New Reinforcement Fiber for FRC/TRC systems. Basalt Fiber

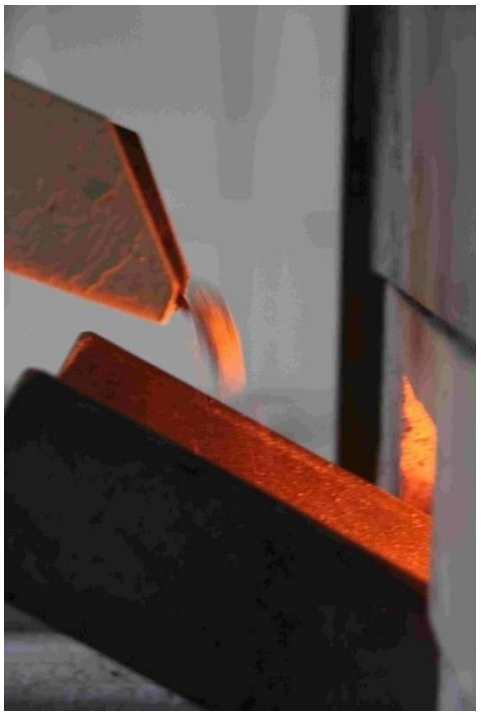
BPG LTD May, 2009

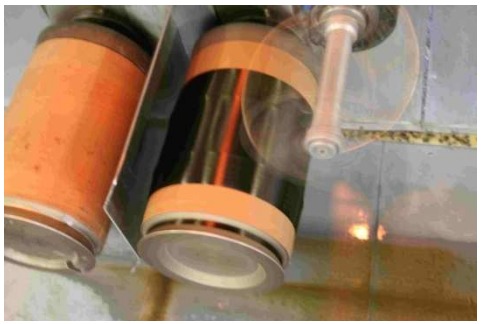
In 1989 we started technological development.

In 1998 BPG LTD received first product of basalt textile fiber.

In 2003 we got the international patent on our own technology.

In 2008 basalt fiber production was started in our daughter company in Germany (DBF GmbH)





In AR-glass the alkali resistance is the key factor in the thread formation process that is encouraged by the heavy metal oxides. The 15% consistence of ZrO_2 determines AR-glass good qualities in concrete reinforcement process. High consistence of iron oxides (12÷14%) in basalt mineral also provides basalt fiber's excellent reinforcement parameters for concrete.

Quantity of heavy metal oxides calculated on thousand SiO_2 molecules in fiber's molecular structure.

Oxides	E-glass	AR-glass	Basalt fiber
Al_2O_3	140	2	78
Fe_2O_3	1.5	0.42	162
ZrO_2	-	161	-
Total	**141.5**	**162.42**	**240**

This means that during formation of AR-glass on the fiber surface ZrO_2 is concentrated, and during the same process on the basalt fiber surface Fe_2O_3 is concentrated. These heavy metal oxides increase alkali resistance of mineral fibers.

By the thermal extension coefficient basalt fiber is very close to concrete parameters than conventional reinforcements – steel and AR-glass. Mineral fiber (basalt fiber) according to its parameters is most compatible amongst concrete reinforcement materials.

Steel	**13**	**$m/m^0K \times 10^{-6}$**
AR-glass	**2**	**$m/m^0K \times 10^{-6}$**
Basalt fiber	**8**	**$m/m^0K \times 10^{-6}$**
Concrete	**10**	**$m/m^0K \times 10^{-6}$**

Concrete density (max 2.5 g/cm^3) is very close to the basalt fiber parameter (max 2.8 g/cm^3) and compared to organic and carbon fibers, basalt fiber has advantage especially in application of concrete seamless floors, where in general are used the various type of chopped fibers to protect the concrete surface from cracks. In this case it is important to note, that chopped basalt fiber for it's higher density distribute evenly in the whole concrete volume while organic fibers concentrate on the surface of the concrete for their low density.

