DELIVERING THE FUTURE OF COMPOSITE SOLUTIONS

CORE MATERIALS

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INTRODUCTION

Gurit is a technical leader in the development and manufacture of structural core materials. Cores in a sandwich construction are specified by designers and architects to increase stiffness and reduce the weight of a composite structure. Gurit has a range of core materials to fit any specification or manufacturing process. Structural core materials are offered in sheet form and with a variety of cut patterns or finishes, tailored to customer needs or processing choice.

**Gurit® Balsaflex™ END GRAIN BALSA WOOD CORE**

Gurit® Balsaflex™ is the classic end-grain balsa wood core, featuring very high strength to weight ratio and is available in range of densities, thickness and format/finish. Gurit® Balsaflex™ is approved by Germanischer Lloyd (GL) / Det Norske Veritas (DNV).

**Gurit® Corecell™ SAN STRUCTURAL FOAM**

Gurit® Corecell™ is a structural foam core material using a SAN (styrene acrylonitrile) polymer base featuring high toughness and impact resistant characteristics. Gurit® Corecell™ has become widely accepted for the construction of large, high performance structures through a wide range of processing methods.

**Gurit® G-PET™ THERMOPLASTIC FOAM CORE**

Gurit® G-PET™ is a highly adaptable, recyclable, thermoplastic PET (polyethylene-terephthalate) core material with good balance of mechanical properties, temperature resistance, density and cost for a wide range of applications and processes.

**Gurit® Kerdyn™ Green THERMOPLASTIC RECYCLED FOAM CORE**

Gurit® Kerdyn™ Green is a 100% recycled PET content structural foam. Offering a perfect solution for application requiring a good balance of mechanical performance, top-in-class resin uptake performance as well as a more sustainable approach to the light weight composite sandwich solution. With highly adaptable and recyclable capabilities, this thermoplastic PET (polyethylene-terephthalate) core material provides an adequate solution with a wide range of applications and processes.

**Gurit® PVC & Gurit® PVC HT CROSS-LINKED PVC FOAM**

Gurit® PVC is a closed cell, cross-linked PVC (polyvinyl chloride) foam. It provides high strength to weight ratio for all composite applications. Other key features of Gurit® PVC include outstanding chemical resistance, low water absorption and excellent thermal insulation capabilities. The HT option offers high temperature processing up to 140°C.
# Gurit’s Range of Structural Core Materials

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<td>- Recyclable&lt;br&gt;- Cost-effective&lt;br&gt;- Excellent mechanical properties</td>
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<td>Gurit® G-PET™ 60</td>
<td>- Benefits from LTE surface treatment on resin uptake</td>
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<td>Gurit® G-PET™ RR</td>
<td>- Recyclable fire retardant foam for civil applications&lt;br&gt;- Also available with LTE surface treatment</td>
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<tr>
<td>Gurit® Korfin™ Green</td>
<td>- 100% recycled PET content&lt;br&gt;- All-electric bath&lt;br&gt;- Suitable for all demanding applications&lt;br&gt;- Superior strength &amp; stiffness:weight&lt;br&gt;- Outstanding chemical resistance</td>
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<td>Gurit® PVC</td>
<td>- All-purpose foam&lt;br&gt;- Suitable for all sandwich applications&lt;br&gt;- Superior strength &amp; stiffness:weight&lt;br&gt;- Outstanding chemical resistance</td>
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<td>- High temperature processing up to 140°C&lt;br&gt;- Self-Extinguishing</td>
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<tr>
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<td>- Industrial grade structural foam&lt;br&gt;- Compatible with prepreg processing&lt;br&gt;- Superior strength &amp; stiffness:weight&lt;br&gt;- Cost-effective</td>
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<tr>
<td>Gurit® Corecell™ M</td>
<td>- High performance foam, ideal for marine applications&lt;br&gt;- High shear strength and low density&lt;br&gt;- Compatibility with prepreg processing&lt;br&gt;- High elongation for toughness</td>
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<tr>
<td>Gurit® Corecell™ S</td>
<td>- Subsea buoyancy foam</td>
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<tr>
<td>Gurit® Ralflute™</td>
<td>- Classic weight core&lt;br&gt;- Available in typical densities &amp; formats&lt;br&gt;- Very high mechanical properties&lt;br&gt;- Sustainability and biodiversity certified</td>
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## shear
- Strength
- Modulus
- Elongation
- Strength
- Modulus
- Impact resistance
- Fatigue
- Fire
- Smoke & toxicity
- Heat
- Stability
- Hot
- PRU
- Out-gassing
- Water
- Absorption
- Machining
- Formability
- Thermal
- Formability
- Recyclability
- Ve
- Pe
- Ep
- 3rd party certifications

