

earth

COLLECTION

composite materials



 **LimbTex**
PROSTHETIC & ORTHOTIC
earth
COLLECTION

FIRST EDITION

LimbTex

and our earth collection

LimbTex Ltd is a specialised independent manufacturer and distributor of materials to the Prosthetic and Orthotic industries. With over 40 years combined technical knowledge and experience we have a very good understanding of what is required and can offer an educated guide on how to achieve it.

Our **earth collection** has been especially developed for the Prosthetic and Orthotic industries to truly offer usable, natural and bio-based alternatives without compromising on quality or strength. Traditionally, laminated prosthetic and orthotic devices are manufactured from many different reinforcing materials which mostly have an acrylic matrix (methyl methacrylate based). Although these resins are good they have many disadvantages i.e. low structural strength, strong solvent odour, hazardous, flammable and irritating. The hardener (organic peroxide), is a combusive and produces CMR products (carcinogenic, mutagenic and reproductive).

Our **earth collection** of eco based materials are less hazardous than those traditionally used, better for the environment, easier and cleaner to work with as well as being cost effective. The collection consists of natural and bio sourced composite materials which are sustainable and have low environmental impact. The natural fibres provide excellent mechanical properties and are comparable with currently used fibres but with the added benefits of less health hazards, less irritating, nontoxic and non-carcinogenic.

We have been developing this range in conjunction with Sarl COP in France and have just completed extensive testing. This testing was carried out at their local University and also in the UK at the University of Leicester and Intertek UK (an independent test house). Sarl COP have been developing engineering polymers for over 25 years. Over the last 5 years of R&D and patent registrations in responsible and sustainable chemistry they have been awarded the 2014 and 2015 ARTINOV awards for its research into non dangerous and green polymers.

earth collection materials

FLAX FIBRE BRAID & TAPES



Flax is a natural fibre that is revolutionizing the world of composites materials. It offers great natural shock absorbing properties never yet attained by any other conventional fibres such as Carbon or Glass fibre. Our specially developed Flax materials besides being environmentally friendly and 100% renewable, make it possible to produce a light and highly resistant composite device.

- No health hazards: non-irritating, non-allergic, VOC Free.
- Good mechanical properties: similar to Glass fibre
- Lighter weight compared to other composite offerings.
- Great shock-absorbing properties: filters vibration and impact.
- Natural resource, renewable and biodegradable.
- Very low environmental impact

Available in Braids and Unidirectional Tape

Code	Description	Weight g/m
FFB130/5	130mm Ø +/- 45° Flax Fibre Braid, 5m Roll	130
FFB150/5	150mm Ø +/- 45° Flax Fibre Braid, 5m Roll	203
FFB225/5	225mm Ø +/- 45° Flax Fibre Braid, 5m Roll	271
Code	Description	Weight g/m
FFT50	50mm Wide Uni-Directional Flax Fibre Tape, 50m Roll	15.65

Flax & Orthopoxy® has proved to exceed traditional stockinette materials and Carbon & Acrylic samples for ultimate flexural and tensile strengths.

Flax & Orthopoxy® show improved comfort due to the natural shock absorbance and vibration damping never before obtained from traditional composites, Flax also provides greater heat regulation properties that are not obtained with traditional composites.

BASALT FIBRE BRAID, TAPE AND CLOTH

LimbTex Basalt is made from superior Basalt fibres derived from volcanic rock making it an eco-friendly and natural material. Specially developed for the industry this material can be used for complete sockets or local reinforcement. By offering a similar surface finish to Carbon fibre it could also be used for a decorative finish.

- Safer and cleaner to use than other composites
- Little to no skin irritation from dust or loose fibres.
- Mechanical properties between, Carbon and Glass fibre makes it a useful and interesting alternative.
- Easier and cleaner to machine than Glass, Carbon and Aramid fibres
- Compatible with all resins but performs best with Orthopoxy®
- Non-toxic and non-carcinogenic.
- Lower Rated PPE required to Carbon Fibre (P1 Dust Mask not P3)
- Excellent strength and durability as well as being lightweight



