

DMDESIGNTM

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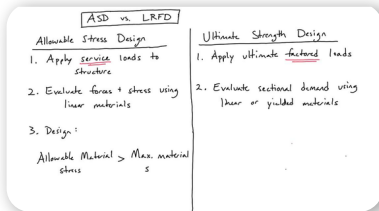
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OVERVIEW

Welcome to **DMDESIGN™**, a specialized section within DM Composites™ dedicated to providing comprehensive design services. Our team is committed to shaping a sustainable engineering future in Australia. We understand the evolving needs of the industry and strive to deliver innovative solutions that not only meet but exceed expectations. At **DMDESIGN™**, we blend creativity with sustainability to create designs that stand out while contributing to a greener tomorrow. Explore our product guide for a glimpse into the possibilities that await your projects.



Expert FRP Design

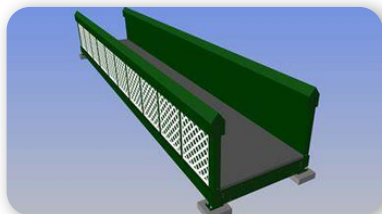


Versatile Connection Designs



Comprehensive Fastener Focus

DMDESIGN™



Efficient Structure specific Design



Innovative Strengthening Techniques



TESTING



In the realm of composite design, **DMDESIGN™** takes pride in delivering cutting-edge services aimed at producing cost-efficient and sustainable engineering solutions. Our approach revolves around utilizing composite materials that not only enhance efficiency but also prove economically viable. We specialize in creating designs that are not only easy to construct but also boast a low-maintenance profile throughout their lifecycle. At **DMDESIGN™**, we are dedicated to shaping the future of engineering by integrating innovative practices that prioritize both effectiveness and environmental responsibility.



National Engineering Register

At **DMDESIGN™**, our team boasts seasoned engineers with over 15 years of valuable Australian experience in material and composite engineering. Our professionals hold Chartered status and are NER accredited by Engineers Australia, showcasing their commitment to industry excellence. With an in-depth understanding of both local and international standards, our team seamlessly integrates this knowledge to deliver effective and efficient composite designs. Trust in our expertise to bring innovation and precision to your engineering projects.

Composites Australia

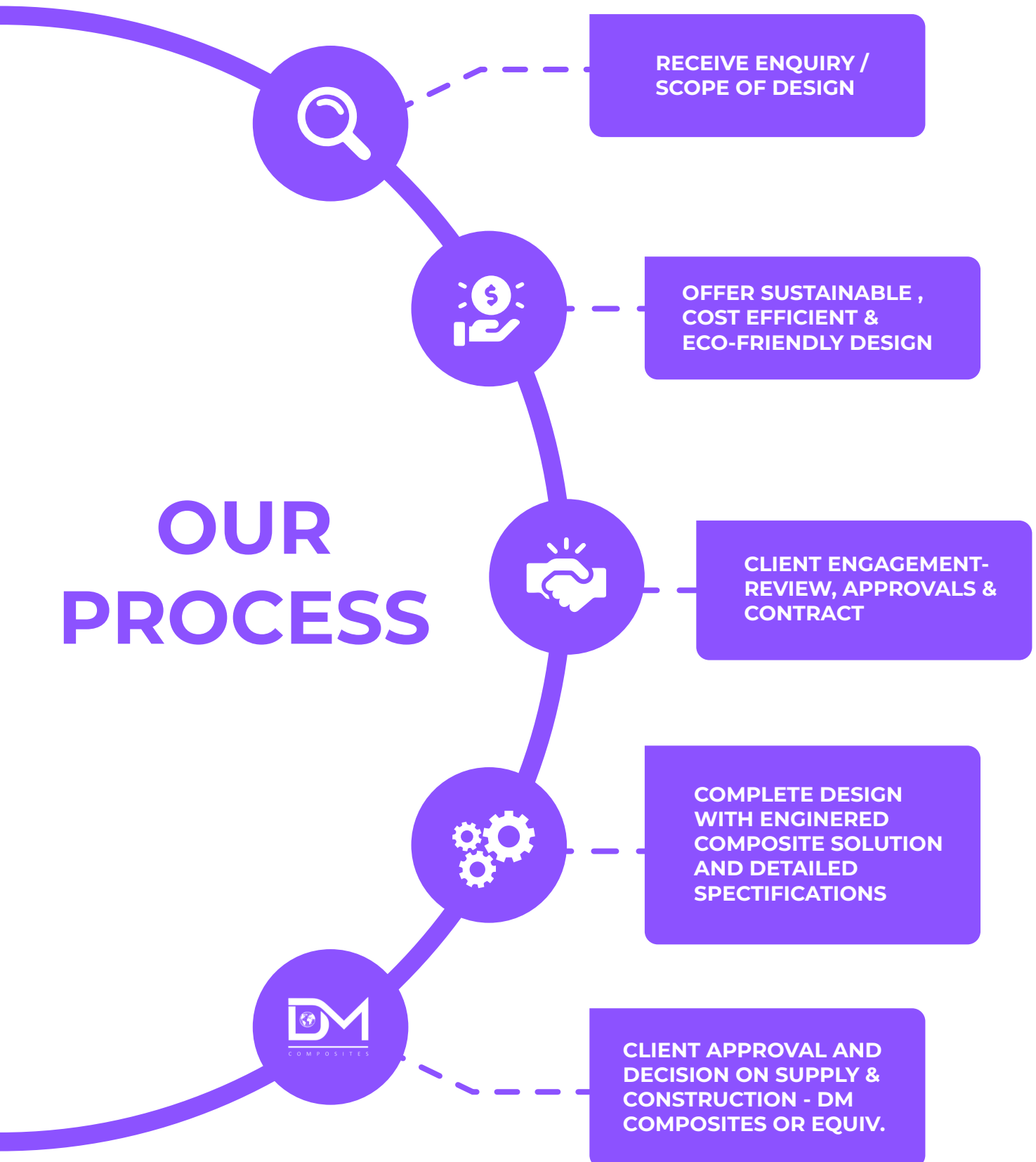
| WHAT WE DO?



At **DMDESIGN™**, our core focus lies in delivering top-tier engineering solutions and composite designs to a diverse clientele, including councils, government entities, and contractors across Australia. We specialize in providing sustainable outcomes for various structures, emphasizing the integration of composite materials, including concrete reinforcement with FRP rebar. Our expertise spans a wide array of projects, ranging from marine jetties and safety access installations to piles, boardwalks, bridges, staircases, and more. Through our commitment to engineering excellence, we strive to enhance the durability, efficiency, and sustainability of structures, contributing to a resilient and environmentally responsible future. Trust **DMDESIGN™** for innovative and customized engineering solutions that stand the test of time.

**ENGINEERING ISN'T ABOUT PERFECT SOLUTIONS;
IT'S ABOUT DOING THE BEST YOU CAN WITH
LIMITED RESOURCES.**

OUR PROCESS



| OUR STANDARDS

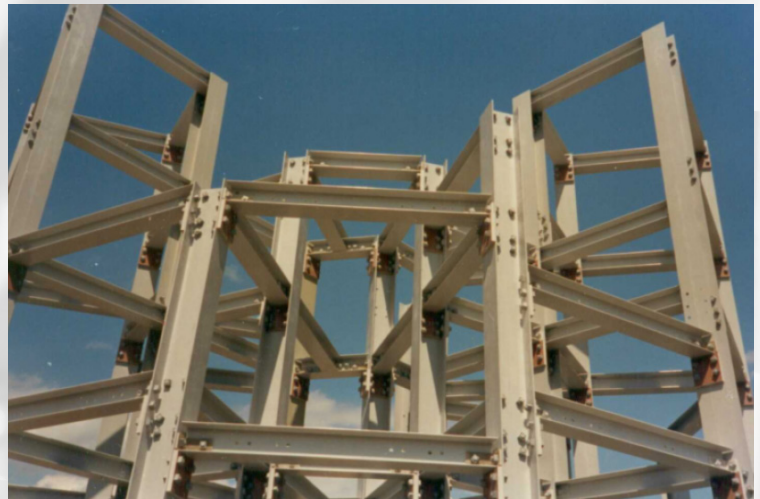
	FIBRE REINFORCE POLYMER (FRP)	COMPOSITE PILES	FRP BRIDGES	COMPOSITE REINFORCEMENT	FRP CABLE LADDERS	CONNECTION DESIGN	COMPOSITE PIPE	FASTENERS	FIRE	STRUCTURAL MATERIAL PROPERTIES
STANDARDS										
ACMA LFRD 2010	✓	✓	✓			✓		✓		
EUROCOMP	✓	✓	✓			✓				✓
ASTME84	✓					✓			✓	
AS1530.3	✓								✓	
AS4997		✓								
AS1170	✓	✓	✓		✓					
AS1428	✓									
AS1657	✓									
NEMA 20B					✓					
NEMA FG1					✓					
AS2156	✓									
AS5100	✓		✓							
SMACNA							✓			✓
EN13706-2										✓
ASTMD395										✓
ASTMD638										✓
ASTMD790										✓
ASTMD953										✓
ASTM5379										✓
ASTMD3917										✓
ASTMD4385										✓
AS2159										✓
NCC										✓

Please note that the table primarily indicates main standards related to the design of composite materials and does not cover all applicable standards. It is imperative to consult with our engineering team before assuming the applicability of any standards without prior knowledge. Each project may have specific requirements, and standards may vary accordingly.

FIBRE REINFORCED POLYMER (FRP)

In the world of **Fiber Reinforced Polymer (FRP)** design, **DMDESIGN™** stands out as a leader, relying on a wealth of experience to create innovative and efficient solutions. Unlike other engineering materials, FRP does not currently have an official Australian standard or a universally recognized global standard. In this dynamic landscape, **DMDESIGN™** leverages its expertise, combining a deep understanding of material behavior with adherence to prominent standards such as EUROCOMP and AMCA LFRD Pre-Standard.

Our team excels in FRP design, considering various criteria, considerations, and assumptions to ensure the highest quality and safety in our engineered solutions. This reliance on experience and industry knowledge sets **DMDESIGN™** apart, allowing us to craft FRP designs that push boundaries and exceed expectations.



Why Choose **DMDESIGN™** for FRP?

EXTENSIVE EXPERIENCE:

Our engineers bring over 15 years of Australian experience in material and composite engineering.

ADHERENCE TO INTERNATIONAL STANDARDS:

While there is no Australian standard, we adhere to Eurocomp and ACMA LFRD pre-standards, ensuring high-quality design.

INNOVATION:

We thrive on crafting innovative FRP solutions that go beyond conventional standards.

VERSATILITY:

From initial design to project completion, we offer a comprehensive suite of engineering services for FRP structures.

SUSTAINABLE ENGINEERING:

Our focus on sustainability ensures that our FRP designs meet environmental standards.

DID YOU KNOW?

The absence of an Australian standard for the design of FRP underscores the critical importance of having experienced engineers at the helm of your FRP structures.

Pultrusion is a continuous manufacturing process used to create Fiber-Reinforced Polymer (FRP) profiles. Here's a brief summary of the process:

Raw Materials:

Reinforcing fibers (like fiberglass) and a liquid polymer resin are used as raw materials.

Impregnation:

Fibers are pulled through a resin bath to coat them thoroughly with resin.

Forming Die:

The resin-coated fibers pass through a shaping die to form the desired cross-sectional profile.

Curing:

The profile enters a heated die or oven to cure and solidify the resin, bonding the fibers together.

Pulling and Cutting:

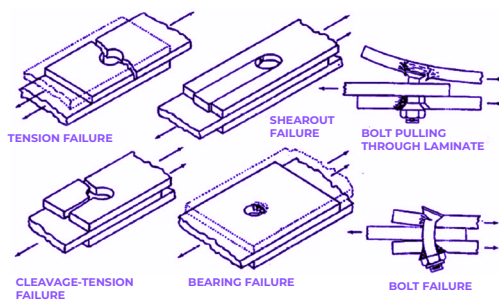
The cured profile is continuously pulled through the machine and cut to the desired length.

Finishing:

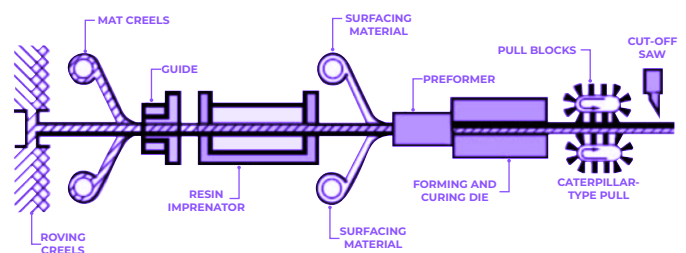
Additional treatments like surface coating or machining may be applied as needed.

Pultrusion produces strong, lightweight, and corrosion-resistant FRP profiles used in construction, infrastructure, automotive, and other industries.

MODES OF FAILURE



Understanding these failure modes is crucial for designing FRP components to withstand anticipated loads and conditions, thereby ensuring the structural integrity and durability of FRP structures and applications.



Tension Failure: This occurs when the FRP material is subjected to a tensile (pulling) force that exceeds its strength, causing it to elongate and ultimately fracture.

Shear Failure: Shear failure happens when the FRP material is subjected to a force parallel to its surface, causing it to slide or deform along the plane of the applied force.

Bolt Pulling Through Laminate: This failure mode occurs when a bolt or fastener pulls through the FRP laminate due to excessive tensile or shear stresses at the hole perimeter.

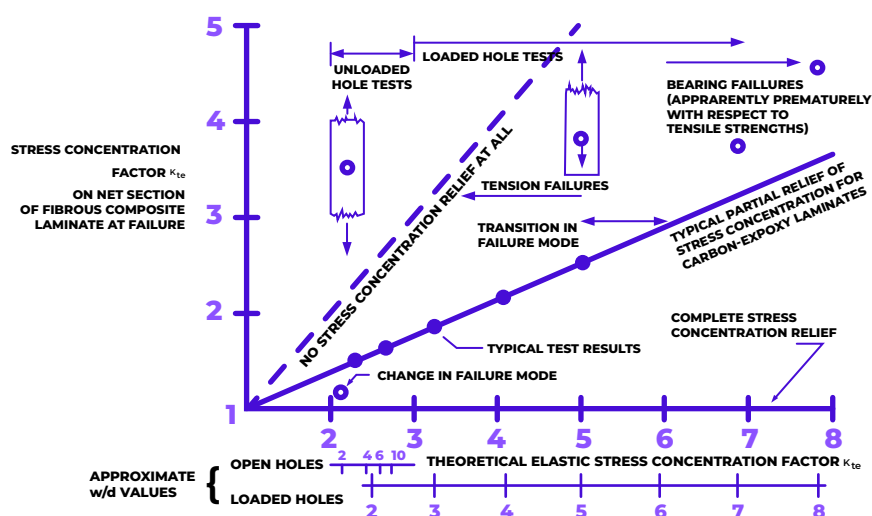
Cleavage-Tension: Cleavage-tension failure happens when the FRP material fractures along a plane perpendicular to the applied tensile force, often due to high stress concentrations.

