



***KARL MAYER***

**The Karl Mayer Guide  
to Technical Textiles**



Contents	Page
Introduction	4
Basic constructions	9
Three-dimensional structures	13
Directionally oriented structures	18
Composite fabrics	26
Stitch-bonded nonwovens	31

Please note: Warp knitting machines are divided in two categories: tricot machines and Raschel machines. In most cases Raschel machines are used for the production of technical textiles.

Stitch-bonding machines are regarded as a special form of warp knitting machines, especially suited for the manufacture of technical textiles, nonwovens and composites.

# Introduction

The production of technical textiles is a rapidly developing trade in textile industry. New end-uses are developed daily and in most cases technical textile structures are used to replace expensive, heavier or technically inferior constructions traditionally produced from other materials. To achieve the objective of a favourable performance/cost ratio, the structures and production methods must be carefully designed.

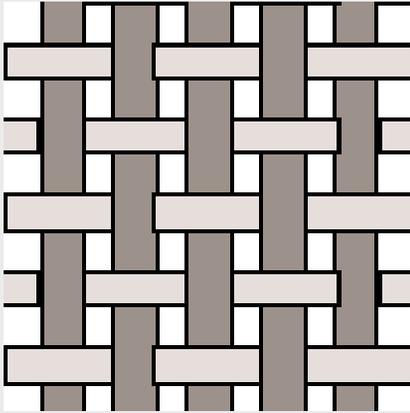
Warp knitting is by far the most versatile fabric production system in textiles. Warp knitted fabrics can be produced elastic or stable, with an open or closed structure; they can be produced flat, tubular or three-dimensional. Fabric width can be over 6 m without seams or even up to a multiple of this width if it is a net construction.

The new concept of fabric engineering was conceived during the evolution of technical textiles as a natural development of the trial and error methods. The commercially available fabrics failed in many cases to satisfy the specifications set by the producer and the designers and textile engineers were called upon to create entirely new structures. The properties in this case have to be „built-in“ or applied to specific areas of the fabric at the correct orientation so as to withstand expected forces while maintaining economical production cost.

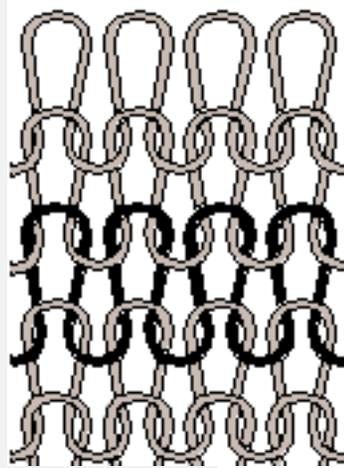
The flexibility of warp knitting techniques makes them attractive both to the designer and to the manufacturer of technical textiles. This guide is designed to make the reader conversant with warp knitting technology, to demonstrate the basic structural configurations available, and to show only a few of the multitude of end-uses actually associated with it.

The major yarn to fabric conversion systems are illustrated on the next page. Woven and weft knitted structures are well known due to their seniority in the history of mankind and their common use in apparel industry. Warp knitting techniques, dating back only a couple of centuries, are virtually unknown to the textile consumer and the products are frequently mistaken for woven or weft knitted ones. The loop structure of warp knitted fabrics is similar in appearance to that of weft knitted structures. The mechanical properties are in many cases similar to those of a woven cloth and even better for certain applications.

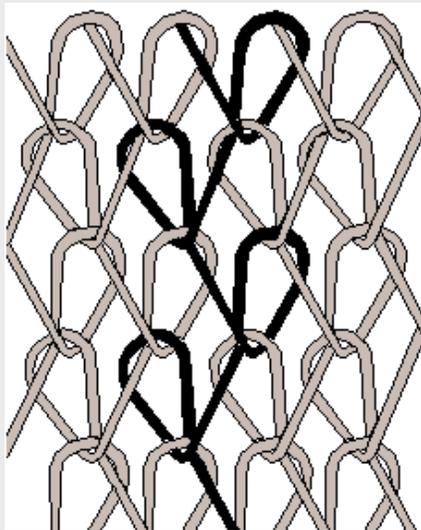
## Conventional textile structures



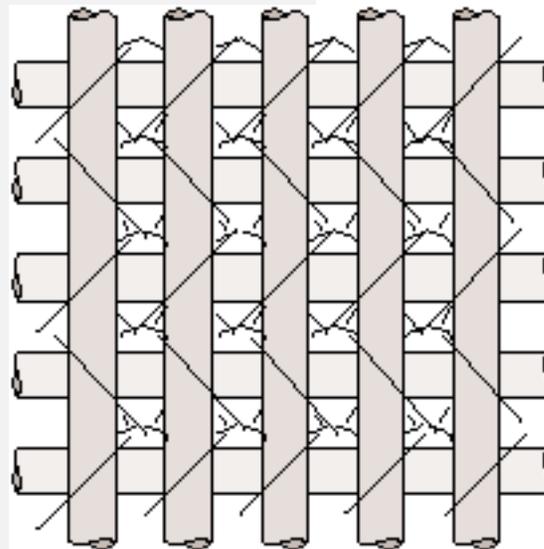
Woven fabric structure



Knitted fabric (flat or circular knitted)



Warp knitted fabric



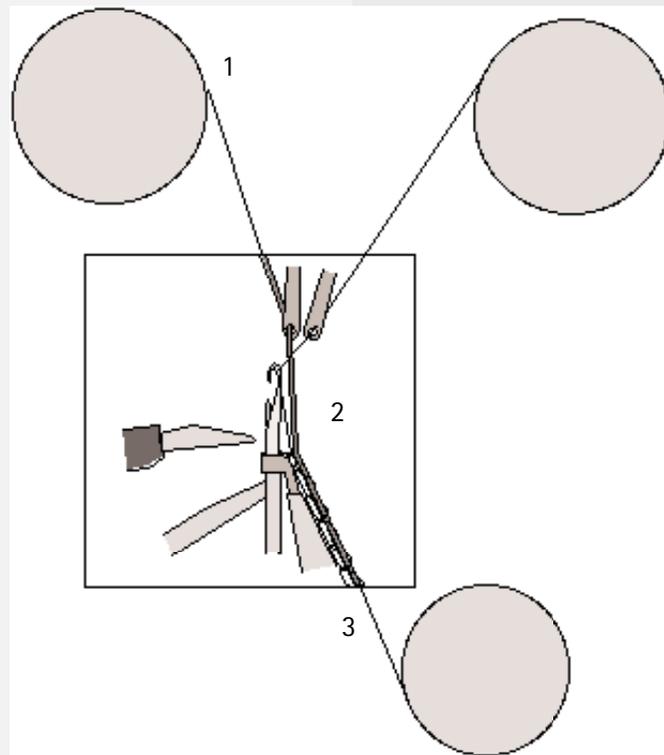
Bi-axial orientated structure

### Some technical terms of warp knitted structures

- 1 - A warp-knitted loop
- 2 - A stitch course - a horizontal row of loops produced during one knitting cycle.
- 3 - A wale - a vertical row of loops produced by a single needle.

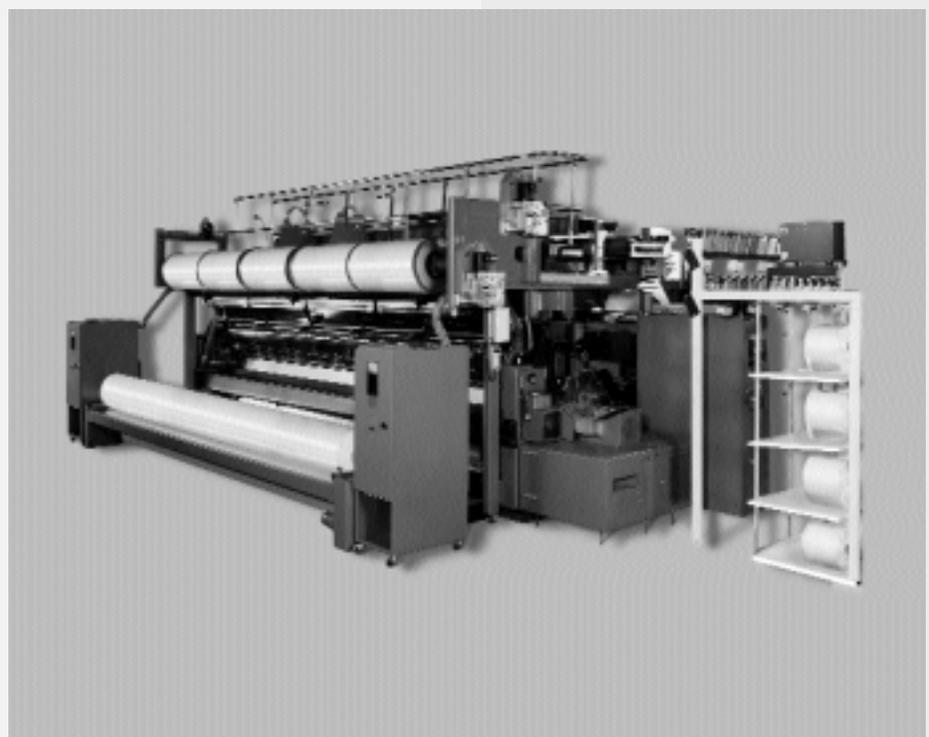
- 4 - An underlap - a straight length of yarn connecting the loops produced during consecutive knitting cycles.
- 5 - Left side (technical back) - the fabric side illustrated. The underlap is on the surface.
- 6 - Right side (technical face) - the fabric side with the loops showing on the surface.

The basic construction of a warp knitting machine is similar to that of a weaving machine, especially in the yarn supply system from warp beams (1) and the fabric batching via the take-up (3). The fabric is produced, however, by intermeshing loops in the knitting elements (2) rather than interlacing warps and wefts as in a weaving machine.



Features of a typical warp knitting machine in standard configuration (RS series):

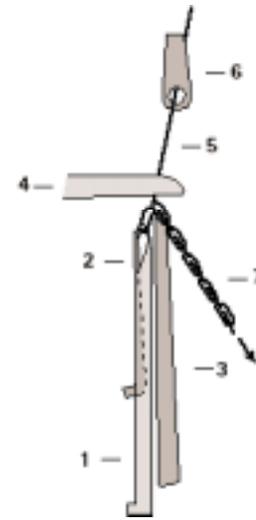
- sturdy construction
- up to 6 guide bars (6 warp-beam unwinding points) for flexibility of structures, end product, and fabric design
- up to 40 needles per inch for open or very dense structures
- up to 6.60 m working width
- up to 2,000 courses per minute



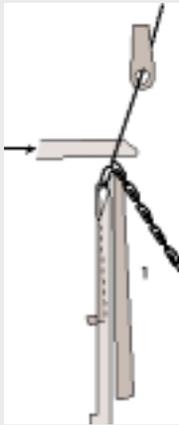
## The fabric producing elements of a warp knitting machine

- 1 - Compound needle - The needles are assembled in a rigid needle bar and move simultaneously.
- 2 - Slide (closing element) - The elements to close the needle hooks are placed in a rigid bar and operate simultaneously.
- 3 - Knock-over bar

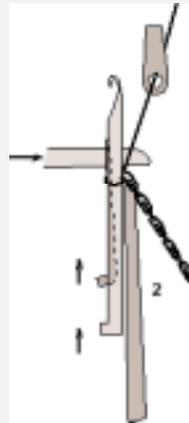
- 4 - Holding-down sinker - The sinkers are assembled in a rigid sinker bar and act simultaneously.
- 5 - Yarn end - The yarn ends are usually fed off a warp beam.
- 6 - Yarn guides - The yarn guides - also called guide needles - are also simultaneously operated. One or several yarn guides are assigned to each needle.
- 7 - Warp-knitted fabric



## The mechanism of loop formation



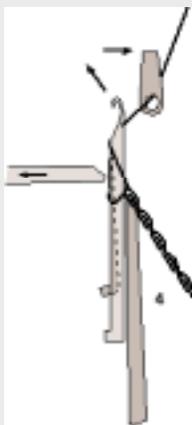
- 1 - The needles are at knock-over position - lowest position - after completion of the previous stitch course. The holding-down sinkers are positioned in between the needles.



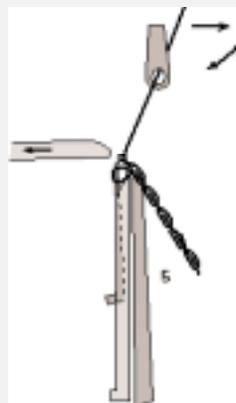
- 2 - The needles ascend to clearing position - highest position. The closing elements rise to a less extent so that the hooks open. The fabric is secured by the holding-down sinkers.



- 3 - The yarn guides (guide bars) swing in between the needles to the hook side.



- 4 - The yarn guides are shogged sideways by one needle and then swing back in between the needles. An overlap is produced. The holding-down sinkers start to withdraw.



- 5 - The needles descend. The closing elements descend slower so that the hooks are closed trapping the newly wrapped yarns. The yarn guides are shogged sideways and start to re-position (underlap).

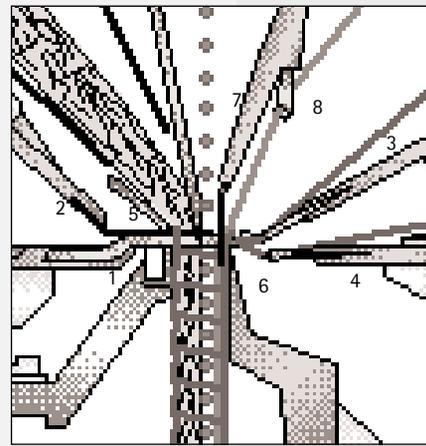


- 6 - The needles descend to knock-over position and the previous loop slips from the needle stem over the needle hook. The loops in the needle hooks are interlaced with the previous loop, thus producing a new course of loops.

