International Symposium on Geosynthetics and Sustainability
Environmental, Civil and Hydraulic Engineering

NGO IGS Netherlands

Sustainable use of geosynthetics in the Netherlands

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Geosynthetics in the Netherlands

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Contents

- Overview of recent projects in various applications in the Netherlands
- Sustainability aspects
  - Benefits of geosynthetics with regards to Sustainability
  - Use of ECI/MKI method to promote low emission designs
  - Reduction in emissions with production of geosynthetics

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Soil-improvement, base-reinforcement and vertical drainage

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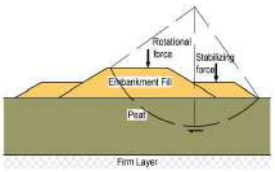
Base-reinforcement, Friesland

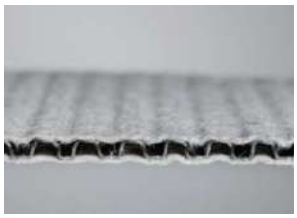
Reclamation IJburg, Amsterdam



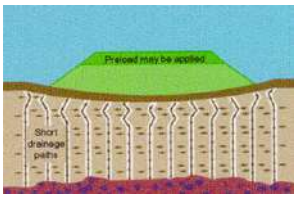
Sustainability benefits:

- Less fill material
- Less emissions
- Less transport movements

Drain made of biobased polymer



Drain made of recycled polymer



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Soil-improvement pile-supported mattress EPS as light weight fill material

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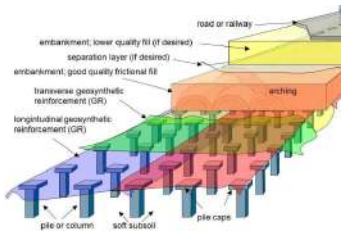

Sustainability benefits:

- Less fill material
- No permanent settlements so extended service life
- Less transportmovements

Pile-supported geosynthetic mattress, A4 Hofvliet, Leiden

Light weight ramp of viaduct over railway line Alphen a/d Rijn - Gouda

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Roadbase reinforcement and platforms

Reinforcement of roadfoundation

Geocells as base reinforcement

Sustainability benefits:
- Less fill material
- Longer service life
- Less transport movements

Platform under construction site of wind turbine, Vlaardingen

Separation layer made of biobased polymer

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Reinforced slopes

A24 Blankenburgconnection, Rotterdam

Sustainability benefits:
- Less fill material
- Less transportmovements
- Less emissions

Reinforced slope, Moerdijk

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Reinforced walls

Earth pressure relief structure behind concrete wall, without connection

Anchored reinforced wall, Steenwijkerland

Sustainability benefits:
- Less fill material
- Less transportmovements
- Less concrete

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Hydraulic applications

Filterlayer Markermeer dikes

Biobased nonwoven, Hondhalstermeer

Reinforced grass in higher part of the slope of a dike, Zeeland

Fascine mattress with filterlayer in bottom protection, Rotterdam

Sustainability benefits:
- Less primary raw material as broken stones, concrete or clay

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Hydraulic applications

Bentonite mat instead of clay on top and outside slope , Beesel

Geosynthetic tube as artificial island

Large sandbags in coastal protection

Concrete mattress in revetment, Berg a/d Maas

Sustainability benefits:

- Less primary raw material as broken stones, concrete or clay
- Less transportmovements

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Geomembranes in landfill covers and lowered roads

Anchorage of veneer-layer on landfill cover

Cover of landfill, Twente

Access road to tunnel

Open tunnel with geomembrane and nonwoven protection layer, N 206, Katwijk

Sustainability benefits:

- Less fill material
- Less transportmovements
- Less concrete

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Quality control





Quality control is executed in well equiped laboratories and in case of geomembranes also at the site

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Economic and Environmental Benefits of Geosynthetics

Advantages of use of geosynthetics

- Economic
  - In many cases reduction of direct costs
- Sustainability
  - Reduced environmental impact
    - Life Cycle Analysis of project and materials
    - Environmental Cost Indicator to be able to compare
    - Valued through the fictitious discount on tender price, based on ECI shadow price
  - Reduced quantity of primary raw materials
  - Innovation in the production of geosynthetics leads to reduced emissions

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Environmental benefits of Geosynthetics

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Various publications with LCA analysis comparing all kind of traditional structures with geosynthetic designs:

Application Area	No. Cases Described	Average Carbon Savings
Walls	6	69%
Embankments and Slopes	4	65%
Armoring	4	76%
Landfill Covers	3	75%
Landfill Liners	2	30%
Retention	3	61%
Drainage Pipe	3	40%
TOTALS	25	65%

GRI-24 Conference on Sustainability, 2011

Savings depending on the application:

CO_2-emission	30 – 89 %
Energy	up to 85 %

Case History	Traditional Approach	Geosynthetic Approach
	CO_2 Footprint (tons)	CO_2 Footprint (tons)
#1 Slope Stability	157	21
#2 Bridge Approach	500	346
#3 Crib Wall	35	11
#4 Sheet Piling Wall	433	69
#5 Concrete Wall	107	20

Waste and Resources Action Program (WRAP), 2010

	Savings compared to traditional structures	
Application	Energy consumption	CO_2 emission
Separation material in a road construction	85%	89%
Road foundation reinforcement	5-10%	32%
Drainage layer	56%	67%
Retaining wall	85%	75%

Stücki et al., 2019

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Sustainability requirements

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Sustainability goals in Paris Agreements:

Increase of global temperature well below 2^o above pre-industrial levels

Targets

- EU target: reduction of emissions of 55 % by 2035 (compared with 1990) and climate neutral by 2050
- Netherlands: reduction of emissions of 55 % by 2035 and 100 % by 2050
- Ministry of infrastructure and watermanagement – Rijkswaterstaat:
  - climate neutral by 2030 (100% reduction of CO_2 by 2030)
  - Circular use of materials in projects by 2030
  - 50 % reduction of primary raw materials (sand, steel, cement etc.) by 2030

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How to achieve this ambitious program?

