ACTA SCIENTIARUM POLONORUM
aspa.sggw.edu.pl
content.sciendo.com/aspa

Acta Sci. Pol.
Architectura 21 (2) 2022, 11–19

ISSN 1644-0633 eISSN 2544-1760 DOI: 10.22630/ASPA.2022.21.2.10

ORIGINAL PAPER

Received: 20.02.2022
Accepted: 25.05.2022

IMPACT OF THE CONSTRICTIONS NUMBER ON FILTRATION CHARACTERISTICS OF NONWOVEN GEOTEXTILES

Anna Markiewicz✉, Eugeniusz Koda

Institute of Civil Engineering, Warsaw University of Life Sciences – SGGW, Warsaw, Poland

ABSTRACT

The use of nonwoven geotextile filters is common in geoenvironmental and geotechnical engineering applications. The main requirements for successful performance of drainage and geotextile filters are soil retention, permeability and clogging resistance. In case of anti-clogging capabilities, the most popular method to evaluate the filtration behaviour of nonwoven geotextile in contact with soils is gradient ratio test. Also the number of constrictions of nonwoven geotextile should be determined on the basis of fibre diameter, thickness and porosity. The number of constrictions has been found to explain the different filtration behaviours of nonwoven geotextiles with similar or even the same opening sizes but different structures for various soil conditions. This paper presents the gradient ratio test program for internally unstable soil and nonwoven geotextiles with different structures. Test results show a significant impact of the number of constrictions on the filtration characteristics of geotextile. What is more some modifications to the filter design criteria are proposed based on interpretation of the experimental results.

Key words: geotextile filter, drainage, clogging, gradient ratio, constrictions

INTRODUCTION

In the field of geotechnical engineering, the major functions of geotextiles can be listed: filtration, drainage, separation and reinforcement. Of these, the filtration, drainage and separation functions interact with each other, so improving the overall drainage performance (Sato, Yoshida & Futaki, 1986; Yoo & Kim, 2016; Portelinha & Zornberg, 2017; Brózda & Selejdak, 2019).

The drainage systems and filters made by natural materials, such as gravel and sand, are being replaced by synthetic materials, mainly because of difficult of obtaining good quality natural materials and transporting materials from great distances. Also important factors for the use of geosynthetics are the cost reductions, the thickness reduction of filter layer, the agility of execution of work and stocking facility (Vieira, Abramento & Campos, 2010; Heibaum, 2014; Palmeira & Trejos Galvis, 2018).

When a nonwoven geotextile is placed in a soil matrix and a hydraulic gradient is applied across the interface, migration of the soil particles adjacent to the geotextile occurs. Three types of particles may occur (Rowe & McIsaac, 2005; Koerner & Koerner, 2015; Miszkowska et al., 2016; Shukla, 2016; Fatema & Bhatia, 2018):

- small particles may be transported through the nonwoven geotextile and into drainage media (piping); some degree of particle transport through the geotextile should occur whenever it is placed against fine-grained soils. This transport continues until a stable filter cake develops at the soil/geotextile interface;
- small to intermediate size soil particles may be electrostatically attracted to the fibres of the geotextile

Anna Markiewicz https://orcid.org/0000-0002-7715-2809; Eugeniusz Koda https://orcid.org/0000-0002-3895-960X
✉anna_markiewicz@sggw.edu.pl

or may lodge in the pores of the fabric; the reduction in the pore volume of the geotextile caused by accumulation of soil particles is termed "physical clogging" and results in reduced flow capacity of the drain (Fig. 1). Clogging can be also caused by biological and/or chemical processes;
- a transitional filter may develop in the soil resulting from successive filtration of fine grained soils; the formation of "filter cake" in the soil at the soil/geotextile interface results in a reduced flow capacity across the interface which is called blinding.

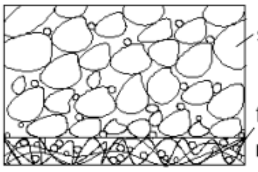


Fig. 1. Physical clogging of nonwoven geotextile

Also three criteria must be met in designing of filtration systems (Lawson, 1982; Giroud, 2010; Moraci, 2010; Miszkowska, Krzywosz & Koda, 2017):
- retention – the pore-channels of the filter should be small enough to retain the erodible soils and prevent piping;
- permeability – the pore-channels should be large enough to enable water to flow away freely from the protected soils, thus preventing the build-up of excess hydrostatic pressure;
- clogging resistance – flow requirements must be maintained over the design life of the structure.

Therefore the performance of geotextile filters is controlled by following factors (Table 1).