## Stitch-bonding as a special case of warp knitting technique

Stitch-bonding is considered to be a special case of warp knitting technique while the loop formation cycle is similar to that of warp knitting. Important differences are as follows:

- constructive design of stitch-bonding area (e.g. horizontal needle arrangement, fixed retaining, backing rail)
- needle types applied („Stitching-needle“)
- reference size for machine gauge (number of needles per 25 mm)
- conversion of unbonded fibrous webs to purely mechanically stitch-bonded nonwovens to 100% from fibres

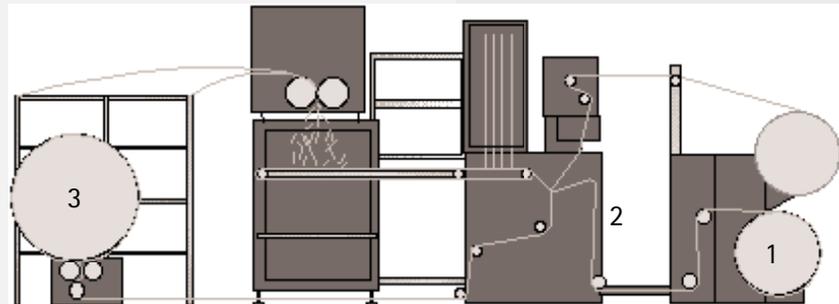


### Stitch-bonding elements:

- 1 Stitching needle
- 2 Closing wire
- 3 Guide needle 1st guide bar
- 4 Guide needle 2nd guide bar
- 5 Knocking-over sinker
- 6 Backing rail
- 7 Retaining pin
- 8 Warp guide needle

weitere Unterschiede:

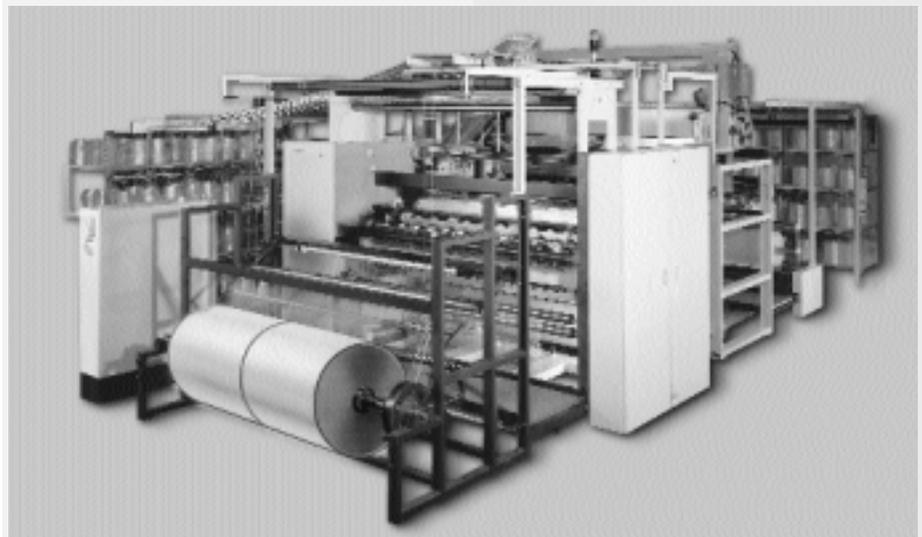
- 1 - Warp-beam let-off position in front of machine and knitting yarn feed from the front
- 2 - Fabric take-down vertically downwards
- 3 - Fabric batching behind the machine



**Example:** Stitch-bonding machine with chopper (glass chopping device)

Characteristic features for stitch-bonding machines are:

- sturdy construction of machine
- a maximum of two stitch-forming guide bars
- machine gauge up to 22 needles per 25 mm
- high production output
  - up to 2,500 courses per minute
  - up to 6,100 mm working width

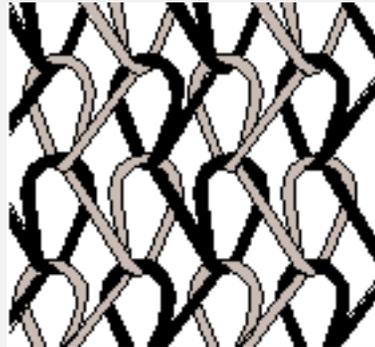


# Basic constructions

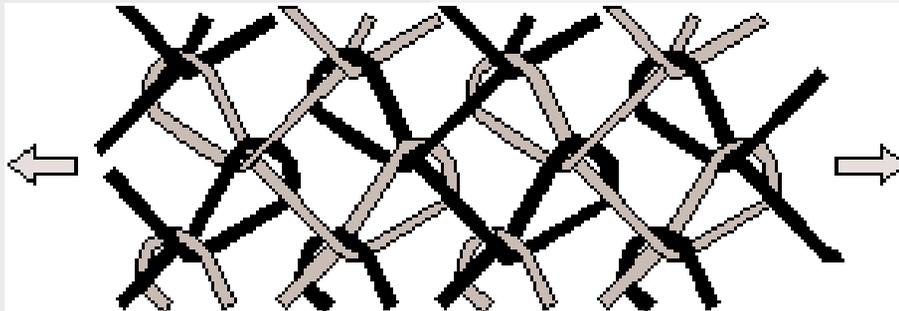
## Elastic structures

For a structure to be stretchable it should be designed with:

- 1 - open fabric construction
- 2 - short underlaps.

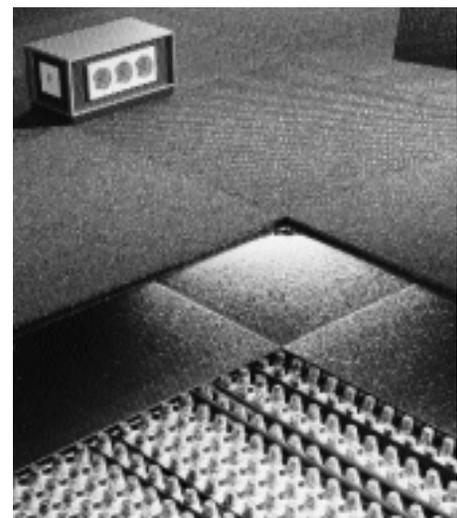


The structure illustrated herein is the most basic one. It is called tricot stitch or 1 and 1 (1 needle underlap and 1 needle overlap).



It is dimensionally stretchable in the width . . .

. . . as well as in the length.

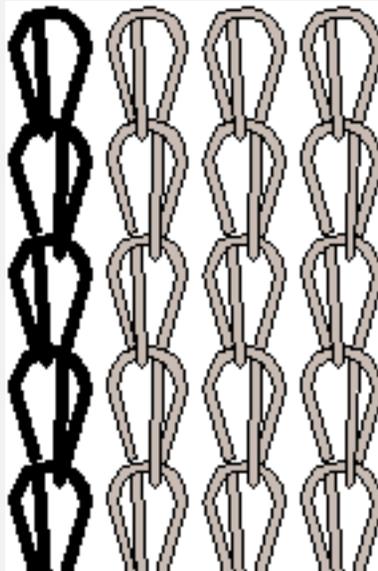


Such a structure made of polyester or glass yarns is coated and moulded into a light-weight three-dimensional and extremely tough „honeycomb“ construction.

Example for end-use:  
False floor for private and institutional use to accommodate power and communication cables.

## Stable structures

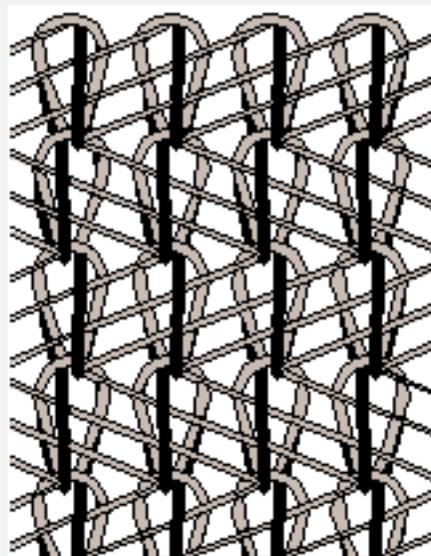
To increase the lengthwise strength, a specific stitch construction is used (pillar stitch).

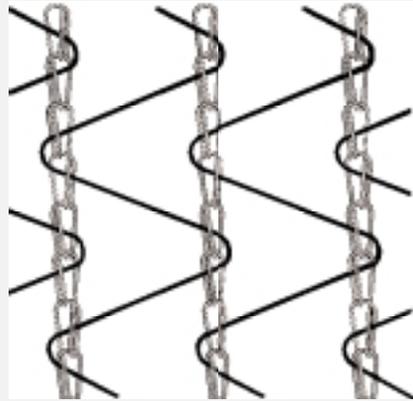


To increase the widthwise stability, the underlaps are lengthened (e.g. satin stitch).



A dimensionally stable structure is achieved by combining these two types of stitch construction (e.g. pillar - satin).

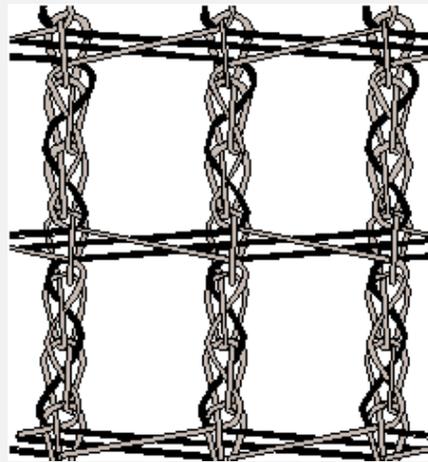




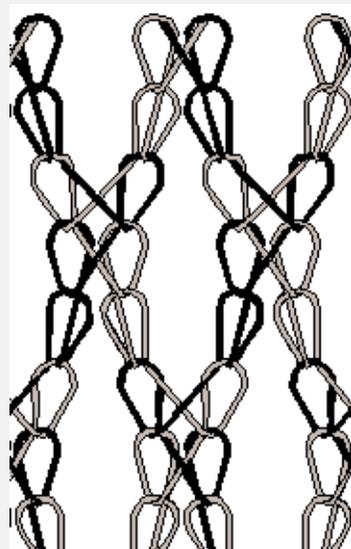
## Open structures

One way to produce an open structure is to knit unconnected pillars continuously while a connecting underlap by horizontal yarns is produced only every few courses.

This open polyethylene net is used to wrap pallet packing units, stacks of crates for safer shipment or as illustrated to stabilise round bales of hay or straw in the field.



The structure shown in the illustration is used as shading net and can be produced in various shade grades.

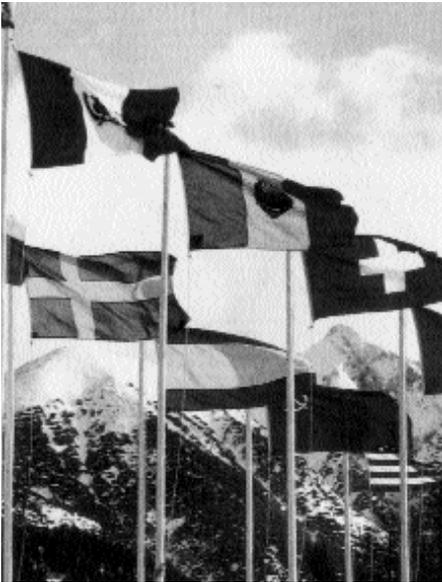


Another way to produce an open structure is to form loops continuously on the same needle and to interlace them laterally at certain intervals.

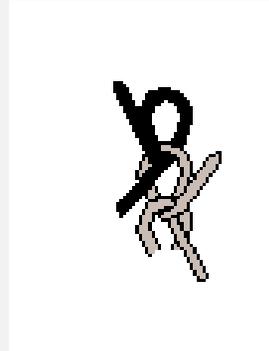
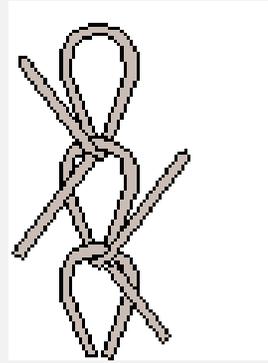
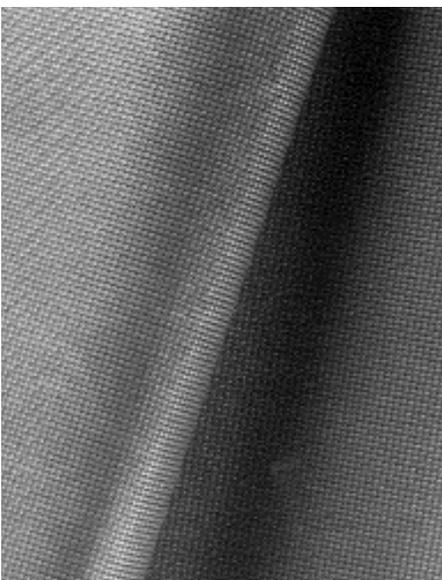
The net shown in the photograph is for extremely heavy duty purposes. High-strength polypropylene or polyester yarns are used therein. The net is used to protect persons and buildings. Fishnets are other possible end-uses.

