Comparative Life Cycle Assessment of Geosynthetics versus Conventional filter layer

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Introduction

Geosynthetic materials are used in many different ap¬plica¬tions in civil and under¬ground engineering, such as in road con¬struc¬tion, in foun¬dation stabilisation, in landfill construction and in slope retention. In most cases they are used instead of minerals based materials such as concrete, gravel or lime.

Environmental aspects get more and more relevant in the construction sector. That is why the environmental performance of technical solutions in the civil and underground engineering sector gets more and more attention. A comparative life cycle assessment of Geosynthetics versus Conventional filter layer has been performed.

Geosynthetic versus mineral filter

The two alternative cases compare the environmental impacts of one square meter of the filter area below the road. The basic conditions are shown in Fig. 1. The additional excavation needed at the boundary area of the mineral filter is not considered in the comparison.

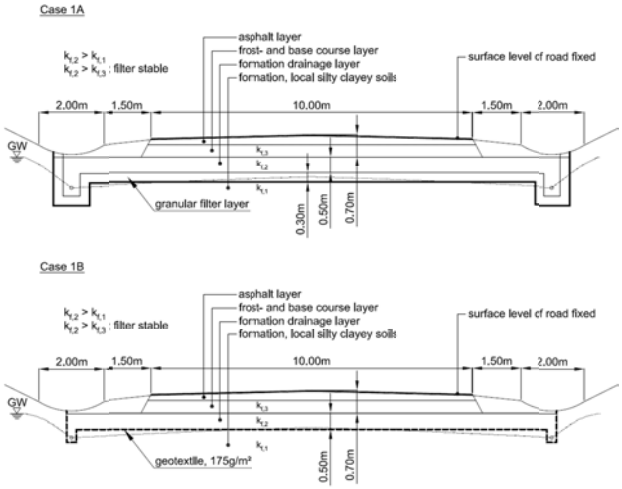

Fig. 1: Cross section of the mineral filter (top) and geosynthetic filter system (bottom)

Some important key figures of the construction of the filter systems are summarized in Tab. 1. The information refers to one square meter filter and a life time of 30 years.

Tab. 1: Selected key figures describing the two constructions of one square meter of filter system

Material/Process	Unit	Gravel filter	Geosynthetic filter
Gravel	t/m^2	0.69	0
Geosynthetic layer	m^2/m^2	0	1
Diesel used in building machines	MJ/m^2	2.04	1.04
Transport, lorry	tkm/m^2	34.5	0.035
Transport, freight, rail	tkm/m^2	0	0.07
Particulates emitted	g/m^2	6.1	0

Results

Fig. 2 shows that the average geosynthetic filter system (1A) causes lower environmental impacts compared to the mineral filter system with regard to all indicators investigated. For all indicators the average filter with geosynthetics (1A) causes less than 25 % of the environmental impacts of a conventional gravel based filter (1B). The geosynthetic filter (1B) layer causes between 0.2 % and 14.3 % of the environmental impacts of the mineral filter layer (1A, water use, CED non-renewable). The greenhouse gas emissions caused by the geosynthetic filter (1B) are 10.4 % of the greenhouse gas emissions caused by the mineral filter (1A). In a sensitivity analysis (1AS1 and 1AS2) the thickness of the gravel filter is varied by +/- 10 cm.

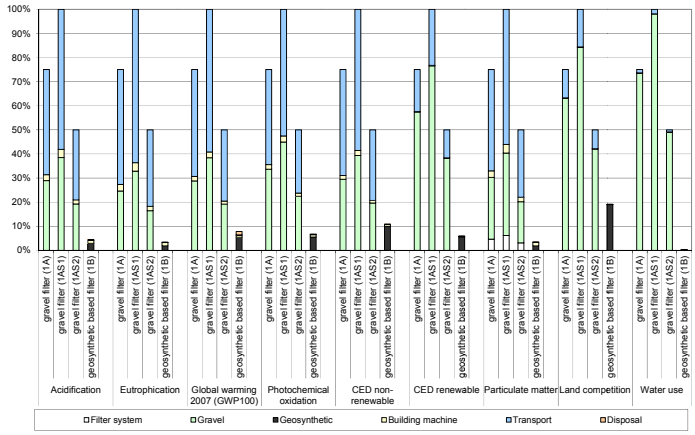

Fig. 2: Sensitivity analysis: environmental impacts of the life cycle of 1 m2 of filter layer. 1AS1 and 1AS2 refer to the sensitivity analysis with a different thickness of the gravel based filter layer. For each indicator, the case with highest environmental impacts is scaled to 100°%.

Contribution analysis geosynthetic production

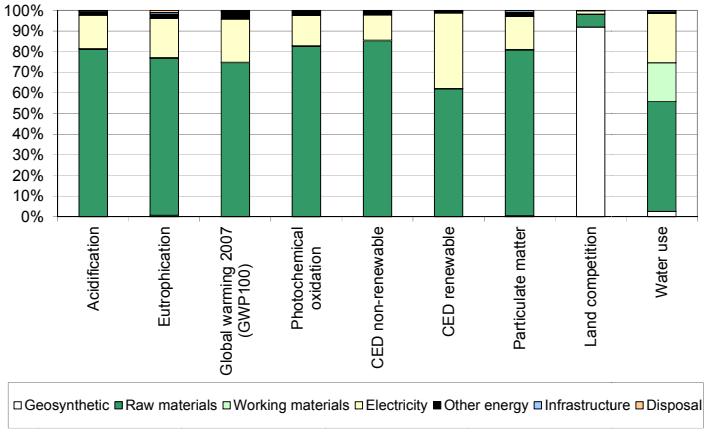

Fig. 3: Environmental impacts of the life cycle of 1 kg geosynthetic layer. Geosynthetic: direct burdens of the geosynthetic production; Raw materials: plastic, extrusion if necessary, and additives; Working materials: water (tap and deionised) and lubricating oil; Other energy: thermal energy and fuels; Infrastructure: construction of the production plant; Disposal: wastewater treatment and disposal of different types of waste.

Conclusions

- Geosynthetic layer cause lower environmental impacts compared to conventional gravel based filter layers with regard to all impact category indicators investigated
- If **30 cm of gravel are saved**, the specific climate change impact of the construction of 1 square meter filter using geosynthetics is about **7 kg CO_2-eq** lower compared to the impacts from the construction of an equivalent gravel based filter.
- At least a layer of **8 cm** of gravel filter must be replaced by geosynthetics in order to cause the same or lower environmental impacts.

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