Bearing Failure: Bearing failure occurs when the FRP material is compressed by a load, causing it to deform or crush under pressure.

Bolt Failure: Bolt failure involves the fracture of a bolt or fastener due to excessive tensile, shear, or bending stresses.

Fibre Reinforced Polymer (FRP) structures rely on meticulous design criteria to ensure durability, safety, and optimal performance. The **American Composites Manufacturers Association (ACMA) LFRD** (Load and Resistance Factor Design) and **Eurocomp standards** serve as guiding principles for designing FRP structures, providing comprehensive guidelines for engineers. Let's delve into the key design criteria, along with sample calculations, highlighting the intricate process behind FRP structural engineering.

DESIGN CRITERIA	ACMA LFRD	SAMPLE CALCULATIONS
LOAD COMBINATIONS	ACMA LFRD outlines load combinations for various scenarios, considering factors like dead loads, live loads, wind loads, and seismic loads. The load combinations are expressed as equations, ensuring that the structure can withstand different conditions.	$\Phi P_n = 0.9 \times P_n$ $\Phi M_n = 0.9 \times M_n$ $\Phi V_n = 0.75 \times V_n$ $\Phi R_n = 0.9 \times R_n$
MATERIAL PROPERTIES	ACMA LFRD defines factors related to material properties, considering the characteristics of FRP materials, such as tensile strength, modulus of elasticity, and shear strength.	Allowable Tensile Stress (F_t) = F_u / Ω_t Allowable Shear Stress (F_v) = F_{uv} / Ω_v
RESISTANCE FACTORS	ACMA LFRD introduces resistance factors (Φ) to account for uncertainties in material behavior and construction methods. These factors ensure a level of safety in the design.	Nominal Strength (N_n) $\times$ Resistance Factor (Φ) = Design Strength (N)
DESIGN CRITERIA	EUROCOMP	SAMPLE CALCULATIONS
ULTIMATE LIMIT STATE (ULS)	Eurocomp focuses on ultimate limit states, addressing scenarios where the structure may reach its maximum load-bearing capacity. It includes factors such as material strength, stiffness, and structural geometry.	Total applied load (N) $\leq$ Total capacity (R_d)
SERVICEABILITY LIMIT STATE (SLS)	Eurocomp considers serviceability aspects, ensuring that the structure remains functional and within acceptable deformation limits under normal usage conditions.	Total applied load (N) $\leq$ Serviceability capacity ($R_{d,s}$)
DURABILITY	Eurocomp emphasizes durability criteria, accounting for environmental effects and long-term performance, ensuring the FRP structure's sustainability.	FRP Material Aging Factor (γ_a) $\times$ FRP Material Environmental Factor (γ_{en}) $\times$ FRP Material Exposure Factor (γ_{ex})



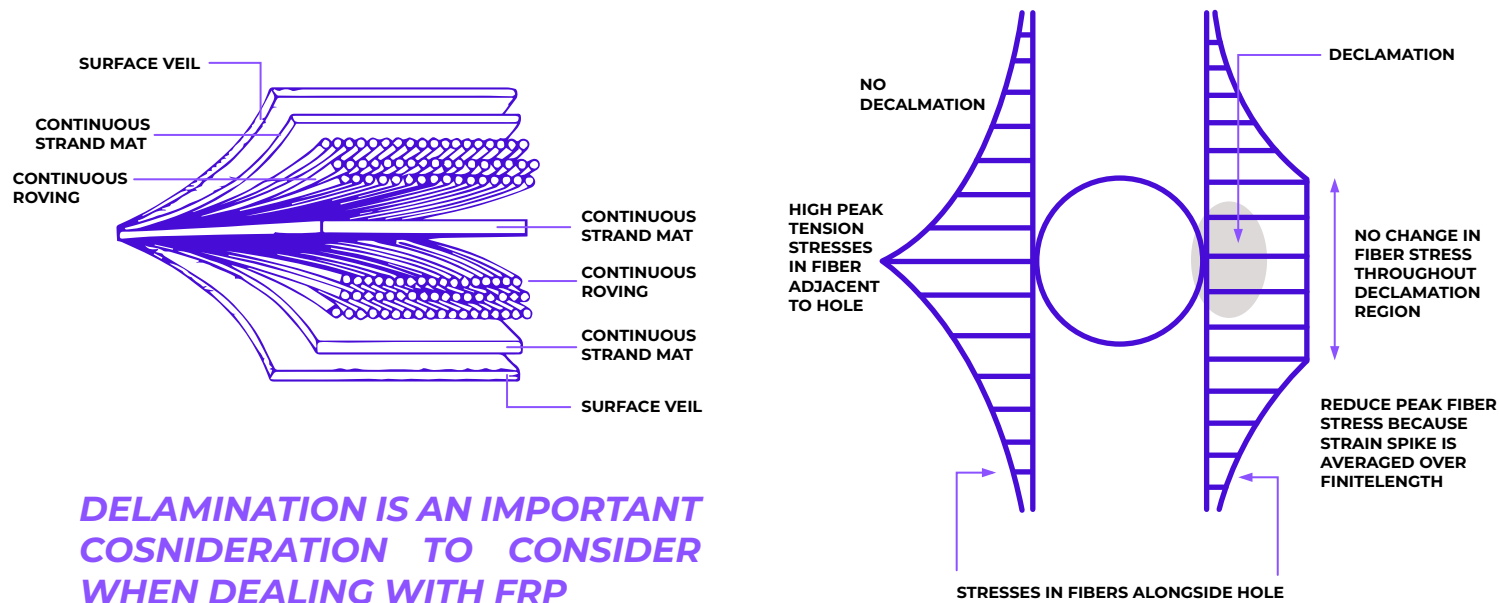
Stress concentration is a key factor in designing FRP structures. Engineers focus on minimizing localized areas of high stress caused by changes in geometry, holes, or abrupt transitions in material properties. Design strategies include optimizing geometry, reinforcing critical areas, and avoiding sharp corners or notches to enhance structural reliability and durability of FRP components.

These are illustrative examples, and actual design considerations should be performed by qualified engineers based on project-specific requirements and material properties.

This comparison table highlights different aspects of design considerations between the ACMA LFRD and Eurocomp standards for Fibre Reinforced Polymer (FRP) structures. While both standards aim to ensure safety and performance, they exhibit variations in their approaches and focus areas.

DESIGN CRITERIA	ACMA LFRD	EUROCOMP
Structural Philosophy	Adheres to a Load and Resistance Factor Design (LFRD) approach.	Follows a more Eurocentric approach, considering factors like structural geometry, design codes, and specifications.
Load Factors	Applies load factors based on combinations of dead, live, wind, and seismic loads.	Incorporates factors specific to European loading conditions, accounting for regional variations.
Material Design Strength	Specifies design strength based on material properties such as tensile strength and modulus of elasticity	Emphasizes the design strength of FRP materials, considering properties like stiffness and structural behavior.
Safety Factors	Employs safety factors to account for uncertainties in material behavior and construction methods.	Integrates safety factors into the design, ensuring a safety margin for uncertainties and variations.
Critical Limit States	Identifies critical limit states related to maximum load scenarios and potential failure modes.	Focuses on limit states where failure may occur, ensuring the structure's robustness under various conditions.
Environmental Considerations	Addresses environmental factors that may affect the structure, including temperature and moisture.	Takes into account environmental aspects and their impact on the long-term performance and durability of the structure.
Risk Management	Incorporates risk management principles in the design process.	Reflects a risk-informed approach, considering uncertainties and potential risks associated with the FRP structure.

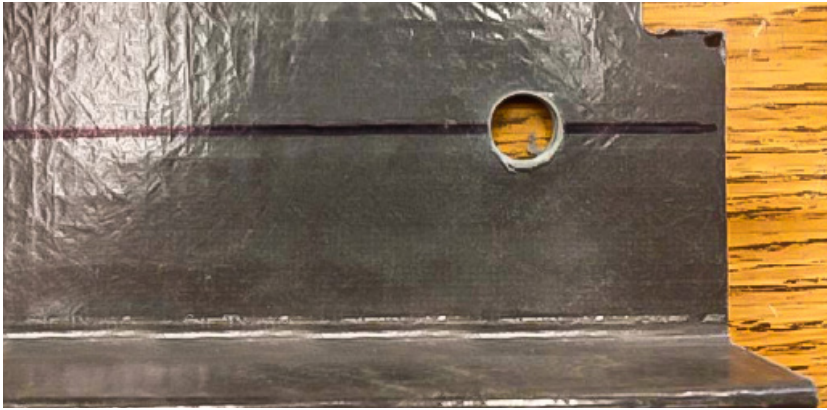
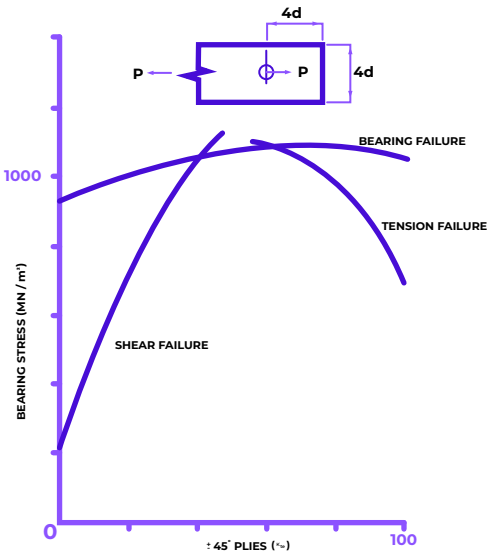
PULTRUSION COMPOSITE DIAGRAM



This section outlines key design assumptions and calculations for FRP structures based on the ACMA LFRD and Eurocomp standards. Each standard adopts specific assumptions and calculations to ensure the structural integrity and performance of FRP materials in various applications.

DESIGN ASSUMPTION	ACMA LFRD	SAMPLE CALCULATIONS
Material Properties	Assumes FRP material properties based on standardized testing, including tensile strength, flexural strength, and modulus of elasticity.	Calculation Example: Tensile Strength (TS) = 60,000 psi.
Load Assumptions	Assumes design loads considering factors such as dead load, live load, wind load, and seismic load	Calculation Example: Total Load (TL) = Dead Load (DL) + Live Load (LL) + Wind Load (WL) + Seismic Load (SL)
Safety Factor	Applies safety factors to account for uncertainties and variations in material behavior and construction processes	Calculation Example: Safety Factor (SF) = 1.5.
Environmental Effects	Considers environmental factors affecting FRP, such as temperature and moisture, in design assumptions.	Calculation Example: Temperature Adjustment Factor (TAF) = 0.95.

DESIGN ASSUMPTION	EUROCOMP	SAMPLE CALCULATIONS
Material Properties	Assumes FRP material properties based on standardized testing, including tensile strength, flexural strength, and modulus of elasticity.	Calculation Example: Tensile Strength (TS) = 60,000 psi.
Load Assumptions	Assumes design loads considering factors such as dead load, live load, wind load, and seismic load	Calculation Example: Total Load (TL) = Dead Load (DL) + Live Load (LL) + Wind Load (WL) + Seismic Load (SL)
Safety Factor	Applies safety factors to account for uncertainties and variations in material behavior and construction processes	Calculation Example: Safety Factor (SF) = 1.5.
Environmental Effects	Considers environmental factors affecting FRP, such as temperature and moisture, in design assumptions.	Calculation Example: Temperature Adjustment Factor (TAF) = 0.95.



Fibre orientation is crucial for determining the required material properties in our designs.

COMPOSITE PILE

In the specialized domain of Composite Piles, **DMDESIGN™** stands as a trailblazer, leveraging profound experience to engineer cutting-edge solutions. Unlike certain engineering materials, Composite Piles governed by AS 2159 have specific standards in Australia. **DMDESIGN™** adeptly incorporates these standards, ensuring meticulous adherence to AS 2159 criteria, considerations, and assumptions. Our team excels in the precise design of Composite Piles, prioritizing quality and safety to deliver engineered solutions that surpass expectations. This commitment to standards and expertise distinguishes **DMDESIGN™**, making us the go-to choice for innovative and reliable Composite Pile designs.

Why Choose **DMDESIGN™** for Composite Piles?

EXPERTISE:

DM Design brings over 15 years of Australian engineering experience to create robust and efficient composite pile solutions.

CUSTOM SOLUTIONS:

We tailor composite piles to specific project requirements, ensuring optimal performance and longevity.

ADHERENCE TO STANDARDS:

Our designs adhere to industry standards, including AS2159, guaranteeing compliance and safety.

SUSTAINABLE MATERIALS:

Using composite materials, we offer eco-friendly alternatives that are 70% lighter than steel, resisting corrosion.

INNOVATION:

With a focus on pushing boundaries, our team combines industry knowledge and experience to deliver cutting-edge composite pile solutions.

DID YOU KNOW?

Composite piles are 70% lighter than steel, offering a corrosion-resistant alternative.



