



FH MÜNSTER  
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BAU

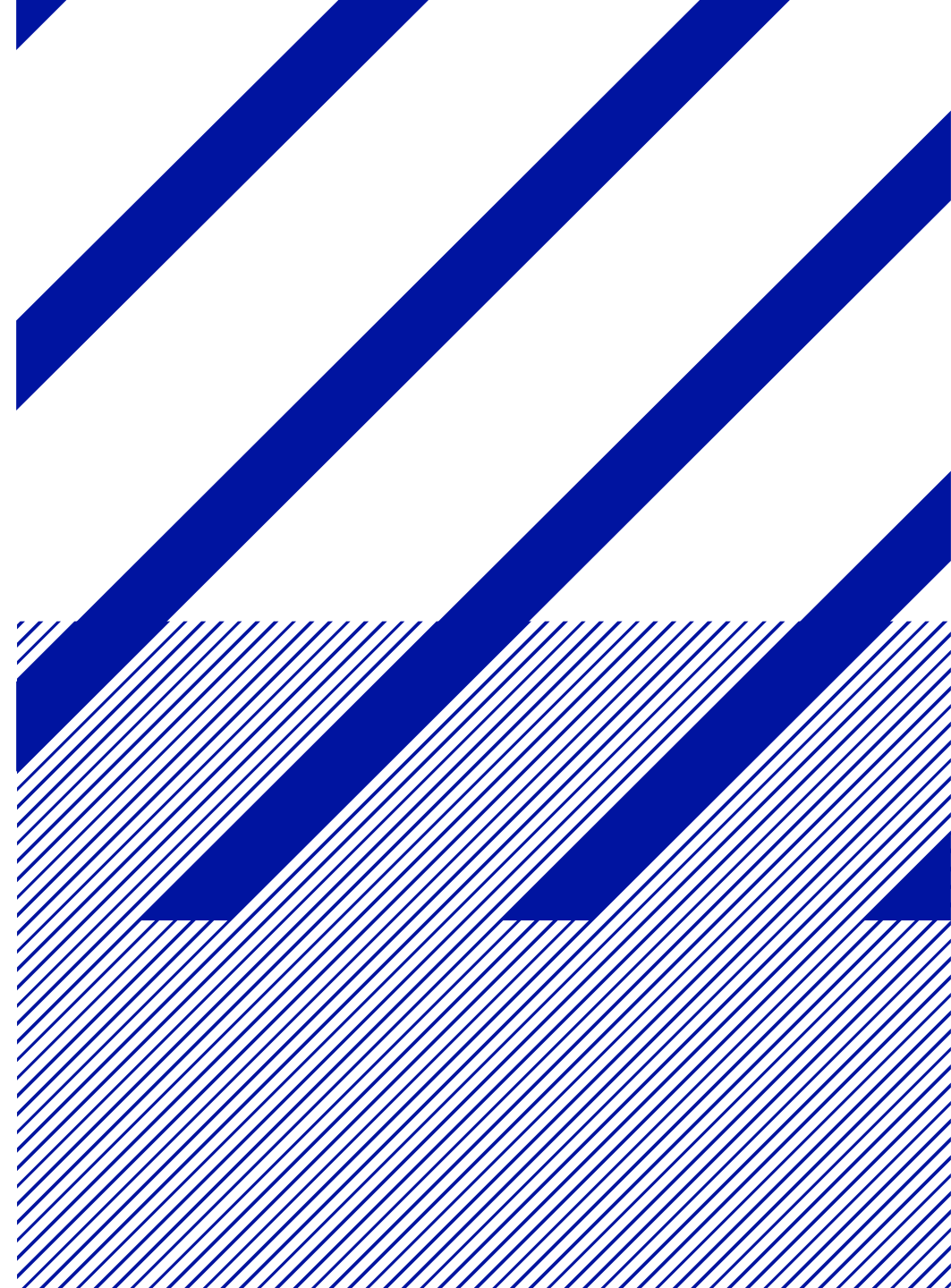
FB Bauingenieurwesen  
Department of Civil Engineering

