Research and Development Profile at Institut für Textil- und Bekleidungstechnik der Technischen Universität Dresden

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Abstract:

The paper presents an overview about the important R&D projects at ITB. Following topics will be explained:

- *development of textile preforms for composites (textile reinforced plastics, reinforcement of concrete and timber)*
- *textile structures for mechanical body and equipment protection (crash, ballistic, cut, stab)*
- *development of insulation materials (heat, cold and sound protection)*
- *evaluating and development of micro-biological barrier textiles for surgical protective clothing.*

The paper demonstrates main fields for the european future of textiles: technical textiles of highest performance, highest quality, unique and in consequence for the best competition position.

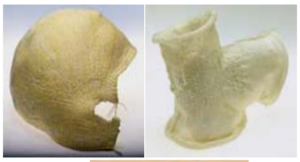
Keywords: technical textiles, composites, protective textiles, insulation materials, barrier textiles

1 Development of Textile Preforms for Composites

Multi-Layer Weft Knits

Initial Situation:

- Flat knitting machines for manufacturing of knitted sets
  - Near net shape
  - Fully-fashioned
- High deformability provided by mesh structure

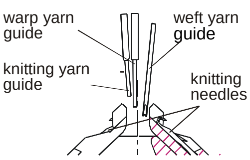


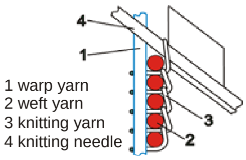
Goal/Verification:

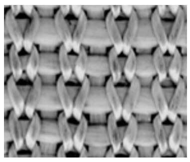
- Integration of straight reinforcement threads
  - Uni-, bi-, multiaxial orientation
  - in n-Layers
- Maintaining the unique 2D- and 3D-shaping possibilities
- Use of high-performance fibres also as knitting yarns
- Utilisation of outstanding drapability

Pictures: Fa. Stoll

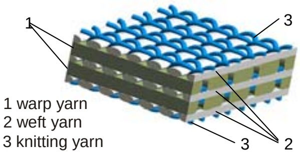
Patented Principle

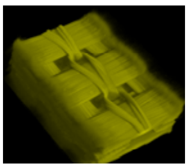






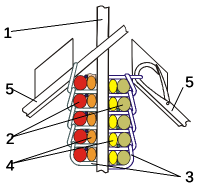
- Working area of a flat knitting machine for manufacturing multi-layer weft knitted fabrics in 2-layers as well as cross-sectional and top-view of a reinforced weft knitted structure.





- 5-layer biaxial reinforced weft knitted fabric (schematic and real structure in the composite)

Laboratory Flat Knitting Machine for Multi-Axial Reinforced Weft Knits



1: warp yarns
2: weft yarns
3: knitting yarns
4: bias yarns
5: latch needles

- 5-layer multi-axial weft knit, cross-section

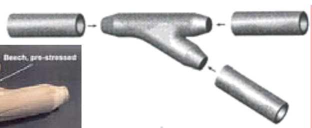
- Multi-axial weft knit with exposed yarn layers

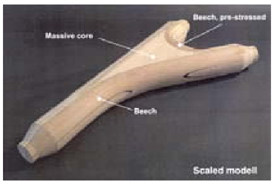
Flat Knitted 3D-Preforms with Different Design Characteristics

Structures for Wood-Textile Composites

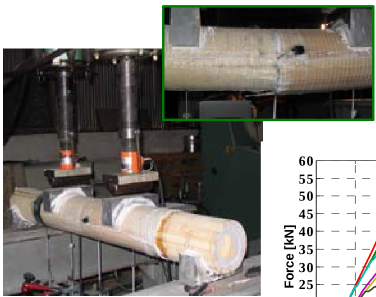
Motivation

- Development of 3-D reinforced weft knitted fabrics with optimal combination of the structural elements (stitch, float, tuck)
- Using of these fabrics as stretched weft knitted fabrics for the reinforcement of wood-textile composites
- Development of 3-D reinforced weft knitted fabrics with the insertion of high-performance yarns in weft or warp direction

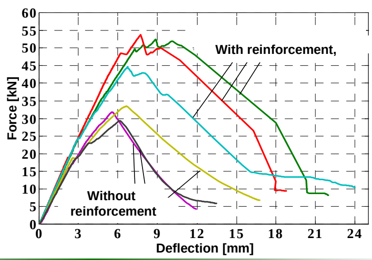




Deflection Test and Advantages



- **Reinforcement in y-direction without any additional equipment**
- **Very big diameters are possible**
- **Length is limited only by the needle bed width**
- **Reinforcement yarns are connected without any structural element like stitch or tuck, so that the integration of very thick yarns is possible**



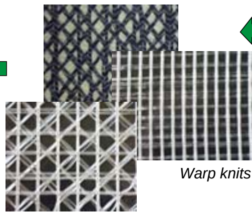
Multi-Layer Warp-Knits

High performance filament yarn

Warp-knitting machine

Restoration

New components



Warp knits

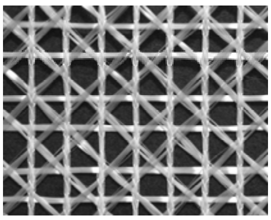
Advantages of textile reinforced concrete:

- Optimal adjustment of the reinforcement
- Flexible in appli-cation and handling
- Good bond
- No corrosion
- Extremely small dimensions
- Extremely thin-walled reinforce-ment layers

Production of Textile Renforcement Structures

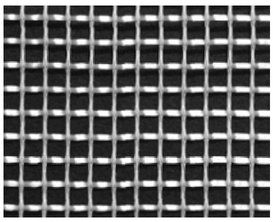
Examples of textile reinforcement structures

- Fibre materials oriented in the direction of loading
- Open faced structures (depending on the grain-size of the concrete matrix)



Multi-axial reinforced warp knit

- Fibre materials orientated in up to four different directions



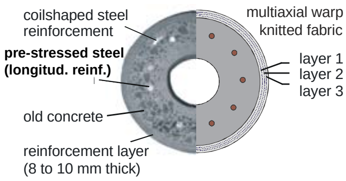
Biaxial reinforced warp knit

- Minimal damage to the yarns (parallel weft in line with the stitch courses; warp in line of wale direction)

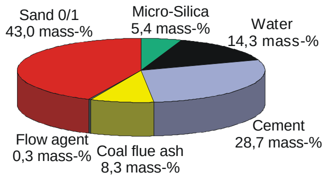
Reinforcement of Concrete Masts

The demonstrated strengthening offers an economical restoration possibility of long-term preservation of existing building structures.

- Multi-axial textile fabric can bear all longitudinal forces without any force deflection
- Shotcrete with a maximum grain size of about 1 mm



Schematic diagram of an restored concrete mast cross-section



Fine grade concrete matrix (CEM III) bending strength 5 N/mm², compression strength 75 to 80 N/mm² after 28 days of curing

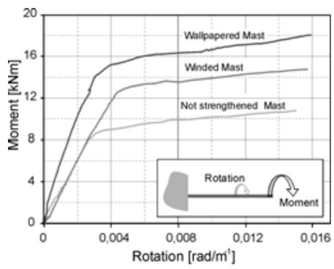
funded by the Working Community Industrial Research Association (AiF)

Reinforcement of Concrete Masts

Torsion Tests

- Determined on 2 m long reinforced concrete masts
- Increase of torsional load capacity of approx. 60%

Torsion test setup



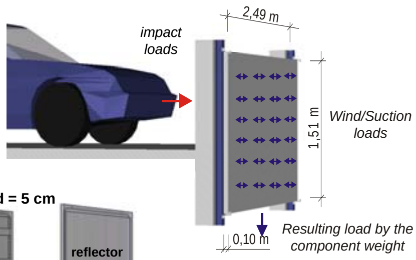
Results of torsion tests

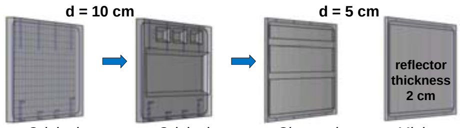
Textile Reinforced Concrete Balustrade-Element

Project Aim

funded by the Working Community Industrial Research Association (AiF)

- Reduction of the element dimensions and element weight
- Improved conditions for transportation and installation
- Mounting parts can remain unchanged
- Integration of protection against collision (impact)
- Variable surface formation





Original element	*Original mounting parts*	*Changed mounting*	*Minimum volume*
V* = 0,38 m³	**V = 0,24 m³**	**V = 0,13 m³**	**V = 0,09 m³**

Two-third reduction of the component volume compared to the original

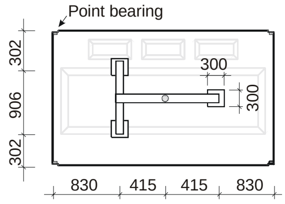
** V= volume*

Multi-Layer-Warp-Knits for Concrete Reinforcement

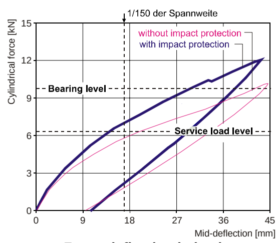
Textile Reinforced Concrete Balustrade-Element

Testing of the bearing capacity

- Large-sized prefabricated concrete units can be reinforced satisfactorily with
- Textile structures for a adequate reinforcement value
- Weight reduction of about 67 % compared to conventional used balustrade elements
- Improved transportation and mounting conditions
- Bearing capacity and serviceability proved



3-point bending test



Force-deflection behaviour

Budapest Polytechnic Jubilee Conference, 4th of September 2004

2 Textile Structures for Mechanical Body and Equipment Protection

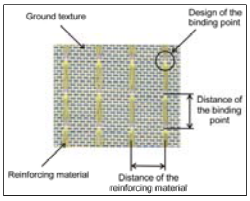
Cut and Stab Resistant Textiles

Motivation

- Higher human body, equipment and environmental protection
- Working safety, accident prevention
- Vandalism, terrorism