DESIGN CRITERIA	SAMPLE CALCULATIONS
AXIAL LOADING	Formula: Axial Load Capacity=Material Strength × Cross-Sectional Area Sample Calculation 257 X12.7 OD: Assume Material Strength = 100 MPa, Axial Load Capacity = 1290KN
PILE IN BENDING	Formula: Bending Moment Capacity=Material Strength × Moment of Inertia/Distance from Neutral Axis Sample Calculation 257 X12.7 OD: Assume Material Strength = 100 MPa, MAX. Bending Moment = 2.7MNm
PILE IN SHEAR	Formula: Shear Capacity = Material Shear Strength×Cross-Sectional Area Sample Calculation 257 X12.7 OD: Assume Material Strength = 100 MPa, MAX. Shear Capacity = 62.5KN
SKIN FRICTION OF SOIL	The skin friction (qs) can be estimated using the following formula: $q_s = \tau \times A_s$ Where: τ is the shear stress along the pile shaft. A_s is the surface area of the pile in contact with the soil. For illustration, let's assume a shear stress (τ) of 100 kPa and calculate the skin friction. Surface Area=Surface Area=$\pi \times D \times L$ $=100 \text{ kPa} \times (257 \text{ mm}) \times q_s = 100 \text{ kPa} \times \pi \times (257 \text{ mm}) \times L$ Assuming a pile length (L) of 10 meters: $=100 \text{ kPa} \times (257 \text{ mm}) \times 10 \text{ m}$ $q_s = 100 \text{ kPa} \times \pi \times (257 \text{ mm}) \times 10 \text{ m}$ $\approx 81,079 \text{ N}$ $q_s \approx 81,079 \text{ N}$
LOAD BEARING CAPACITY	The load-bearing capacity of the composite pile can be determined using the load-bearing formula for piles: $Q_b = A_s \times c_s + \pi \times D \times L \times \sigma_t$ Where: A_s is the surface area of the pile in contact with the soil, c_s is the unit cohesion of the soil, D is the diameter of the pile, L is the length of the pile, σ_t is the undrained shear strength of the soil. Let's assume the following values for illustration: - Diameter (D) of the pile = 257 mm - Length (L) of the pile = 10 meters - Unit cohesion (c_s) of the soil = 50 kPa - Undrained shear strength (σ_t) of the soil = 100 kPa Surface Area Surface Area (A_s)=$\pi \times D \times L = \pi \times (257 \text{ mm}) \times 10 \text{ m} \times 50 \text{ kPa} + \pi \times (257 \text{ mm}) \times 10 \text{ m} \times 100 \text{ kPa}$ $Q_b = 10002,527,844 \text{ N}$ $kN = 2527,844 \text{ kN}$
MINIMUM EMBEDMENT	Assuming a skin friction of 50 kN/m250kN/m2 and soil strata data providing the required embedment as D, the minimum embedment (E) can be calculated as: $E = D \times 3 \times D \times f_s$ Given that $D = 257 \text{ mm}$ and $f_s = 50 \text{ kN/m}^2$ $E = 0.257 \text{ m} \times 3 \times 0.257 \text{ m} \times 50 \text{ kN/m}^2 \approx 0.771 \text{ m}$ $E \approx 0.771 \text{ m}$ So, the minimum embedment required for the 257 mm composite pile, based on skin friction and soil strata data, is approximately 0.771 m.
MAXIMUM PILING LOAD	Assuming a maximum allowable stress (allow) of 120 MPa, the maximum piling load (Pmax) can be calculated using the formula: $P_{max} = A_{pile} \times \sigma_{allow}$ Given that A_{pile} is the cross-sectional area of the pile, which is $4 \times 24\pi \times D^2$: $pile = 4 \times (257 \text{ mm})^2 \times 24\pi = 4\pi \times (257 \text{ mm})^2$ $max = 4 \times (257 \text{ mm})^2 \times 120 \text{ MPa}$ $P_{max} = 4\pi \times (257 \text{ mm})^2 \times 120 \text{ MPa}$ $max = 261,451 \text{ kN}$ $P_{max} \approx 261,451 \text{ kN}$

DESIGN ASSUMPTIONS & CONSIDERATIONS

DESIGN ASSUMPTIONS & CONSIDERATIONS		WHY WE NEED TO MAKE ASSUMPTION?
Pile Material and Geometry	The pile is made of Fiber Reinforced Polymer (FRP).	FRP material is chosen for its corrosion resistance, high strength, and lightweight properties.
Axial Loading	The pile is subject to an axial load (P)	The axial load represents the vertical force acting on the pile due to structural loads or external forces.
Bending Moment and Shear Force	Bending moment (M) is calculated using $P \cdot L/4$ and shear force (V) using $P/2$	These calculations help determine the internal forces and moments within the pile, essential for assessing structural integrity.
Skin Friction	This is obtained from Geotech report of the site.	Skin friction influences the load-bearing capacity of the pile in cohesion with the surrounding soil.
Soil Strata Data	The interaction with the soil is modeled based on the pile diameter (D).	The diameter of the pile affects the interaction with the surrounding soil, influencing factors like skin friction.
Minimum Embedmen	Minimum embedment (E) is calculated as $D+3 \times D \times f_s$	The minimum depth of embedding ensures adequate soil contact for stability and load transfer.
Maximum Piling Load	Maximum piling load is calculated as $\max D \times L \times \sigma_{\max}$	This assessment helps determine the maximum load the FRP pile can bear without compromising safety.



These are illustrative examples, and actual design considerations should be performed by qualified engineers based on project-specific requirements and material properties.

FRP BRIDGES

In the realm of Composite Bridges, **DMDESIGN™** stands at the forefront, harnessing extensive experience to craft state-of-the-art solutions. Unlike certain engineering materials, Composite Bridges adhering to AS 5100 possess specific standards in Australia. **DMDESIGN™** seamlessly integrates these standards, ensuring meticulous compliance with AS 5100 criteria, considerations, and assumptions. Our team excels in the precision design of Composite Bridges, placing a paramount focus on quality and safety to deliver engineered solutions that exceed expectations. This unwavering commitment to standards and expertise sets **DMDESIGN™** apart, establishing us as the preferred choice for innovative and dependable Composite Bridge designs.

Why Choose **DMDESIGN™** for FRP Bridges?

EXPERTISE AND EXPERIENCE:

DMDESIGN™ brings a wealth of experience, with seasoned engineers specializing in Composite Bridge design, ensuring proficiency and innovative solutions.

PRECISION IN DESIGN:

We prioritize precision in our design process, incorporating meticulous attention to detail and utilizing advanced engineering techniques to ensure optimal performance.

ADHERENCE TO STANDARDS:

Our commitment to adhering to industry standards, particularly AS 5100, guarantees that our Composite Bridges meet and exceed regulatory requirements.

SAFETY FIRST:

The safety of our engineered structures is paramount. DM Design places a strong emphasis on creating Composite Bridges that prioritize both user safety and long-term structural integrity.

CUSTOMIZATION AND INNOVATION:

DMDESIGN™ embraces innovation and customization, tailoring Composite Bridge solutions to meet specific project requirements, ensuring versatility and adaptability in diverse applications.

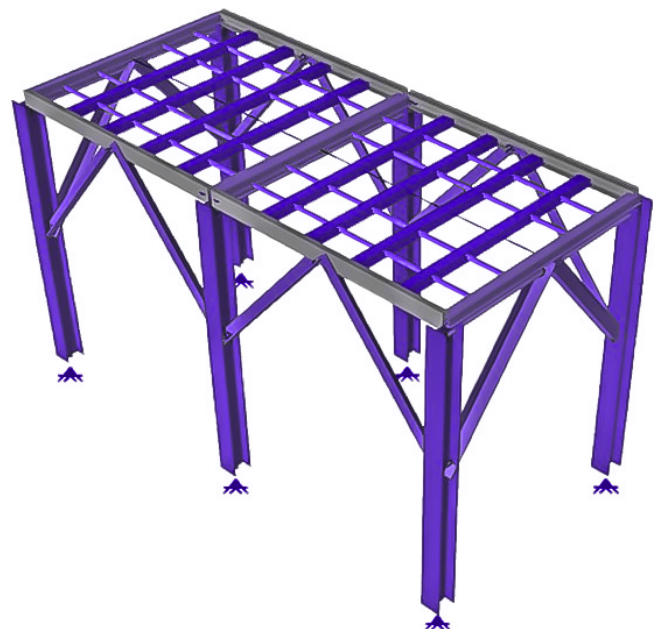
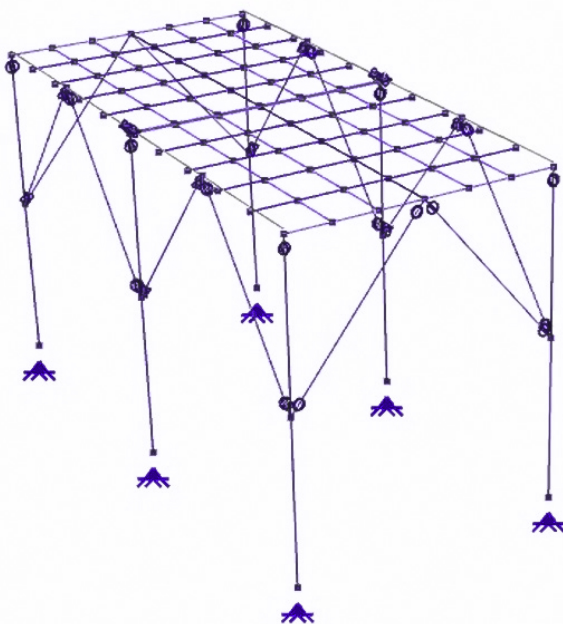


DID YOU KNOW?

FRP composite bridges weigh 70% less than steel counterparts, allowing modular drop-in installations and smaller abutment designs. Perfect for remote areas, they offer structural efficiency and easy deployment.

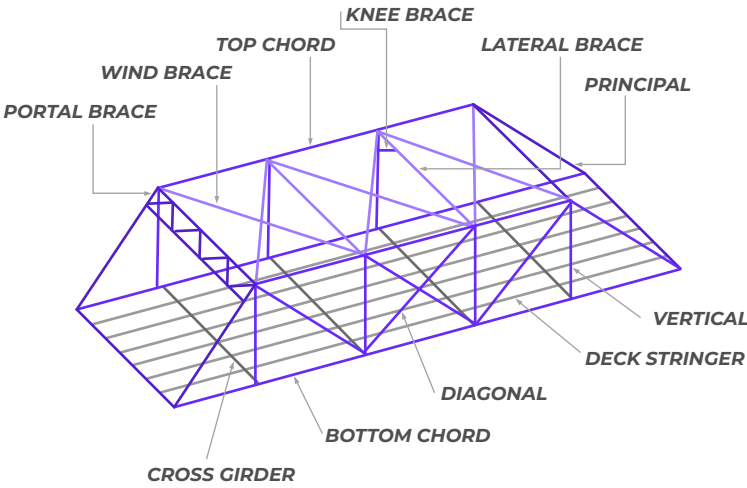
DESIGN ASSUMPTIONS & CONSIDERATIONS		WHY WE NEED TO MAKE ASSUMPTION?
Pre-Camber	Pre-camber involves a slight upward curvature in the bridge structure to counteract deflection under the anticipated load.	Assuming a bridge span of 20 meters and a live load of 5 kN/m, the pre camber can be calculated using the formula: Pre-Camber = (Live Load × Span²) / (8 × Elastic Modulus × Moment of Inertia).
Deflection	Deflection measures the vertical movement of the bridge under load, ensuring it remains within permissible limits for safety and serviceability.	Assuming a bridge span of 20 meters and a live load of 5 kN/m, the pre camber can be calculated using the formula: Pre-Camber = (Live Load × Span²) / (8 × Elastic Modulus × Moment of Inertia).
Flood Loading	Considering potential flood scenarios, the bridge must be designed to withstand additional loads, ensuring stability and safety during extreme weather events.	Assessing flood loading involves determining the buoyant force exerted on the structure, considering factors such as water density, submerged depth, and bridge geometry.
Material Strength	Ensuring the composite materials used in the bridge meet or exceed specified strength requirements for durability and load-bearing capacity.	Calculating material strength involves assessing tensile, compressive, and shear strengths based on material testing data and standards compliance.
Dynamic Loading	Accounting for dynamic forces such as vehicular traffic, wind, and seismic events to guarantee the bridge's stability and longevity.	Dynamic loading calculations vary based on factors like traffic patterns, wind speed, and seismic zone, requiring complex modeling and analysis.
Temperature Effects	Considering the impact of temperature variations on material properties, expansion joints, and overall structural integrity.	Calculating thermal stresses and strains involves evaluating the coefficient of thermal expansion, temperature differentials, and material properties.

IT IS IMPORTANT TO GET YOUR CONNECTION TYPES CORRECT WHEN MODELLING DM BEAM FRP PROFILES



These are illustrative examples, and actual design considerations should be performed by qualified engineers based on project-specific requirements and material properties.

DESIGN ASSUMPTIONS	
MATERIAL HOMOGENEITY	Assuming the FRP composite materials used in the bridge exhibit uniform properties, with consistent strength, stiffness, and durability characteristics.
STANDARDIZED ENVIRONMENTAL CONDITIONS	Assuming the bridge will primarily operate under standardized environmental conditions, with variations in temperature, humidity, and exposure considered within acceptable limits.
APPROPRIATE FOUNDATION SUPPORT	Assuming the bridge foundations provide stable and sufficient support, considering factors like soil bearing capacity and foundation settlement.
INSPECTION AND MAINTENANCE	Assuming the bridge foundations provide stable and sufficient support, considering factors like soil bearing capacity and foundation settlement.
ACCURATE LOAD DISTRIBUTION	Assuming the loads on the bridge, including live loads, traffic loads, and dynamic forces, are accurately distributed across the structure according to design specifications.
COMPLIANCE WITH BUILDING CODES	Assuming that the design adheres to relevant building codes and standards, ensuring regulatory compliance and structural safety.
TRAFFIC LOADING CONSISTENCY	Assuming a consistent and predictable traffic loading scenario, with considerations for potential variations during peak usage and special events.
ADEQUATE DRAINAGE MEASURES	Assuming that the bridge design incorporates effective drainage solutions to prevent water accumulation and potential damage from prolonged exposure.
PROPER EXECUTION OF CONSTRUCTION	Assuming that the construction process adheres to the approved design and engineering plans, ensuring the bridge is built according to specifications.
LIMITED ENVIRONMENTAL IMPACT	Assuming that the bridge design and construction have minimal adverse impacts on the surrounding environment, ecosystems, and water bodies.



Incorporating bearing pads into your DM Beam FRP bridge design is an effective way to enhance efficiency and performance.



COMPOSITE REINFORCEMENT

In the realm of Composite Reinforcement for bridges, **DMDESIGN™** stands at the forefront, leveraging extensive expertise to craft cutting-edge solutions. Unlike certain engineering materials, Composite Reinforcement adhering to AS 5204:2023 possesses specific standards in Australia. **DMDESIGN™** seamlessly integrates these standards, ensuring meticulous compliance with AS 5204:2023 criteria, considerations, and assumptions. Our team excels in the precision design of bridges with Composite Reinforcement, placing a paramount focus on quality and safety to deliver engineered solutions that surpass expectations. This unwavering commitment to standards and expertise sets **DMDESIGN™** apart, establishing us as the preferred choice for innovative and dependable Composite Reinforcement bridge designs.

Why Choose **DMDESIGN™** for Composite Reinforcement?