Table 1. The main factors effecting on filter properties (Hoare, 1982)

Material	Factor
Geotextile	Pore size distribution (characteristic opening size), porosity, thickness, fibre size
Soil	Grain size and its distribution, porosity, permeability, cohesiveness
Soil + Geotextile	External stress and strain
Water	Hydraulic conditions

What is more, in order to experimentally evaluate the drainage performance of a geotextile incorporated with a soil, the test method employed should simulate the actual interaction between the geotextile and the soil. According to some of the previous s studies, for example Calhoun (1972), Haliburton and Wood (1982), it was proposed that the drainage performance of geotextiles be estimated by gradient ratio tests. Gradient ratio (*GR*) is defined as the hydraulic gradient through the lower 25 mm of the soil plus geotextile divided by the hydraulic gradient through the adjacent 50 mm of the soil, according the standard ASTM D5101-1 (ASTM International [ASTM], 2012). Gradient ratio values exceeding 3.0, were believed to signify excessive nonwoven geotextile clogging (Carroll, 1983; Giroud, 2010; Fannin, 2015).

Apart from the gradient ratio, the number of constrictions of nonwoven geotextile should be determined. The constriction is a "window" delimited by three or more fibres, through which soil particles could migrate (Giroud, 1996; ASTM, 2016; Fig. 2).

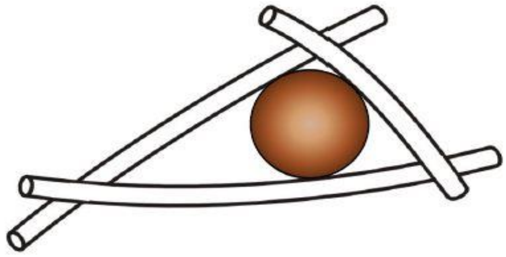


Fig. 2. Constriction between fibers (Giroud, 2010)

The number of constrictions "*m*" can be basically defined by the following equation (Giroud, 1996):

$$m = \sqrt{1 - n_{\mathrm{GTX}}}\,\frac{t_{\mathrm{GTX}}}{d_f}, \tag{1}$$

where:
n_{GTX} – geotextile's porosity,
t_{GTX} – geotextile thickness,
d_f – fiber diameter.

Porosity (*n*) is calculated from (Wayne & Koerner, 1993):

$$n_{\mathrm{GTX}} = 1 - \frac{\mu_{\mathrm{GTX}}}{\rho_{\mathrm{GTX}} t_{\mathrm{GTX}}}, \tag{2}$$

where:
μ_{GTX} – mass per unit area of geotextile,
ρ_{GTX} – density of the geotextile.

The optimal constriction numbers should range between 25 and 45 (Giroud, 1996). However the research scientists recommend conducting more tests to assess the significance of this parameter when comparing two products with different opening sizes. What is more the limit was set based on the filtration opening size, i.e. $FOS = O_{100}$ (Fig. 3). Meanwhile, the geotextile filter criteria in Europe, according to the standard ISO 12956:2019 (International Organization for Standardization [ISO], 2019), should be based on characteristic opening size O_{90}.

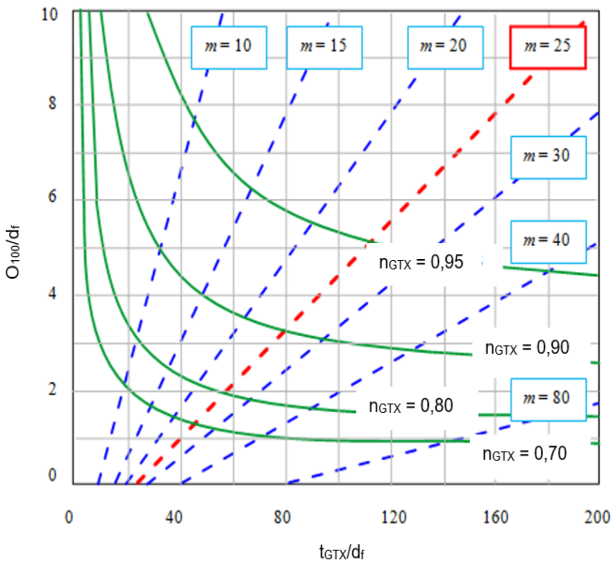


Fig. 3. The relationship between O_{100}/d_f and t_{GTX}/d_f (Giroud, 1996)

The main purpose of this study to analyse the influence of the number of constrictions on the filtration properties of nonwoven geotextiles. The research goal was (i) to determine the number of constrictions of three needle-punched nonwoven geotextiles and (ii) to perform gradient ratio tests.