*Please contact your local sales representative for further information on the products.

**Key:**
- Fair
- Good
- Excellent
- Outstanding

**3rd party certifications:**
- Germanischer Lloyd
- ABS
- BV
- DNV
- Lloyd’s
- RINA
- BSS 7239
- FAR 25.853
- ASTM E662
- ASTM E1354
- DNV-GL
- BV
- ABS
- RINA
- Hydrostatic Crush
- ISO 218

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<th>PRODUCT</th>
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**GURIT'S RANGE OF STRUCTURAL CORE MATERIALS**

### Density: 80
- **Short Edge Marking:** Brown/Blue
- **Nominal Density (kg/m³):** 80
- **Half Sheet Size:** 1005/1220 x 1220
- **Nominal Sheet Size:** 1005/1220 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 90
- **Short Edge Marking:** Orange/Blue
- **Nominal Density (kg/m³):** 94
- **Half Sheet Size:** 1005/1220 x 1220
- **Nominal Sheet Size:** 1005/1220 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 110
- **Short Edge Marking:** Blue/Orange
- **Nominal Density (kg/m³):** 114
- **Half Sheet Size:** 1005/1220 x 1220
- **Nominal Sheet Size:** 1005/1220 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 135
- **Short Edge Marking:** Grey/Blue
- **Nominal Density (kg/m³):** 135
- **Half Sheet Size:** 1005/1220 x 1220
- **Nominal Sheet Size:** 1005/1220 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 200
- **Short Edge Marking:** Black/Blue
- **Nominal Density (kg/m³):** 200
- **Half Sheet Size:** 1005/1220 x 1220
- **Nominal Sheet Size:** 1005/1220 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 60 FR
- **Short Edge Marking:** Blue/Blue
- **Nominal Density (kg/m³):** 65
- **Half Sheet Size:** 1005/1220 x 1220
- **Nominal Sheet Size:** 1005/1220 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 75 FR
- **Short Edge Marking:** Blue/Yellow
- **Nominal Density (kg/m³):** 76
- **Half Sheet Size:** 1005/1220 x 1220
- **Nominal Sheet Size:** 1005/1220 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 100 FR
- **Short Edge Marking:** Blue/Green
- **Nominal Density (kg/m³):** 100
- **Half Sheet Size:** 1005/1220 x 1220
- **Nominal Sheet Size:** 1005/1220 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 200 FR
- **Short Edge Marking:** Blue/Black
- **Nominal Density (kg/m³):** 200
- **Half Sheet Size:** 1005/1220 x 1220
- **Nominal Sheet Size:** 1005/1220 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

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**GURIT® G-PET®**

### Density: 30
- **Foam/Colour:** Aqua/Blue
- **Nominal Density (kg/m³):** 40
- **Half Sheet Size:** 1330 x 2850
- **Nominal Sheet Size:** 1330 x 2850
- **Unbonded Thickness:** 3.8
- **Thickness Range:** 1/8 - 3 1/4

### Density: 40
- **Foam/Colour:** Lime/Blue
- **Nominal Density (kg/m³):** 60
- **Half Sheet Size:** 1195 x 2440
- **Nominal Sheet Size:** 1195 x 2440
- **Unbonded Thickness:** 3.8
- **Thickness Range:** 1/8 - 3 1/4