LEADING FRP REBAR EXPERTISE:

Rely on our extensive expertise in FRP Rebar design, adhering to AS 5204:2023 standards ensuring cutting-edge solutions for reinforcement applications.

CHARTERED AND NER ACCREDITED ENGINEERS:

Our team includes Chartered and NER accredited engineers, ensuring a high level of professionalism and adherence to engineering excellence in FRP reinforcement projects.

COMPLIANCE WITH AS 5204:2023 STANDARDS:

We strictly comply with AS 5204:2023 standards, guaranteeing that our FRP reinforcement designs meet the rigorous requirements set forth in the Australian Standard.

CUSTOM SOLUTIONS FOR VARIED APPLICATIONS:

DMDESIGN™ provides tailored FRP reinforcement solutions for diverse applications, including structural components, ensuring versatility and reliability in design.

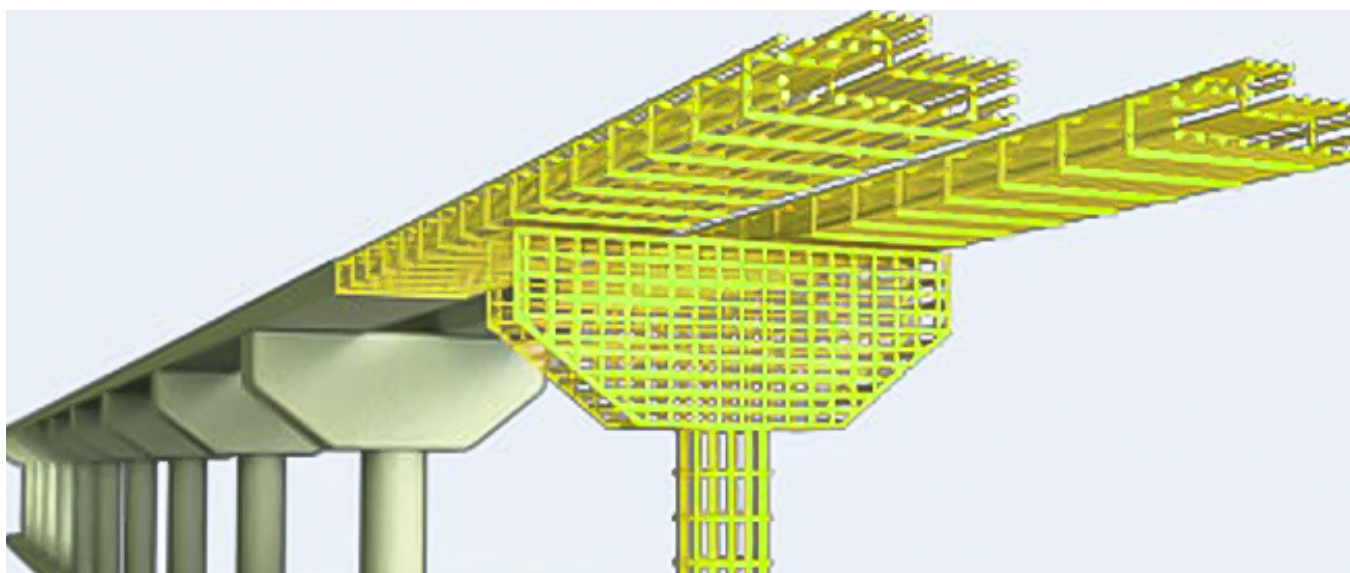
OPTIMIZED COST-EFFECTIVE DESIGNS:

Our focus on cost efficient engineering designs with FRP reinforcement prioritizes economy, sustainability, and ease of implementation, aligning with AS 5204:2023 standards.

DID YOU KNOW?

AS 5204:2023 is Australia's inaugural standard for FRP (Fiber Reinforced Polymer) reinforcement, representing a significant step towards standardized composite solutions in construction.

DESIGN ASSUMPTIONS & CONSIDERATIONS		WHY WE NEED TO MAKE ASSUMPTION?
Tensile Strength	Ensures the FRP Rebar withstands applied loads without failure.	Tensile Strength=Force/Area, Assuming a force of 10 kN and an area of 1000 mm ² , 10 kN/1000 mm ² =10 MPa 10kN/1000mm ² =10MPa.
Flexural Strength	Measures the ability of FRP Rebar to resist bending loads.	Flexural Strength= $3 \times \text{Moment} / 2 \times \text{Depth} \times \text{Width}^2$ Assuming a moment of 100 Nm, depth of 15 mm, and width of 5 mm, $3 \times 100 \times 15 \times 5^2 = 0.67 \text{ MPa}$ $2 \times 15 \times 5^2 \times 100 = 0.67 \text{ MPa}$.
Shear Strength	Evaluates FRP Rebar's resistance to forces acting parallel to its cross-sectional area.	Shear Strength=Force/Area. Assuming a shear force of 5kN and an area of 800 mm ² , 5kN/800 mm ² =6.25 MPa 5kN/ 800mm ² =6.25MPa.
Bond Strength	Measures the adhesion between FRP Rebar and concrete.	Bond Strength=Force/Surface Area. Assuming a bond force of 8 kN and a surface area of 1200 mm ² , 8 kN/1200 mm ² =6.67 MPa 8kN/1200mm ² =6.67MPa.
Durability Considerations	Accounts for factors like corrosion resistance, environmental conditions, and long term performance.	N/A (Qualitative assessment).



These are illustrative examples, and actual design considerations should be performed by qualified engineers based on project-specific requirements and material properties.



DESIGN ASSUMPTIONS		
Material Compatibility	Assumes compatibility between FRP Rebar and surrounding concrete mix to ensure proper bond and durability.	FRP Rebar designed considering compatibility with specified concrete mix constituents.
Installation Quality	Assumes proper installation practices to achieve the intended performance of FRP Rebar.	Assumes installation practices such as maintaining a minimum cover of 25 mm and proper spacing between adjacent FRP Rebars during concrete placement.
Temperature Considerations	Assumes the designed FRP Rebar can withstand temperature variations without compromising structural integrity.	Assumes FRP Rebar maintains at least 90% of its designed strength within the temperature range of -20°C to 60°C.
Moisture Exposure	Assumes the FRP Rebar is designed considering exposure to moisture and potential effects on material properties.	Assumes FRP Rebar designed to resist moisture absorption, with a maximum moisture content of 0.5% by weight.
Chemical Resistance	Assumes FRP Rebar's resistance to chemicals present in the concrete mix and environmental exposure.	Assumes FRP Rebar designed to resist exposure to common concrete chemicals, such as chlorides, sulfates, and alkaline solutions.
Long-Term Performance	Assumes the FRP Rebar maintains structural performance over an extended period.	Assumes FRP Rebar designed to meet a minimum service life of 50 years under normal environmental conditions.



FRP CABLE LADDER

In the realm of FRP Cable Ladders, **DMDESIGN™** takes the lead, utilizing extensive expertise to create cutting-edge solutions. Unlike certain engineering materials, FRP Cable Ladders following NEMA 20B and NEMA FG1 standards have specific criteria in the industry. **DMDESIGN™** seamlessly incorporates these standards, ensuring meticulous compliance with NEMA 20B and NEMA FG1 criteria, considerations, and assumptions. Our team excels in the precision design of cable ladders, emphasizing quality and safety to deliver engineered solutions that exceed expectations. This steadfast commitment to standards and expertise establishes **DMDESIGN™** as the preferred choice for innovative and reliable FRP Cable Ladder designs.

Why Choose **DMDESIGN™** for FRP Cable Ladder?

PRECISION CRAFTSMANSHIP:

DMDESIGN™ employs meticulous engineering, ensuring FRP Cable Ladders are crafted with precision for reliable cable management.

ADHERENCE TO STANDARDS:

We strictly adhere to industry standards such as NEMA 20B and NEMA FG1, guaranteeing compliance and high-quality FRP Cable Ladders.

VERSATILITY IN APPLICATIONS:

Our cable ladders are designed for diverse applications, providing adaptability and efficiency in various layouts and environments.

INNOVATIVE SOLUTIONS:

DMDESIGN™ brings innovation to cable management, offering custom connections like flange plates, divider strips, and clamps for tailored solutions.

SUSTAINABLE ENGINEERING:

Committed to sustainability, our FRP Cable Ladders are crafted from recycled materials, providing eco-conscious cable management solutions.

DID YOU KNOW?

FRP Cable Ladders from DM Design don't conduct electricity like their metal counterparts. This non conductive feature enhances safety, making them an excellent choice for diverse applications where electrical insulation is crucial.

DESIGN CRITERIA		SAMPLE CALCULATIONS
LOAD-BEARING CAPACITY	Ensures the FRP Cable Ladder can support the specified loads safely.	Formula: Load-Bearing Capacity = Maximum Applied Load Sample Calculation: Assuming a maximum load of 2000 N, Load-Bearing Capacity = 2000 N.
SPAN LENGTH	Measures the distance between support points, ensuring structural integrity.	Formula: Span Length = Maximum Distance Between Supports Sample Calculation: Assuming a maximum span of 2.5 meters, Span Length = 2.5 meters.
FLAME RESISTANCE	Evaluates the ability of the FRP Cable Ladder to resist combustion.	N/A (Qualitative assessment based on testing TO AS1530.3/ASTM E84)
CHEMICAL RESISTANCE	Ensures resistance to corrosive chemicals in diverse environments.	Formula: N/A (Qualitative assessment based on testing). Testing Standard: ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
DURABILITY CONSIDERATIONS	Measures the ability of the FRP Cable Ladder to withstand UV exposure.	Formula: N/A (Qualitative assessment based on testing). Testing Standard: ASTM G154 - Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
ELECTRICAL INSULATION	Verifies that the FRP Cable Ladder provides electrical insulation for cables.	Formula: N/A (Qualitative assessment based on testing). Testing Standard: ASTM D149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.

These are illustrative examples, and actual design considerations should be performed by qualified engineers based on project-specific requirements and material properties.

DESIGN ASSUMPTIONS

LOAD-BEARING CAPACITY	Assumes that the FRP Cable Ladder can safely support specified loads.	Load-bearing capacity assumes a maximum load of 2000 N.
SPAN LENGTH	Assumes the distance between support points, ensuring structural integrity.	Span length assumes a maximum distance between supports of 2.5 meters.
DEFLECTION TOLERANCE	Assumes flexibility without breaking, allowing deflection up to 6 meters.	Deflection tolerance assumes compliance with NEMA FG1 standards.

DESIGN CRITERIA

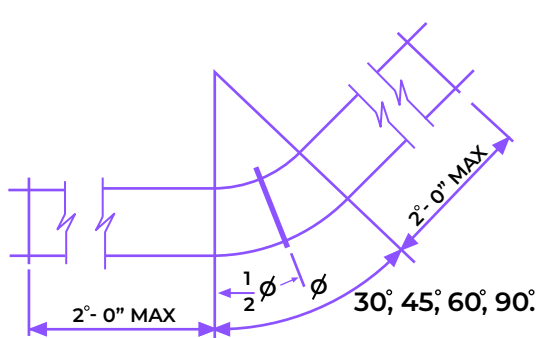


FIGURE 6-1
HORIZONTAL ELBOWS

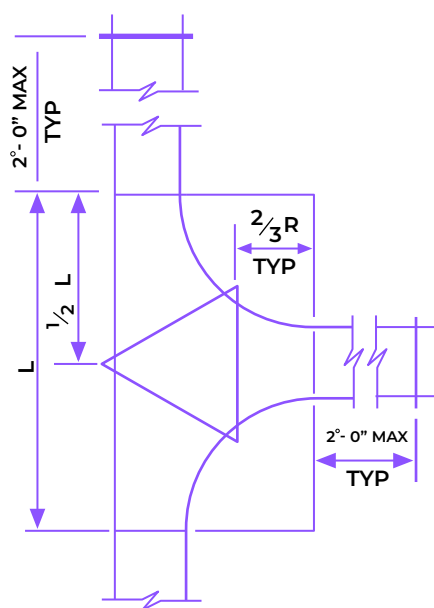
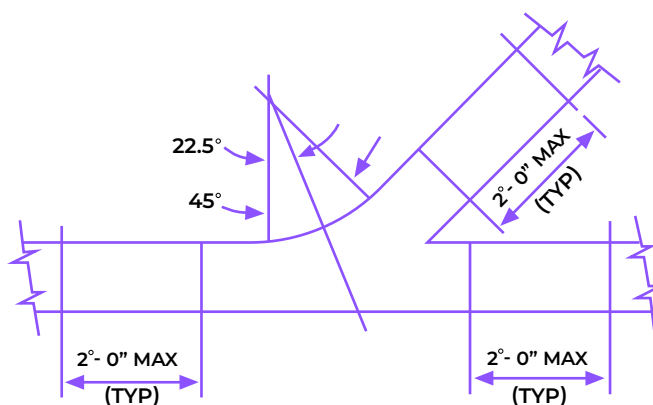