Concrete	**–**	**2.2 ÷ 2.5 g/cm^3**
Basalt	**–**	**2.5 ÷ 2.8 g/cm^3**
AR-glass	**–**	**2.5 ÷ 2.6 g/cm^3**
Carbon	**–**	**1.6 ÷ 2.1 g/cm^3**

Compared to E-module of glass fiber and low elongation coefficient of organic fibers, basalt fiber remain one of the best reinforcement

materials in concrete application especially in the TRC systems.

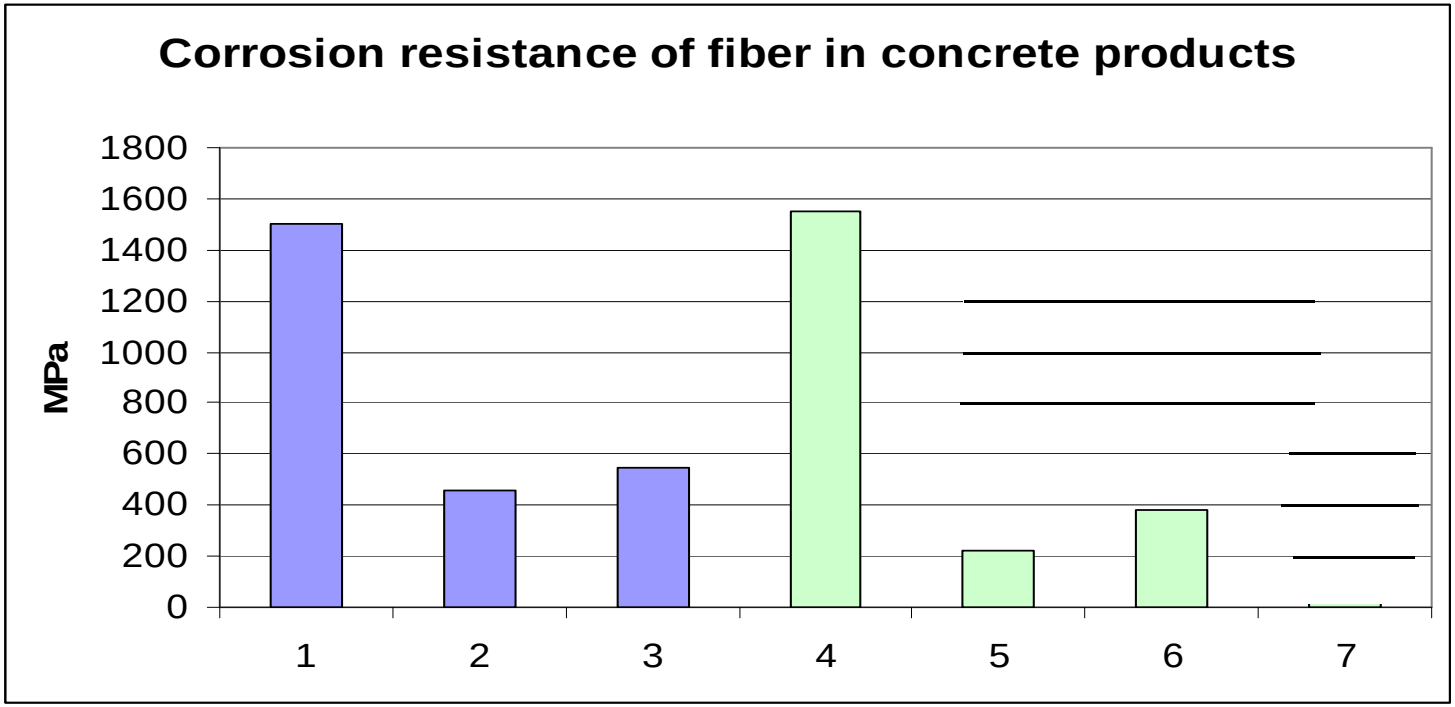
	AR-glass	Basalt
E-module (MPa)	77000	89000

	Basalt	**AR-glass**	**Polypropylene**	**Polyester**	**Polyamide**
Elongation (%)	3.15	4.7	10 – 15	8 – 20	15

Compared to steel, organic and carbon fibers, Basalt fiber's low thermal conductivity coefficient is the main advantage in thin concrete products with wide surface and in TRC systems for reinforcement. Compare to thermal conductivity basalt fiber has this parameter better than AR-glass.