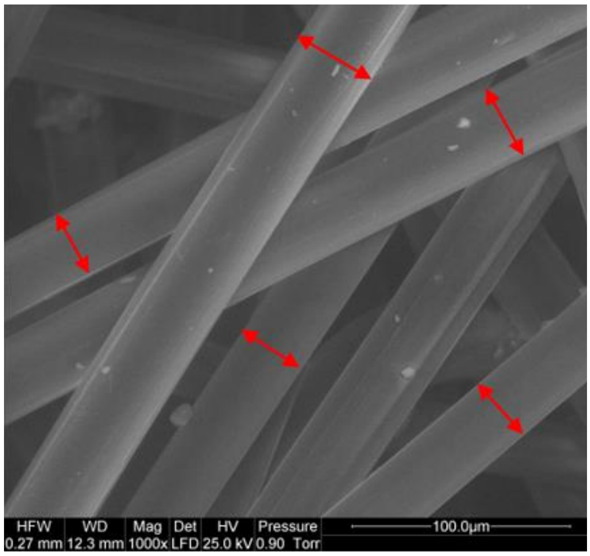
MATERIAL AND METHODS

Nonwoven geotextiles

Two types of polypropylene needle-punched nonwoven geotextile samples were analysed in gradient ratio tests and will be further referred to as A and B.

To calculate the number of constrictions the fibre diameters of tested samples were determined by the use of scanning electron microscope (SEM). The SEM images are presented in Figure 4.

a



b

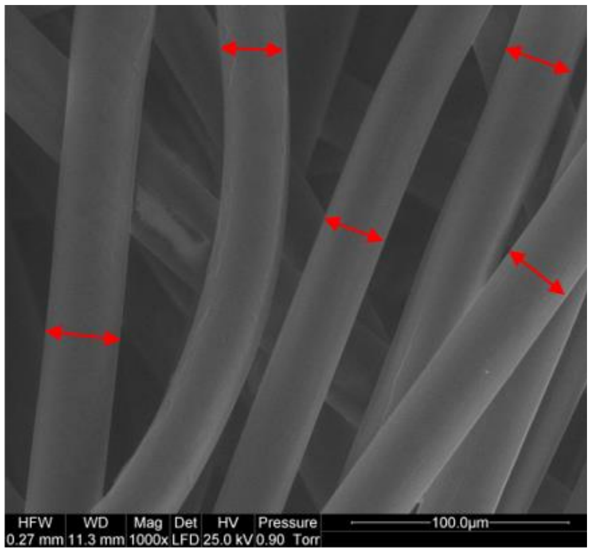


Fig. 4. The SEM images of nonwoven geotextile sample A (a) and sample B (b)

The fibre diameters were determined based on the average value from fifty measurements. The mean values of fibre diameters were equal to 34.50 and 33.15 μm for samples A and B, respectively. The physical, hydraulic and mechanical properties of tested geotextiles are summarized in Table 2.

Table 2. The main factors effecting on filter properties (Hoare, 1982)

Properties	Geotextile A	Geotextile B
Mass per unit area [g·m^{-2}]	246	310
Thickness under 2 kPa [mm]	1.34	1.62
Porosity [%]	0.80	0.79
Tensile strength – MD[a] [kN·m^{-1}]	20	25
Tensile strength – CMD[b] [kN·m^{-1}]	20	25
Elongation at maximum load – MD [%]	50	50
Elongation at maximum load – CMD [%]	55	60
Characteristic opening size O_{90} [mm]	0.070	0.065
Water permeability coefficient [m·s^{-1}]	0.00546	0.00476
Number of constrictions [-]	17	22

[a]MD – machine direction, [b]CMD – cross machine direction.

Soil

According to ISO 14688-2 (ISO, 2017), the soil used in gradient ratio tests was classified as silty sand (siSa). For this material Table 3 presents the particle size dimensions. The soil was internally unstable (Kenney & Lau, 1985; Figs 4 and 5, and Table 4).