Available in Braids, Unidirectional Tape and 2/2 Twill Cloth

Code	Description	Weight g/m
BFB130/5	130mm Ø +/- 45° Basalt Fibre Braid, 5m Roll	244
BFB150/5	150mm Ø +/- 45° Basalt Fibre Braid, 5m Roll	488
BFB225/5	225mm Ø +/- 45° Basalt Fibre Braid, 5m Roll	661
Code	Description	Weight g/m
BFT50	50mm Wide Uni-Directional Basalt Fibre Tape, 50m Roll	27.65
Code	Description	Weight g/m
BFC	Basalt Fibre Cloth 200g/m² ,1270 x 790mm Sheet	211g

Basalt Braids & Orthopoxy® require 3 times the amount of force to break under flexion compared to Carbon & Acrylic. It also required well over double the amount of force to break samples under tension. The UD flexural strength again proved to be superior over Carbon Acrylic.
N.B. Graphs in the Testing section show Basalt & Orthopoxy® exceeded carbon when being pulled apart and bent to destruction.

BASALT FIBRE & LUREX® BRAIDS



This is a decorative structural material made from Basalt fibres braided with bright and shiny Lurex® film. It can be used to create both inside and outside socket finishes. The braids have been developed to give a consistent diamond pattern which keep their shine once laminated giving a pleasingly different look. It is recommended to use a backing layer of either standard Basalt braid or NYLONBLK to keep the Lurex® defined.

Code	Description	Weight g/m
BFBSL130/5	130mm Ø +/- 45°Basalt Fibre & Lurex® Braid, 5m Roll	185
BFBSL150/5	150mm Ø +/- 45°Basalt Fibre & Lurex® Braid, 5m Roll	370
BFBSL225/5	225mm Ø +/- 45°Basalt Fibre & Lurex® Braid, 5m Roll	461

Available in Braids only



HYBRID FLAX & BASALT FIBRE BRAIDS & TAPES



In addition to the Flax and Basalt reinforcements the Flax & Basalt Hybrid range offers the benefits of both materials combined in one. This allows even more customisation possibilities for your device achieving rigidity and flexibility where you require it.

Code	Description	Weight g/m
FBFB130/5	130mm Ø +/- 45° Flax and Basalt Fibre Braid, 5m Roll	190
FBFB150/5	150mm Ø +/- 45° Flax and Basalt Fibre Braid, 5m Roll	265
FBFB225/5	225mm Ø +/- 45° Flax and Basalt Fibre Braid, 5m Roll	441
Code	Description	Weight g/m
FBFT50	50mm Wide Flax and Basalt Fibre Tape, 50m Roll	22.05

Available in Braids and Unidirectional Tape



Hybrid Flax & Basalt has proved to exceed traditional stockinette materials, as well as Carbon & Acrylic samples for flexural and tensile strengths. When comparing the same types of materials in combination with Orthopoxy® resin it's possible to achieve similar results but create a thinner, lighter lamination with less fibre volume.

PIGMENTING

It is not possible to directly pigment the earth braids, but if this is required LimbTex natural cotton stockinette can be used on the inner and outer surfaces which will accept the pigments.

Available in Stockinettes

Code	Description
NCOTTON6	6 cm Natural Cotton Stockinette, 1 Kg Roll
NCOTTON8	8 cm Natural Cotton Stockinette, 1 Kg Roll
NCOTTON10	10 cm Natural Cotton Stockinette, 1 Kg Roll
NCOTTON12	12 cm Natural Cotton Stockinette, 1 Kg Roll
NCOTTON15	15 cm Natural Cotton Stockinette, 1 Kg Roll
NCOTTON20	20 cm Natural Cotton Stockinette, 1 Kg Roll



ORTHOPOXY®



**BPA
FREE**

BPA is an endocrine disruptor that can interfere with our hormones, causing harmful effects even at very low doses: infertility, cancer, diabetes, obesity, etc. Compared to acrylic resin, there is less danger and it uses less oil to produce it.

Orthopoxy® is a patented new generation resin system for the manufacture of Prosthetic and Orthotic devices. It consists of Biosourced epoxy/acrylic resins which are Bisphenol A (BPA) - free. These resins have been designed to impregnate our Basalt and Flax fibres but will also work with traditional fibres.