Description	Thermal conductivity (W/mK)
Concrete	0.17 ÷ 2.33
Basalt	1.1
AR-glass	1.3
Carbon	67

From 2002 in company laboratory the researches were held according to the EN 14649 standard's methodology. Results of research showed that basalt fiber produced on ordinary silan sizing kept the same hardness in the concrete made from puzzolan cement as AR-glass produced with special sizing.



1 AR-glass 15 μm; 550 tex, unprocessed in concrete

2 AR-glass in concrete from Portland cement 5 year aging

3 AR-glass in concrete puzzolan cement 5 year aging

4 Basalt fiber 12 μm; 600 tex, unprocessed in concrete

5 Basalt fiber in concrete from Portland cement 5 year aging

6 Basalt fiber in concrete from puzzolan cement 5 year aging

Note: Basalt fiber has ordinary silan sizing different from AR-glass fiber.

Basalt fiber advantages toward the other concrete reinforcement fibers:

- Basalt fiber is most close to the concrete by the thermal extension parameter;
- According to the specific weight basalt fiber is much compatible with concrete than other concrete reinforcement fibers;
- Comparing with the AR-glass basalt fiber has high E-module;
- Basalt fiber has better elongation coefficient, than any concrete reinforcement fibers;
- Basalt fiber has most low thermal conductivity coefficient amongst the concrete reinforcement fibers;
- Comparing with the AR-glass basalt fiber has equal characteristics of stability in concrete;
- Basalt fiber is cheapest in price than AR-glass, because the basalt fiber is the mineral with high consistence of metal oxides.

Comparative table of various characteristics of fibers that are used in concrete works for earthquake resistance

	E-modulus GPa	Adhesion in Matrix	Acid resistance in concrete	Price €/kg
Carbon Fiber	160 ÷ 830	Poor to good	Excellent	> 25
Basalt Fiber	90 ÷ 110	Excellent	good	4.5 ÷ 5.0
AR-glass	72 ÷ 73	Excellent	good	9 ÷ 10

Basalt-Carbon multiaxial textile fabrics' hybrid combination provides incomparable effect in concrete for earthquake resistance.

- There is no need to apply different type of textile fabrics;
- Balanced E- modulus on the entire surface of the detail;
- Best adhesion with concrete;
- Best acid resistance;
- Best price for consumer.

Basalt Fiber Application for Plastics Reinforcement.

Plastics reinforced with Basalt-Carbon hybrid textile fabrics less prone to over heating than plastics reinforced with pure carbon textile fabrics.

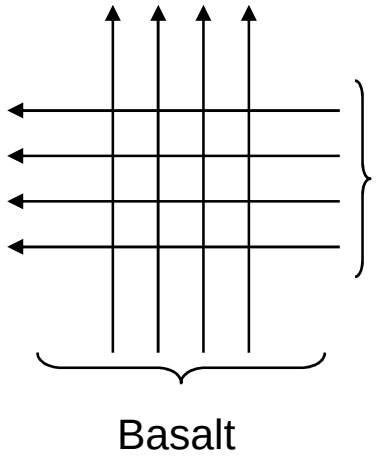
	E-modulus [GPa]	Thermal Conductivity [W/m.K]
Carbon Fiber	160÷830	5÷185
Basalt Fiber	90÷110	1.3÷1.6

The negative effect from comparatively low E-modulus of Basalt fiber is neutralized by the asymmetric weaving in multiaxial fabrics, when the impacts are balanced on the entire area of the fabric.