## Closed structures

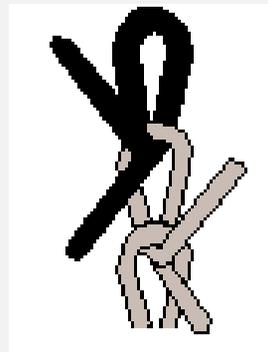
Closed structures of warp knitted fabrics can be produced by:



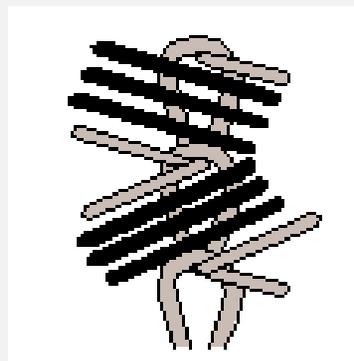
Example for end-use of closed structures:  
High-quality flags produced on an automatic three-needle bar warp knitting machine



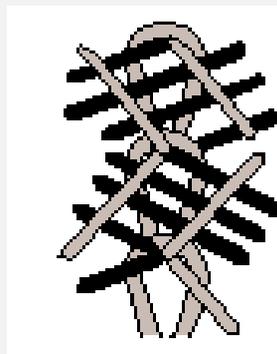
decreasing the loop size



using heavier yarn materials



making longer underlaps



using more guide bars

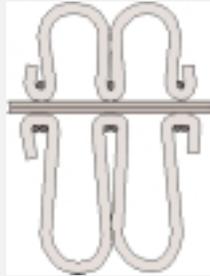
combining any of the above methods

# Three-dimensional structures

Three-dimensional structures can be produced both on single-needle bar warp knitting machines (pile fabric) and on two-needle bar Raschel machines (spacer or tubular fabrics).

## Pile fabrics

The three-dimensional characteristic manifests itself by pile loops on one or on both fabric faces. The loops are formed by means of pile sinkers or other auxiliary elements (e.g. via needles) or produced by enhanced yarn feed of individual systems.



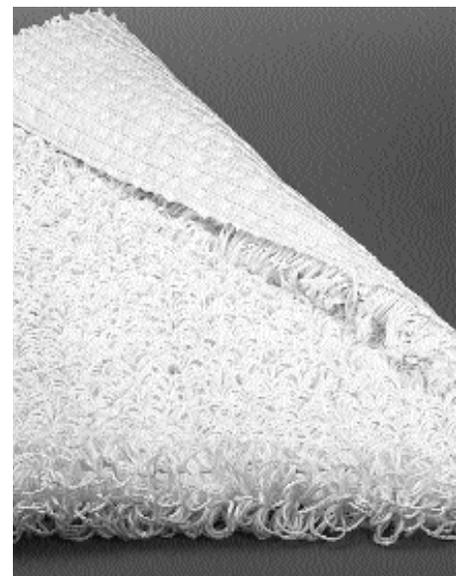
The pile loops are fixed by:  
a) a stitch-forming yarn system provided in front of the pile systems, or



b) intermeshing of the front piles by themselves



End-uses: Special cleaning cloths, incontinence wear, fibre-reinforced plastics



Cleaning textiles (cleaning mop)

## Spacer and tubular fabrics

The following diagrams are used to demonstrate the knitting principles on a double-needle bar Raschel machine. The following points should be noted:

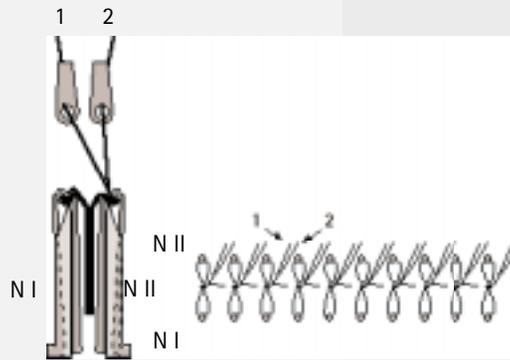
- 1 The knitting action of each needle bar is similar to that of a standard Raschel machine.
- 2 The needle bars are operating alternately.
- 3 The guide bars swing between the needles of each needle bar in turn.

4 Each guide bar can be shogged to make an overlap on either needle bar and so form knitted loops on the selected needle bar. A warp-knitted double-face fabric is produced.

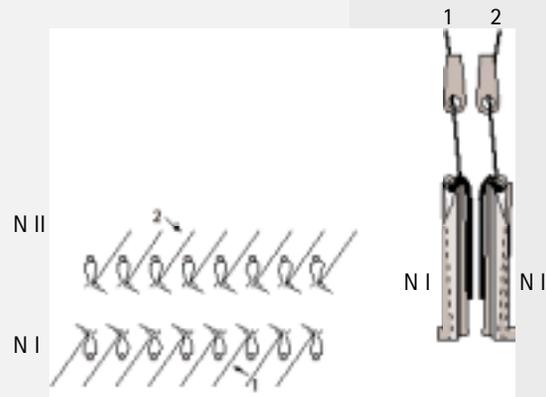
5 Typical features of warp-knitted double-face fabrics are:  
The fabric has got two right sides, that is, there are loop heads both on face and back.

## Warp-knitting cycles on a double-needle bar Raschel machine

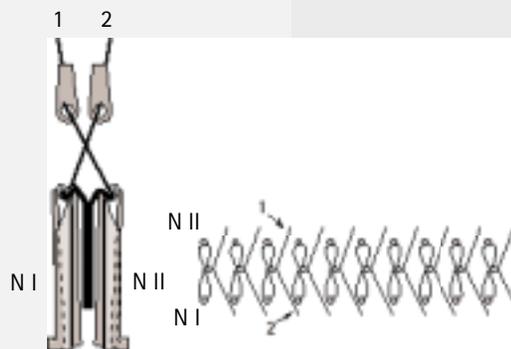
Guide bars 1 and 2 are shogged to overlap both needle bars (N I; N II) and so form loops on the respective needle bar. A knitted double-face fabric is produced.



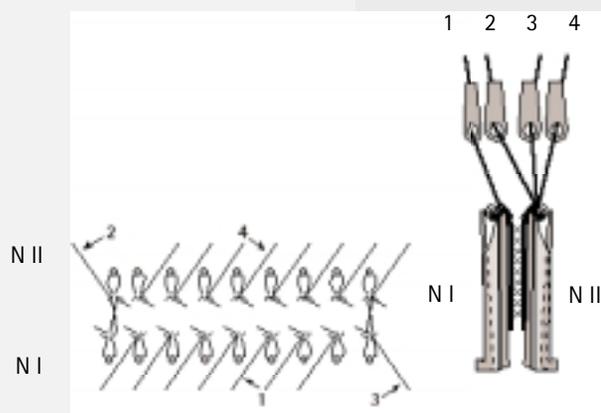
Guide bar 1 forms overlaps (loops) only on needle bar I. Guide bar 2 forms overlaps (loops) only on needle bar II. Two separate fabrics are formed.



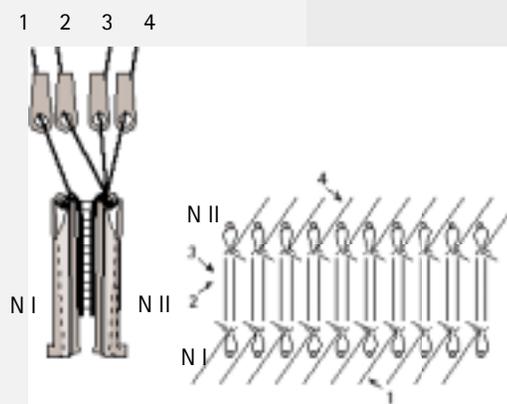
Guide bar 1 forms overlaps on needle bar II while guide bar 2 overlaps only needle bar I. Two fabrics are produced. They are joined however by the underlaps into a single fabric sheet. The ideal way to produce a plated double-face fabric made of two materials.

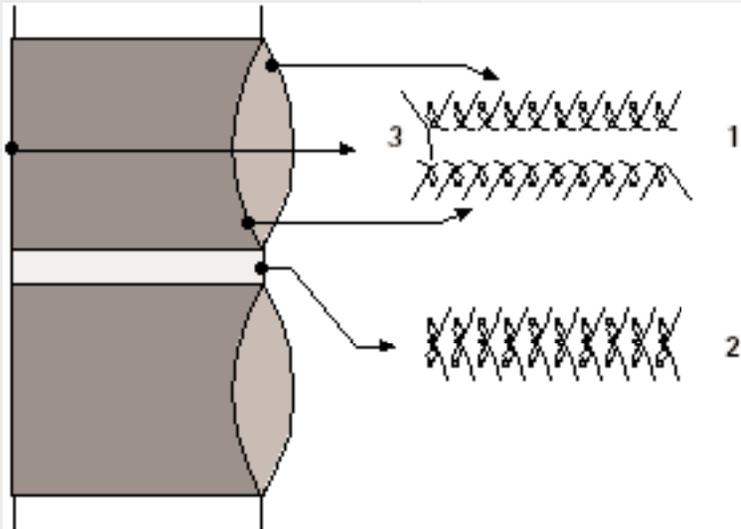


Guide bar 1 is fully threaded and overlaps needle bar I. Guide bar 4 is also fully threaded and overlaps needle bar II. Guide bars 2 and 3 are threaded only through one yarn guide each at the extremities of fabric and overlap both needle bars. A seamless tubular warp-knitted fabric is formed. With the right threading arrangement many tubes can be formed across the machine and the diameter of tubes can easily be altered by changing the threading arrangement.



Guide bar 1 is fully threaded and overlaps needle bar I. Guide bar 4 is also fully threaded and overlaps needle bar II. Guide bars 2 and 3 which are threaded to form together a full set of yarns overlap both needle bars. A spacer fabric is formed.





## Horizontal tube production for sacks

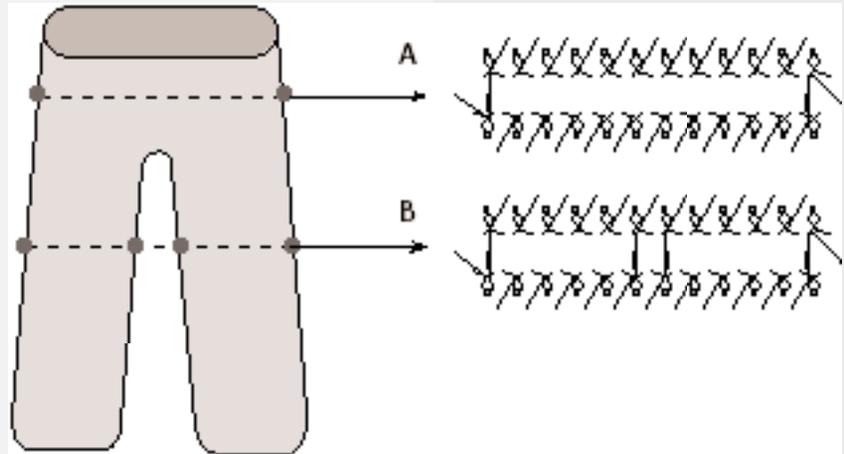
Horizontal tubes can be produced using the principles explained earlier. During phase 1, the guide bars are driven to form two separate fabric faces. During phase 2, the two fabric faces are joined to each other horizontally in certain intervals by change in lapping. The colour-marked joining guide bar produces the bottom seam of packing sack and joins the two fabric faces in vertical direction (3).

Here are a few examples for end-uses of sack structures (horizontal sacks as continuous packing sack runs) for various packing purposes, used in fully-automatic packing lines.

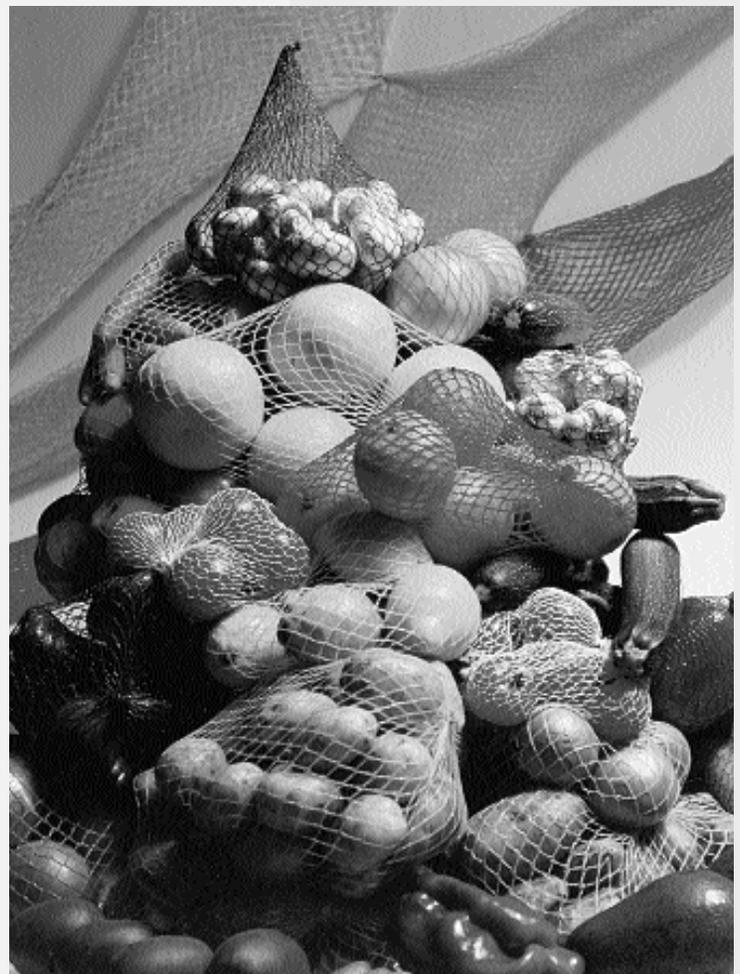
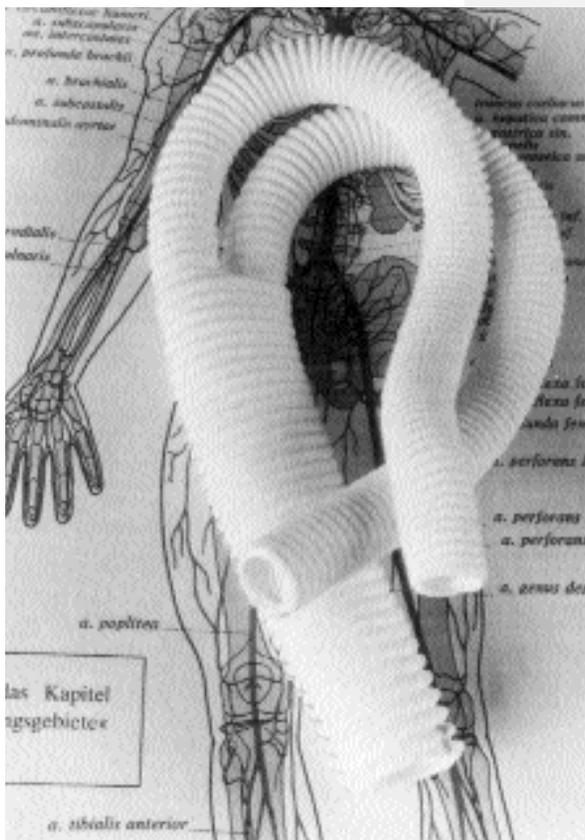