# Geosynthetics for Sustainable Road Infrastructure

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# Geosynthetics / Geotextiles

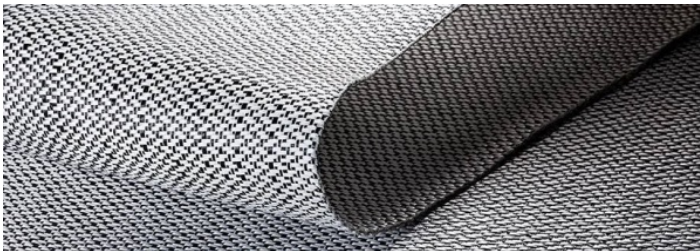
## Geotextiles

e.g. nonwoven, woven, knitted fabrics  
*water-permeable*



**Nonwoven**

Foto: Huesker

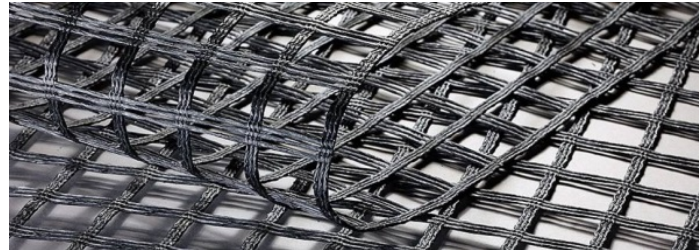


**Woven**

Foto: Huesker

## Geogrids and grid-related

e.g. woven, expanded, layed geogrids; straps, rod-shaped grids,  
*water-permeable*



**Geogrid**

Foto: Huesker



**Woven Geogrid**

Foto: Beco Bermüller

## Membranes

Synthetic sealing membrane,  
clay sealing membrane  
*non / marginal water-permeable*



**Geomembrane**

Foto: Beco Bermüller



**Clay sealing membrane**

Foto: Huesker

Composites



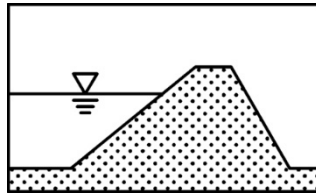
**Geocomposite**

Foto: Huesker

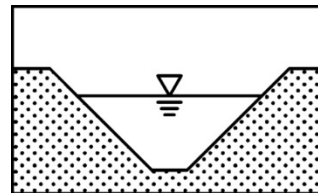
Other textile fabrics

*water-permeable/  
non water-permeable*

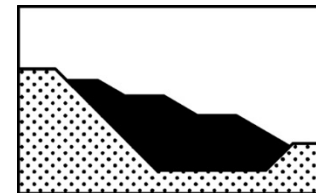
# Applications of Geotextiles



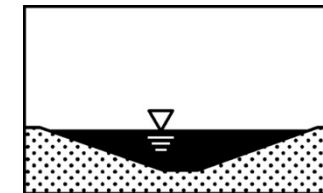
Reservoirs, dams



Canals



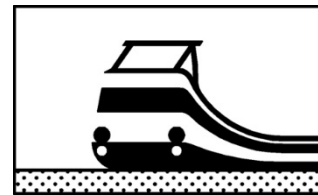
Solid waste



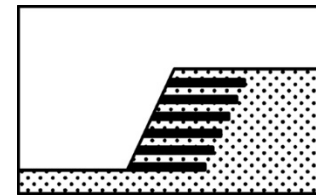
Liquid waste



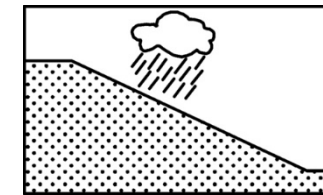
Roads



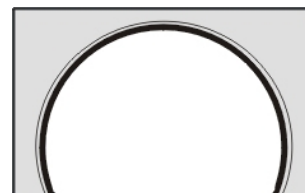
Rail roads



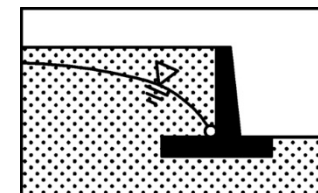
Retaining walls



Erosion protection



Tunnel and underground constructions



Drainage systems



# Examples

## Dam constructions

### Bridge abutments



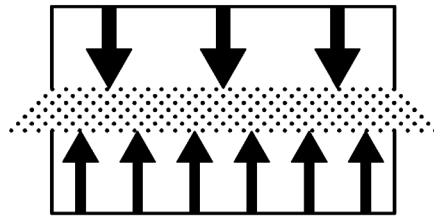
Savings mineral building materials  
(e.g. concrete, crushed stone layer)