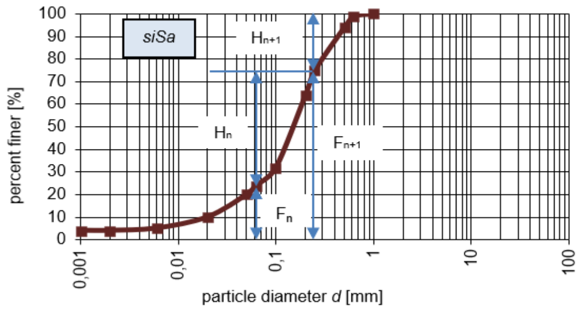


Fig. 4. Particle size distribution curve of silty sand and the example of coordinates to construction of soil internal stability graphs according to Kenney and Lau (1985)

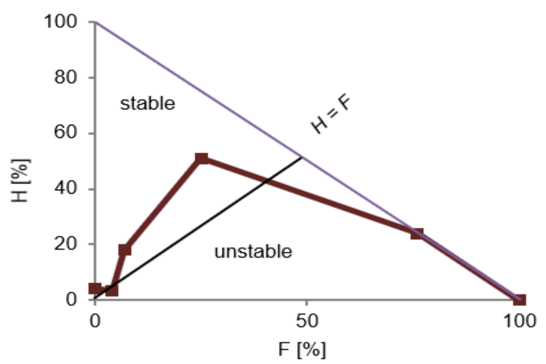


Fig. 5. Internal stability of soil graph according to Kenney and Lau (1985)

Table 3. Particle size characteristics of tested silty sand

Particle diameter				Coefficient of uniformity	Coefficient of curvature
d_{10}[a]	d_{30}	d_{50}	d_{60}	(C_U) d_{60}/d_{10}	(C_C) $d_{30}^2/d_{60}d_{10}$
0.02	0.095	0.16	0.19	9.50	2.38

[a]d_n – diameter for which n% in mass of the remaining soil particles are smaller than that diameter.

Table 4. Point coordinates F_n and H_n in relation to soil particle diameters

Particle diameter (*d*) [mm]	Point coordinate (F_n; H_n)
0.001	(F_0; H_0) = (0; 4)
0.004	(F_1; H_1) = (4; 3.5)
0.016	(F_2; H_2) = (7; 18)
0.064	(F_3; H_3) = (25; 51)
0.256	(F_4; H_4) = (76; 24)
1.024	(F_5; H_5) = (100; 0)

Gradient ratio test

An ASTM D5101-12 gradient ratio test modified apparatus was used to perform the tests (ASTM, 2012). The additional piezometers (6 and 7) were installed to obtain additional pressure measurements in layer of soil situated close to nonwoven geotextile sample. Figure 6 presents schematically the device used in the work.

The tested soil was dried (under 105°C for 24 h) and sieved with mesh 2 mm. Then, the siSa sample was placed around the nonwoven geotextile material. The water was delivered into the apparatus from bottom to the top slowly in the beginning for 24 h. After that, flow direction was changed. When the water flow reached a steady condition, volume of flow (V), time of flow (t), pressure of individual piezometer (Δh) and the temperature of water flow (T) were measured for each of the hydraulic gradients at 1.0, 2.5, 5.0, 7.5 and 10.0. Two tests were performed for each type of nonwoven geotextile and one type of soil.

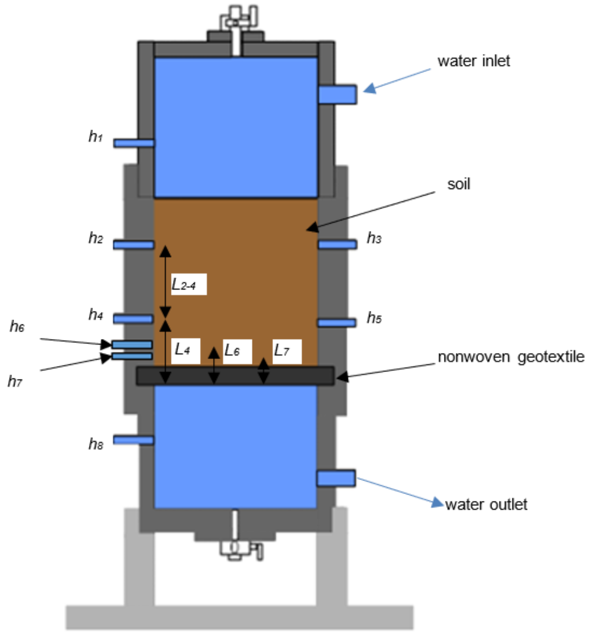


Fig. 6. Scheme of gradient ratio test device (h_1–h_8 – piezometers)

The following piezometer readings were taken in individual zones:

- for soil–geotextile:
  - zone 7–8 (geotextile and 4 mm layer of soil between seventh and eighth piezometer),
  - zone 6–8 (geotextile and 8 mm layer of soil between sixth and eighth piezometer),
  - zone 4.5–8 (geotextile and 25 mm layer of soil between fourth along with fifth piezometer and eighth piezometer);
- for soil:
  - zone 6–7 (4 mm layer of soil within the distance from 4 to 8 mm above nonwoven geotextile between sixth and seventh piezometer),
  - zone 4.5–6 (17 mm layer of soil within the distance from 8 to 25 mm above nonwoven geotextile between fourth along with fifth piezometer and sixth piezometer),
  - zone 2.3–4.5 (50 mm layer of soil within the distance from 25 to 75 mm above nonwoven geotextile between second along with third piezometer and fourth as well as fifth piezometer).