Orthopoxy® Fast: Designed with a fast working time and for the manufacture of Prosthetic Sockets. **Working time = 35 mins.**

Orthopoxy® Slow: Designed with a slow working time and for manufacture of Orthotic devices or large Prosthetic devices. **Working time = 90 mins**

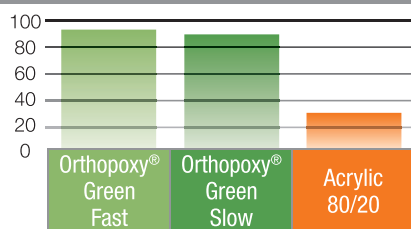
For the optimal mechanical properties once the resin is set, the device must be post cured at 100°C for 1hr.

There are many benefits for the user of this resin system:

- Structural
- More rigid
- Less fragile
- Can be slightly heat adjusted
- Low, non-aggressive odour
- Less resin & materials used when laminating
- Non-flammable
- Non-carcinogenic
- Contains up to 36 % bio sourced components
- Lower level PPE required (Nitrile Gloves)

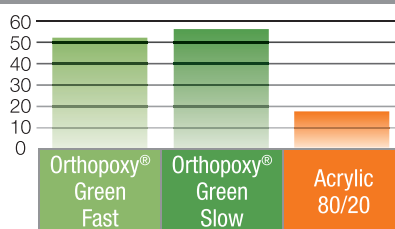


FLEXURAL STRENGTH



Tensile Strength (Mpa)	94.6	88.6	35.4
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TENSILE STRENGTH



Tensile Strength (Mpa)	52	56	19.4
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ORTHOPOXY® VS ACRYLIC 80/20

	Orthopoxy® Fast	Orthopoxy® Slow	Acrylic 80/20
Glass Transition Temperature °C	73	68	70
Final Hardness ShD	86	85	85

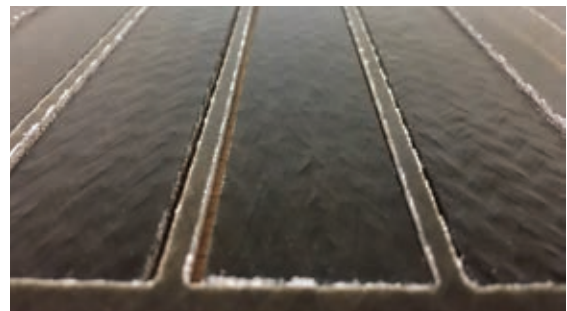
Code	Description FAST	Working Time
EPOX-FD03	Orthopoxy® Green Fast Epoxy Hardener 2 x 1Kg	35 Mins
EPOX-FR03	Orthopoxy® Green Fast Epoxy Resin 5Kg	35 Mins
Code	Description SLOW	Working Time
EPOX-SD03	Orthopoxy® Green Slow Epoxy Hardener 2 x 1Kg	90 Mins
EPOX-SR03	Orthopoxy® Green Slow Epoxy Resin 5Kg	90 Mins

Orthopoxy® The tensile and flexural strengths of both the fast and slow versions exceed the traditional Acrylic 80/20 by over double and this is before reinforcement materials are introduced into the matrix.

Testing of the earth collection vs Traditional Composites

TEST SAMPLES

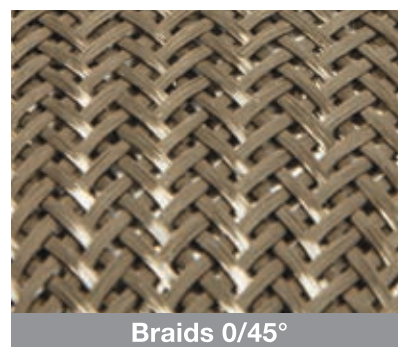
Sample sheets, representing the materials in application were manufactured with Braids placed $\pm 45^\circ$ and UD Tapes $\pm 90^\circ$. These were manufactured to give a realistic representation of the variance in wall thickness of prosthetic sockets. Once manufactured they were left to cure for 1 ½ hours at an ambient room temperature of 15°C after which they were post cured in an oven at 100°C for 1 hour. The actual test pieces were cut from these sheets with a waterjet cutter to the required dimensions in accordance ATSM standards. There were 5 samples of each material for each test, the results can be seen on the following graphs.