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**Gurit® PVC & Gurit® PVC-HT**

### Density: 80
- **Nominal Density (kg/m³):** 80
- **Half Sheet Size:** 120 x 1220
- **Nominal Sheet Size:** 120 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 100
- **Nominal Density (kg/m³):** 100
- **Half Sheet Size:** 120 x 1220
- **Nominal Sheet Size:** 120 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

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**Gurit® Corrugate™**

### Density: 110
- **Nominal Density (kg/m³):** 110
- **Half Sheet Size:** 120 x 1220
- **Nominal Sheet Size:** 120 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 150
- **Nominal Density (kg/m³):** 150
- **Half Sheet Size:** 120 x 1220
- **Nominal Sheet Size:** 120 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

### Density: 200
- **Nominal Density (kg/m³):** 200
- **Half Sheet Size:** 120 x 1220
- **Nominal Sheet Size:** 120 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

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**Gurit® Kerdyme® Green**

### Density: 100
- **Nominal Density (kg/m³):** 100
- **Half Sheet Size:** 120 x 1220
- **Nominal Sheet Size:** 120 x 2440
- **Unbonded Thickness:** 3.25
- **Thickness Range:** 1/8 - 9 5/8

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**PLEASE NOTE:** Maximum unbonded thicknesses can vary across Gurit sites. Please contact your local sales representative for more information.

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**PLEASE NOTE:** Available in all densities supplied in thickness range 1/8 - 9 5/8 inches (3.25 - 24.4 mm).
\[6\] Gurit® G-PET™ and Gurit® G-PET™ LITE

Recyclable Structural Foam

- Recyclable
- ABS & GL Certified
- High Process Temperature

- Withstands high process temperatures
- Excellent adhesion & mechanical properties
- Excellent chemical resistance
- Recyclable
- Compatible with all types of composite manufacturing techniques
- Now benefits from ‘LITE’ surface treatment technology to reduce resin uptake

INTRODUCTION

Gurit® G-PET™ is a highly adaptable, recyclable, thermoplastic foam with a good balance of mechanical properties, temperature resistance, density and cost for a wide range of applications and production processes. Gurit® G-PET™ is GL approved.

Gurit® G-PET™ can be processed at high temperatures, withstanding exotherms up to 150°C and offers outstanding fatigue properties, chemical resistance, good adhesion and is a highly consistent extruded foam. It is ideal for wind energy, marine, industrial and transportation applications.

Gurit® G-PET™ LITE is a surface treatment available for Gurit® G-PET™ core thicknesses of 15 - 150mm. The treatment significantly reduces panel resin uptake by up to 0.8 - 0.8kg / sqm without reducing adhesion performance.

TYPICAL APPLICATIONS

Gurit® G-PET™ is used extensively in wind turbine blades, civil and marine structures. Gurit® G-PET™ is available in sheet, grooved / perforated forms or kit-cut to customers’ desired shapes. A fire retardant version, Gurit® G-PET™ FR, is also available.

\[7\] Gurit® PVC & Gurit® PVC HT

All-Purpose Foam Core

- Suitable for all composite sandwich applications
- Outstanding chemical resistance
- Superior strength and stiffness to weight ratio
- Excellent thermal insulation capabilities
- Self extinguishing
- High temperature resistance up to 140°C with Gurit® PVC HT

INTRODUCTION

Gurit® PVC is a closed cell, cross-linked PVC foam. It provides superior strength to weight ratio for all composite applications.

Other key features of Gurit® PVC include outstanding chemical resistance, negligible water absorption, and excellent thermal insulation capabilities. It is compatible with most common resin systems including epoxy, polyester and vinyl ester.

Gurit® PVC is available in a wide range of formats with all standard cut patterns and finishes possible.