## Vertical tube production

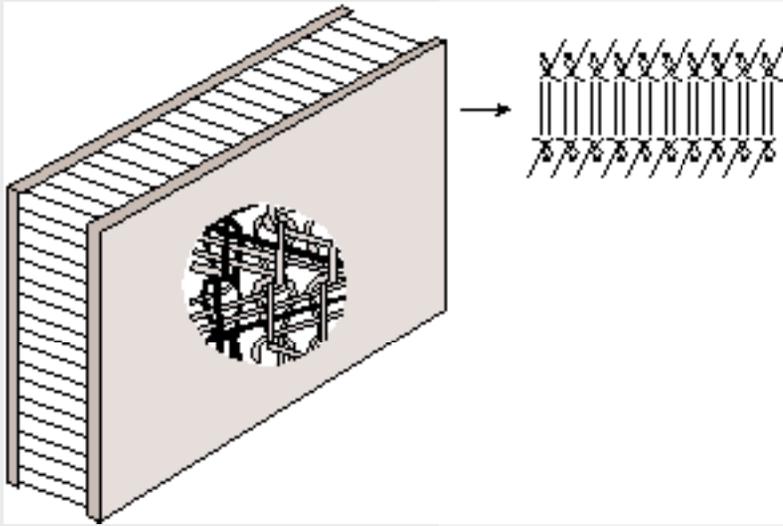
With a combination of fully threaded guide bars (A) to produce two separate fabrics and another combination of partly threaded guide bars to make the connection between the two guide bars and/or fabrics, tubes of different sizes can be formed. With the appropriate number of guide bars (B) even even branched tubular structures can be produced.



Branched artificial blood arteries are produced on a fine gauge Raschel machine with 16 guide bars.



Use of coarse tubular structures as packing materials.



## Spacer fabric production

To form a spacer structure, fully threaded guide bars are used to form each of the side fabrics while an additional fully threaded guide bar joins the two fabric sides by joining threads. The spacer fabric may be up to 60 mm in thickness.

The spacer fabric incorporated herein offers an excellent seating comfort thanks to its perfect climatic behaviour.

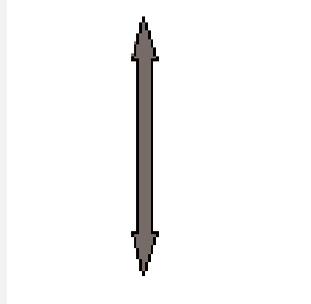
Here, an elastic spacer fabric is used as underwear for diver's suits.



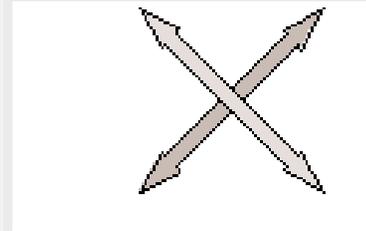
# Directionally oriented structures

Directionally oriented structures or D.O.S. are unique multi-ply fabrics which are produced by warp knitting/stitch-bonding techniques. With these techniques straight ends of absolutely parallel and noncrimped yarns are inserted into the structures at almost any desirable angle. Fabric characteristics can be engineered to enhance the in-plane properties only in the required orientations so that the fabric produced has the ideal combination of excellent mechanical properties and cost-effective production.

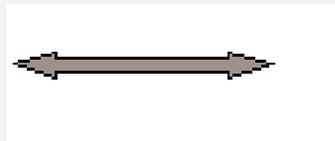
The range of D.O.S.:



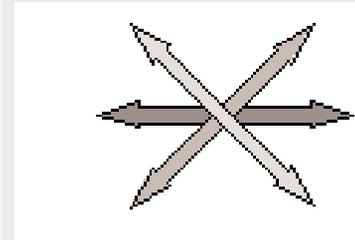
Warp direction: mono-axial



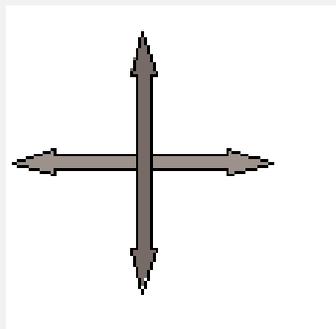
Diagonal: bi-axial



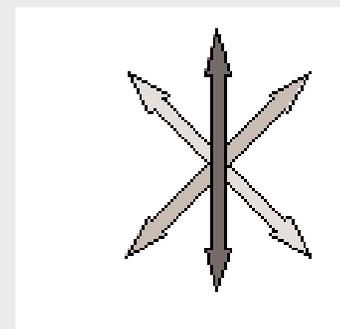
Weft direction: mono-axial



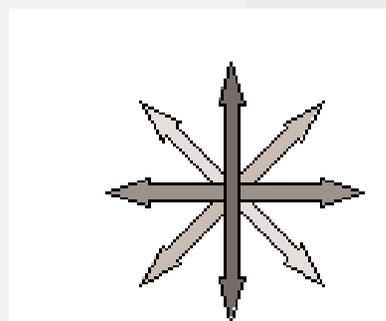
Diagonal and weft: tri-axial



Perpendicular: bi-axial

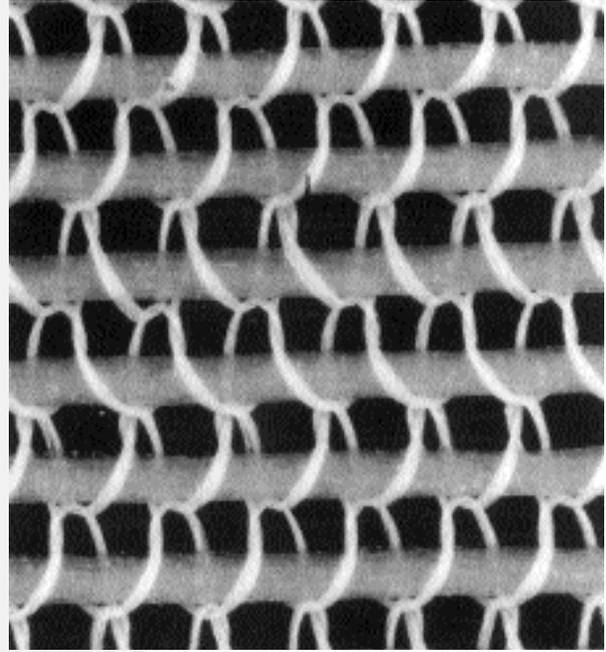
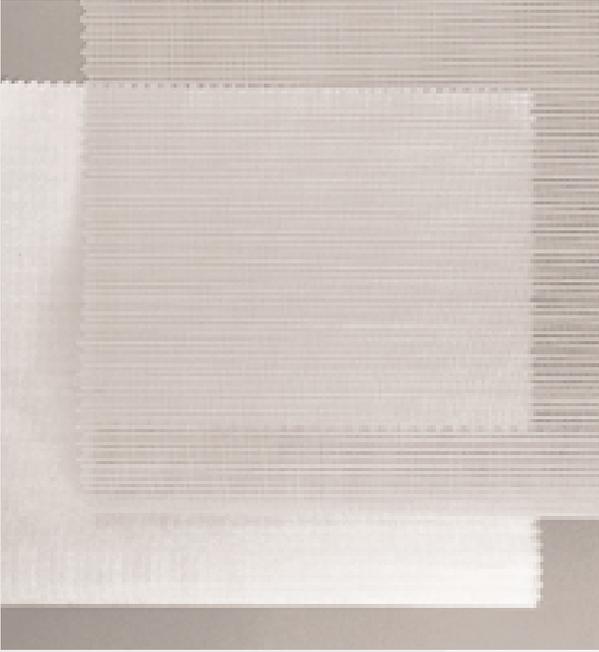


Diagonal and horizontal: tri-axial



Multi-axial

## Mono-axial structures



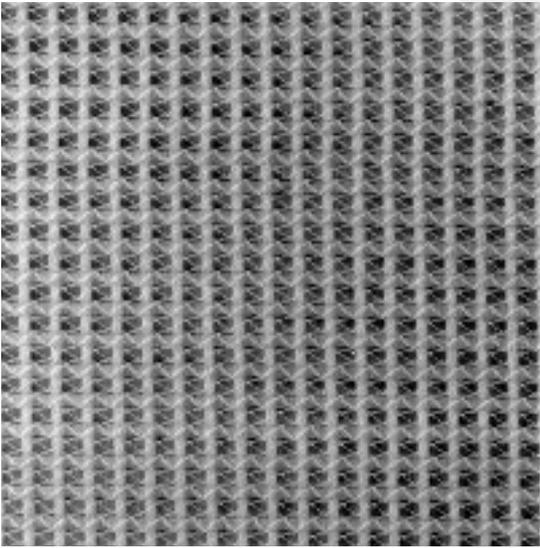
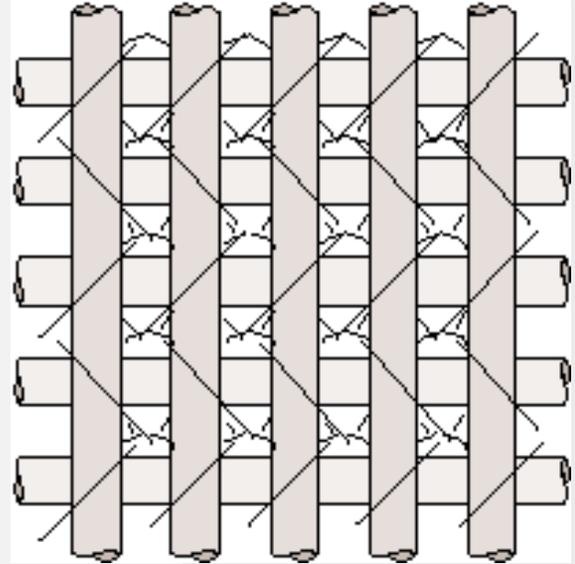
Heat-reflecting and shade-providing warp-knitted sun-protection fabric. The special properties of this structure are: economical production, high strength and high dimensional stability. No sagging of the fabric and good rolling behaviour due to stretched weft yarn layers. The porous structure prevents heat accumulation and ensures additional shading. The aluminium coating serves for sun reflection and heat insulation.

This close-up photograph shows the simplicity of this structure, the uniformity of the yarn arrangement, and the fine loop binding element.

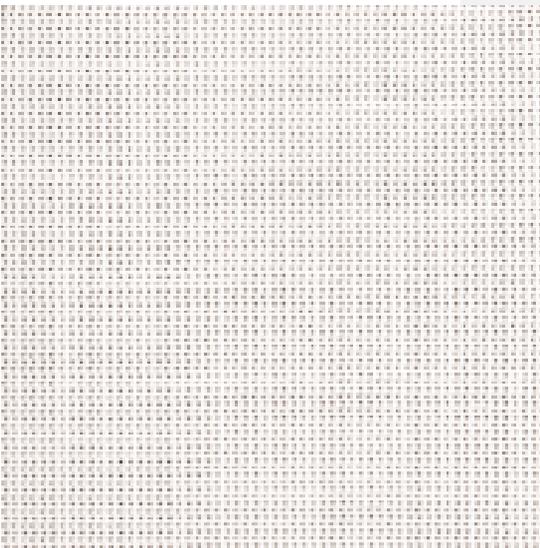


## Bi-axial structures

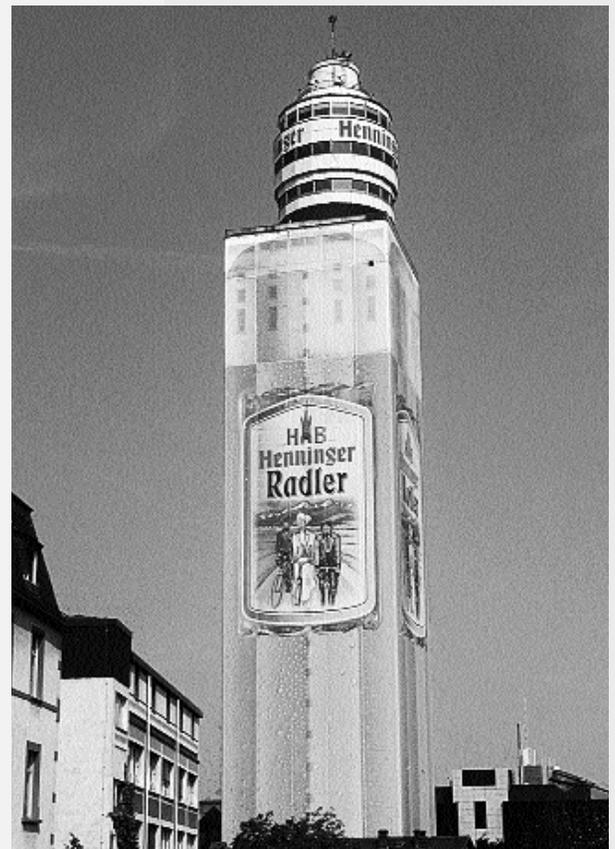
Bi-axial technical structures are formed as a combination of magazine weft insertion and a mislapping guide bar to obtain the lengthwise and widthwise reinforcement respectively.