Orientation of fibres in direction of force during the testing

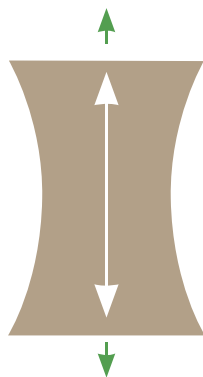


UD Tape 0/90°



Braids 0/45°

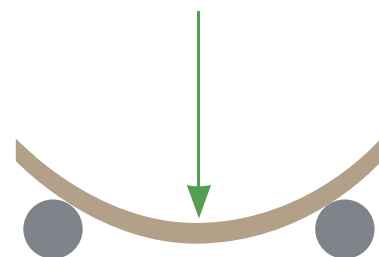
MECHANICAL TESTS



TENSILE TESTING (Pulled Apart)

Tensile testing is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The ultimate tensile strength is the material's ability to resist breaking under tension.

Carried out in accordance with ASTM D3039-14 with a mean average of 5 test samples per set



FLEXURAL TESTING (Bend strength)

Flexural strength, also known as modulus of rupture is a material property defined as the stress in a material just before it yields in a flexural test. Flexural strength is the materials ability to resist deformation under load.

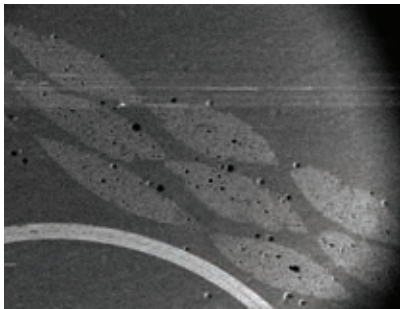
Tested in accordance with ASTM D790-10 with a mean average of 5 test samples per set

Scanning Electron Microscopy and Micro CT X-ray Tests - Data & Results

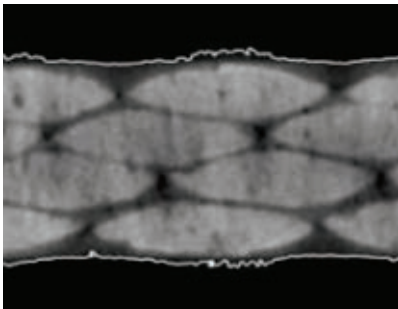
Sample sets of both traditional and **earth collection** materials were given to the University of Leicester who used a Scanning Electron Microscopy and Micro CT X-ray to view the degree of resin penetration and adhesion.

SCANNING ELECTRON MICROSCOPY AND MICRO CT X-RAY RESULTS

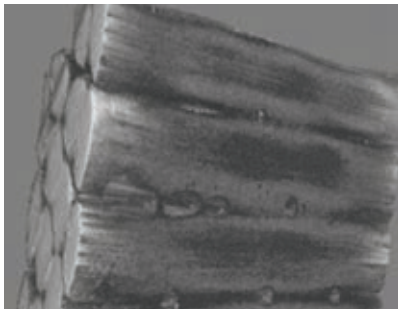
The results showed that both traditional and **earth collection** materials had good penetration and adhesion around the fibres. The examination of materials also provided us with low resolution images from micro CT X-ray and 3D reconstructions where we can see the individual fibres surrounded by the resin.



Electron Microscopy x 50



X-Ray of Fibres x 50



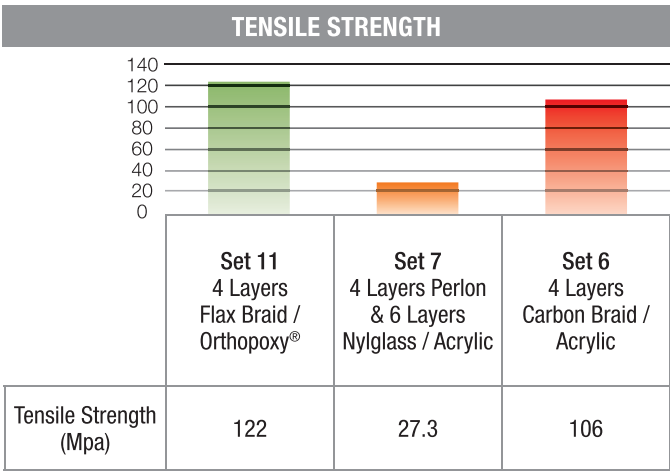
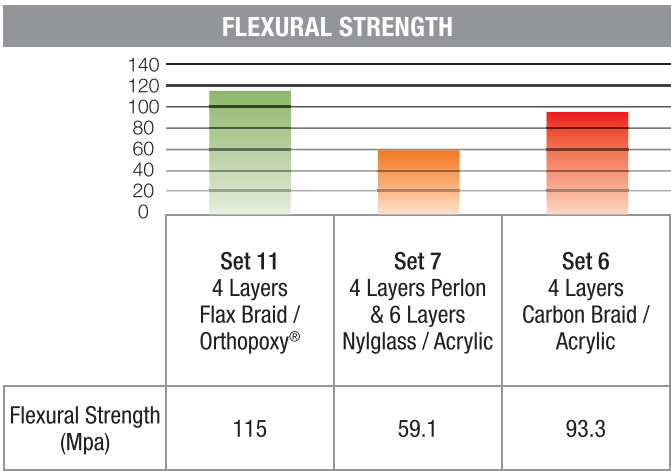
3D Reconstruction of the individual fibres

