EXPLOITING COMPOSITE MATERIALS TO REALISE A GLOBAL AMBITION

This briefing document provides a high-level introduction to the potential of composite materials in addressing the challenges and opportunities in the construction sector.
Ambitious ideas, revolutionary materials, advanced technologies and challenging environments are shaping our understanding of what is possible in the design and construction of high-performance structures and products.

Demand for ground-breaking structures that meet a complex array of design challenges in terms of scale, strength, weight and shape is growing.

As traditional building materials reach the limits of their practical application, composite materials, and their associated manufacturing processes, provide solutions to many of these challenges.

The superyacht, the Maltese Falcon, has redefined what is possible in the construction of large, monohull sailing vessels, with the largest free-standing DynaRig in the world. Three carbon fibre masts, each 58 metres tall, have the ability to rotate and carry 15 sails, and are embedded with 96 fibre optic sensors to monitor load when sailing. The Maltese Falcon is considered to be one of the greenest superyachts afloat.
Aviation transport has been revolutionised since the first bi-planes over a century ago. The new Boeing 787 Dreamliner is the first large-scale commercial aircraft made using mostly composite materials. More than half of the wings, spanning 60 metres, are made from carbon fibre, enabling the aircraft to carry 250 passengers whilst weighing less and consuming less fuel than its rivals.

New architectural structures, with radical and unconventional shapes, are redefining traditional practices, demonstrating how creative ideas can be realised through advanced design and construction techniques.

The high strength-to-weight ratio of composite materials provides architects and designers with a material that has the creative flexibility to deliver ambitious ideas and complex shapes.

Structures that are designed and constructed making use of composites can achieve more fluid, dynamic, curved and creative structures that amaze the people that use them.

The superb resistance to weathering, low maintenance, long life and lightweight properties of composites all make them an ideal material for use in construction and infrastructure projects.

Additionally, composite materials provide better performance for thermal expansion and contraction for use in the most extreme climatic areas of the world.
REALISING AMBITIOUS, CREATIVE CONCEPTS

Today’s architects and designers have the ability to realise structures that challenge conventional thinking, using composites to build stadia, shell structures, bridges, facades, roofs, and transportable event and architectural structures.

Courtesy of Optima Projects
By harnessing the potential of advanced composite materials, designers’ ambitions are no longer limited by conventional construction materials and methods.

**SCALE**
Designers can go higher and wider. Composites can be used to create extremely strong, self-supporting components for large-scale applications in buildings, bridges and public art.

**SHAPE**
Shape is no longer limited to angular lines; elegant curves can be utilised to create more fluid, dynamic and unique solutions.

**LOADING**
As a result of their light weight, compared to other construction materials, composite components and structures can be positioned on existing buildings or used in situations where weight is a deciding factor.

Buildings can be completely re-clad using large, lightweight panels with minimum impact on the structural integrity of the original building and maximum impact on aesthetics.

The lightweight nature of composites means required foundations are less extensive, minimising ground excavation and costs.

**AUTOMATION**
Designers and architects now have the ability to create large-scale, automated structures (for example, bridges and roofs that open and close). These solutions are only possible with incredibly strong, lightweight and high-performance materials.

**SHORT-TERM SOLUTION**
Composite materials can create shorter term infrastructure solutions that require reduced substructure requirements and can be dismantled, downsized or reused elsewhere, such as extensions to stadia and temporary bridges and walkways for crowd movement.
Advanced composite materials are finding new applications in high-performance sectors, delivering performance characteristics that surpass conventional design thinking and construction materials.
Motorsport, defence, oil and gas, aresospace and marine are all sectors with deep experience of exploiting the performance characteristics of composites.

More recently, the art and architectural community is realising the potential of this advanced and highly flexible construction material.

Composite materials provide architects and designers with a material that has the creative flexibility to deliver ambitious ideas.

Structures that are designed and constructed making use of composite materials can achieve creative, thought-provoking, breathtaking and inspirational spaces that delight and amaze the people that use them.

The light weight of composite components provides real advantages for assembly, operation and reuse, with significantly improved ease of handling.

Able to operate at extreme temperatures, geographical location is not a barrier to exploiting the performance of composite materials.
Magma Structures is a global leader in composite technology, providing world-class structural engineering expertise and flexible manufacturing resources and processes to deliver high-performance solutions for unique and challenging requirements.
Harnessing the potential of composite materials to engineer innovative solutions that deliver very specific performance characteristics in terms of strength, durability, scale and weight.

Magma Structures provides clients with a unique team of highly experienced, global experts with world-leading capabilities in composite engineering and proven expertise in the application of composite technology in specialist structures and components.

Operating at the leading edge of composite technology, we are the chosen partner for architects and designers who want a collaborative, design and engineering-led approach to realise their creative ideas through composite solutions.

We design and build high-performance structures that meet some of the most demanding structural requirements, matching the best technology and build process to each individual project.

We have access to world-class, in-house testing facilities, robotic engineering expertise, as well as extensive experience in through-life fibre optic strain monitoring systems for large, complex structures.

Our specialist team have worked on some of the most advanced applications of composite technology in the world. A portfolio of global projects is available on our website.
SERVICES PORTFOLIO: AN END-TO-END, IN-HOUSE SERVICE OFFERING

We provide an end-to-end portfolio of services, delivered in-house, to harness the potential of advanced composite materials in diverse and challenging applications and sectors.
Magma Structures provides the specialist knowledge, expertise and resources to help clients at every stage through a proven process, all delivered in-house:

**CONSULTANCY**
We support clients in the early stages with advice on the application of composite materials and processes through feasibility studies.