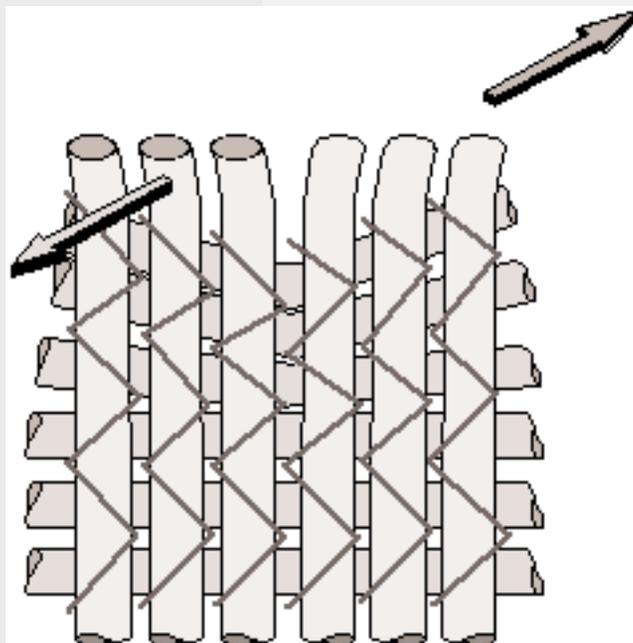
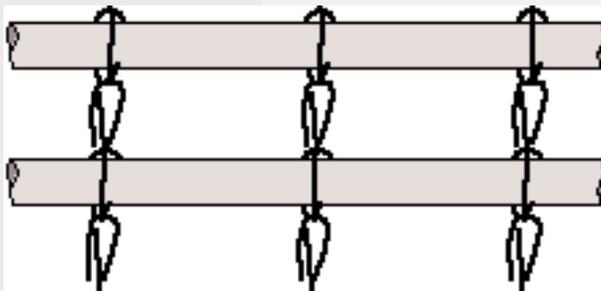
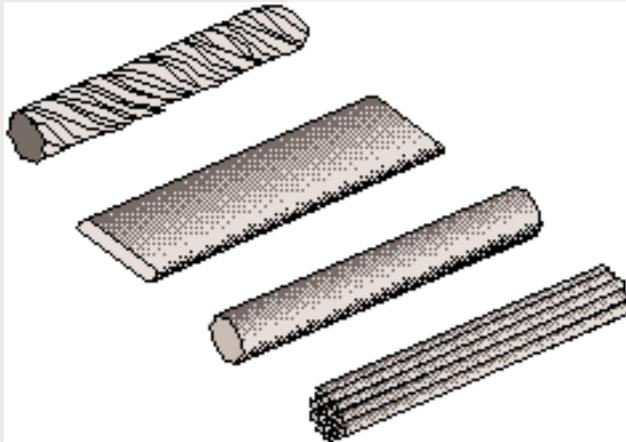
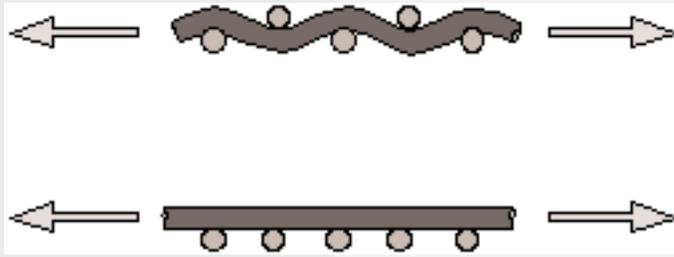
Bi-axial, dimensionally stable structures for coating and laminating



High-quality laminating substrate for advertising sheets, backlit awnings, sun protection, camping chairs, and deck chairs



Mega-Poster for advertising applications, open structure, coated, ink-jet printed of up to 5 m in width



## Advantages of mono- and bi-axial D.O.S.

Unlike the arrangement in a woven structure, the yarns in D.O.S. are absolutely straight and parallel.

- Yarn properties are fully utilised to withstand deformation forces.
- Optimally structured modulus.
- Fabric engineering is simple and fabric properties can be pre-calculated according to the intended end-use.

Any yarn type can be processed - from low-twist soft staple yarns to high-tenacity filament yarns.

The secured interlacing of yarns, even in very open mesh structures, makes transportation and handling during further operations such as coating and laminating much simpler.

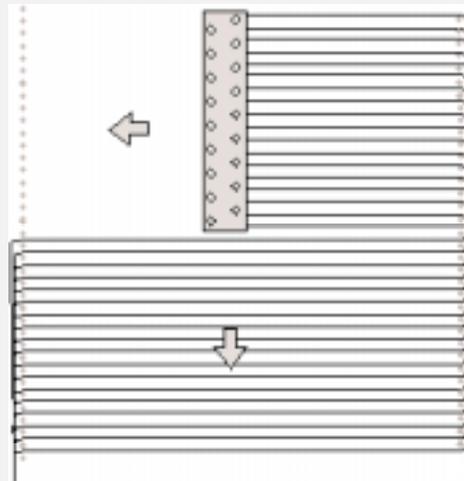
Excellent tear and tear propagation resistance. The yarn layers tend to bunch together under load. A greater extent of force is so required to destroy the structure.

## Weft insertion systems

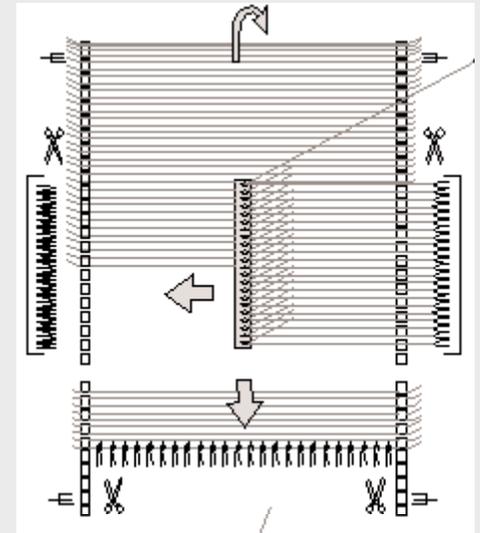
The principle of magazine weft insertion in warp knitting involves the insertion of long yarn ends, stretched in parallel across the whole width of machine. Insertion of a yarn sheet into the hook-needle chains accounts for the high productivity of warp-knitting machines. In dependence on the weft yarn materials processed, the MSUS (magazine return weft insertion) or the EMS (single-end magazine weft insertion) principles are used. Further to parallel weft insertion a slightly crossed weft insertion (typical of Malimo) is possible.

The advantages of weft insertion systems:

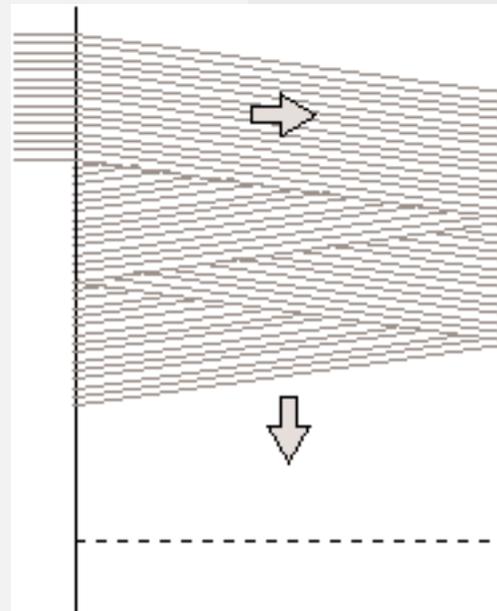
- Working width of up to 245" (6.22 m)
- Production speed of up to 1,400 r.p.m., that is, a weft insertion rate of up to 7,560 m/min\* (on the basis of 24 yarn ends)
- \* depending on the relevant product to be produced
- Weft take-up speeds of up to 320 m/min (on the basis of 24 yarn ends)
- Flexible weft insertion system (weft repeat, number of weft yarn ends)
- All yarn types including high-tenacity and fragile technical yarns can be inserted
- High flexibility of yarn counts
- Very high efficiency and productivity



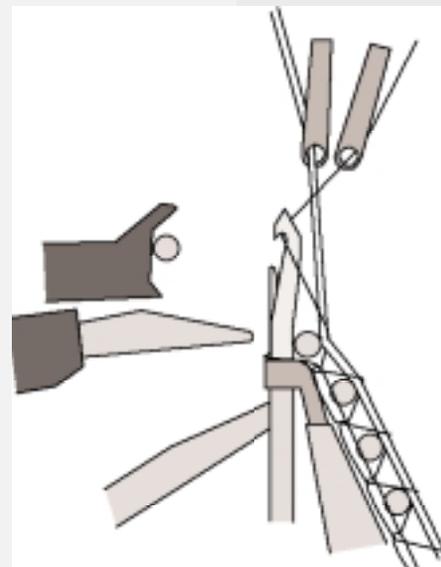
MSUS principle



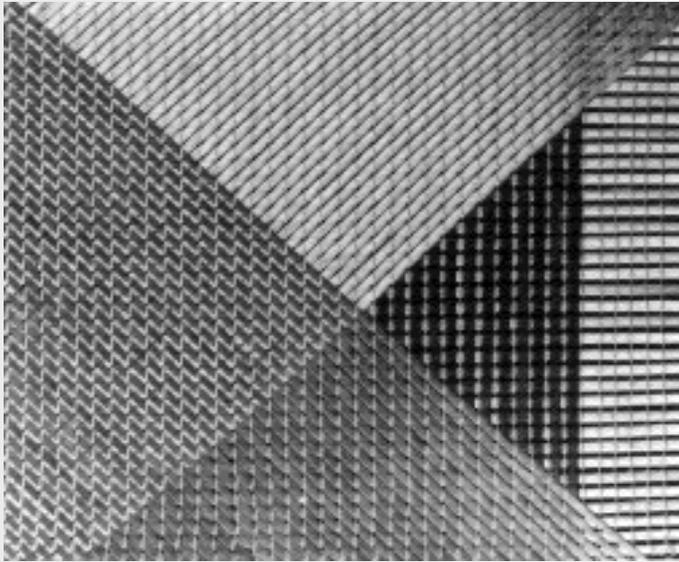
EMS principle



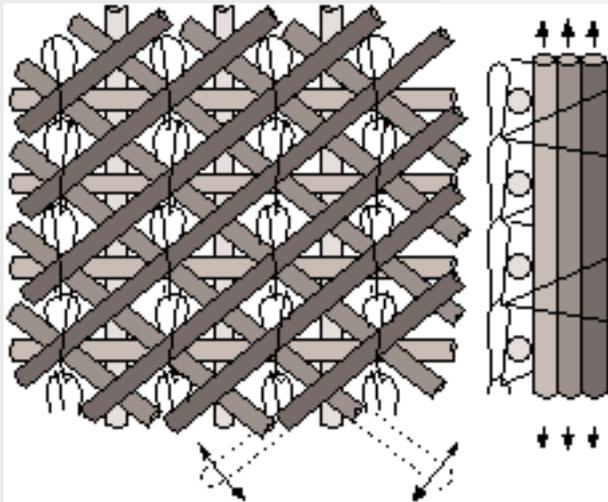
Weft insertion typical of Malimo



Knitting area of Raschel machine with magazine weft insertion



Four yarn layers placed in perfect order each on top of the other. Each layer shows the uniformity of the non-crimped parallel yarns interlaced by stitches. The structure is dimensionally stable in all directions:  $+450/-450/0^{\circ}/90^{\circ}$ .



A multi-axial multi-ply fabric demonstrating the two diagonal yarn sets in addition to the bi-axial yarn sets created by the mislapping guide bar (warp or ST-yarn) and the magazine weft insertion system (weft).

## Multi-axial structures

Multi-axial multi-ply structures are fabrics bonded by a loop system, consisting of one or several yarn layers stretched in parallel. Said yarn layers may have different orientation and different yarn densities of single ends.

Multi-axial multi-ply fabrics are used to reinforce different matrices. The combination of multi-directional fibre layers and matrices has proved capable of absorbing and distributing extraordinarily high strain forces.

## Multi-axial structures for substrates

The typical feature of warp-knitted multi-axial multi-ply structures for substrates is the interlacing of single ends in line with the stitch courses and the associated almost smooth processing of fed yarns. These products are multi-ply structures with angles of  $30^{\circ}$  up to  $60^{\circ}$  and/or  $90^{\circ}/0^{\circ}$



Applications are: inflatable bodies, such as airships, inflatable boats, inflatable life-rafts, rescue tents, gas membranes, V-belts, flexible roofing membranes etc.

