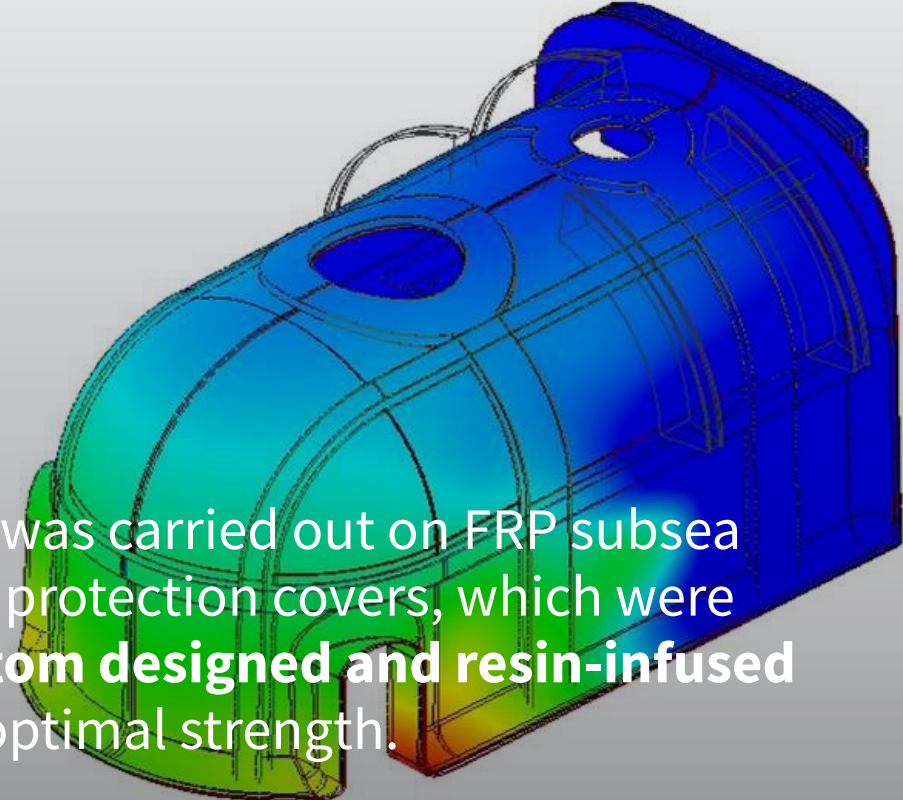
The unique combination of cutting-edge design and advanced manufacturing provides our clients with an all-encompassing solution, maximizing safety, efficiency, and weight control.

Experienced and skilled, our engineers are dedicated to providing sustainable and optimized solutions, solving the most complex of projects in a multimedia environment. The ESD capabilities consistently develop to encompass broader technical service provisions across a wide range of materials and applications, as required by clients, with the ability to work directly within the client's own design offices (national or international).