KEY:

- **earth collection**
- **Mixed Traditional & earth collection**
- **Traditional Materials**

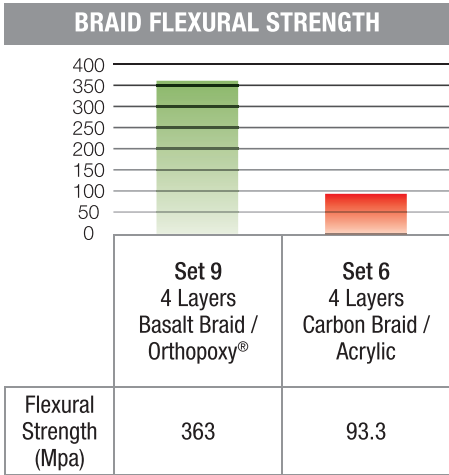
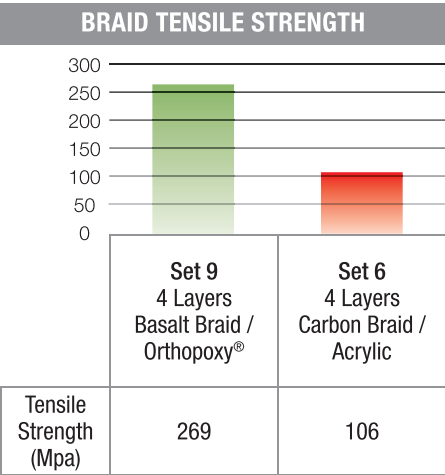
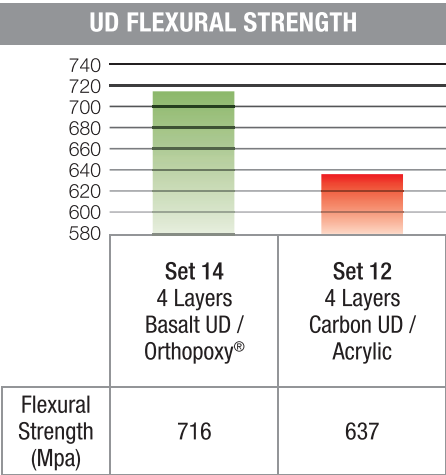
The results and data provided throughout the **earth collection**, have been collated from data obtained from Sarl COP-Chimie, The University of Leicester and Intertek UK.