## Multi-axial structures for fibre reinforced plastics

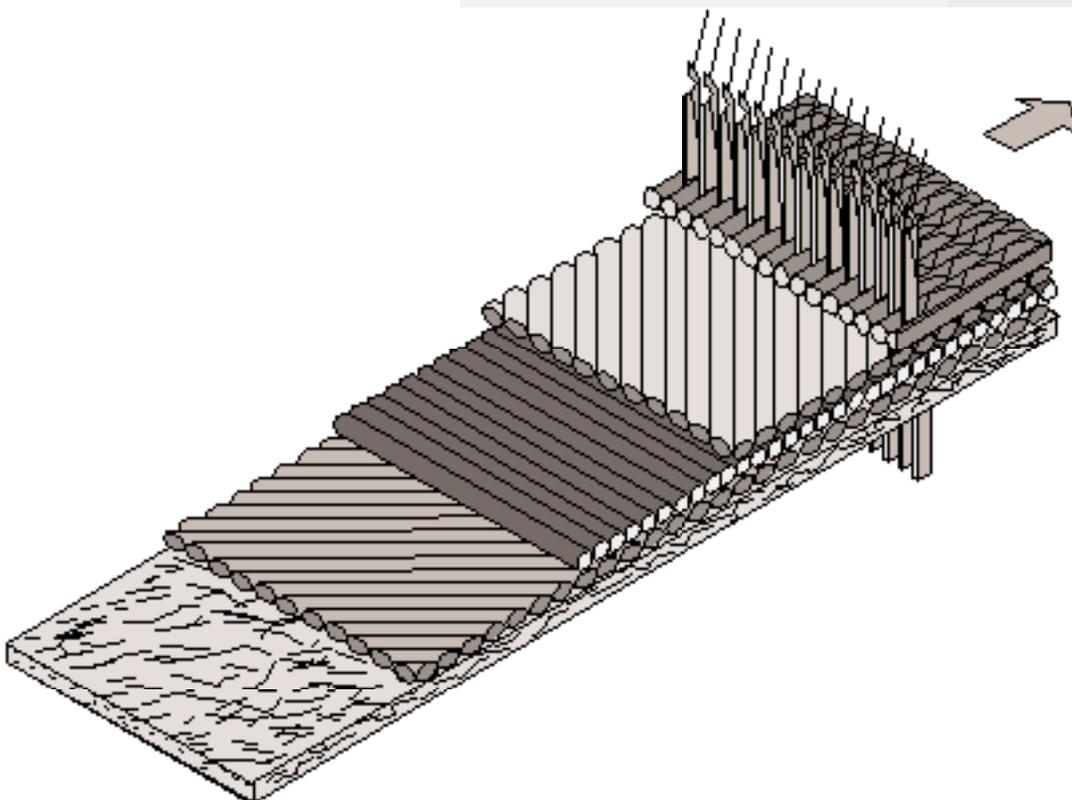
The typical feature of warp-knitted multi-axial multi-ply structures for fibre reinforced plastics is the stitching-through principle, ensuring a uniform distribution of yarn ends and preventing gap formation. In addition, fibrous webs, films, foams and other materials can be incorporated. Angle positions of  $-45^\circ$  through  $90^\circ$  up to  $+45^\circ$  and  $0^\circ$  are generally used, being infinitely variable.

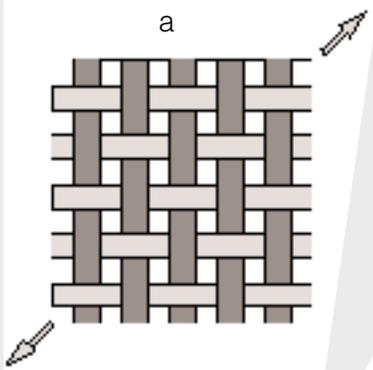
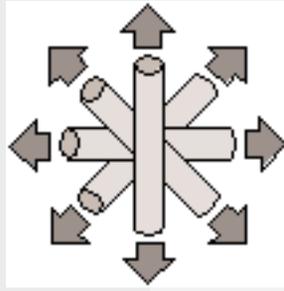
- Due to the noncrimped and parallel yarn sheets, such as multi-axial multi-ply structures are particularly suitable to reinforce plastics to form fibre reinforced plastics (F.R.P.).
- The special characteristics of such composites are:
  - low specific weight
  - adjustable stiffness between extremely stiff and extremely stretchable
  - resistance to corrosion and chemicals
  - highest mechanical load resistance

Applications:

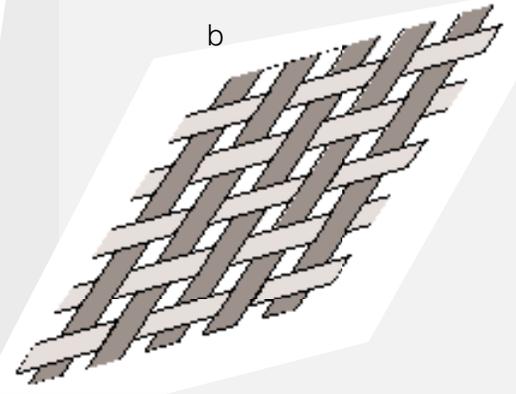
Rotor blades for wind power stations.  
Moulded parts for automotive, aircraft, and ship building.

Equipment for sports and leisure-time activities e.g. skis, snowboards, surfboards, sports boats . . .

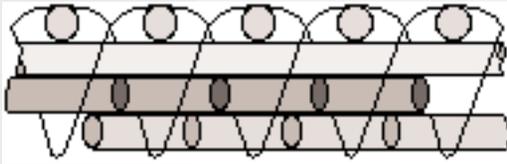




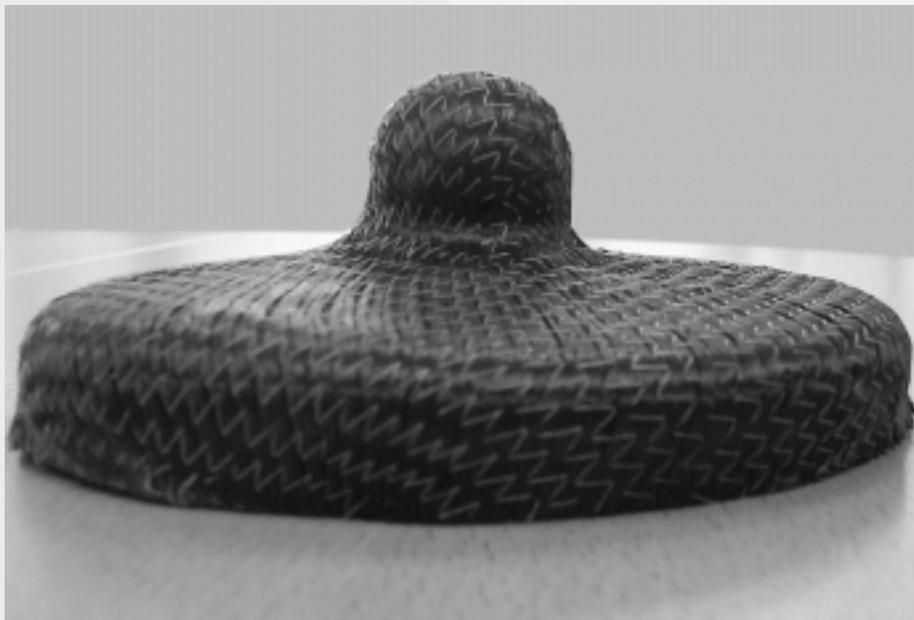
Unlike woven fabrics, multi-axial multi-ply structures have a high shearing strength under diagonal forces



Multi-ply structure



Woven fabric



## Advantages of multi-axial multi-ply structures

- Dimensionally stable in any direction
- Isotropic distribution of stress forces, uniform strain behaviour

- Optimal utilisation of tensile yarn strength in any directions of strain unlike woven fabrics
- Reinforced 3rd dimension, that is, in Z-direction, thus reduced delamination tendency by the interlacing yarn system

- Directly oriented, parallel yarn layers straightly placed each on top of the other -without yarn crimp, providing the following advantages:

- enhanced interlaminar shearing strength
- quick curing of resin
- reduced resin quantities
- increased impact resistance
- excellent draping characteristics

- Lowest weight per unit area at maximum total strength possible

- Cost effective production and economical ready made

- Product-relevant and variable layer structure in various angular directions, allowing for additional materials to be incorporated, to be manufactured in only one operation.

Yarn materials to be used:

Fibreglass, aramid, carbon, high-tenacity PES, PA, PE, PP. Used as matrix materials are:

Thermosetting or duroplastic materials, polyvinyl chloride PVC, ethylene vinyl acetate EVA, synthetic rubber, recently also pressure setting matrix materials such as concrete, cement and the like.

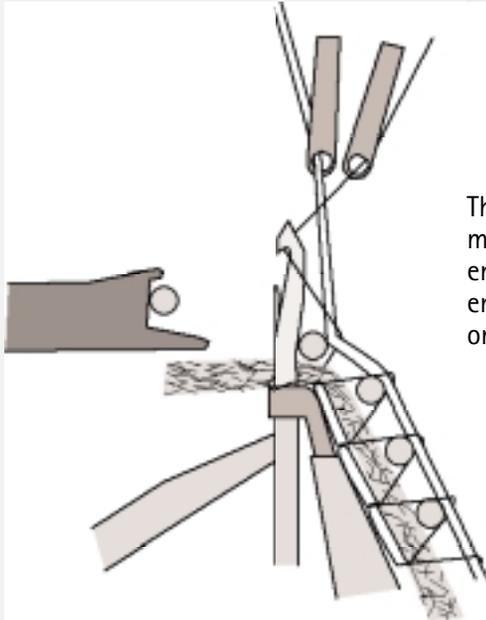
Example for good mould capability of multi-axial multi-ply structures

# Composite fabrics

Composite fabrics are also unique structures produced using warp knitting and stitch-bonding techniques. The idea behind composite fabrics is to combine several materials of partly opposite properties to create a single membrane that performs much better than its components. With all other textile manufacturing techniques, the components are produced individually and then combined with different gluing, soldering or sewing techniques. With the latest warp knitting, Raschel, and stitch-bonding machines, the composite fabric is produced in a single, simple and very productive operation.

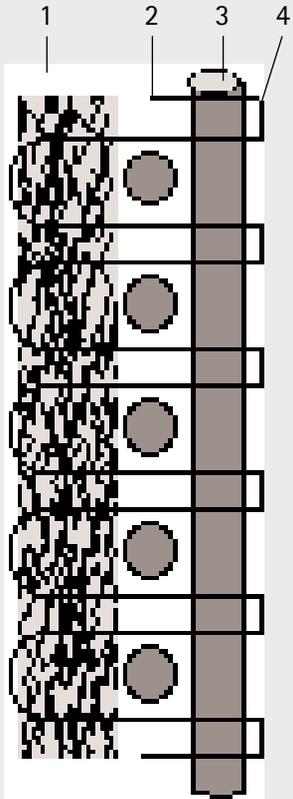
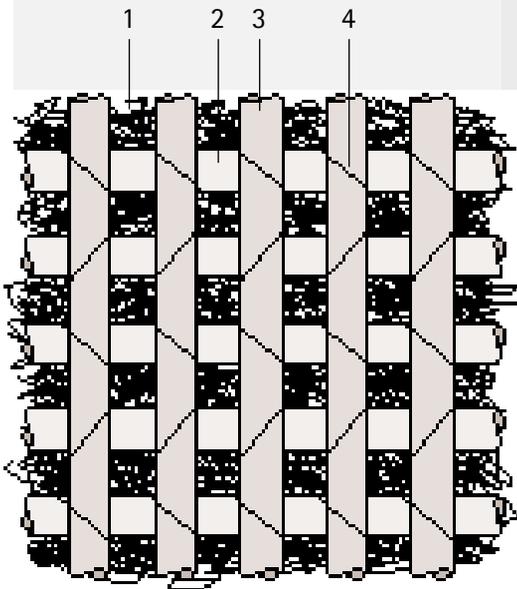
The most popular composite fabric is a bi-axial reinforced nonwoven.

Any fabric to be pierced can be reinforced with a mono-, bi- or multi-axial yarn element on Raschel and/or stitch-bonding machines. Webs, mechanically bonded webs, unbonded chopped strand mats (CSM) and, moreover, nonwovens bonded thermally or by binder are reinforced.



The knitting elements of this Raschel machine with web feed facility are engineered to place the two vertically entering reinforcements (warp/weft) onto the nonwoven.

Schematic illustration of a bi-axial reinforced nonwoven with elements: warp, weft, interlacing yarns and nonwoven.



Web on the reverse side of composite fabric

- 1 - web
- 2 - weft yarn
- 3 - warp yarn
- 4 - interlacing yarn

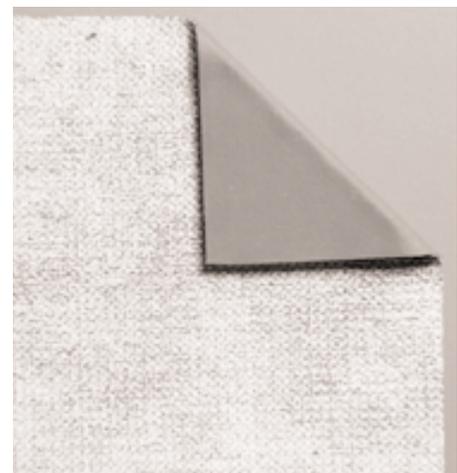


## Bi-axial reinforced nonwovens

Bi-axial reinforced nonwovens are frequently used as substrate for laminating or in the field of geotextiles.