The gradient ratio ($GR = GR_{25}$) in soil–geotextile system, was calculated from:

$$GR_{25} = \frac{\Delta h_{4.5-8}/L_4}{\Delta h_{2.3-4.5}/L_{2-4}}, \tag{3}$$

where:

$\Delta h_{4.5-8}$ – the difference manometer readings between average reading of fourth as well as fifth piezometer to eighth piezometer [mm],

$\Delta h_{2.3-4.5}$ – the distance in manometer readings between average reading of second as well as third piezometer and average reading of fourth as well as fifth piezometer [mm],

L_4 – the distance between fourth piezometer and the bottom of geotextiles [mm],

L_{2-4} – the distance between second and fourth piezometer [mm].

In addition, the GR_8 and $GR4$ were calculated according the following equations:

$$GR_8 = \frac{\Delta h_{6-8}/L_4}{\Delta h_{2.3-4.5}/L_{2-4}}, \tag{4}$$

$$GR_4 = \frac{\Delta h_{7-8}/L_4}{\Delta h_{2.3-4.5}/L_{2-4}}, \tag{5}$$

where:

Δh_{6-8} – the distance in manometer readings between reading of sixth and eighth piezometer [mm],

Δh_{7-8} – the difference manometer readings between reading of seventh and eighth piezometer [mm].

RESULTS AND DISCUSSION

The gradient ratio test results are presented in Table 5. Ideal conditions would yield a uniform head loss through the soil sample, and a gradient ratio value of unity ($GR_{25} = 1$). Entrapment of fine particles within or on the nonwoven geotextile yields a zone of relatively lower permeability and an increased head loss across the composite soil–geotextile filter zone. So the clogging phenomenon causes the value of gradient-ratio to exceed unity (Fannin, 2010). For tested samples, the GR_{25} did not exceed the limit of gradient ratio equal 3. The U.S. Army Corps of Engineers proposed a criterion $GR_{25} < 3$ to avoid any unacceptable clogging, based on the findings of Haliburton and Wood (1982) from tests on silty sand samples with different silt content. The tested soil contains 24% of fine particles (silt and clay).

Table 5. The gradient ratio values at the end of test for hydraulic gradient at 10.0

Geotextile	Gradient ratio		
	GR_{25}	GR_8	GR_4
A	2.96	3.86	4.92
B	2.42	2.86	3.75

However, $GR_4 > GR_8 > GR_{25}$. It indicates that the significant clogging occurred in the 4-mm and 8-mm layer above the nonwoven geotextile. What is more, the gradient ratio values increases with time (Figs 7 and 8) due to physical clogging.

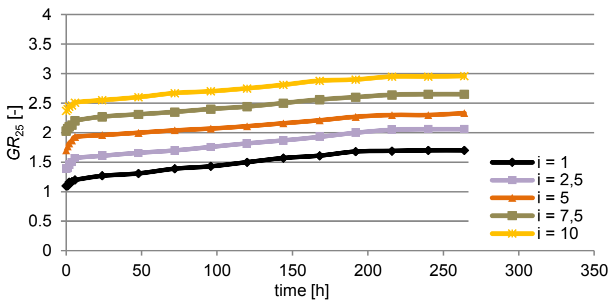


Fig. 7. Change of gradient ratio GR_{25} with time under different hydraulic gradients for soil–nonwoven geotextile A system

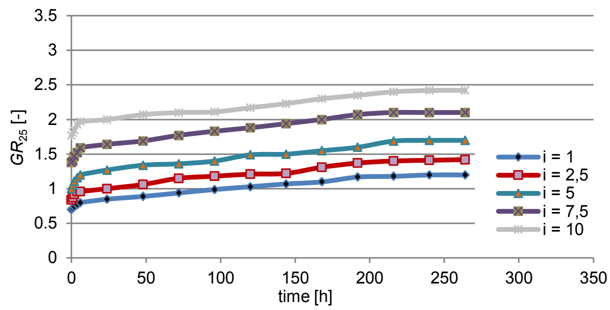


Fig. 8. Change of gradient ratio GR_{25} with time under different hydraulic gradients for soil–nonwoven geotextile B system

Also Fannin et al. (1996) introduced an additional measurement location at Port 6, located only 8 mm above the geotextile, yielding a value of GR_8 that is a more sensitive index to piping or clogging in the soil–geotextile composite zone. Test device were also modified by Palmeira and Matheus (2000).