TYPICAL APPLICATIONS

Gurit® PVC is an all purpose core and can be used in decks, hull sides, bulkheads, floors and wind turbine blade shells.

\[8\] Gurit® Kerdyn™

Green Recycled Structural Foam

- 100% recycled PET content
- Improved mechanical properties
- Recyclable
- Compatible with all types of composite manufacturing techniques

INTRODUCTION

Gurit® Kerdyn™ is a new recyclable, thermoplastic foam with an improved balance of mechanical properties, enhanced resin uptake performance, and good temperature resistance for a wide range of applications and production processes.

TYPICAL APPLICATIONS

Gurit® Kerdyn™ is used extensively in wind turbine blades, civil and marine structures. Gurit® Kerdyn™ is available in plain sheet form and the density range will be extended through 2017. A fire retardant version is also available with certification under review.
**INTRODUCTION**

Gurit® Corecell™ T has been developed as a technological step-change from traditional PVC and Balsa structural core. Gurit® Corecell™ T is an outstanding core material in every application where balsa or cross-linked PVC is commonly used. High mechanical toughness and thermal stability give Gurit® Corecell™ T excellent fatigue characteristics. This reliability makes Gurit® Corecell™ T a natural replacement for cross-linked PVC or balsa in applications where a significant service life is required.

The high temperature stability of Gurit® Corecell™ T also means that it can be used in manufacturing processes to at least 120°C (250°F) with short durations during a cure cycle to over 150°C (300°F). This makes it ideal for use with conventional prepregs and in some liquid infusion processes where high resin exotherms can often be seen. Gurit® Corecell™ T is available in every resin infusion format and is compatible with polyester, epoxide and epoxy resin systems. Low resin absorption characteristics of Gurit® Corecell™ T and unique knife cut formats allow for higher performing infusions, lower resin cost and lower weight than any other structural core.

**TYPICAL APPLICATIONS**

Ideal for applications where loads are less dynamic in nature, such as above the waterline on yachts, on wind turbines and in mass transport.

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**INTRODUCTION**

Gurit® Corecell™ S has been designed specifically for use in sub-sea buoyancy applications. Its resistance to crushing means that it can withstand depths of over 900m, and its closed-cell structure gives it a high water resistance that ensures buoyancy is maintained over time. With its very high compressive strength, Gurit® Corecell™ S can also replace other materials, such as plywood, when creating high strength inserts for through-bolting in composite laminates.

**TYPICAL APPLICATIONS**

Gurit® Corecell™ S has been used in a variety of demanding sub-sea applications from buoys, civil and military submarines as well as highly loaded marine applications units. Gurit® Corecell™ S can be supplied in sheet form or kit-cut out format. This is a Gurit special product.

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**INTRODUCTION**

Gurit® Balsaflex™ is the classic end-grain balsa wood core, featuring very high strength to weight ratio. When an application requires high-strength and stiffness and cost effectiveness, Gurit® Balsaflex™ is a suitable solution due to a good balance between cost, properties and weight. Gurit® Balsaflex™ is available in a range of densities, thicknesses, formats and finishes. Gurit® Balsaflex™ is GL approved.

**TYPICAL APPLICATIONS**

Gurit® Balsaflex™ is used for wind turbine blades and nacelles, marine, automotive, truck, rail and aircraft parts. Gurit® Balsaflex™ can be supplied in sheet form or kit-cut out to customer’s desired shapes.
**INTRODUCTION**
Gurit standard product forms are described in the following tables toward faster response. Gurit can also tailor sheets to your own specification depending on lead-time and volume - please call to discuss your requirements.

**PL** – Plain Sheet – Optimum material properties. Limited bending in-mould.

**PH** – Plain with Bleeder Holes – Assists air release in vacuum bag processes.

**CUTS FOR CONFORMABILITY (FOAM)**
Gurit double-cut finish is standard for Gurit® Corecell™ and Gurit® G-PET™ and can be also considered for Gurit® PVC. Alternatives single-cut or the less common triple-cut can also be performed. Please be advised that cuts are dependent upon the density and thickness of the material. Higher density and thickness materials may need to be saw cut (0.9/1mm), rather than knife cut (0.5mm) although the spacing will be constant.