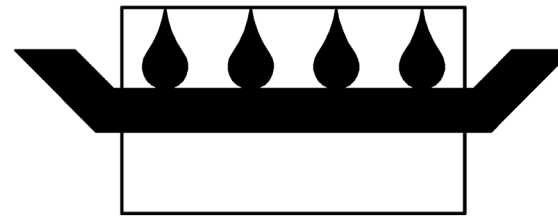
source: Huesker Synthetic

# Functions according DIN EN ISO 10318-2

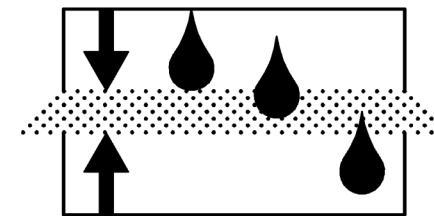
Separation



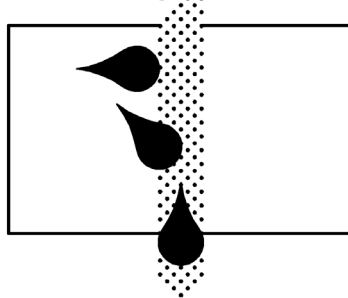
Barrier



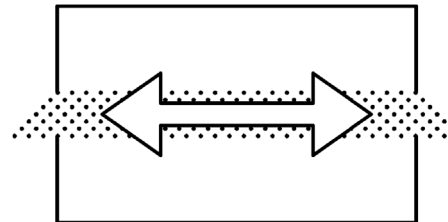
Filtration



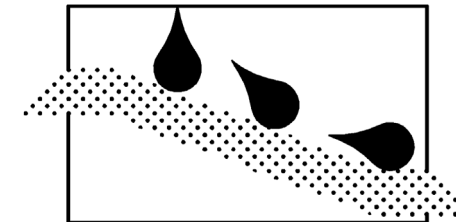
Drainage



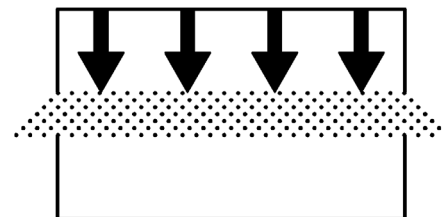
Reinforcement



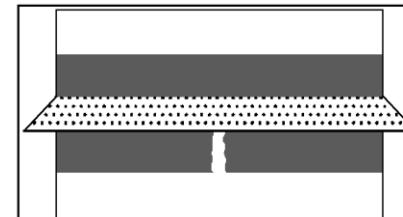
Surface Erosion Control



Protection



Stress relief (for asphalt overlay)



# Multilayer Geotextiles

- combination of two or more geotextiles
- different layers with same geotextile type or of different types: nonwoven, woven or knitted
- combination of different layers gives the product specific properties based on the particular properties of each layer
- different type of connection between layers
- new functions (e.g. swell or adsorption)



# Construction Products Regulation (CPR) 305/2011

	Basic requirements for construction works
1	Mechanical resistance and stability
2	Safety in case of fire
3	Hygiene, health and the environment
4	Safety and accessibility in use
5	Protection against noise
6	Energy economy and heat retention
<b>7</b>	<b>Sustainable use of natural resources</b>



Essential characteristics of geotextiles shall be laid down in harmonised technical specifications in relation to the basic requirements for construction works.