In the research conducted by Nishigata et al. (2000) the GR_8 were determined too. The authors confirmed that $GR_8 > GR_{25}$ (Fig. 9) in tests with needle-punched nonwoven geotextile with mass per unit area 332 g·m^{-2}. The fine contents for tested soil samples were the following: 18% (for soil 1), 25% (for soil 1-A) and 33% (for soil 1-B).

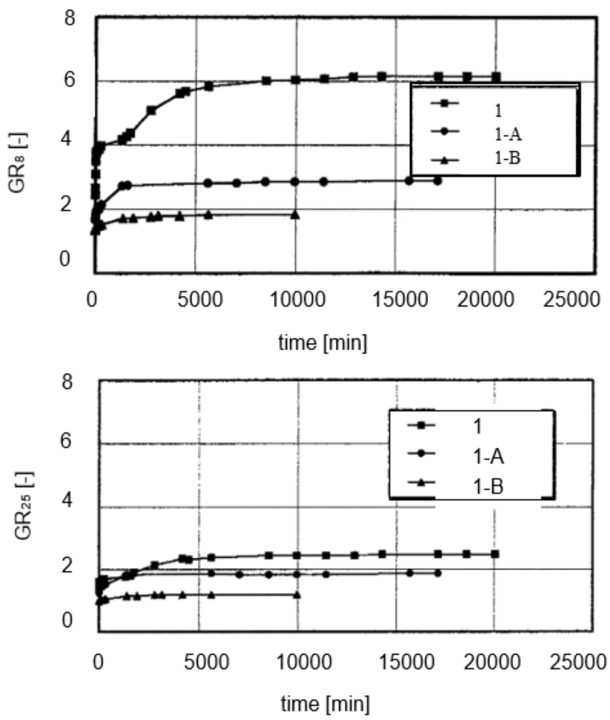


Fig. 9. Change of gradient ratios GR_8 and GR_{25} with time (Nishigata, Fannin & Vaid, 2000)

What is more, the obtained results in this study show that nonwoven geotextile B with the number of constrictions of 22, can be used as the filtration layer for silty sand, as opposed to nonwoven geotextile A with the number of constrictions of 17. Therefore, the influence of the number of constrictions on the filtration properties of nonwoven geotextiles was confirmed. What is important, the minimal acceptable value of the number of constrictions should be 20 (not 25), because the optimal range of the number of constrictions established in the literature varies between 25 and 45 (Fig. 3) is mainly due to the include of O_{100} (not O_{90}) when preparing the geotextile filter design criteria.

CONCLUSIONS

In conclusion the following comments appear relevant to the use of nonwoven geotextile filters in engineering applications:

- the internal stability of a granular soil and the properties of geotextiles are the key parameters in the design of a nonwoven geotextile filter;
- gradient ratio test is necessary for the geotextile filters design in contact with unstable granular soils;
- the number of constrictions of nonwoven geotextile should be determined to properly design of geotextile filter;
- the acceptable range of number of constrictions value should be defined with reference to characteristic opening size O_{90};
- the authors recommend the minimal value of the number of constrictions equal to 20.

Authors' contributions

Conceptualisation: A.M. and E.K.; methodology: A.M.; validation: A.M. and E.K.; formal analysis: A.M. and E.K.; investigation: A.M.; resources: A.M.; data curation: A.M.; writing – original draft preparation: A.M.; writing – review and editing: A.M. and E.K.; visualisation: A.M.; supervision: A.M. and E.K.

All authors have read and agreed to the published version of the manuscript.

REFERENCES

ASTM International [ASTM] (2012). *Standard Test Method for Measuring the Filtration Compatibility of Soil-Geotextile Systems* (ASTM D5101-12). West Conshohocken, PA: ASTM International.

ASTM International [ASTM] (2016). *Standard Practice for Determining the Number of Constrictions "m" of Non-Woven Geotextiles as a Complementary Filtration Property* (ASTM D7178-16e1). West Conshohocken, PA: ASTM International.