FIGURE 6-2
HORIZONTAL TEE

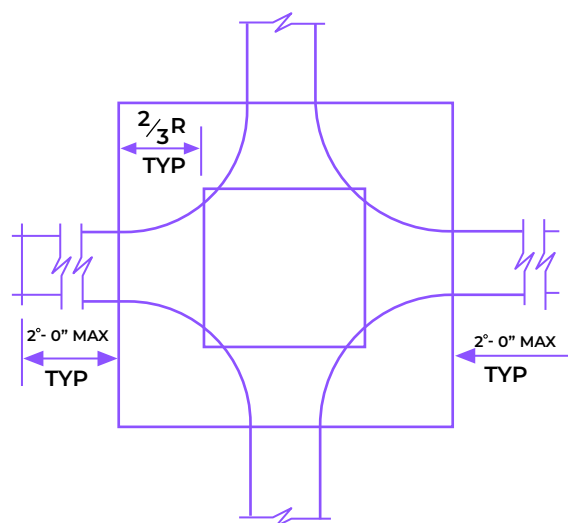


FIGURE 6-3
HORIZONTAL CROSS

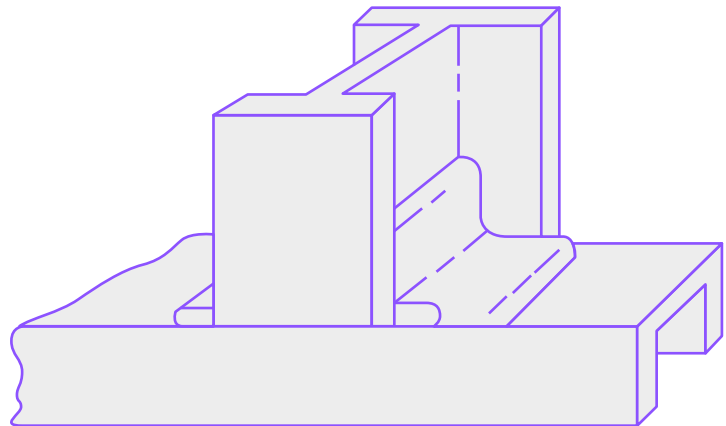
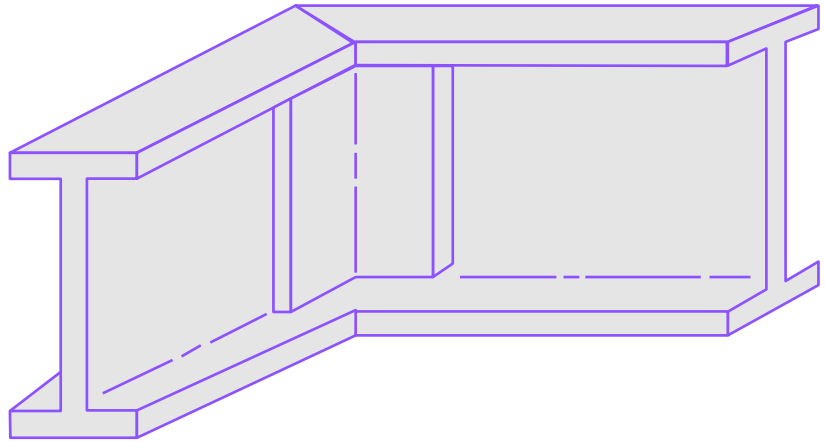
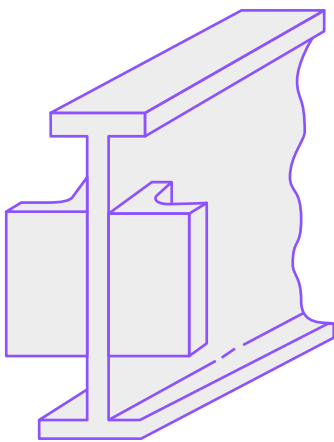
CONNECTIONS

In the domain of FRP Bolted Connections, **DMDESIGN™** stands at the forefront, leveraging extensive expertise to craft cutting-edge solutions. Distinct from certain engineering materials, FRP Bolted Connections governed by ACMA standards possess specific criteria in the industry. **DMDESIGN™** seamlessly integrates these standards, ensuring meticulous compliance with ACMA criteria, considerations, and assumptions. Our team excels in the precision design of bolted connections, emphasizing quality and safety to deliver engineered solutions that surpass expectations. This unwavering commitment to standards and expertise establishes **DMDESIGN™** as the preferred choice for innovative and reliable FRP Bolted Connection designs.

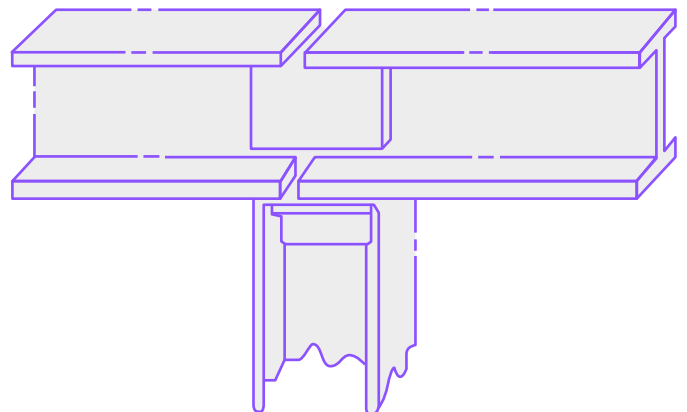
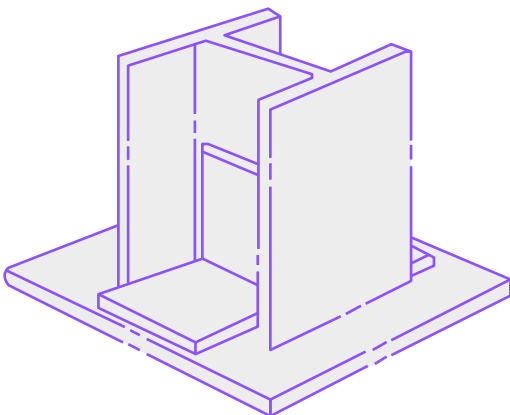
DIFFERENCES BETWEEN FRP AND STEEL BOLTED CONNECTIONS

FEATURES	FRP BOLTED CONNECTIONS	STEEL BOLTED CONNECTIONS
MATERIAL STRENGTH	High-strength fiberglass reinforced polymer	Conventional steel, susceptible to corrosion
WEIGHT	Lightweight, reducing structural load	Heavier, adding to overall structure weight
CORROSION RESISTANCE	Inherently corrosion-resistant, suitable for harsh environments	Prone to corrosion, requires protective coatings
ELECTRICAL CONDUCTIVITY	Non-conductive, suitable for applications with electrical concerns	Conductive, may require precautions for electrical isolation
INSTALLATION AND MAINTENANCE	Easy to install and maintain due to lightweight and corrosion resistance	Installation and maintenance may be more labor-intensive, especially in corrosive environments

I-BEAM JOINTS



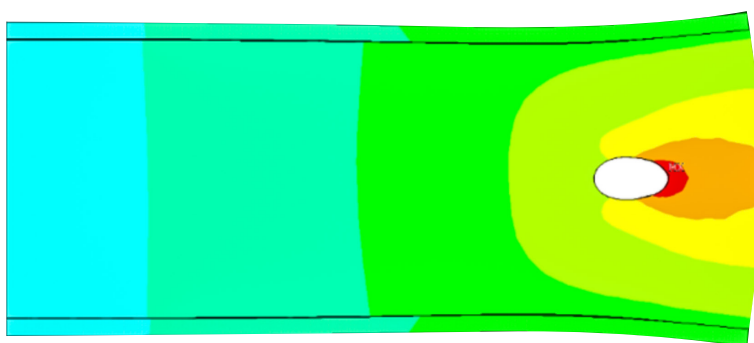
PLATFORM SUPPORTS



DESIGN CRITERIA		SAMPLE CALCULATIONS
PIN BEARING STRENGTH	Evaluates the capacity of the bolted connection to resist bearing loads on the pins.	Assuming a pin diameter (d) of 10 mm and an ultimate bearing stress (σ) of 150 MPa, $4P = 4\pi \cdot d \cdot \sigma = 3.14 \cdot 10 \cdot 1504 = 117.75$ $P = 43.14 \cdot 10 \cdot 150 = 117.75 \text{ kN}$
DELAMINATION	Ensures the integrity of the composite layers, checking for separation or peeling between them.	Delamination factor (DF) is a qualitative measure based on inspection and testing.
LATERAL-TORSIONAL BUCKLING	Examines the potential for lateral deflection and twisting of the bolted connection under loads.	Lateral-torsional buckling capacity (M) depends on various factors, including material properties and geometry, $M = C_b \cdot E \cdot I$ where C_b is the lateral-torsional buckling coefficient, E is the modulus of elasticity, and I is the moment of inertia.
JOINT SLIP	Considers the possibility of relative movement or slippage between the connected components.	Joint slip is influenced by the coefficient of friction (μ) and the applied load.
FASTENER MATERIAL COMPATIBILITY	Addresses the compatibility of the fastener material with the composite material to prevent corrosion or other issues.	Compatibility is assessed based on corrosion potential and material compatibility charts.
FATIGUE RESISTANCE	Addresses the ability of the bolted connection to withstand cyclic loading over time.	Fatigue life predictions involve complex calculations considering stress cycles, loading conditions, and material fatigue data.

NODAL SOLUTION

STEP = 1
 SUB = 1
 TIME = 1
 UX (AVG)
 P SYS = 0
 DNX = .004032
 SNX = .004031

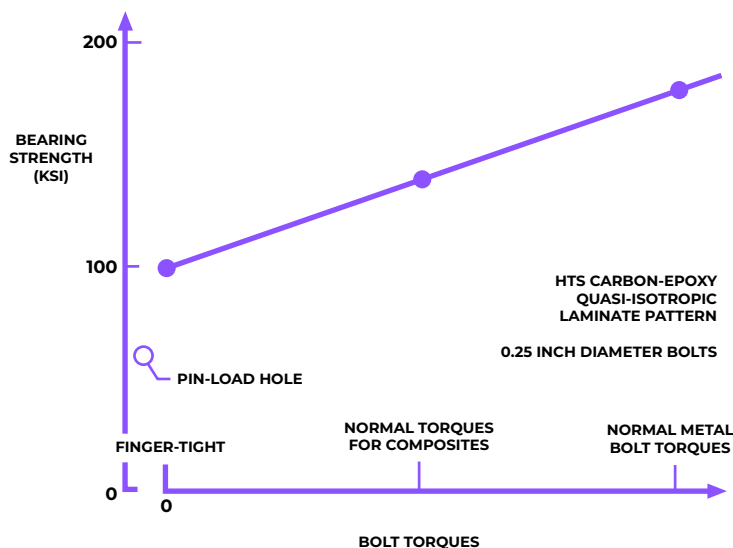


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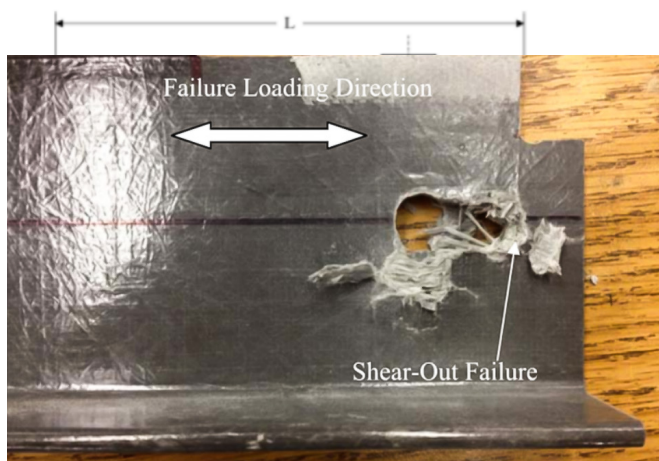
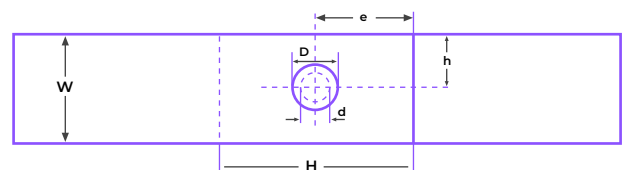
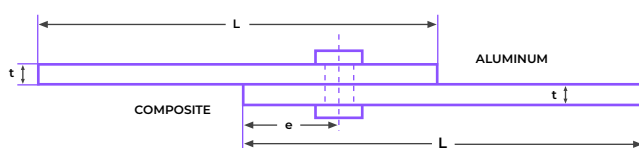
These are illustrative examples, and actual design considerations should be performed by qualified engineers based on project-specific requirements and material properties.

DESIGN CRITERIA	SAMPLE CALCULATIONS
EDGE DISTANCE Considers the distance from the edge of the composite material to the centerline of the bolt, ensuring structural integrity.	The formula for edge distance is generally given as: $e = d + C1$ Where: • e is the edge distance, • d is the diameter of the bolt, and • $C1$ is the specified minimum edge distance. Let's consider a specific example with ACMA guidelines specifying a minimum edge distance of 1.5 times the bolt diameter. Suppose we have a bolt with a diameter (d) of 10 mm. $= 10 \text{ mm} + (1.5 \times 10 \text{ mm}) = 10 \text{ mm} + (1.5 \times 10 \text{ mm})$ $= 25 \text{ mm}$ So, in this example, the edge distance (e) should be greater than or equal to 25 mm to meet ACMA guidelines.
PRELOAD TENSION Examines the initial tension applied to the bolt to ensure proper clamping force.	The formula for preload tension is generally given as: $T = P_{\text{preload}} \times A_s$ Where: • T is the preload tension, • P_{preload} is the preload percentage, • A_s is the tensile stress area of the bolt. Let's consider a specific example with ACMA guidelines specifying a preload percentage of 70% and a bolt with a diameter (d) of 12 mm. $= 0.70 \times T = 0.70 \times A_s$ $A_s = 4\pi \times d^2$ $T = 0.70 \times (4\pi \times (12 \text{ mm})^2)$ $\approx 264 \text{ kN} \approx 264 \text{ kN}$ So, in this example, the preload tension (T) would be approximately 264 kN based on a preload percentage of 70% and a bolt diameter of 12 mm.



The torque applied to a bolt can affect the bearing strength in FRP connections.

DESIGN CRITERIA	SAMPLE CALCULATIONS
COMPOSITE LAMINATE STRENGTH	Laminate strength (σ) can be calculated using material properties and applied loads. Suppose we have a composite laminate with an applied tensile load (N) of 10,000 Newtons. The cross-sectional area (A) of the laminate is 0.01 square meters. $\sigma = \frac{N}{A} = \frac{10,000 \text{ N}}{0.01 \text{ m}^2} = 1,000,000 \text{ N/m}^2$ So, in this example, the laminate strength (σ) would be 1,000,000 N/m² or 1 MPa (Megapascal)
BOLT SPACING	Considers the distance between bolts to prevent concentration of stress and ensure even load distribution. Let's consider an example where ACMA guidelines recommend a minimum bolt spacing of 3 times the bolt diameter (d) for a specific application. Bolt Spacing = 3 × d Assuming a bolt diameter (d) of 12 mm: Bolt Spacing = 3 × 12 mm Bolt Spacing = 36 mm In this example, according to ACMA guidelines, the bolt spacing should be a minimum of 36 mm to ensure proper load distribution and prevent stress concentration.



The geometry of a single lap connection impacts the overall strength of the FRP bolted connection.

DESIGN ASSUMPTIONS		
BOLT MATERIAL STRENGTH	Assumes that the bolts used in the connection meet specified material strength requirements.	Bolts are made of stainless steel with a minimum tensile strength of approximately 482.6 MPa (Megapascals)
HOLE QUALITY	Assumes proper hole preparation and quality to ensure a secure fit for the bolts.	Holes are drilled using high-quality equipment, meeting ACMA guidelines for hole diameter and cleanliness.
CONTACT SURFACE CONDITION	Assumes that the contact surfaces between components are clean and free from contaminants.	Surfaces are prepared to ACMA standards, ensuring no dirt, debris, or release agents are present.
TORQUE APPLICATION	Assumes proper application of torque during bolt tightening to achieve the desired preload.	Torque is applied using calibrated tools following ACMA recommendations for the specific bolt size.