### Features/Advantages:

- Good surface covering power of nonwoven
- Excellent processability due to anti-slip grey fabric structure
- During the coating process (preference is given to calender coating)
  - tear and tear propagation resistance
  - cohesion of substrate and matrix are increased by the web filaments (bunching effect).
- Thanks to one-sided coating on the yarn side, the nonwoven side allows for:
  - protection of coat/foil when being incorporated e.g. in refuse dumps
  - moisture drainage system e.g. in party tents to prevent water drip formation
  - enhanced wear comfort of protection suits
- Constructive increase of the mechanical properties of nonwoven by bi-axial yarn layers in accordance with the product-specific requirements. Although nonwovens themselves do not have good mechanical properties, the exceptional tear resistance of the composite fabric is achieved by the directionally oriented reinforcement.

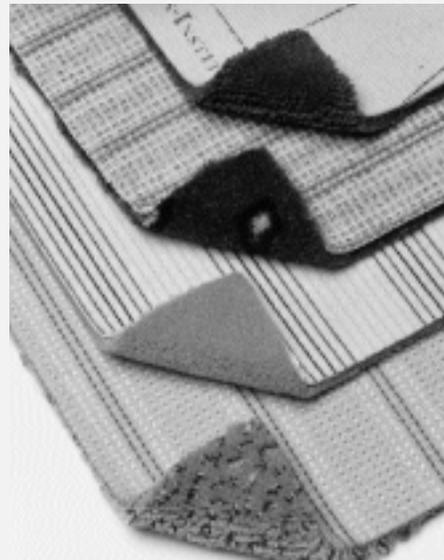


- Improved flame-retardant properties by using fibreglass nonwovens, reinforced by glass yarns and used as bituminous roll roofing for the insulation of flat roofs.



- Improved foot-fall sound attenuation and heat insulation with textile appearance -used as secondary carpet backing.

- Reduced material cost (less yarn material needed)



**Comparison of composite and woven fabrics**

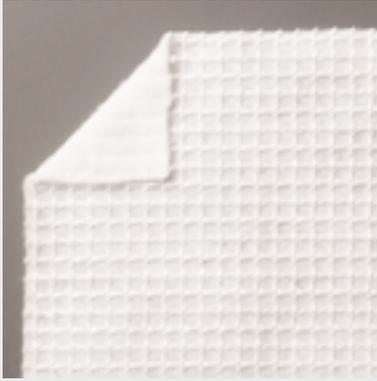
**Example:  
Laminating substrate**

Lengthwise (warp)  
 Widthwise (weft)  
 Weight (D.O.S.)  
 Weight (web)  
 Weight (grey fabric)  
 Weight (coated)  
 Tear propagation resistance\*  
 -Warp  
 -Weft

D.O.S. Composite structure	Woven
2.5 ends/cm	14 ends/cm
2.5 ends/cm	14 ends/cm
33 g/cm <sup>2</sup>	-
50 g/cm <sup>2</sup>	-
88 g/cm <sup>2</sup>	165 g/cm <sup>2</sup>
518 g/cm <sup>2</sup>	550 g/cm <sup>2</sup>
175 N	120 N
142 N	120 N

Both coated fabrics are produced with identical 550 dtex PE yarns. The raw material cost of the knitted composite nonwoven is around 50 % of that of

the woven fabric.  
 \*Tear propagation resistance test according to the trapezoid method DIN 53363



## Bi-axial reinforced composite fabrics for geotextiles

### Fabric properties:

- High tensile strength
- Less elongation
- Good water permeability
- Very low creep
- Very good fabric/soil interaction

A composite fabric specially designed for use in soil geotechnical structures is the symbiosis of the properties of a nonwoven and those of a reinforcement structure. The strength properties of substrate system are permanently maintained, differences in the carrying capability are compensated for, and the carrying capability is altogether enhanced.

Fabric function:	Function performed by:	Functional description
<b>Separation</b>	Nonwoven	Prevents admixtures and harmful grain rearrangements
<b>Filtration</b>	Nonwoven	Ensures non-pressurised water flow between different soil layers
<b>Drainage</b>	Nonwoven	Drains gravitational water according to transverse gradient
<b>Protection</b>	Nonwoven	Protects the yarn layers from damages
<b>Reinforcement</b>	Bi-axial multi-ply structure	Prevents deformations by instant tensile strength absorption Increase and stabilisation of soil carrying capacity Ensures high resistance to mechanical loads during placement and operation



### Application: Railroad foundation

- Reduced dumping heights
- Reduction of granular materials
- Separation of different soils
- Better drainage

- High friction coefficient between geotextile and soil
- Faster consolidation (settlement) of subsoil
- Uniform load distribution reduces the danger of soil breaking

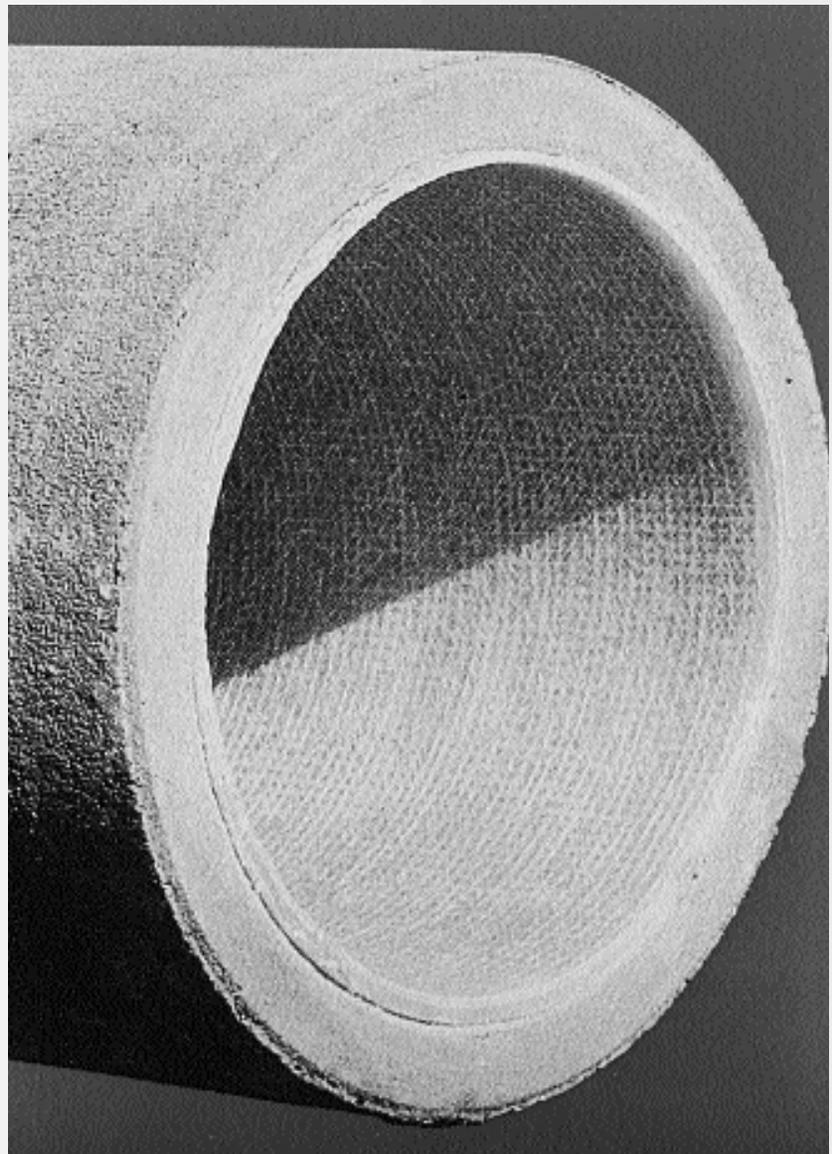
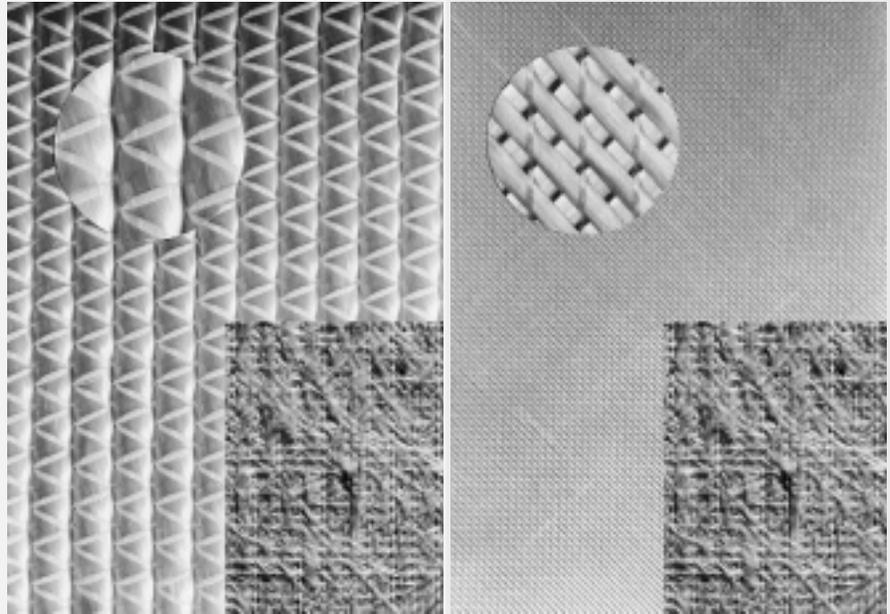
## Bi-axial and multi-axial reinforced composite fabrics for fibre reinforced plastics

Another attractive example for composite fabrics are substrate materials for laminated structures to produce fibre reinforced plastics. Such yarn materials as fibreglass, carbon, aramid in conjunction with fibrous webs, chopped strand mats (CSM) and substrate cloths are preferably used.

A stitch-bonding machine was developed to make bi-axial fabrics on which purely mechanically bonded composite articles combined of unbonded CSM, parallel weft (90°), and warp yarns (0°) can be produced in one operation only.

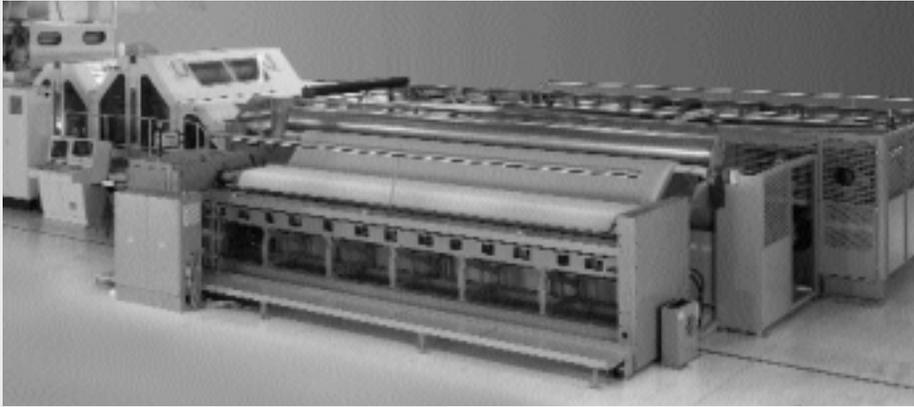
The multi-axial machine offers the unique possibility to produce multi-axial composites e.g. in the combination of CSM, multi-axial yarn layers, and unbonded CSM on the top face of fabric in one operation.

These techniques so offer best conditions for cost-effective production of long-staple reinforced composites with optimal bi- and multi-axial load absorption as being used for moulded parts in automotive, boat, container, and sports equipment building as well as for profiles etc. (see also „Bi- and Multi-axial structures“ chapter).



Pipe renovation

# Stitch-bonded nonwovens



Stitch-bonded fabrics made according to fibre-processing stitch-bonding methods are purely mechanically bonded nonwovens.

Bonding takes place by:

- one- or two-sided formation of stitches from the fibres of length-wise-, cross-laid or random webs fed (web/pile web nonwovens), or
- stitching-over of said webs with a maximum of two stitch-forming knitting yarn systems (web/yarn nonwovens)



## MALIVLIES

- Stitch-bonded Malivlies nonwovens consist to 100 % of fibres.
- Fibres are grasped by the needle hook from a generally cross-laid fibrous web and pulled through the half stitches hanging on the needle stem, thus producing a stitch pattern which resembles to that of a warp-knitted fabric on the reverse side of web.
- The intensity of stitch formation is dependent on the number of fibres in the needle hook and can be controlled by the position of insertion sinkers.