# Construction Products Regulation (CPR) 305/2011

Basic requirement No. 7

## **Sustainable use of natural resources**

The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and in particular ensure the following:

- (a) reuse or recyclability of the construction works, their materials and parts after demolition;
- (b) durability of the construction works;
- (c) use of environmentally compatible raw and secondary materials in the construction works



# Life-Cycle-Assessment (EPD)

Determination and presentation of environmental effects according to

- EN 15804 and
- EN ISO 14025

for life cycle phases A, B, C and D



# Life-Cycle-Assessment



Description of the system boundary (X = included in LCA)																
Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport	Installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-, Recovery-, Recyclingpotential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Results of the LCA – Environmental impact: 1 m <sup>2</sup> geogrid TriAx TX150-GD		
Parameter	unit	A1 – A3
Global warming potential	[kg CO <sub>2</sub> -Eq.]	1,04E+00
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	5,80E-11
Acidification potential of land and water	[kg SO <sub>2</sub> -Eq.]	2,42E-03
Eutrophication potential	[kg (PO <sub>4</sub> ) <sup>3</sup> -Eq.]	2,36E-04
Photochemical Ozone Creation Potential	[kg Ethen-Eq.]	3,55E-04
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	2,54E-07
Abiotic depletion potential for fossil resources	[MJ]	3,03E+01

# Life-Cycle-Assessment



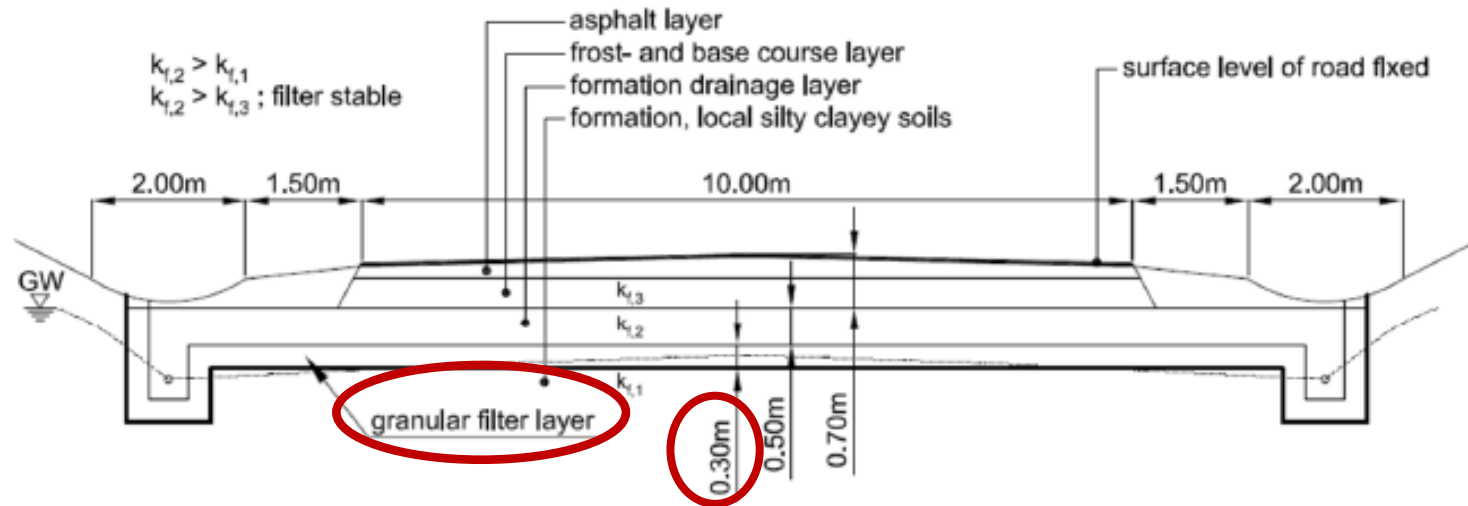
Results of the LCA – Resource use: 1 m <sup>2</sup> geogrid TriAx TX150-GD		
Parameter	unit	A1 – A3
Renewable primary energy as energy carrier	[MJ]	1,11E+00
Renewable primary energy resources as material utilization	[MJ]	IND
Total use of renewable primary energy resources	[MJ]	1,11E+00
Non-renewable primary energy as energy carrier	[MJ]	1,56E+01
Non-renewable primary energy as material utilization	[MJ]	1,64E+01
Total use of non-renewable primary energy resources	[MJ]	3,20E+01
Use of secondary material	[kg]	IND
Use of renewable secondary fuels	[MJ]	IND
Use of non-renewable secondary fuels	[MJ]	IND
Use of net fresh water	[m <sup>3</sup> ]	4,16E-03