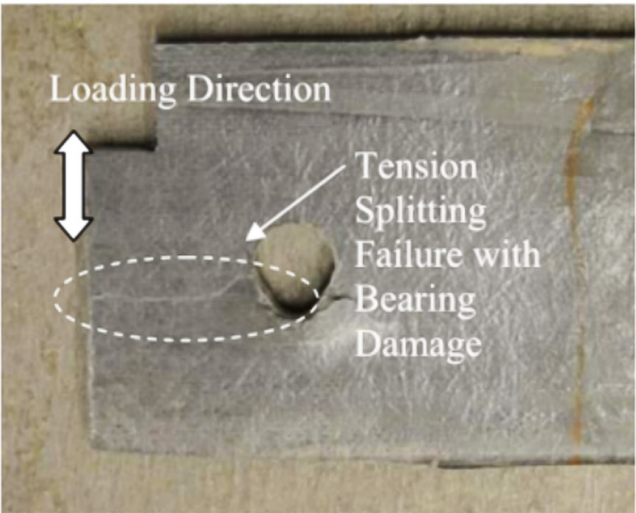
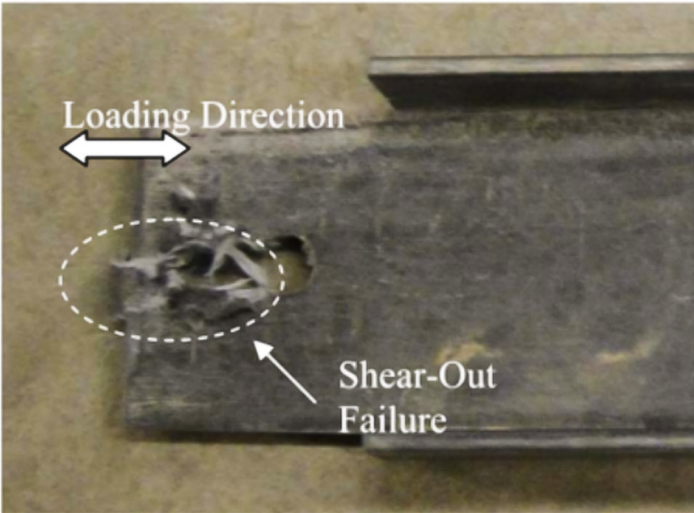
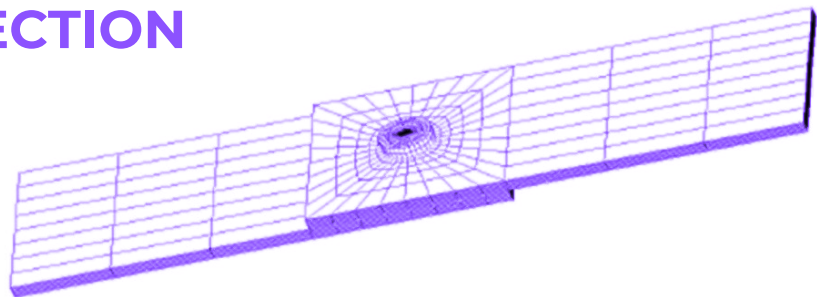
TENSION SPLITTING

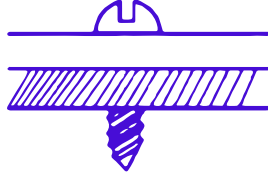
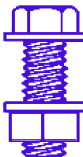
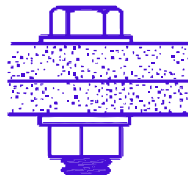
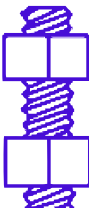
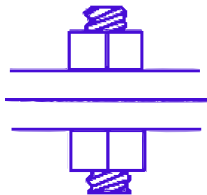
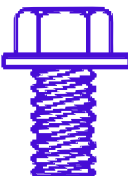
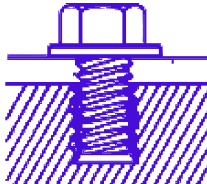


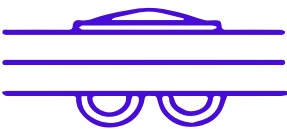
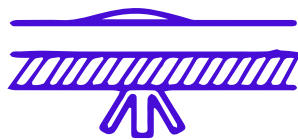
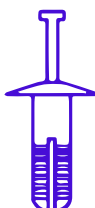
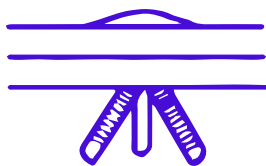
SHEAR-OUT FAILURE

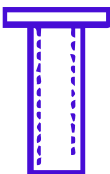
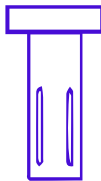
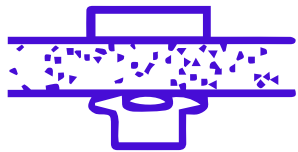
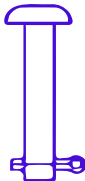
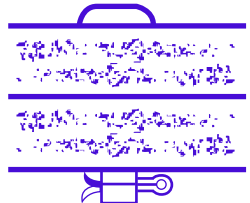
DESIGN ASSUMPTIONS		
ENVIRONMENTAL CONDITIONS	Assumes the connection will operate within specified environmental conditions.	The connection is designed for an outdoor environment with exposure to sunlight and occasional rain.
STRUCTURAL ALIGNMENT	Assumes proper alignment of structural components before and during bolt n installation.	Components are aligned within permissible tolerances to ensure accurate bolt placement
LOAD DISTRIBUTION	Assumes that the connected components are designed to distribute loads evenly.	Assumes that the connected components are designed to distribute loads evenly.

FINITE ELEMENT ANALYSIS OF A BOLTE CONNECTION



APPLICATION	FASTENER	ENGAGE
SCREW Used for fastening DMBEAM™ profile to metal. Use metal as back up to fiberglass.		
BOLT AND NUT Used for fastening profiles together. Best to use washers to distribute load whenever possible. Steel, galvanized, silicon, bronze, nylon, polyester and other materials available for a wide range of applications. Check with your supplier.		
SUPERSTUD!™ /NURS Threaded fiberglass rods with molded fiberglass nuts. Good for highly corrosion applications. Good Shear values.		
BOLTS AND THEADED HOLE Possible assembly technique, however, special construction of DMBEAM™ profile required. Fiberglass nuts above are made by this technique. Epoxies or other adhesives greatly improve joint strength.		
LAG SCREW Can be used to attach profiles to wood. Washer should be used to distribute load. Not recommended for attaching fiberglass to fiberglass.		
TUBULAR RIVET Used in conjunction with washer or metal backup plate. Stronger than pop-rivets because of solid shank. Requires accessibility from both side of profile.		

APPLICATION	FASTENER	ENGAGE
SOLID RIVET Use with back up plate or washer. Must have accessibility to both side of profile.		
BLIND RIVET Pull-up mandrel. Special tool required. Assembly from one side only. Good for fiberglass to metal or with washer backup. Steel or aluminum.		
NYLON RIVET Crimp type rivet. Requires special tool for installation. Good for insulating in mildly corrosive environment.		
T-RIVET (Aluminum) Good for metal to fiberglass or fiberglass to fiberglass with backup plate. Wide expansion provides good load distribution and prevents tear.		
DRIVE RIVET (Aluminum) Good for fiberglass to metal. Can be installed with hammer. Can also be removed from one side by driving out mandrel.		
DRIVE RIVET (Nylon) Installed with hammer. Same mas above. Lower shear value than metal. Center core stays i place.		

APPLICATION	FASTENER	ENGAGE
BLIND THREAD INSERTS Applies metal threads to profile. Good for products for which disassembly is required. Hexagon shape available to prevent twist. Special tool required.		
BLIND THREAD INSERTS Better torque and shear strength. Loads are more evenly spread on back surface.		
CLEVIS AND PIN (Metal) Can be used for some installations. Not normally a very tight fit.		
CLEVIS AND PIN (Nylon) Used in some installations. Electrical insulating properties.		

In the realm of FRP Bonded Connections, **DMDESIGN™** takes the lead, leveraging extensive expertise to create cutting-edge solutions. Unlike traditional materials such as steel, which relies on welding, FRP Bonded Connections following ACMA standards utilize bonding. This unique approach ensures meticulous compliance with ACMA criteria, considerations, and assumptions. Our team excels in the precision design of bonded connections, emphasizing quality and safety to deliver innovative solutions that surpass expectations. This steadfast commitment to standards and expertise establishes **DMDESIGN™** as the preferred choice for reliable and forward-thinking FRP Bonded Connection designs.

FRP BONDED CONNECTIONS VS STEEL WELDED CONNECTIONS

FEATURES	FRP BONDED CONNECTIONS	STEEL WELDING
JOINING TECHNIQUE	Bonding using adhesive or resin	Welding using heat and molten material
MATERIAL COMPATIBILITY	Suited for a wide range of materials	Limited to materials with similar melting points
INSTALLATION	Adhesive application and curing process	Requires welding equipment and skilled labor
ENVIRONMENTAL IMPACT	Generally environmentally friendly	May involve emissions, fumes, and waste
FLEXIBILITY	Allows for flexibility in design and materials	Generally rigid, limiting design options

DESIGN CRITERIA		SAMPLE CALCULATIONS
BONDING STRENGTH	Measures the adhesive strength between FRP components.	Formula: Bonding Strength = Applied Force / Bonded Area Sample Calculation: Assuming an applied force of 25 kN and a bonded area of 500 mm ² , Bonding Strength = 25kN / 500mm ² = 10MPa
SHEAR STRENGTH	Evaluates the ability of the bonded joint to resist forces acting parallel to the bond line.	Formula: Shear Strength = Shear Force / Bonded Area Sample Calculation: Assuming a shear force of 3 kN and a bonded area of 300 mm ² , Shear Strength = 3kN / 300 mm ² = 10MPa
PEEL STRENGTH	Measures the force required to peel bonded layers apart.	Formula: Peel Strength = Peel Force / Bonded Width Sample Calculation: Assuming a peel force of 8 N and a bonded width of 20 mm, Peel Strength = 8 N / 20mm = 0.4N/mm
COHESIVE STRENGTH	Assesses the internal strength of the adhesive material.	Cohesive Strength = Cohesive Force / Cohesive Area Sample Calculation: Assuming a cohesive force of 6 kN and a cohesive area of 600 mm ² , Cohesive Strength = 6 kN / 600 mm ² = 10 MPa
ENVIRONMENTAL DURABILITY	Addresses the compatibility of the fastener material with the composite material to prevent corrosion or other issues.	Compatibility is assessed based on corrosion potential and material compatibility charts.

These are illustrative examples, and actual design considerations should be performed by qualified engineers based on project-specific requirements and material properties.

DESIGN ASSUMPTIONS		
SURFACE PREPARATION	Assumes the surface preparation is carried out according to ACMA guidelines to achieve proper bonding.	Surface preparation includes cleaning, roughening, and ensuring a contaminant-free surface.
ADHESIVE MATERIAL PROPERTIES	Assumes the adhesive material properties meet specified standards.	Adhesive material complies with ACMA standards regarding strength, durability, and environmental resistance
BONDED SURFACE AREA	Assumes the bonded surface area is consistent with the design specifications.	The calculation of bonding strength assumes the correct bonded surface area.
CURING CONDITIONS	Assumes that the adhesive is cured under appropriate conditions as per ACMA recommendations.	Curing temperature, humidity, and duration adhere to ACMA guidelines for optimal bonding performance.
LOADING CONDITIONS	Assumes that the bonded joint will experience loads within the specified range.	Calculations are based on loading conditions that fall within the design limits provided by ACMA.

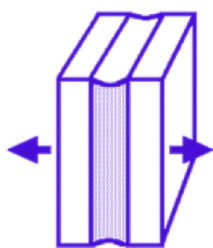
DESIGN ASSUMPTIONS

ENVIRONMENTAL EXPOSURE	Assumes that the bonded connection will be exposed to environmental conditions as defined in the project requirements.	Bonded connections are designed considering factors like exposure to moisture, temperature variations, and chemical agents.
QUALITY CONTROL MEASURES	Assumes the implementation of quality control measures during the bonding process.	Regular inspections and testing are conducted to ensure the quality of the bonded connections.
JOINT GEOMETRY	Assumes that the joint geometry aligns with the design specifications.	The design calculations consider the specific geometry of the bonded joint.

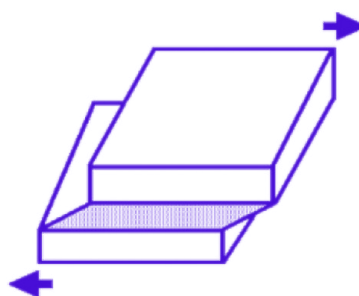
DIFFERENT FORMS OF BONDED CONNECTION FAILURE



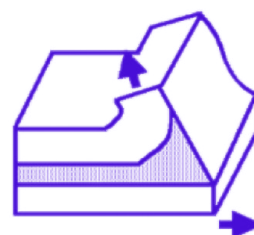
CLEAVAGE



TENSILE

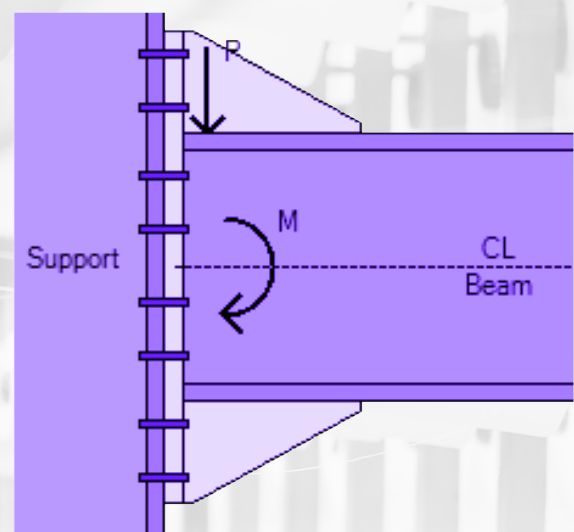
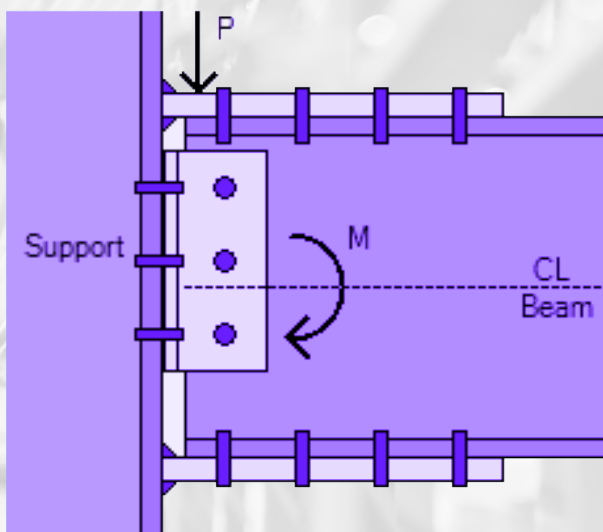


SHEAR



PEEL

In the field of FRP Moment Connections, **DMDESIGN™** stands as a pioneer, drawing upon extensive expertise to craft advanced solutions. Unlike conventional materials like steel, which relies on welding, FRP Moment Connections adhering to ACMA standards utilize a bonding approach. This distinctive method ensures precise compliance with ACMA criteria, considerations, and assumptions. Our team excels in the accurate design of moment connections, prioritizing quality and safety to deliver innovative solutions that exceed expectations. This unwavering commitment to standards and expertise positions **DMDESIGN™** as the preferred choice for reliable and cutting-edge FRP Moment Connection designs.