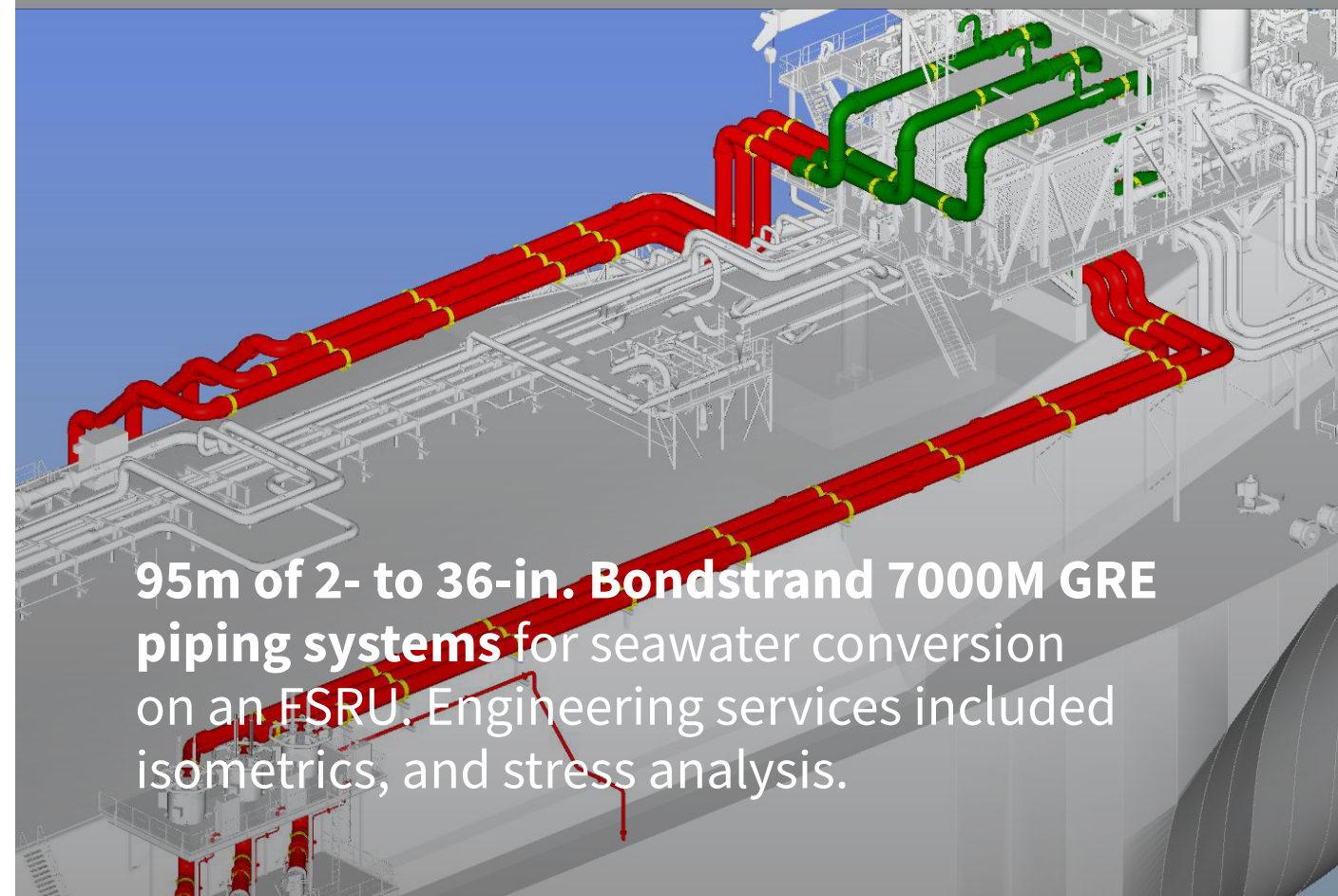
Our engineering services include:

- Piping design assistance and verification, including support design and isometric production
- Caesar II piping stress analysis, including transient, seismic, and dynamic loads
- Composite pressure vessel design
- Structural engineering, including design verification (Cat III, Caesar II, etc.)
- Finite element analysis (FEA)
- Computational fluid dynamics
- Electronic surveys and dimensional control
- Innovation research and development, including 3D printing and prototyping
- Building information modeling (BIM) level 2

Download the flyer below to discover more.



FEA was carried out on FRP subsea hub protection covers, which were **custom designed and resin-infused** for optimal strength.



95m of 2- to 36-in. Bondstrand 7000M GRE piping systems for seawater conversion on an FPSO. Engineering services included isometrics, and stress analysis.

Subsea solutions

Safety, structural integrity, and corrosion resistance are essential factors to consider in harsh offshore and subsea environments.

We have a long history of providing complete turnkey solutions for owners, engineers, and contractors, and we assist at every stage of a project—from conception, FEED, detail design, commissioning through to operation. With extensive experience in designing, engineering, and manufacturing complex, and bespoke products for a wide range of applications, we've also delivered the following FRP structures:

- Subsea manifold and pipe protection systems – including covers, hatches
- Wellhead protection – Cocoon and Shroud™
- Mudmats – for pipelines and structures
- Specialist components and structures – e.g. Seabox treatment unit (pictured right)

With an in-house resin infusion and transfer molding manufacturing capability, we have the facilities and engineering available to design and build complex, unique structural shapes for the subsea environment including the associated precision tooling. Railway footbridge structures have also been manufactured from a hybrid of resin infused and pultruded FRP profiles, uniting aesthetics and strength.

We use FEA for complex geometry and laminate design to provide a behavioral evaluation, allowing us to optimize designs in both static and dynamic environments. Built offsite, our advanced composite structures provide the weight and maintenance savings that are crucial. With our specialist fabrications, engineering support services, and offshore site teams, we can provide you with lightweight and virtually maintenance-free standard and bespoke systems to meet your strict offshore and subsea requirements.

Download the flyer below to discover more.



Fiber Glass Systems manufactured the state-of-the-art treatment unit for NOV's Seabox seawater treatment module. Watch the installation [here](#).