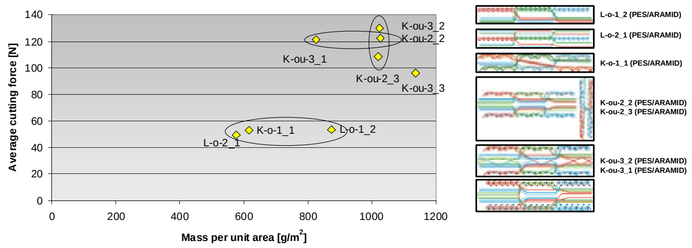
Technological Solutions

- By using special yarns and weave constructions without the use of stainless steel
- Manufacturing of the woven fabrics for the examinations of the cutting behavior have been carried out according to the following scheme:
  - Changing of the binding point distance
  - Changing of the reinforcing material distance



Determination of Cutting Force

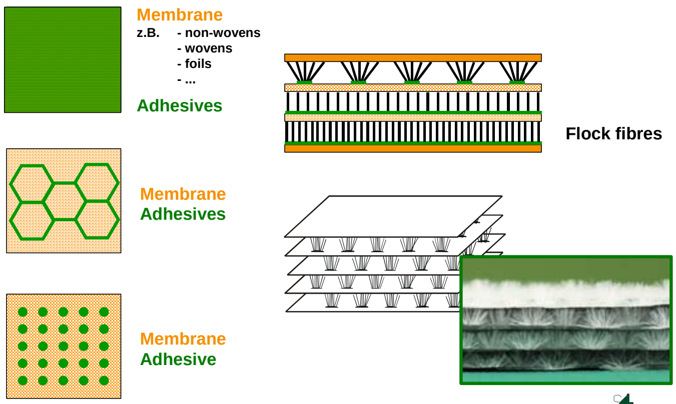
Relation between cut resistance and weight per unit area



- No direct correlation between the cutting force of the multi-layer fabrics and their area weight
- Generally, an increased area weight leads to a higher cutting force
- For economic reasons an optimum must be found between the cutting force and the required area weight of the reinforced structures.

3 Development of Insulation Materials

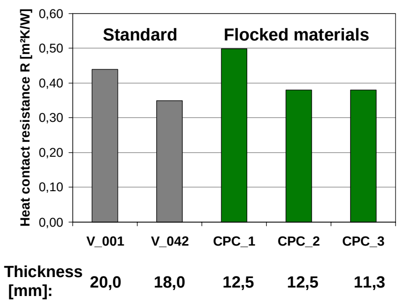
Development of Textile Multi-Layer Flock Structures for Thermal Insulation Materials



Cold Protective Clothing

Structure

- Layer-forming membrane: silver coated PA-woven with PES non-woven
- Fibres: 3 mm length, 22 dtex fineness



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4 Evaluating and Development of Micro-Biological Barrier Textiles for Surgical Protective Clothing

Microbiological Barrier Textiles for Surgical Protective Clothing

Aims and Motivation

Determining the resistance of surgical gowns to the

- Penetration of liquids and
- Transmission of particle by

Praxis relevant penetration method

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Search the reason of the transmission by

- Optical structure analysis

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Recommendation to the manufacturing of improved barrier fabric

The optical analysis method

Contour tracing

Determination of relative frequency of pore area:

- Definition of size of pore
- Classification of marking colour:

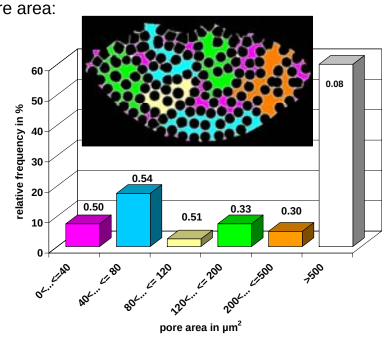
Pore area (µm²)	Pore area (µm²)
0 <...≤ 40	120 <...≤ 200
40 <...≤ 80	200 <...≤ 550
80 <...≤ 120	> 500

- Definition of form factor f:

$$f = \frac{4\,\pi\,F}{U^2}$$

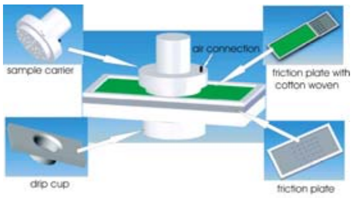
F ... area [µm²]
U ... perimeter [µm]

f = 1 circle
f = 0,87 square
f ≈ 0 long stretched pore

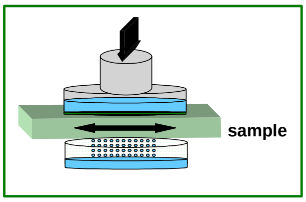


Test Arrangement of Penetration

- **Modification of abrasion test device**



- **Determination of penetration rate**



$$P = \frac{n_{filtrate}}{n_{total}}$$

P … penetration rate
n … mass of liquid

- **Test conditions**

Liquid	Quantitity of liquid [ml]	Pressure [kN/m²]	Time [s]
Artifical blood	20	90	120
Florecense microspheres (4 µm)	20	90	120