WHAT IS A MOMENT CONNECTION?

In the field of FRP Moment Connections, **DMDESIGN™** stands as a pioneer, drawing upon extensive expertise to craft advanced solutions. Unlike conventional materials like steel, which relies on welding, FRP Moment Connections adhering to ACMA standards utilize a bonding approach. This distinctive method ensures precise compliance with ACMA criteria, considerations, and assumptions. Our team excels in the accurate design of moment connections, prioritizing quality and safety to deliver innovative solutions that exceed expectations. This unwavering commitment to standards and expertise positions **DMDESIGN™** as the preferred choice for reliable and cutting-edge FRP Moment Connection designs.

COMPOSITE PIPE

In the domain of Composite FRP Pipes, **DMDESIGN™** stands at the forefront, leveraging extensive expertise to craft cutting-edge solutions. Distinct from certain engineering materials, Composite FRP Pipes following SMACNA standards have specific criteria in the industry. **DMDESIGN™** seamlessly incorporates these standards, ensuring meticulous compliance with SMACNA criteria, considerations, and assumptions. Our team excels in the precision design of composite pipes, emphasizing quality and safety to deliver engineered solutions that surpass expectations. This unwavering commitment to standards and expertise establishes **DMDESIGN™** as the preferred choice for innovative and reliable Composite FRP Pipe designs.

Why Choose **DMDESIGN™** for Composite FRP Pipes?

SMACNA COMPLIANCE:

Our engineering and design of Composite FRP Pipes strictly adhere to SMACNA standards, ensuring the highest quality and reliability in ductwork applications.

INNOVATIVE MATERIALS:

DMDESIGN™ utilizes advanced composite materials, providing superior strength, durability, and corrosion resistance for optimal performance in various applications.

PRECISION ENGINEERING:

Our team employs precision engineering techniques to meet the stringent requirements of SMACNA standards, delivering accurate and efficient solutions for ductwork systems.

CUSTOMIZABLE SOLUTIONS:

We offer tailored solutions with diverse configurations, sizes, and specifications, providing flexibility to address unique project requirements according to SMACNA guidelines.

SUSTAINABLE PRACTICES:

Committed to sustainability, **DMDESIGN™** incorporates eco-friendly materials in the construction of Composite FRP Pipes, aligning with SMACNA's emphasis on responsible and efficient engineering practices.

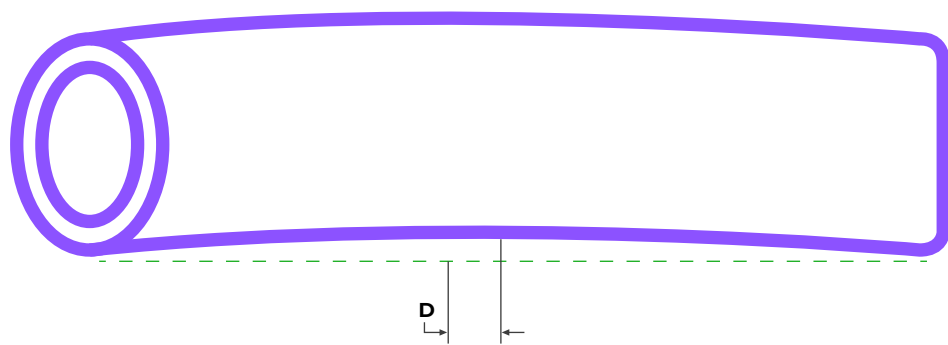
DID YOU KNOW?

Composite FRP Pipes and Inlets offer exceptional corrosion resistance, making them ideal for harsh environments. With lightweight construction, they simplify installation and maintenance while providing longevity and durability in diverse applications.

DESIGN CRITERIA		SAMPLE CALCULATIONS
	MATERIAL STRENGTH	Ensures the FRP duct material can withstand applied loads without failure. Formula: Material Strength = Applied Load / Cross-Sectional Area Sample Calculation: Assuming an applied load of 5 kN and a cross sectional area of 4000 mm², Material Strength=5kN/ 4000mm² =1.25MPa
	BUCKLING RESISTANCE	Evaluates the duct's ability to resist buckling under compressive loads. Formula: Buckling Resistance = Critical Load / Applied Load Sample Calculation: Assuming a critical load of 8 kN and an applied load of Buckling Resistance=8kN /5kN=1.6
	DEFLECTION CRITERIA	Specifies the maximum allowable deflection of the FRP duct under different loads. Formula: Deflection = Load × Length³ / (48 × Young's Modulus × Moment of Inertia) Sample Calculation: Assuming a load of 10 kN, a length of 3 meters, Young's Modulus of 20 GPa, and Moment of Inertia of 5000 mm⁴, Deflection=48×20×103mm²×5000mm⁴10kN×(3000mm)³ =9.375mm
	THERMAL EXPANSION	Accounts for the thermal expansion of the FRP duct material. Formula: Thermal Expansion = Coefficient of Thermal Expansion × Temperature Change × Length Sample Calculation: Assuming a coefficient of thermal expansion of 8 × 10⁻⁶ /°C, a temperature change of 50°C, and a duct length of 4 meters, Thermal Expansion=8×10⁻⁶×50×4000=0.16mm
	JOINT INTEGRITY	Ensures the integrity and reliability of joints between FRP duct sections. N/A (Qualitative assessment based on construction and material compatibility).

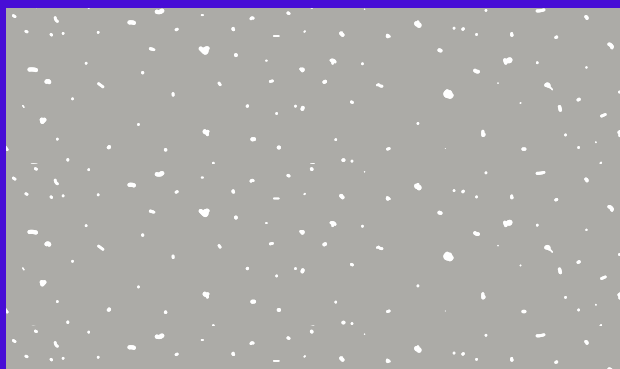
These are illustrative examples, and actual design considerations should be performed by qualified engineers based on project-specific requirements and material properties.

DESIGN ASSUMPTIONS		
MATERIAL CONSISTENCY	Assumes consistent material properties throughout the FRP duct fabrication process.	Assume uniform resin and fiber distribution during manufacturing.
ADEQUATE FABRICATION TECHNIQUES	Assumes the use of proper fabrication techniques to achieve the intended duct geometry.	Assume skilled craftsmanship and adherence to SMACNA guidelines during fabrication.
ENVIRONMENTAL CONDITIONS	Assumes the FRP duct will be exposed to typical environmental conditions within the specified range.	Assume an operating temperature range of -20°C to 50°C.
INSTALLATION PRECISION	Assumes accurate installation to maintain the structural integrity and performance of the FRP duct.	Assume precise alignment and connection during installation.
MAINTENANCE CONSIDERATIONS	Assumes routine maintenance to ensure continued performance over the duct's lifespan.	Assume regular inspections and cleaning as part of a maintenance schedule.



EHANCING STRENGTH IN FRP

By strategically selecting and implementing appropriate fillers, the strength and overall performance of FRP structures can be significantly enhanced, making them more resilient and adaptable to diverse engineering challenges.



GROUT

Injecting grout into hollow FRP sections.

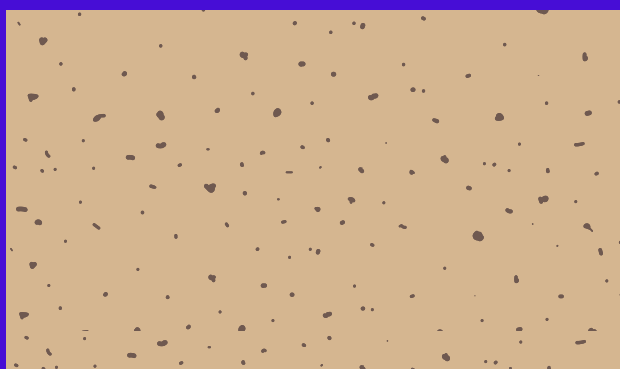
Improves axial and lateral strength, enhancing stability. Pin Bearing Strength enhanced by providing additional support against compressive



RESIN

pouring hollow sections with specialized resins.

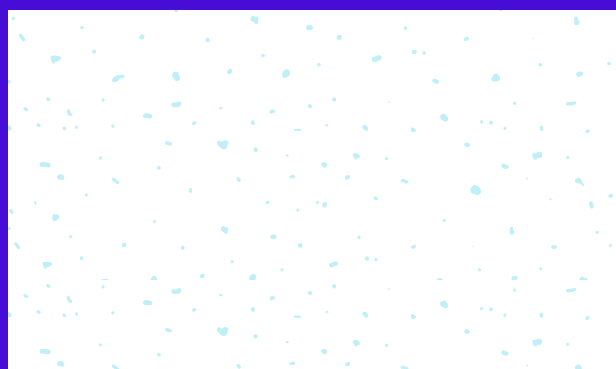
Reinforces structural integrity, particularly in bending and torsional loading. Pin Bearing Strength bolstered by a uniformly reinforced interior.



SAND

Compaction of sand as a filler material.

Improves axial and lateral strength, enhancing stability. Pin Bearing Strength enhanced by providing additional support against compressive



PU FOAM

Infusing polyurethane foam into FRP hollow spaces.

Increases overall strength, stiffness, and resistance to deformation. Enhances bonding interfaces, reducing stress concentrations

Utilizing advanced lamination techniques at **DMDESIGN™** empowers our engineers to elevate essential structural elements, offering a holistic solution to reinforce web components, connections, and overall load-bearing capabilities in FRP structures. This strategic approach is pivotal in optimizing our FRP designs for a myriad of applications and various loading scenarios, ensuring unparalleled strength and performance.

Why we implement lamination in our designs ?

Increased Web Thickness:

Laminating FRP flat plates boosts the web thickness. The augmented web thickness enhances the section's resistance to shear forces, providing robustness against various loading conditions.

Enhanced Connection Strength:

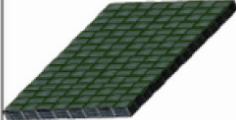
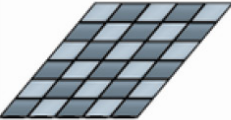
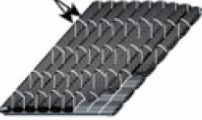
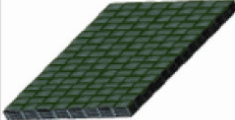
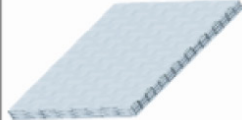
Lamination positively impacts the overall connection strength. The bonded flat plates fortify connections, reducing vulnerability to dynamic forces and improving long-term stability.

Improved Web Shearing Resistance:

Lamination contributes to heightened resistance against web shearing. The bonded layers create a cohesive structure, significantly increasing the ability to withstand shearing forces along the web.

Uplift and Point Load Resistance:

Lamination enhances resistance against uplift and point loads. By reinforcing critical areas through lamination, FRP structures become more adept at withstanding concentrated loads and upward forces.

	T300/VE	T700/VE · F	T700/VE · K	T300/EP	Eglass/VE
Weave	 Plain woven : Normal yarn (fiber bundle 2mm)	 Plain woven : Flat yarn (fiber bundle 10mm)	 Knitted fabric	 Plain woven : Normal yarn (fiber bundle 2mm)	 Plain woven : Normal yarn (fiber bundle 2mm)
Fiber	T300-3K-50B	T700SC-12K-50C		T300-3K-50B	WL230-104BS6
Matrix resin	DERAKANE MOMENTUM:100 Permek N:0.8 Cobalt naphthenate:0.06			Epikote 828:100 MHAC-P:103.6 2E4MZ:1	DERAKANE MOMENTUM:100 Permek N:0.8 Cobalt naphthenate:0.06
Number of layers	8	9	4	9	10
Volume fraction	49%	53%	52%	52%	33%
Forming	RTM (Resin Transfer Molding)	RTM (Resin Transfer Molding)	VARTM (Vacuum Assisted RTM)	Hand lay up method	VARTM (Vacuum Assisted RTM)
Cure schedule	25°C × 48h 150°C × 2h	25°C × 48h 150°C × 2h	25°C × 48h 150°C × 2h	70°C × 12h 150°C × 4h 190°C × 2h	25°C × 48h 150°C × 2h

ANTI-CRUSH

Anti-crush tubes or blocks play a vital role in enhancing the structural integrity of FRP components.

Why we implement anti-crush blocks in our designs ?

Failure Preventions:

Strategically placed elements prevent pin bearing failure and ensure the integrity of critical areas.

Enhanced Strength:

These components contribute to uniform load distribution, impact absorption, and overall section strength.

Resistance to Deformation:

High crush resistance and prevention of section distortion maintain the intended shape and structural stability.