FLAX WITH ORTHOPOXY® RESIN vs TRADITIONAL MATERIALS & ACRYLIC RESIN

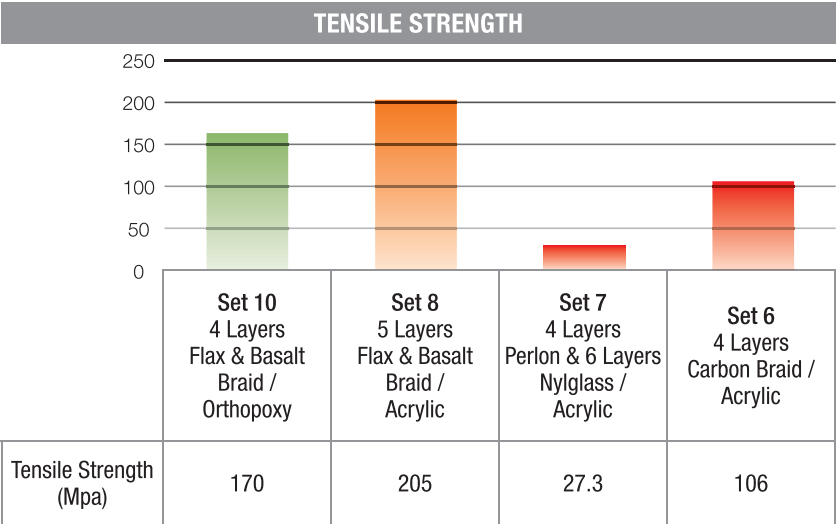
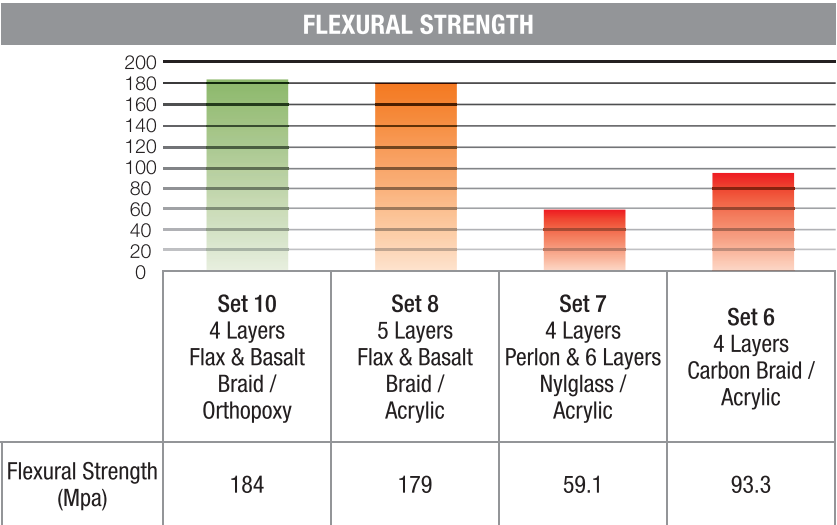


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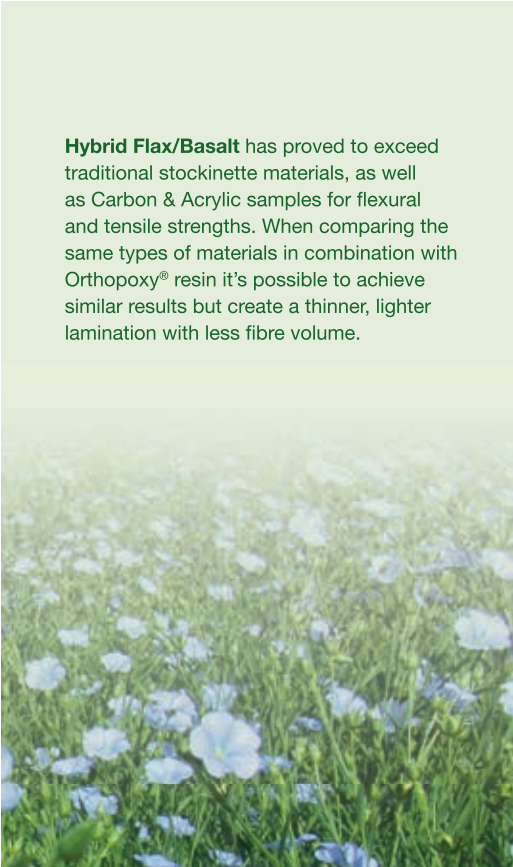
BASALT WITH ORTHOPOXY® RESIN vs CARBON & ACRYLIC RESIN



HYBRID FLAX/BASALT WITH ORTHOPOXY® RESIN vs HYBRID FLAX/BASALT WITH ACRYLIC RESIN vs TRADITIONAL MATERIALS & ACRYLIC RESIN



Basalt Braids & Orthopoxy® require 3 times the amount of force to break under flexion compared to Carbon & Acrylic. It also required well over double the amount of force to break samples under tension. The UD flexural strength again proved to be superior over Carbon Acrylic.