Knife cuts are not visible when the sheets lie flat and these narrow knife-cuts minimise overall resin consumption compared to saw-cut core finishes. Maximum sheet size is half of a full-size sheet. Please contact your customer support representative for more information.

**SC** – Single Cut – Provides flexibility in a single direction on one or both sides of a sheet. If done on both sides, the cuts intersect so no bleeder holes are necessary for vacuum bagging. Max sheet size is half of a full-size sheet.

**DC** – Double Cut – Provides flexibility in two directions on one or both sides of the sheet. If Double Cut on both sides, the intersecting cuts make DC a highly effective resin infusion medium. The cuts are not visible when the sheets lie flat and these narrow knife-cuts minimise unnecessary resin accumulations compared to sawn core materials.

**CS** – Contour Scrim – provides optimum flexibility in two directions. Sheets are cut in squares and bonded to a glass scrim. Available on sheets up to 25mm (0.98") thick (dependent on density). Maximum standard sheet size is half of the full sheet.

**SURFACE GROOVES FOR INFUSION (FOAM)**

**VIC** – Vacuum Infusion Core – There are several VIC options and Gurit can customize grooving patterns and bleeder holes as required. For curved laminate sections, double-sided DC is very effective system for resin infusion with low weight gain. Heat-forming VIC surface cut also useful for obtaining curved panels with minimal resin uptake.

Combination – Combinations of these aforementioned formats are also available.

**PRODUCT FORMATS (BALSA)**

Gurit® Balsaflex™ is available plain or with typical formats including perforations, grooves, contour scrim and with optional coating.

**OTHER PRODUCT FORMATS**
Fillet strips – Triangular edge strips to create tapered panel edge drop-offs, or stringer base fillets.

**FINISHING**
Complete Core Solutions

**FINISHING CONT’D**
Complete Core Solutions

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<tr>
<th>DETAILS</th>
<th>GURIT® CORECELL™</th>
<th>GURIT® G-PET™/ GURIT® KERDYN™ GREEN</th>
<th>GURIT® PVC / PVCCELL™</th>
<th>GURIT® BALSAFLEX™</th>
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<td></td>
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<tr>
<td><strong>PH</strong></td>
<td>Spacing = 50 x 50mm Dia. = 1.6/2mm (with 25 x 25 option)</td>
<td>Spacing = 20 x 20mm Dia. = 2mm (with 40 x 40 option)</td>
<td>Spacing = 25.4 x 25.4mm Dia. = 3mm (with 50.8 x 50.8 option)</td>
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<tr>
<td><strong>CS</strong></td>
<td>Spacing = 30 x 30mm Width = Knife &lt;0.5mm / Saw 0.9/1mm</td>
<td>Spacing = 20 x 20mm Depth = 2mm</td>
<td>Spacing = 19 x 19mm Width = 2mm Depth = 2mm</td>
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<tr>
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For details regarding the maximum window of capabilities related to core type, thickness and density, please contact your local Sales Team: www.gurit.com/contact.aspx

**KITTING**
Complete Core Solutions

**INTRODUCTION**
Gurit has an extensive kitting capability to provide all the Gurit® Corecell™ formats in customised, numbered, ready to use, CNC machined kits. Gurit can make comprehensive kits using either full customer drawings or their B² SmartPac software solution. All types of core can be supplied and machined including Gurit® Corecell™ (SAN), Gurit® PVC, Gurit® G-PET™ and Gurit® Balsaflex™.

Gurit use either 5-Axis, or 3-Axis CNC machines along with a range of semi-automatic and manual machines to provide the optimum kitting solution depending upon kit complexity. Gurit has developed specific knowledge and experience on the correct flute and clearance angles to provide optimum cutting conditions. This allows for quick cutting to minimise cost, accurate cutting for component dimensions and fine cutting to allow the best nesting routines so maximising yield rates and minimising waste.