**STRUCTURAL ENGINEERING DESIGN**
Our engineering design team works with architects, engineers and designers in specialist sectors, providing specific engineering design services for advanced and extreme structures and components.

**PROTOTYPING**
We provide a range of prototyping services to help clients evaluate potential applications.

**TESTING**
We have state-of-the-art, in-house test facilities for rigorous analysis of performance characteristics prior to manufacture.
We combine cutting-edge, in-house manufacturing capabilities with structural engineering expertise, state-of-the-art on-site testing and rigorous quality control and qualification systems.
FLEXIBLE MANUFACTURING RESOURCES

We construct bespoke, one-off, large-scale structures using a range of advanced manufacturing processes and appropriate materials to ensure the optimum build method for each project.

These processes include:
- Autoclave
- Vacuum infusion
- Robotic tape laying, including thermosets and thermoplastics
- Laser robotic welding
- Precision driven controlled laminate curing
- On-site impregnators
- Pre-preg
- In-mould cure ovens
- A variety of fibre types to suit the project
- A variety of thermosets and thermoplastics to suit the project

Our flexible manufacturing facilities can quickly and efficiently adapt to different sized projects and our waterside location enables the delivery of large structures by water.

ROBOTIC CELL

Robotic cell manufacturing techniques offer key performance benefits for component manufacture over and above conventional methods: high-precision, high-quality, highly repeatable and process control.

Projects run through our robotic cell are overseen by an expert team of structural designers and engineers with access to a world-class, in-house composite testing facility and Lloyds qualification.

Our robotic manufacturing capabilities allow the provision of bespoke small-scale, high margin projects, as well as large volume, specialist components at lower margins.
PROJECT MANAGEMENT, DELIVERY AND INSTALLATION
We manage complex logistics and oversee installation and trials, delivering one-of-a-kind composite projects of unprecedented physical scale and build length. Everything is managed in-house with our team of experienced project managers, designers and design and structural engineers.

THROUGH-LIFE MONITORING
We provide innovative fibre optic strain and structural monitoring systems together with expertise in live data acquisition, analysis and feedback that is setting new world standards.

8 years of data from embedded fibre optics on the Maltese Falcon masts - the world's largest free-standing rig - enables the team to analyse historical data on the structural health and performance of composite structures, proving the viability and longevity of composite materials.

Used across diverse sectors and applications - oil and gas, aerospace, marine, wind turbine and renewables
- advanced fibre optic sensor technology can also be applied to materials other than composites.

QUALIFICATION AND CERTIFICATION
We work to the compliance requirements of insurers and other regulatory bodies.
Our clients are ambitious individuals and organisations who want to challenge what is possible in the construction of bespoke, high-performance structures and components.
Current Projects (In Build)
Magma Structures currently has in build a number of highly innovative free-standing masts in excess of 65 metres with automated sailing systems that one person can control.

Magma Structures carried out the initial appraisal and rig engineering and is now in the build process before installation and commissioning. Magma Structures is responsible for the project management which includes design, test and build, supply of rigs, including sails, control systems and automation.

World’s Tallest Composite Masts
Magma Structures recently delivered the world’s tallest carbon composite free-standing masts. The rigs are over 90m in length and are designed to withstand bending moments of more than 40 MNm, more than twice the load on a Boeing Dreamliner wing. Each mast is able to rotate using systems mounted on ‘wings’ at the side of each mast; adding to the design complexity and build challenge. Despite their height, each cantilevered freestanding mast weighs around 50 tonnes. The masts support a sail area greater than a standard sized football pitch, with full automation in terms of sail deployment, setting and reefing.

The Wind Wand, 2000, Canary Wharf, London
A huge, asymmetric mast embedded with lights and built out of E glass. The needle thin, 50 metre high Wind Wand, designed by Architect Ron Arad, is made of vivid red carbon fibre, which is designed to flex gently in the wind.

The Glasgow Science Centre Millennium Tower
The 127 metre tall aerofoil shaped tower holds the Guinness World Record for being the tallest tower in the world in which the whole structure is capable of rotating 360 degrees.

The Magma Structures logo and some text.
The team were approached by Gerard Dykstra in 2001 to ascertain whether the engineering of a free-standing version of the DynaRig concept could be made to work. After extensive analysis and investigation, the conclusion was that it could be made to work using sensible risk management techniques. The team went on to spend over 90,000 design and development hours on the rig, the fittings, the sails and the sailing system. The fully automated precise control of setting and recovering sails using this system had never been done successfully before.

Today, more than eight years since her launch, Maltese Falcon has sailed more than 100,000 miles and executed more than 10,000 individual sail sets, through storms, gales and calms, raced in many events and transatlantic races, without any failures. Indeed the system has proved so reliable that the vessel is considered to be one of the greenest superyachts afloat, having the capability to rely on sail performance alone, and minimising fuel consumption.
Magma Global designs and manufactures m-pipe®, a high-performance pipe created to meet the challenging demands and applications in the Oil and Gas sector.

Magma Global has developed a unique manufacturing process that produces high-performance carbon/polymer pipes, that offer improved reliability, increased performance, lighter weight and longer life than conventional un-bonded flexible pipe or steel solutions.

The state-of-the-art manufacturing process is fully automated, repetitive robotic manufacturing using compact equipment with a high degree of process control and documentation.

The process has a diameter capability of 2-24” and unlimited wall thickness which can be variable along the pipe and riser length.
Please call Simon Walley,
Business Development Manager,
on +44 (0) 2393 233216 or email
simon.walley@magmastructures.com

For more information about Magma
Structures, please visit our website.

WWW.MAGMASTRUCTURES.COM