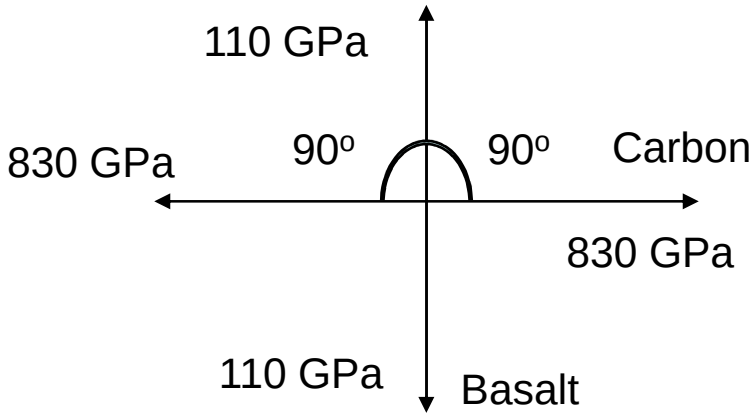
This is the example of effective combination of basalt fiber with carbon fiber, also it will have the same effect in other variations.

Schematic depiction of strength distribution according to the fiber's E-modulus in various type of textile fabrics

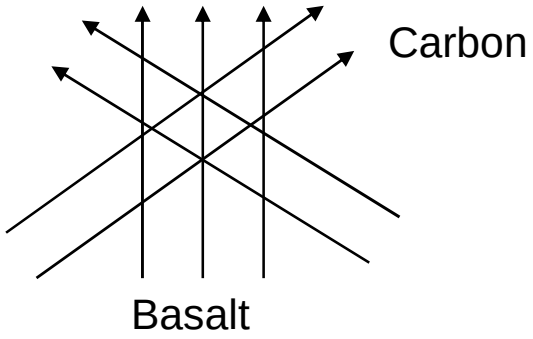
Plain Weaving



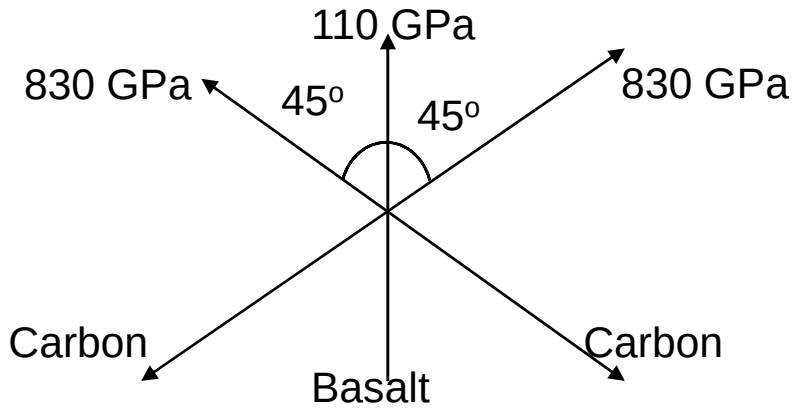
Strength distribution in Fabrics



Multiaxial Weaving



Strength distribution in Fabrics



Applications, where BPG's products are successfully used.

EDAG light car composite.
This model was built by basalt fiber and was presented on the Motor Show hall 2, stand 2158, in 4th of March 2009 in Geneva, Switzerland.
Source: http://www.edag-light-car.com/index_en.html#/news

Car Brakes

Bag Filters for industrial sector

We hope that our presentation of new mineral fiber – basalt textile fiber will help producers to propose new application at market of reinforced plastics.

To the presented perspective of basalt fiber application in concrete reinforcement, could be added new reinforcement material with the same characteristics in plastics, especially in the hybrid textiles for reinforcement.

Hybrid textiles give opportunity to preserve all good characteristics of fibers in finish plastics and suggest to consumer best quality in acceptable price.

Thank you for your kind attention.

More detailed information is available on the www.bpg.ge