Brózda, K. & Selejdak, J. (2019). The functions of the geosynthetics in roadway applications. *Acta Scientiarum Polonorum. Architectura*, *18* (2), 27–31. doi: 10.22630/ASPA.2019.18.2.19

Calhoun, C. (1972). *Development of Design Criteria and Acceptance Specifications for Plastic Filter Cloths* (Technical Report S-72-7). Vicksburg, MS: U.S. Army Corps of Waterways Experiment Station.

Carroll, R. G. Jr. (1983). Geotextile Filter Criteria. *Transportation Research Record*, *916*, 46–53.

Fannin, R. J. (2010). On the clogging of geotextile filter. In E.M. Palmegiano (Ed.) *9th International Conference on Geosynthetics: geosynthetics, advanced solutions for a challenging world, ICG 2010* (pp. 401–412). São Paulo: Brazilian Chapter of the International Geosynthetics Society (IGS-Brazil).

Fannin, R. J. (2015). [Geosynthetics column. Editor's text about the use of gradient ratio test for the selection of geotextiles in filtration]. *Geotechnical News*, *33* (3), 33–36.

Fannin, R. J., Vaid, Y. P., Palmeira, E. M. & Shi, Y. C. (1996). A modified gradient-ratio test device. In S.K. Bhatia & L.D. Suits (Eds) *Recent Developments in Geotextile Filters and and Prefabricated Drainage Geocomposites*, *ASTM Special Technical Publication 1281* (pp. 100–112). Denver, CO: American Society for Testing and Metals.

Fatema, N. & Bhatia, S. K. (2018). Sediment Retention and Clogging of Geotextile with High Water Content Slurries. *International Journal of Geosynthetics and Ground Engineering*, *4* (13), 1–15.

Giroud, J. P. (1996). Granular Filters and Geotextile Filters. In J. Lafleur & A.L. Rollin (Eds) *GeoFilters '96: comptes rendus* (pp. 565–680). Montreìal: Eìcole polytechnique.

Giroud, J. P. (2010). Development of criteria for geotextile and granular filters. In E.M. Palmegiano (Ed.) *9th International Conference on Geosynthetics: geosynthetics, advanced solutions for a challenging world, ICG 2010* (pp. 45–65). São Paulo: Brazilian Chapter of the International Geosynthetics Society (IGS-Brazil).

Haliburton, T. A. & Wood, P. D. (1982). Evaluation of the US Army Corps of Engineers gradient ratio test for geotextile performance. In *Proceedings of the 2nd International Conference on Geotextiles* (pp. 97–101). St. Paul, MN: Industrial Fabrics Association International.

Heibaum, M. (2014). Geosynthetics for waterways and flood protection structures – Controlling the interaction of water and soil. *Geotextiles and Geomembranes*, *42*, 374––393. https://doi.org/10.1016/j.geotexmem.2014.06.003

Hoare, D. I. (1982). Synthetic fabrics as soil filters: a review. *ASCE Report*, *108* (GT10), 1240–1245.

International Organization for Standardization [ISO] (2017). *Geotechnical and Testing. Identification and Classification of Soil. Part 2: Principles for A Classification* (ISO 14688-2:2017). Geneva: International Organization for Standardization.

International Organization for Standardization [ISO] (2019). *Geotextiles and geotextile-related products. Determination of the characteristic opening size* (ISO 12956:2019). Geneva: International Organization for Standardization.

Kenney, T. C. & Lau, D. (1985). Internal stability of granular filters. *Canadian Geotechnical Journal*, *22*, 215–225. https://doi.org/10.1139/t85-029

Koerner, R. M. & Koerner, G. R. (2015). Lessons learned from geotextile filters failures under challenging field conditions. *Geotextiles and Geomembranes*, *43* (30), 272––281. https://doi.org/10.1016/j.geotexmem.2015.01.004

Lawson, C. R. (1982). Filter criteria for geotextiles: relevance and use. *Journal of the Geotechnical Engineering Division*, *ASCE*, *108* (GT10), 1300–1317.

Miszkowska, A., Koda, E., Krzywosz, Z., Król, P. & Boruc, N. (2016). Zmiana właściwości filtracyjnych geowłókniny po 22 latach eksploatacji w drenażu zapory ziemnej. *Acta Scientiarum Polonorum. Architectura*, *15* (3), 119–126.

Miszkowska, A., Krzywosz, Z. & Koda, E. (2017). Kryteria doboru geosyntetyków na warstwy filtracyjne. *Magazyn Autostrady*, *3*, 30–32.