Ministry of infrastructure and watermanagement:

1. Roadmaps – transition paths for various applications, such as:
   - structures
   - road - pavement
   - coastal works and river works
   - sustainable building site organisation and logistics
2. Agreements between Rijkswaterstaat and branch organizations on:
   - adaption of equipment
   - recycling of concrete
   - recycling of asphalt from road surface
   - use of innovative materials

Financially supported by Rijkswaterstaat and guaranteed for use in the coming years

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Main action plan

3. Reduction of emission of building equipment: trucks, cranes, ships
   - Electrification of equipment
   - Loading facilities with renewable energy
   - Development of cleaner engines with hydrogen power (dredgers, ships etc.)
4. Life-extending designs and materials
5. Reduction of volumes of primary raw materials
   - Directly related emissions will reduce
   - Emissions as result of transport and installation will reduce
   - Room for innovative designs:
     - Geosynthetic reinforced walls
     - Roadbase reinforcement

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Main action plan

6. Circularity in use of materials and components
   - Recycled materials
     - Recycling of concrete, asphalt, sand
     - Geosynthetics made of recycled polymers
   - Re-use of components (circularity design)
     - Concrete beams
     - Steel components
     - Geosynthetic layers

7. Favor designs with low environmental costs by the use of the ECI as a price-quality criterion during tendering

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Tender award based on best price-quality ratio

The quality aspects of a design are valued:

a. Performance
b. Quality aspects
c. Environmental Cost

- Each category has a fictitious value of approx. 20% of the standard price

- A fictitious discount is determined for each category based on an assessment of the proposed design and the execution.

- The Environmental Cost Indicator is used to determine the Environmental Costs and to assess these costs.

The ECI is a method to calculate the costs of emissions that are the result of construction of projects. Normalised method (EN 15804) resulting in a “shadow price”.

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Environmental Costs category

- An emission target for a new project is set with maximum and minimum levels for ECI
  - Execute a Life Cycle Analysis for all tendered designs
  - Calculate the ECI / MKI for all designs. Use Dubocalc software.
  - The minimum ECI equals the maximum fictitious discount. The maximum ECI value equals no fictitious discount
  - Determine the fictitious discount based on interpolation between the limits.
- Deduct the 3 fictitious discounts from the tender price

Tender with the lowest discounted value is selected

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Innovation in the production of Geosynthetics

Reduction in emissions with production of geosynthetics

- Use of recycled polymers
  - Recycled polymer from other qualified sources than geosynthetics
  - Mixture of virgin and recycled raw material
  - Products already on the market: vertical drain, nonwovens, woven
- Use of biobased polymers
  - Available products: vertical drain
- Recycling of used geosynthetics
  - Mechanical and chemical recycling
- Use of renewal energy during production of the geosynthetics
- Re-use of geosynthetic elements
  - Evaluate quality, reduced properties, effect on service life

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Conclusions

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Use of geosynthetics can result in:
- Considerable reduction in CO_2 emissions
- Considerable reduction in energy consumption

Use of Environmental Cost Indicator (MKI) during tender awards evaluation results in:
- Designs with longer service life are preferred
- Recycling of materials and components is promoted
- Use of geosynthetics in structures and construction methods offer feasible alternative

Use of recycled polymers as raw material for geosynthetics
- Real possibility but not yet generally applicable due to shortage of recycled polymer

Use of re-used geosynthetics
- Possible for non-reinforced applications
- After examination and testing possible for reinforcement applications

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Actions by Nederlandse Geotextiel Organisatie

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Publications and lectures

- CROW committee which prepares a guideline for durable and sustainable use of geosynthetics
- Life Cycle Analysis of projects and sustainability comparison of typical projects presented at membership meetings
- Special Issue of Geokunst, December 2022 with a study of the geosynthetics share in total plastic use, the amounts of geosynthetics waste in the environment, recycling and re-use

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Nederlandse Geotextiel Organisatie

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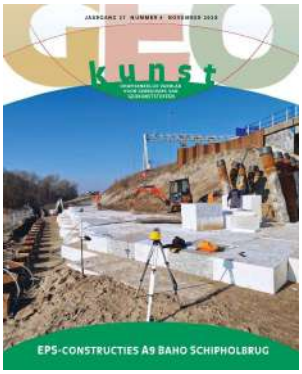
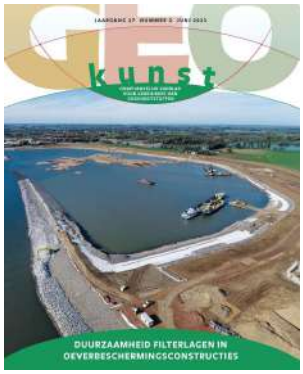
Why become an NGO member

- 2 - 3 times per year a digital or physical meeting with presentations on Geosynthetics and their use in projects
- 3 times a year a new issue of Geokunst with publications on Geosynthetics in general and in applications
- Free membership of IGS
- Access to all international papers through IGS libary
- Network of experts on design and types





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Nederlandse Geotextiel Organisatie

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