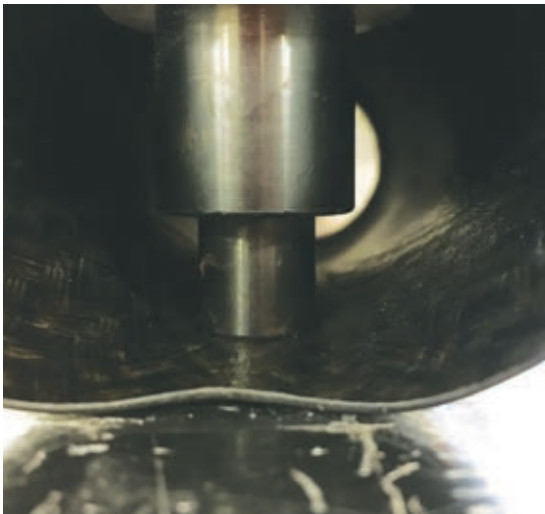
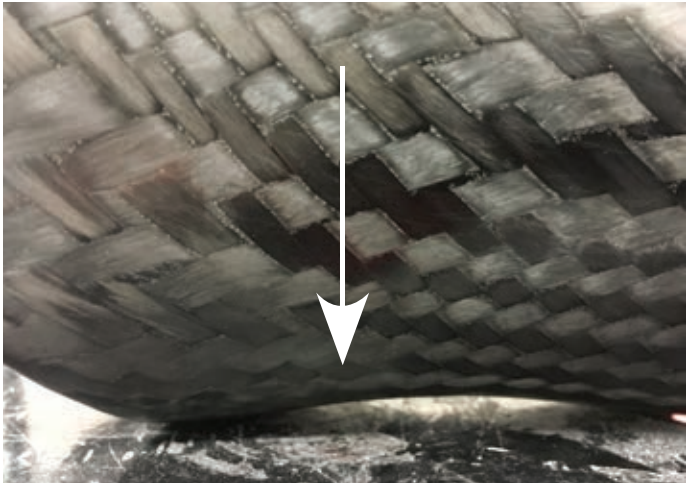
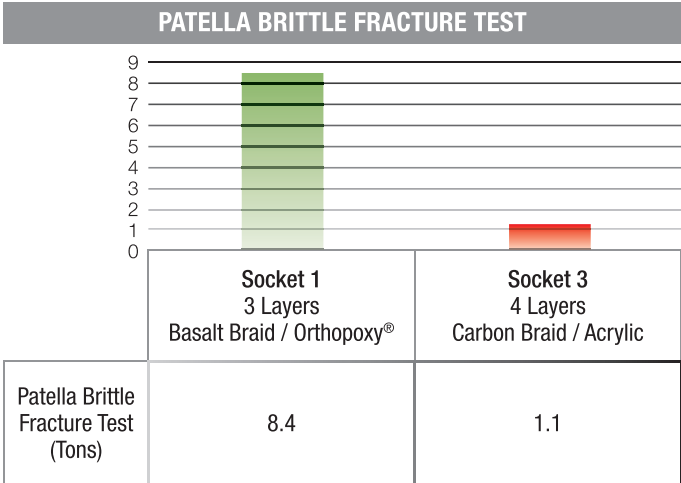
Kneeling Test

BASALT WITH ORTHOPOXY® RESIN vs CARBON WITH ACRYLIC RESIN

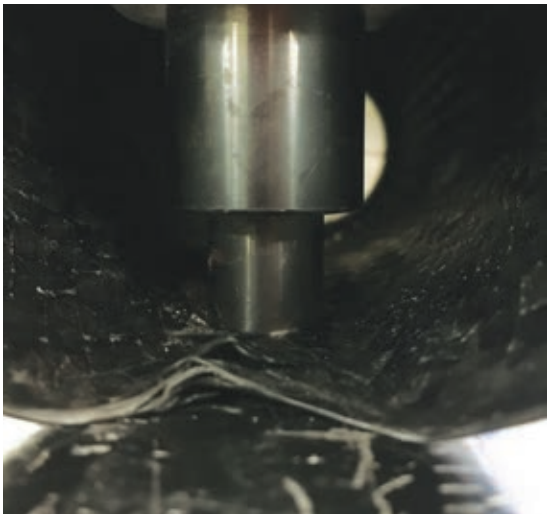
A basic experiment was conducted to show how the flexibility of the **Orthopoxy®** resin could offer a practical benefit to prosthetic limb wearers. It is a very common problem to have trim lines cracking especially when the wearer of a device kneels on a hard floor. Sample sockets were manufactured and then clamped into a press and subjected to a measured downward force on the patella area replicating kneeling on the socket. The goal was to measure the force required to crack the socket.