Moraci, N. (2010). Geotextile filter: Design, characterization and factors affecting clogging and blinding limit states. In E.M. Palmegiano (Ed.) *9th International Conference on Geosynthetics: geosynthetics, advanced solutions for a challenging world, ICG 2010* (pp. 413–435). São Paulo: Brazilian Chapter of the International Geosynthetics Society (IGS-Brazil).

Nishigata, T., Fannin, R. J. & Vaid, Y. P. (2000). Blinding and clogging of a nonwoven geotextile. *Soils and Foundations*, *40* (4), 121–127. https://doi.org/10.3208/sandf.40.4_121

Palmeira, E. M. & Matheus, E. (2000). Gradient ratio tests on artificially clogged nonwoven geotextiles. In J. Lafleur & A.L. Rollin (Eds) *GeoFilters '96: comptes rendus* (pp. 149–156). Montreìal: Eìcole polytechnique.

Palmeira, E. M. & Trejos Galvis, H. L. (2018). Evaluation of predictions on nonwoven geotextile pore size distribution under confinement. *Geosynthetics International*, *25* (2), 230–240. https://doi.org/10.1680/jgein.18.00004

Portelinha, F. H. M. & Zornberg, J. G. (2017). Effect of infiltration on the performance of an unsaturated geotextile-reinforced soil wall. *Geotextiles and Geomembranes*, *45* (3), 211–226. https://doi.org/10.1016/j.geotexmem.2017.02.002

Rowe, R. K. & McIsaac, R. (2005). Clogging of tire shreds and gravel permeated with landfill leachate. *Journal of Geotechnical and Geoenvironmental Engineering*, *131*, 682–693. https://doi.org/10.1061/(ASCE)1090-0241(2005)131:6(682)

Sato, M., Yoshida, T. & Futaki, M. (1986). Drainage Performance of Geotextiles. *Geotextiles and Geomembranes*, *4*, 223–240. https://doi.org/10.1016/0266-1144(86)90043-9

Shukla, S. K. (2016). *An Introduction to Geosynthetic Engineering*. Leiden: CRC Press.

Vieira, J. L., Abramento, M. & Campos, M. V. W. (2010). Experimental study of clogging in drainage systems. In E.M. Palmegiano (Ed.) *9th International Conference on Geosynthetics: geosynthetics, advanced solutions for a challenging world, ICG 2010* (pp. 1145–1148). São Paulo: Brazilian Chapter of the International Geosynthetics Society (IGS-Brazil).

Wayne, M. H. & Koerner, R. M. (1993). Correlation between long-term flow testing and current geotextile filtration design practice. In B.R. Christopher (Ed.) *Geosynthetics '93: Conference Proceedings* (pp. 501–517). St. Paul, MN: Industrial Fabrics Association International.

Yoo, C. & Kim, B. (2016). Geosynthetics in Underground Construction. In *6th European Geosynthetics Congress (EuroGeo6) – Proceedings* (pp. 208–225). Ljubljana: International Geosynthetics Society.

Markiewicz, A., Koda, E. (2022). Impact of the constrictions number on filtration characteristics of nonwoven geotextiles. *Acta Sci. Pol. Architectura*, *21* (2), 11–19, doi: 10.22630/ASPA.2022.21.2.10

WPŁYW LICZBY PRZEWĘŻEŃ NA WŁAŚCIWOŚCI FILTRACYJNE GEOWŁÓKNIN IGŁOWANYCH

STRESZCZENIE

Filtry z geowłóknin są powszechnie stosowane w konstrukcjach inżynierskich. Podstawowymi wymaganiami prawidłowego działania systemów drenażowych z wykorzystaniem geowłóknin są zdolność zatrzymywania cząstek, odpowiednia przepuszczalność oraz odporność na kolmatację. Najczęściej do oceny zachowania się układu grunt–geowłóknina wykorzystuje się badanie wskaźnika gradientów. Ponadto istotne jest wyznaczanie liczby przewężeń geowłóknin, która zależy od średnicy włókien, grubości geowłókniny i jej porowatości. Liczba przewężeń powinna być stosowana do rozróżniania właściwości filtracyjnych geowłóknin o takim samym lub podobnym wymiarze porów. W artykule przedstawiono badania wskaźnika gradientów dla gruntu wewnętrznie niestabilnego i geowłóknin o różnej strukturze. Wyniki badań wykazały znaczący wpływ liczby przewężeń geowłóknin na ich właściwości filtracyjne. W pracy zaproponowano także modyfikację kryterium odporności na kolmatację.

Słowa kluczowe: filtr geotekstylny, drenaż, kolmatacja, wskaźnik gradientów, przewężenia