Gurit’s machining strategy for core is to develop a range of cutting techniques that provide a cost-effective and flexible kitting solution to satisfy customer requirements.
Gurit’s heritage lies in engineering high-performance yachts such as Americas Cup, Open 60’s and Volvo 70’s. However, over the past 30 or so years, Gurit has been involved with almost every type of marine craft including military power boats, production cruisers, and some of the world’s most spectacular superyachts. Whilst Gurit is most widely recognised for its marine expertise, the team has considerable experience in the provision of innovative engineering solutions to many different structures.

The range of projects worked on covers any large composite structural application and includes:

- Raceboats
- Wind turbines
- Civil Engineering
- Superyachts
- Underwater turbines
- Architectural features

To show how different core materials are considered in industry, some of the challenges that designers face for superyachts and wind energy turbine blades are discussed below.

### SUPERYACHT DESIGN

#### Hulls

Hulls

The hull and deck shells of a boat provide the watertight safety cell for the crew and also the foundation to support the rig and keel. The amount of pressure from the water that the hull of a yacht has to sustain varies along the length of the boat and also from the bottom to the sheerline. Classification societies adopt a quasi-static analysis, which defines a hydrostatic pressure distribution. The hull bottom panels see higher pressure than the topside panels because they are submersed deeper in the water. The pressure distribution also decreases from the bow to the stern due to decreasing exposure to waves.

**To avoid print through if hull topside has a dark colour finish**

**Slamming loading is recognised by most classification societies by giving credit for cores with a higher shear elongation**

**Thermoformability or adequate cut pattern is required to fit pronounced curvature**

#### Decks

As superyacht length increases, boats get sleeker and the fore and aft bending stiffness becomes an increasing challenge, putting decks under increased compressive loads.

For smaller size boats, deck stiffening tapes are added over the full width of the deck. The critical failure mode is likely to be Euler Buckling (Fig. 1 & 2). As boat size increases, the most common solution is to concentrate the deck tapes at the edges of the panel. This changes the critical failure mode from Euler Buckling of the overall side deck panel to shear crimping in way of the concentrated tapes (Fig. 3).

**Skin wrinkling**

Core provides insufficient out-of-plane support to skins allowing local, independent buckling. Occurs on panels subjected to high compressive strains, independently of panel width.

**Shear crimping**

Core shear modulus is too low to transfer loads between outer laminate skins. Occurs on panels subjected to high compressive loads, independently of panel width.

**Panel buckling**

The panel has insufficient bending stiffness to prevent buckling. Occurs on wide flat panels subjected to high compressive load (Euler buckling), or on deep panels subjected to high shear load (Shear buckling).

**Impact resistance**

Core toughness and resistance to cracking is too low to absorb high energy slamming loads. Occurs in core materials with low shear elongation.

**Shear failure**

Core shear strength is too low to carry shear stress. Occurs on panels subjected to high bending loads.

**Sandwich panel engineering theory**

Single skin laminates, made from glass, carbon, aramid, or other fibers may be strong, but they can lack stiffness due to their relatively low thickness. Traditionally the stiffness of these panels has been increased by the addition of multiple frames and stiffeners, adding weight and construction complexity.

A sandwich structure consists of two high strength skins separated by a core material. Inserting a core into the laminate is a way of increasing its thickness without incurring the weight penalty that comes from adding extra laminate layers. In effect the core acts like the web in an I-beam, where the web provides the lightweight "separator" between the load-bearing flanges. In an I-beam the flanges carry the main tensile and compressive loads and so the web can be relatively lightweight. Core materials in a sandwich structure are similarly low in weight compared to the materials in the skin laminates.

Engineering theory shows that the failure mode of the sandwich panel can be linked to specific properties of the core material used.