Results of the LCA – Waste and output flows: 1 m <sup>2</sup> geogrid TriAx TX150-GD		
Parameter	unit	A1 – A3
Hazardous waste disposed	[kg]	4,24E-06
Non-hazardous waste disposed	[kg]	1,32E+00
Radioactive waste disposed	[kg]	6,53E-04
Components for re-use	[kg]	IND
Materials for recycling	[kg]	IND
Materials for energy recovery	[kg]	IND
Exported electrical energy	[MJ]	IND
Exported thermal energy	[MJ]	IND

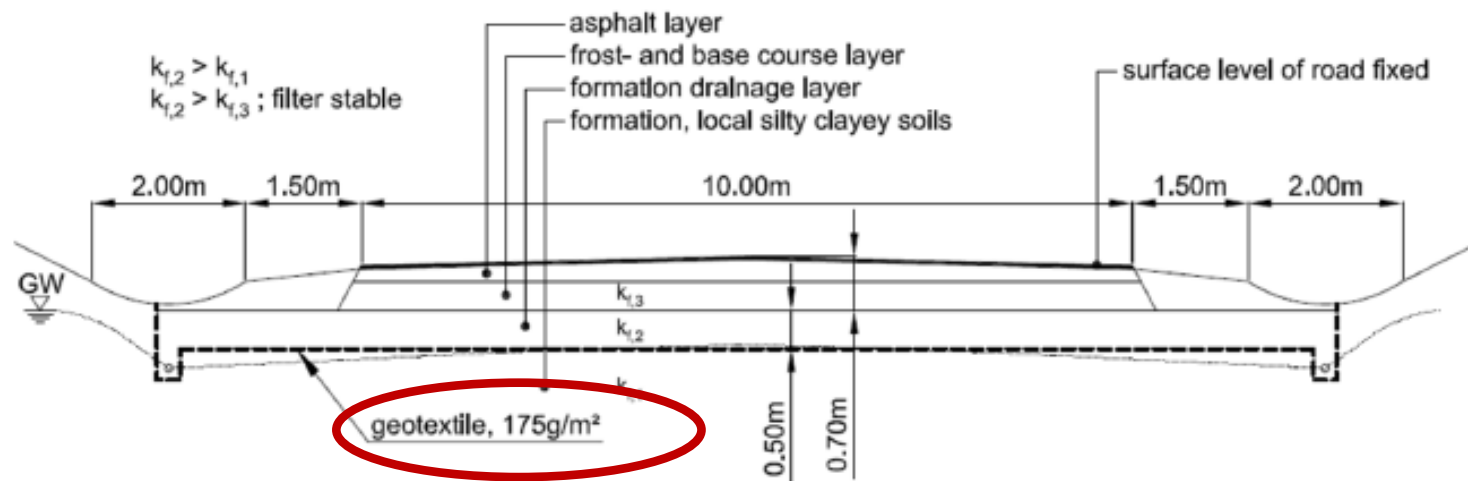
# EAGM-Study



Case 1A



Case 1B





# Life-Cycle-Assessment



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A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Abiotic depletion potential for fossil resources	[MJ]	3,03E+01