Long-Term Stability:

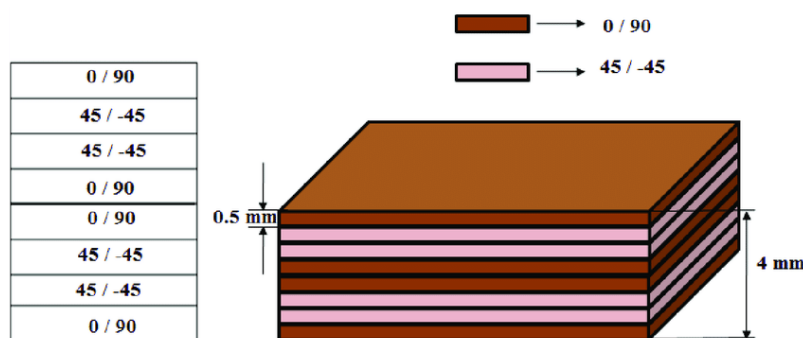
Anti-crush features extend the lifespan of FRP structures by enhancing uplift resistance and preventing issues from concentrated loads.



DID YOU KNOW?

Anti-crush tubes are preferred over blocks for their easy installation. Aligning blocks across a hollow section with bolt locations can be challenging, making tubes a more convenient choice for efficient assembly in FRP structures.

DESIGN CRITERIA	DESIGN CRITERIA	DESIGN CRITERIA	DESIGN CRITERIA	DESIGN CRITERIA
SURFACE VEIL	0.3	0.12	RANDOM	Enhances surface finish and durability.
CSM	0.65	0.24	RANDOM	Provides strength and impact resistance.
FABRIC (90°)	0.65	0.24	90°	Reinforces in the direction of the weave.
FABRIC (45°)	-	0.20	45°	Adds strength at a 45-degree angle.
TOTAL	-	12.73	-	Combined thickness of all layers.



DID YOU KNOW?

Smart adjustment of layering sequences in composite structures can significantly boost material properties by up to 70% compared to standard layers. This strategic approach enhances strength, durability, and performance, showcasing the innovation behind composite engineering.

Stacking beams and bonding with both bolted and bonded adhesives is a strategic method for reinforcing FRP structures. The shear cohesion interface becomes crucial, and wide flange beams are ideal due to their expansive bonding area. Up to three beams can be stacked, enhancing stiffness, bending, and shear strengths, enabling longer spans economically.

KEY POINTS OF NOTE WHEN DESIGNING FOR A STACKED BEAM SOLUTION

Precise Alignment:

Strategically placed elements prevent pin bearing failure and ensure the integrity of critical areas.

Thorough Surface Preparation:

These components contribute to uniform load distribution, impact absorption, and overall section strength.

Adherence to Recommended Procedures:

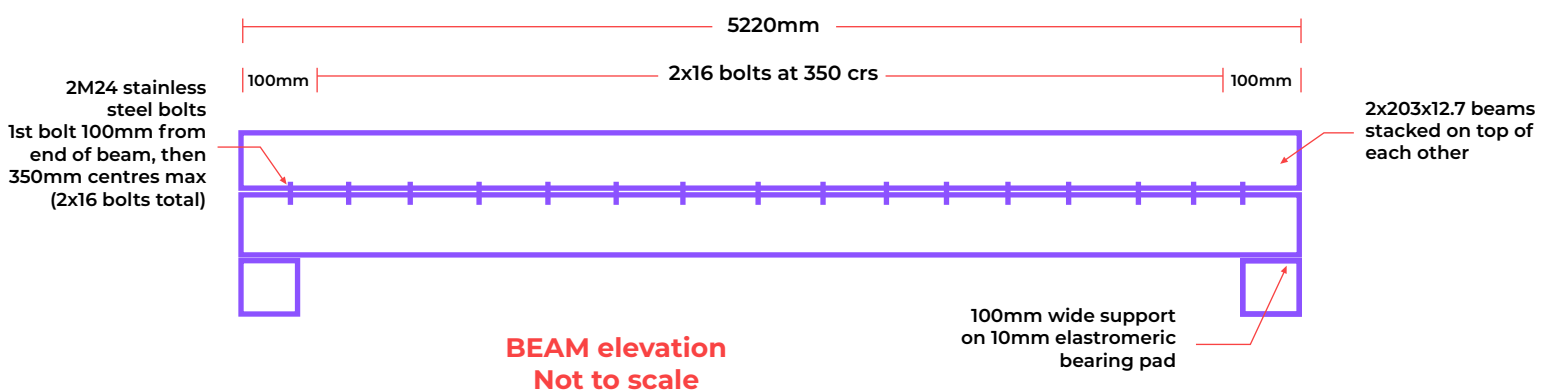
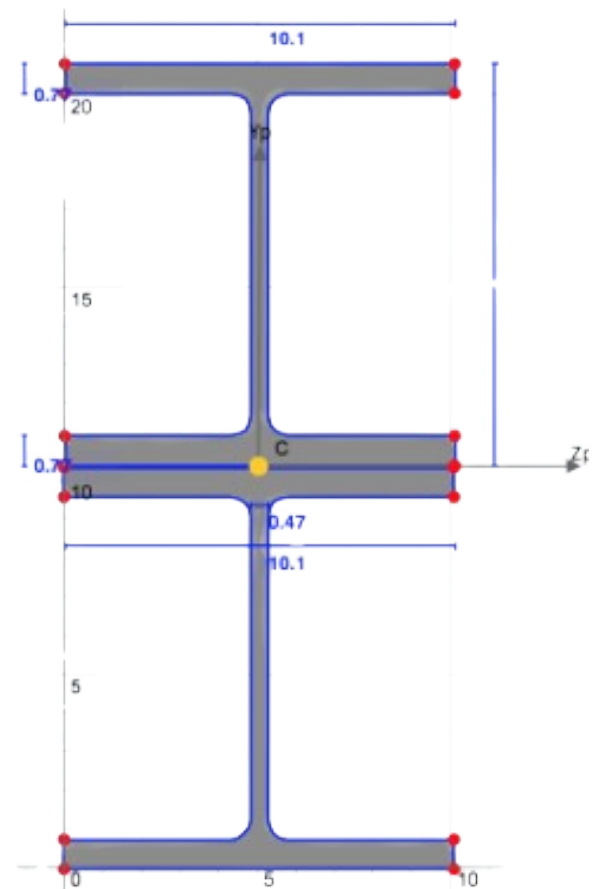
High crush resistance and prevention of section distortion maintain the intended shape and structural stability.

Customized Solutions:

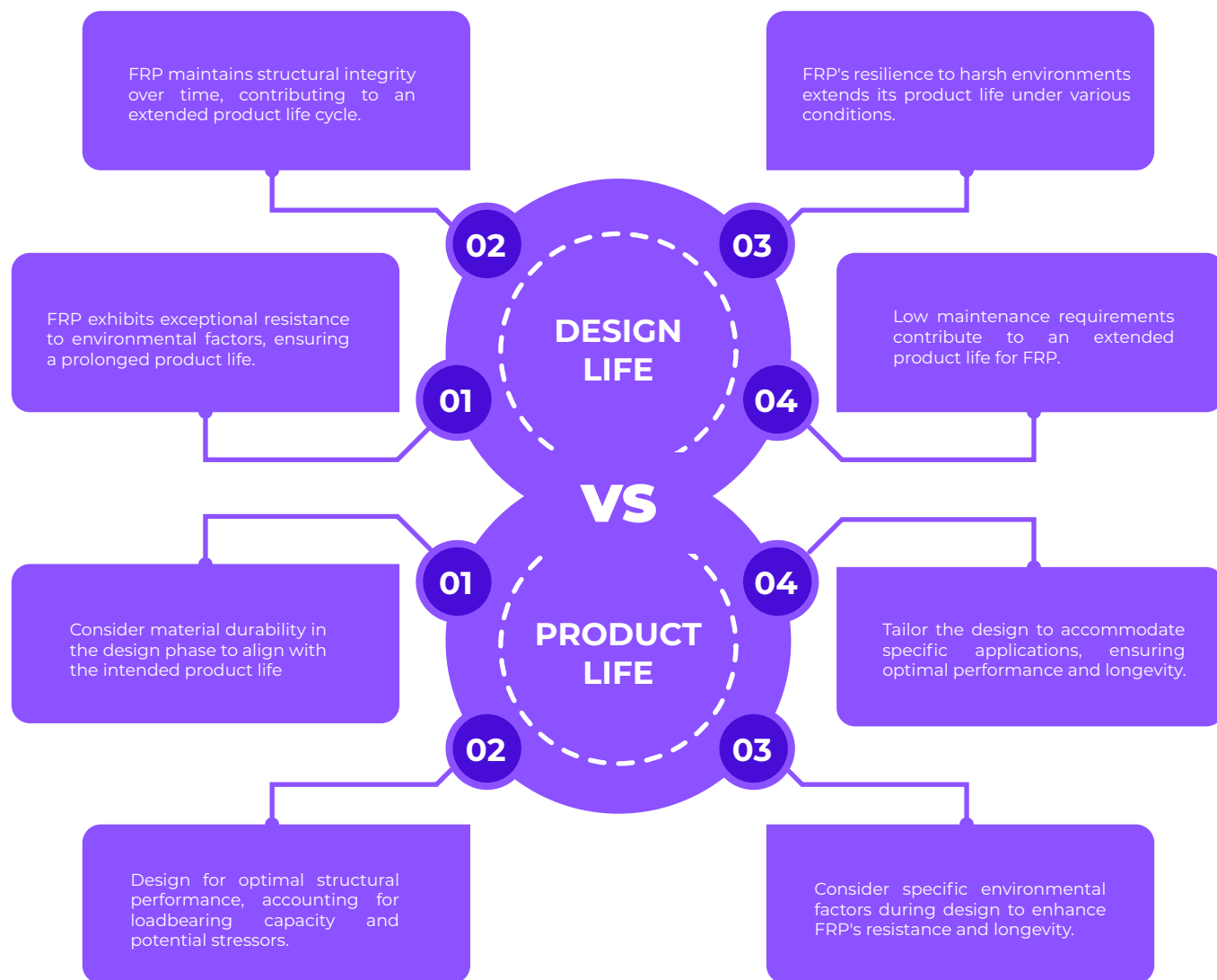
Anti-crush features extend the lifespan of FRP structures by enhancing uplift resistance and preventing issues from concentrated loads.

Optimization of Structural Performance:

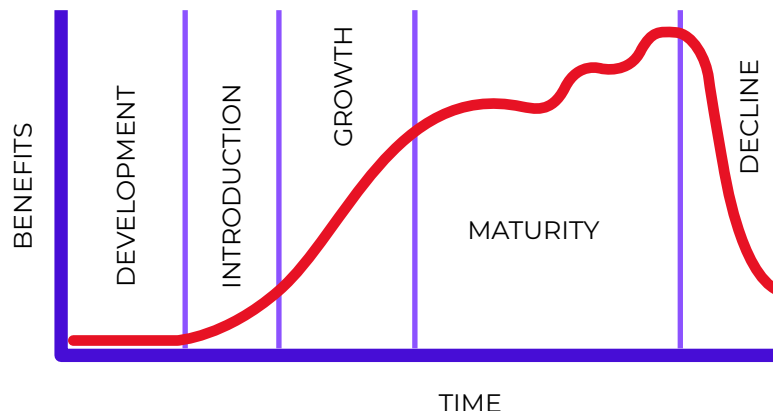
By combining precise alignment, thorough surface preparation, and adherence to procedures, the method optimizes the overall structural performance of FRP applications, facilitating longer spans economically.



These points highlight the interconnected relationship between the product life and the design life of FRP, emphasizing the importance of thoughtful design considerations for prolonged durability and functionality.



PRODUCT LIFECYCLE



In the realm of **DMDESIGN™**, ensuring the reliability and precision of our engineering solutions is paramount. While standards guide us in many aspects, the absence of prominent standards and site variabilities often necessitate verification through testing.

EXAMPLES WHERE TESTING IS USED TO VERIFY OUR DESIGNS

PILE DESIGN WITH PDA TESTING:

For piles with specific embedment depths, on-site PDA testing is conducted to validate engineering calculations, ensuring the designed foundation's actual performance.

SITE SURVEYS FOR TERRAIN AND TOPOGRAPHY:

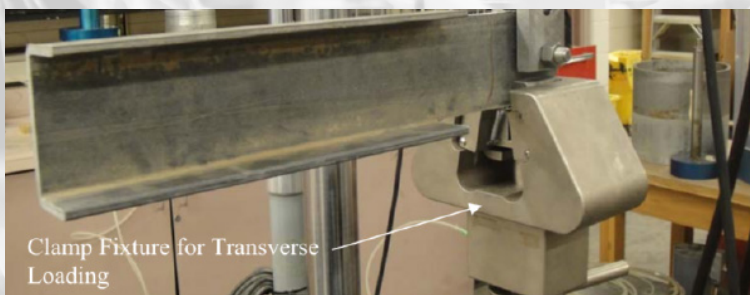
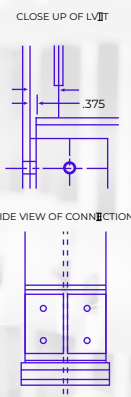
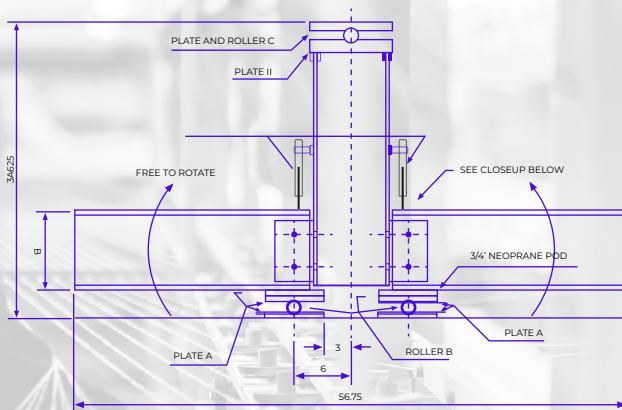
In projects where site variations are significant, survey pegs are employed to verify set-out levels, providing accurate measurements for structural alignment.

ADHERENCE TO RECOMMENDED PROCEDURES:

High crush resistance and prevention of section distortion maintain the intended shape and structural stability.

TESTING IN FRP STRENGTHENING METHODS:

Innovative methods like stacking beams for FRP structures may undergo testing to validate calculations, ensuring the effectiveness of the chosen strengthening approach.



Verification through testing adds an extra layer of assurance, especially in scenarios where standardization is evolving or lacking. At **DMDESIGN™**, this commitment to precision and adaptability ensures that our engineered solutions stand the test of real-world conditions.

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