### Advantages of MALIVLIES fabrics:

- Cost-effective production at working widths of up to 6.10 m and exclusive use of non-spun fibrous material
- All cardable kinds and blends of fibres can be processed
- Well-proportioned strength-strain behaviour in lengthwise and widthwise directions, infinitely variable (through fibrous material, weight per unit area, machine gauge, intermeshing intensity, stitch length)
- Excellent draping characteristics and shaping facility
- Excellent recycling facility, processing of reclaimed fibres possible



Applications:  
Car headliner  
Laminating substrate for seat upholstery fabrics (as foam substitutes),

flame-resistant interlinings in firemen's suits, cleaning cloths

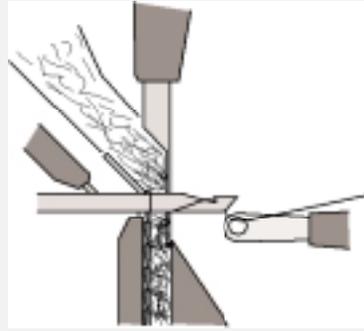


## MALIWATT

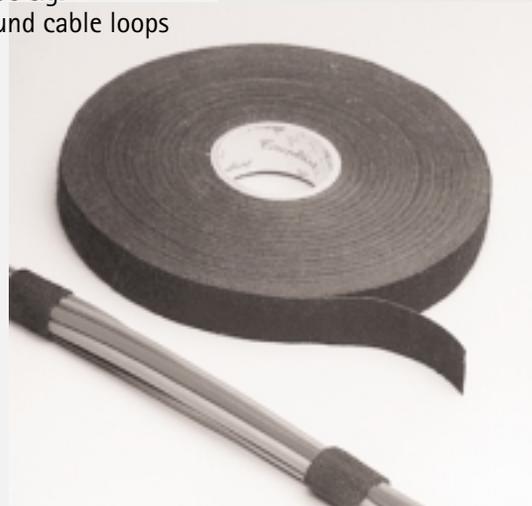
- Stitch-bonded MALIWATT fabrics are made from unbonded or pre-bonded fibrous webs stitched-over across the total surface or partly with one or two stitch-forming yarn systems.
- The possibility for embedding of pierce-through plane and/or scattering materials is provided (nonwovens, composites).

### Advantages of MALIWATT fabrics:

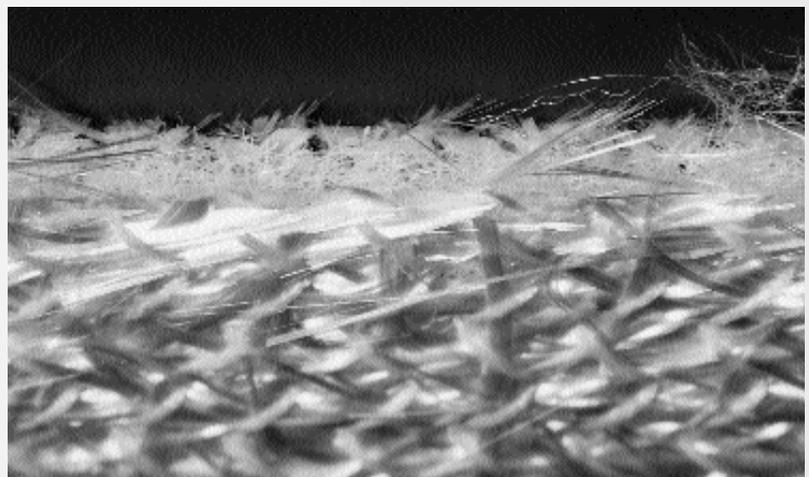
- Cost-effective production at working widths of up to 6.10 m
- All cardable kinds and blends of fibres as well as all pierce-through materials can be processed as backing fabrics within a large weight per unit area range (15 ... 3,000 g/m<sup>2</sup>) with a fabric thickness of up to 20 mm
- Large count range of stitching yarns processed (44 ... 4,400 dtex), featuring the possibility to work through pile sinker of up to 23 mm (one-side knitted pile)
- Strength-strain behaviour in length-wise and widthwise directions adjustable via backing fabric/knitting yarn material, weight per unit area, machine gauge, interlacing and tension of stitching yarn, stitch length
- 0° direction can be additionally reinforced by noncrimped warp yarns
- High variety of variants due to the combination of various materials to make composites
- Special Maliwatt G configuration to process fibreglass webs and/or chopped glass strands even in combination with substrate fabrics e.g. fibreglass fabrics
- Processing of reclaimed material possible.



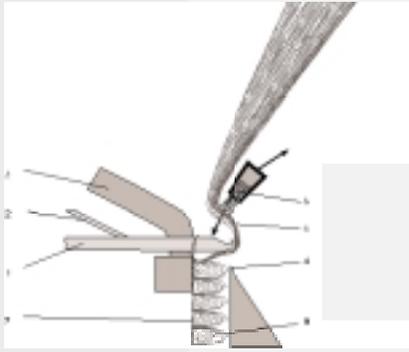
Adhesive tape e.g. to wrap around cable loops



Applications:  
Laminating substrates  
Cleaning cloths  
Insulation materials (fibreglass)  
Substrates for fibre reinforced plastics



Maliwatt -composite made from chopped glass strands (CSM)



- 1 Stitching needle
- 2 Closing wire
- 3 Knocking-over sinker
- 4 Backing rail
- 5 Oscillating brushing device
- 6 Fibrous web
- 7 Fibre stitches
- 8 Pile creases



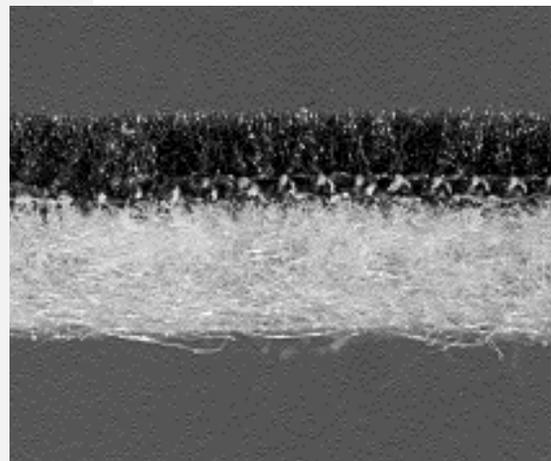
## KUNIT

- Three-dimensional fabric made of 100 % fibres, comprised of one stitch side and one pile loop side with almost vertical fibre arrangement
- A normally lengthwise-oriented fibrous web is folded and compacted into a pile fibre web at feed speed fabric take-down speed and supported by a brush bar. Further, fibres are pressed into the needles hook by the brush bar and converted into a stitch.

### Advantages of KUNIT fabrics:

- Cost-effective production at working widths of up to 2.80 m and exclusive use of non-spun fibrous material
- All cardable kinds and blends of fibres can be processed
- Very good air permeability, excellent compression elasticity (due to vertical fibre arrangement) at low weight per unit volume, fabric thickness of up to 10 mm
- Purposeful manipulation of properties (via fibrous material, weight per unit area/volume, machine gauge, finish)
- Excellent shaping facility/draping characteristics
- Very good recycling facility, processing of reclaimed fibres possible.

Laminating substrate e.g. for car seat upholstery fabrics (as foam substitute)



## MULTIKNIT

- Three-dimensional fabric of 100% fibres, both top sides of nonwoven are formed into a closed surface by stitches and joined with each other by almost vertically oriented fibres.
- One-side knitted pile fibre nonwovens made according to the KUNIT technique are used as basic products.
- The possibility for embedding of pierce-through plane and/or scattering materials is additionally provided.

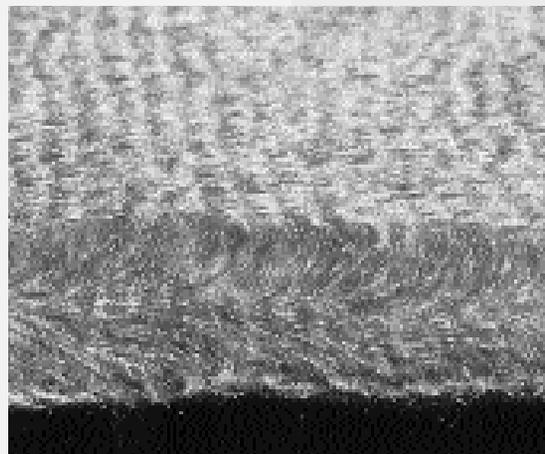
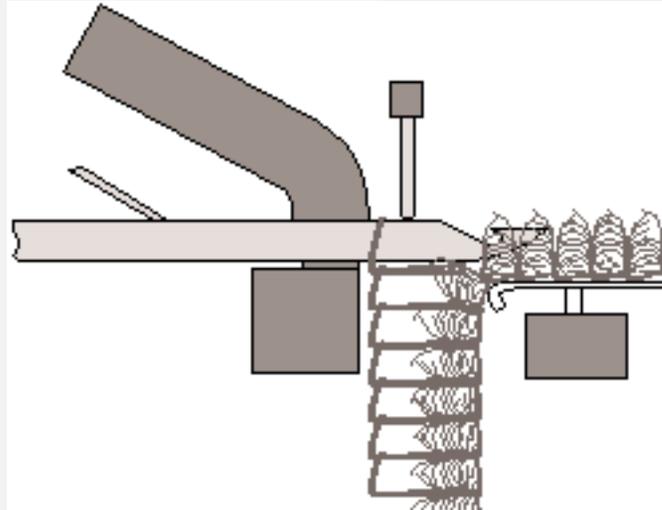
### Advantages of MULTIKNIT fabrics:

- Production of three-dimensional knitted structures of high thickness (up to 16 mm) exclusively from fibres maintaining the vertical fibre arrangement between the outer plane stitch layers
- All cardable kinds and blends of fibres can be processed
- Very good air permeability, excellent compression elasticity (due to vertical fibre arrangement) at low weight per unit volume
- Excellent shaping facility
- Very good recycling facility, processing of reclaimed fibres possible
- High variety of variants due to the combination of various materials as well as the possibility of only partly stitch formation to make composites.

### Applications:

Kynol activated ACMK carbon  
Multiknit for gas filtration (e.g. for use in super-clean rooms, inner car filters, protective suits, and masks)

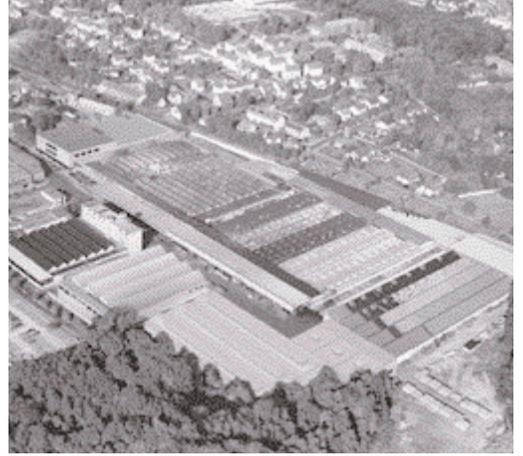
Oil absorbing mat



References:  
Dr. S. Raz , "The Karl Mayer Guide to Technical Textiles"  
edited by Karl Mayer Textilmaschinenfabrik GmbH , Obertshausen

Copyright 2000  
Reprint, even partially, only allowed with editor's consent.  
Edited by Karl Mayer Textilmaschinenfabrik GmbH, 63179 Obertshausen, Germany

- Germany KARL MAYER Textilmaschinenfabrik GmbH  
Brühlstraße 25, D-63179 Obertshausen  
Tel.: +49-(0)6104-4020,  
Fax: +49-(0)6104-43574  
Internet: <http://www.karlmayer.de>  
E-Mail: [info@karlmayer.de](mailto:info@karlmayer.de)
- KARL MAYER Malimo Textilmaschinenfabrik GmbH  
Mauersbergerstraße 2, D-09117 Chemnitz  
PF 713, D-09007 Chemnitz  
Tel.: +49-(0)371-81430  
Fax: +49-(0)371-8143110  
E-Mail: [info@karlmayer.de](mailto:info@karlmayer.de)
- U.K. Karl Mayer Textile Machinery Ltd.  
Kings Road, Shepshed, Leic. LE 12 9HT  
Tel.: 0044/1509/502056  
Fax: 0044/1509/508065  
E-Mail: [ghlehner@karlmayer.co.uk](mailto:ghlehner@karlmayer.co.uk)
- USA Mayer Textile Machine Corp.  
310 Brighton Road  
Clifton, New Jersey 07012  
Tel.: 001/973/7733350  
Fax: 001/973/4733463  
E-Mail: [edmtmc@aol.com](mailto:edmtmc@aol.com)
- Mayer Textile Machine Corp.  
310 North Chimney Rock Road  
Greensboro, North Carolina 27409  
Tel.: 001/336/2941572  
Fax: 001/336/8540251  
[Mbmtmc@aol.com](mailto:Mbmtmc@aol.com)
- Brazil Karl Mayer Máquinas Textêis Ltda.  
Avenida Presidente Costelo Branco, 7.777  
CEP 05034-000 Sao Paulo/Brasil  
P. O. Box 61098-CEP 05071-970  
Tel.: 0055/11/8611933  
Fax: 0055/11/8612085  
E-Mail: [email@karlmayer.com.br](mailto:email@karlmayer.com.br)
- Japan Nippon Mayer Co. Ltd.  
No. 27-33 1-chome, Kamikitano  
Fukui-City, 918-85-22  
Tel.: 0081/776/545500  
Fax: 0081/776/273400  
E-Mail: [nmsecret@silver.ocn.ne.jp](mailto:nmsecret@silver.ocn.ne.jp)
- P.R. China KARL MAYER TEXTILE MACHINERY LTD.  
159, East Renmin Road  
Hutang Town, Wujin City  
Jiangsu Province, P.R. China  
Tel.: +86-(0)519-6551541/42  
Fax: +86-(0)519-6553412  
E-Mail: [karlmr@public.cz.js.cn](mailto:karlmr@public.cz.js.cn)
- Hong Kong KARL MAYER (H.K.) Ltd.  
Units 1601A-3, 16/F., Stelux House  
No. 698, Prince Edward Road East,  
San Po Kong, Kowloon  
Hong Kong  
Tel.: 00852/27239262  
Fax: 00852/27398730  
E-Mail: [mayerhk@pacific.net.hk](mailto:mayerhk@pacific.net.hk)



**KARL MAYER**