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Applications of geosynthetic membranes in soil stabilization and coastal defence structures

Brian O. Oyegbile [a,b,*], Benjamin A. Oyegbile [c]

[a] Department of Civil Engineering, Federal University Oye-Ekiti, PMB 373, Oye-Ekiti, Nigeria
[b] Department of Civil Engineering, University of Cape Town, South Lane, Ring Road Rondebosch, 7701, South Africa
[c] Department of Civil Engineering, Elizade University Ilara-Mokin, Wuraola Ade Ojo Avenue, PMB 002, Ilara-Mokin, Ondo State, Nigeria

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Abstract

The use of geosynthetic in soil and coastal engineering is increasing and improving due to improvements in its engineering properties and fabrication techniques. While some geosynthetic coastal structures have attained advanced stage in terms of applications and efficiency, others still lack well-structured design formulas and specifications on a sound scientific basis, hence continued experimental works for the better understanding of the hydraulic performance, stability and modes of failure of these structures. Coastal areas are dynamic with unique geomechanical feature such as soil instability, which in any case, may affect the overall performance of coastal defence structures constructed on soft soil or weak foundation. This paper reviews the developments and applications of geosynthetics in soil stabilization and protection of coastal areas with emphasis on shoreline protection. Relevant empirical research data are presented as well as the present and likely future challenges in the use of geosynthetics in soil stabilization and coastal defence structures.

Keywords: Geosynthetics; Shoreline protection; Coastal engineering; Hydraulic performance

Contents

* Corresponding author at: Department of Civil Engineering, Federal University Oye-Ekiti, PMB 373, Oye-Ekiti, Nigeria.
E-mail addresses: brian.oyegbile@fuoye.edu.ng, brian.oyegbile@gmail.com (B.O. Oyegbile), hollander196@yahoo.com (B.A. Oyegbile).
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Nomenclature

CBR	California bearing ratio
Δh	change in height of geotextile tube (m)
D	characteristic diameter of sand container (m)
L	circumference of the geotextile in a container (m)
GSC	geosynthetic sand-filled containers
C_1 and C_2	GSC coefficients (–)
A	cross-sectional area of GSC (m^2)
L_o	deep water wave length (m)
d_{fill}	degree of filling of GSC (–)
ρ_W	density of water (kg/m^3)
ρ_E	density of sand container elements (kg/m^3)
a and b	dimensions of a flat rectangular sand bag (m)
DEM	discrete element modelling
C_W	empirical parameter (–)
EMI	Ernst-Mach-Institute
R_c	freeboard (m)
f	friction coefficient between the geotextile and the concrete substructure (–)
$r(x)$	geosynthetic radius of curvature (m)
GRS	geosynthetic reinforced soil
GRS RW	geosynthetic reinforced soil retaining wall
T	geosynthetic tensile force (kN/m)
GWR	geotextile wrap-around revetment
$p(x)$	hydrostatic pressure of the slurry (kN/m^3)
H_s	incident significant wave height (m)
h_o	initial height of geotextile tube (m)
w_o and w_f	initial and final water content of fill material (–)
ξ_o	iribarren number (–)
l_c	length of the critical sand container (m)
l	length of sand container (m)
H_m	mean wave height (m)
MSW	mechanically stabilized wall
MPASR	Multi-purpose artificial submerged reef
CR	over consolidation ratio
n	porosity of filling material (–)
PVD	prefabricated vertical drain
RSS-RW	reinforced soil segmental retaining wall
Δ_t	relative density of geotextile tube (–)
Δ_c	relative density of submerge GSCs (–)
$\frac{R_c}{H_s}$	relative freeboard (–)
SRW	segmental retaining wall
H_s	significant wave height (m)
α	slope angle of GSC/geotextile tube structure (°)
G_s	specific gravity of solid (–)
N_s	stability number (–)
D_{50}	thickness of armour layer of GSC (m)
γ_{slurry}, γ_{soil}	unit weight of fill slurry and the consolidated soil (kN/m^3)
γ_w	unit weight of water (kN/m^3)
V	volume of GSC/geotextile tube (m^3)
B	width of geotextile tube (m)
SIM	stepped isothermal method
TTS	time–temperature superposition
PET	polyethylene–terephthalate
HDPE	high density polyethylene
RLT	rapid load tensile tests
UTM	universal testing machine
DEM	discrete element modelling

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