<table>
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<tr>
<th>Skin wrinkling</th>
<th>Shear crimping</th>
<th>Panel buckling</th>
<th>Impact resistance</th>
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<td>Compressive modulus</td>
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**Sandwich panel engineering diagram**

- Skin wrinkling
  - Core provides insufficient out-of-plane support to skins allowing local, independent buckling. Occurs on panels subjected to high compressive strains, independently of panel width.
- Shear crimping
  - Core shear modulus is too low to transfer loads between outer laminate skins. Occurs on panels subjected to high compressive loads, independently of panel width.
- Panel buckling
  - The panel has insufficient bending stiffness to prevent buckling. Occurs on wide flat panels subjected to high compressive load (Euler buckling), or on deep panels subjected to high shear load (Shear buckling).
- Impact resistance
  - Core toughness and resistance to cracking is too low to absorb high energy slamming loads. Occurs in core materials with low shear elongation.
- Shear failure
  - Core shear strength is too low to carry shear stress. Occurs on panels subjected to high bending loads.

**Particle board sandwich panels**

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- Thermoformability or adequate cut pattern is required to fit pronounced curvature

**Structural engineering with core materials**

- Raceboats
- Wind turbines
- Civil Engineering
- Superyachts
- Underwater turbines
- Architectural features

To show how different core materials are considered in industry, some of the challenges that designers face for superyachts and wind energy turbine blades are discussed below.
Material solutions developed by Gurit for manufacturers of wind turbine blades have continuously contributed to the increasing efficiency of wind power installations. This progress is most visible when looking at the increase of a typical blade size from 23m to over 80m+. The growing dimensions create enormous challenges for wind turbine blade manufacturers as the longest blades today weigh in excess of 20 tons each. New materials solutions were needed to keep the weight of the blades as light as possible, yet maximising their strength, stiffness and durability.

Wind Energy Turbine Blades

The blade shells are manufactured using sandwich structures due to the large panel size and the requirement for good bending stiffness at the lowest design weight. As the main requirement of the shell panels is to resist deformation under aerodynamic loading, the core’s primary function is to provide stability (resistance to buckling of the load carrying laminate) under compressive, shear and out of plane loading. Three types of buckling failure mode can be considered:

- **Euler buckling:** Panel bending stiffness failure - dependent on thickness and shear modulus of the core
- **Skin wrinkling:** Local skin deformation - dependent on the shear and tensile modulus of the core and the skin thickness of the laminate
- **Shear crimping:** Core failure - Shear modulus is too low to transfer the loads between the skins and especially relevant for thicker skin laminates

When you consider the design of the structural shell for a wind blade the loading profile of the shell changes considerably from the root to the tip and furthermore the blade geometry places further constraints on possible laminate configurations. Therefore, the requirements for the core properties change along a shell structure. Due to the high loads in the root section the laminate thickness is high and therefore shear crimping becomes a driving design criterion. Therefore, balsa is widely used in these areas due to its very high shear modulus. Further outboard along the blade the loads are lower but the strains become higher and the failure of the core is more likely to be due to skin wrinkling or panel (Euler) buckling. For this area of a blade the thickness of the sandwich structure has much more influence to resist these failure modes and therefore a core with lower shear modulus can be used. It is also desirable to reduce weight of the panel the further you move away from the root area due to the increased bending moment. Therefore, core density and resin uptake is a key consideration.

The most common cores used for wind blade manufacture are PVC followed by SAN foam as they have good properties for their density and are relatively competitive with respect to their cost. They also have significantly lower resin uptake characteristics than Balsa and have higher strain capability which is useful for the transport and handling of blades after manufacture and before service life begins. PET has also made some progress and is now extensively used in blade design, but it does have a weight disadvantage over PVC and SAN cores and can be too brittle for blade lifting points.
TECHNICAL INFORMATION

For more detailed information on core materials, as well as the complete Gurit product portfolio, please visit: www.gurit.com to view the following:

- Product Data Sheets
- Corporate Videos
- News / Case Studies
- Composite Guides
- Events Schedules
- Representatives Contact Details
- Product Brochures

For pricing or other enquiries, please contact gurit@gurit.com