# Multilayer Geotextiles (LCA Stage C and D)

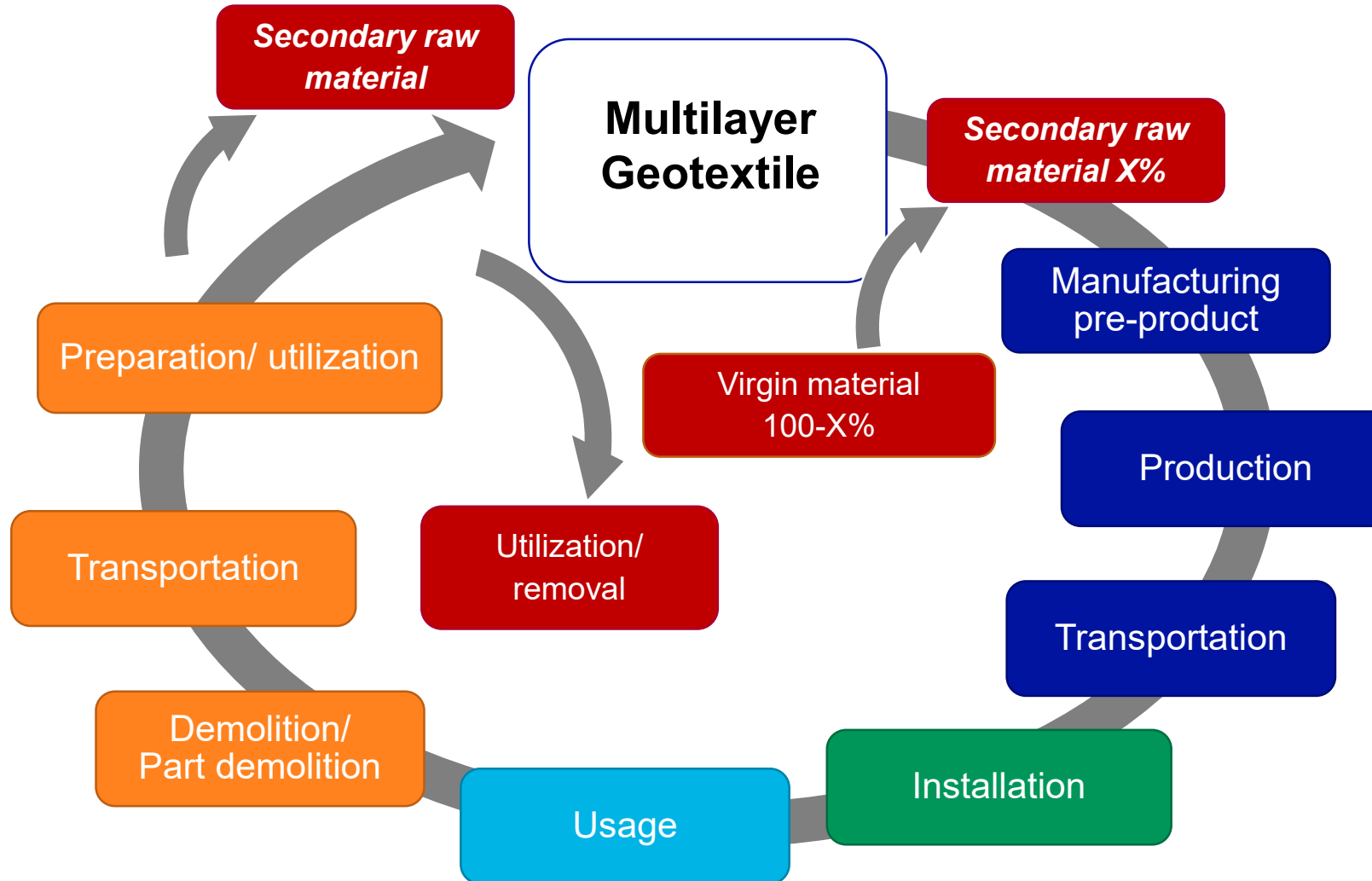
- Procedural separation of the layer
- Purity of the dismantled materials  
→ Use as secondary raw material
- Separation of the geosynthetic residuals out of mineralic material (e.g. soil)
- Ressource conservation of mineralic material