It can be seen from the results below that the **Basalt & Orthopoxy®** resin exceeded the Carbon & Acrylic resin sample tested by nearly 8 times and still did not break on the trim-lines.

It was determined that wearers with problem sockets when kneeling would benefit from using **Basalt with Orthopoxy®** resin.



BASALT & ORTHPOXY > 8 TON



CARBON & ACRYLIC > 1 TON



Selection Guide

LimbTex can now provide comparison data to enable an accurate selection of **earth collection** materials when comparing them to traditional materials for socket prescriptions and builds.

THE earth collection vs TRADITIONAL COMPOSITES

Traditional materials & Acrylic resin	=	earth collection materials & Orthopoxy® resin	Uses & Areas
Perlon (Single)	=	Natural Cotton (Single)	Finishing Layer, Pigmented Laminates.
Perlon (Double)	=	Flax Braid (Single)	Light, Structural Braid or Flax Finishing Layer.
Perlon (2 Double) + Nylglass (3 Double)	=	Flax Braid (2 Double)	Light, Structural Braid or Flax Finishing Layer.
Glass Fibre Braid	=	Flax Braid	Light, Structural Braid or Flax Finishing Layer.
Glass Fibre Matting	=	Hybrid Flax & Basalt UD Tapes	Damping and Structural Tape, filters vibration and shock, adds thickness and rigidity distally.
Glass and Carbon Fibre Braid	=	Hybrid Flax & Basalt Braid	Medium, Structural Braid or Hybrid Flax & Basalt Finishing Layer.
Carbon Fibre 12K Braid	=	Basalt Braids	Heavy, Structural Braid or Basalt Finishing Layer.
Carbon Fibre 12K UD Tapes	=	Basalt UD Tapes	Local Reinforcement Tapes, Over & under adaptors distally.
Carbon Fibre 2/2 Twill	=	Basalt 2/2 Twill	Local Reinforcement or Finishing Layer

Disclaimer:

LimbTex Ltd, provides all manufacturing and lay up recommendations in good faith as technical guidelines. It is the responsibility of the clinicians and technicians to ensure the lay-up of materials, amounts used and manufacturing process are of sound quality and have been prescribed in accordance to patient's weight, activity level and componentry. LimbTex Ltd bases all guidelines on research and development and can provide training and advice but cannot take responsibility for individual devices manufactured as LimbTex Ltd holds no patient data and cannot guarantee its customer's individual manufacturing quality and competencies.

Workshop and Training

LimbTex can offer practical training for small groups in our new purpose built workshop or on site in your workshop. The workshop is to promote manufacturing techniques whilst using the highest quality materials to create prosthetic and orthotic devices.

TRAINING WILL COVER:

- Introduction to the materials and their development.
- Mechanical testing and performance.
- Material selection and comparisons to traditional builds.
- Manufacture of Trans-Tibial socket.
- Curing and finishing process

THE earth collection STARTER KIT

The starter comes complete with everything you need to get started to manufacture your first **earth collection** sockets using a cleaner safer choice of materials. There is enough material depending on builds to manufacture 4 or 5 Trans-Tibial sockets with a variety of materials and finishes.

CONTAINS:

1.4Kg **Orthopoxy®** Resin Fast Kit

- 2.5m of Basalt130 Braid
- 2.5m of Flax130 Braid
- 2.5m of Basalt/Flax130 Braid
- 2m of Basalt UD Tape
- 2m of Flax UD Tape
- 2m of Flax and Basalt/Flax UD Tape
- ½ Sqm Basalt Cloth
- 2m 10cm Natural Cotton
- 1 x Non Abrasive Pads
- Laminating Roller
- Petroleum Jelly
- 3 x Wet and Dry Sheet



call **+44 (0) 116 2785440** or visit **www.limbtex.com**



LimbTex®
PROSTHETIC & ORTHOTIC



materials for health

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