Foto: Herold

# Multilayer Geotextiles

## (LCA Stage C and D)





# Influence of low temperature on the brittleness of Geosynthetics

## Field Conditioning – Kemi, Finland



source: N. Depenbrock

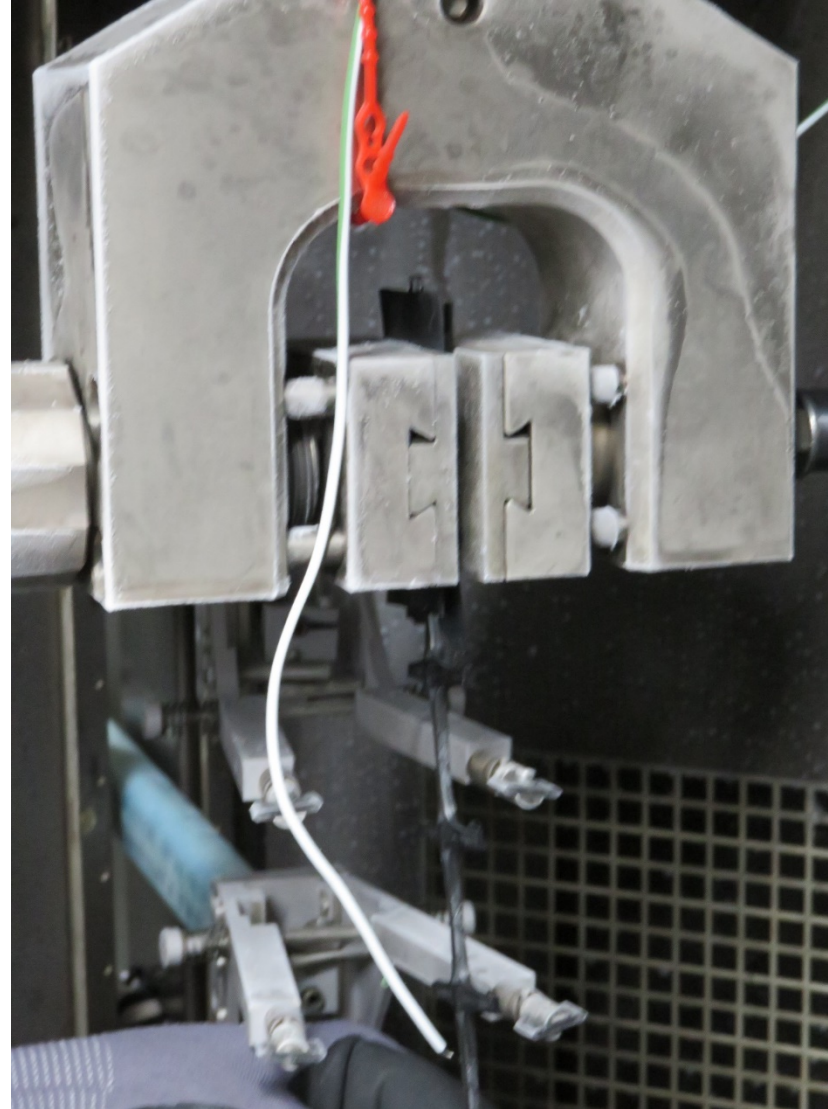




source: N. Depenbrock



# Temperature Conditioning



Tensile Strength Testing  
at  $+23^{\circ}\text{C}$  /  $0^{\circ}\text{C}$  /  $-10^{\circ}\text{C}$  /  $-20^{\circ}\text{C}$

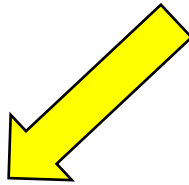
Single Rib Testing Procedure

Strength was tested inside a  
cooling chamber.

source: N. Depenbrock

## Multilayer Geotextiles/Geosynthetics for Road Infrastructure

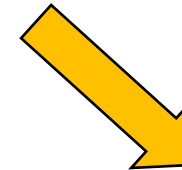
Ecological – Sustainable – For the Future



- LCA criteria are moving into the focus of the essential characteristics of a product



- LCA-Thinking
- Deconstruction and reuse must be guaranteed
- New business model for producer



- Multifunctional use of geosynthetics with new functions
- Special Tests and Development





# Thank you for your attention!

