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COUPLED PHENOMENA IN ENVIRONMENTAL GEOTECHNICS

SHEAR STRENGTH OF MUNICIPAL WASTE MATERIALS FROM TWO LANDFILLS IN SERBIA

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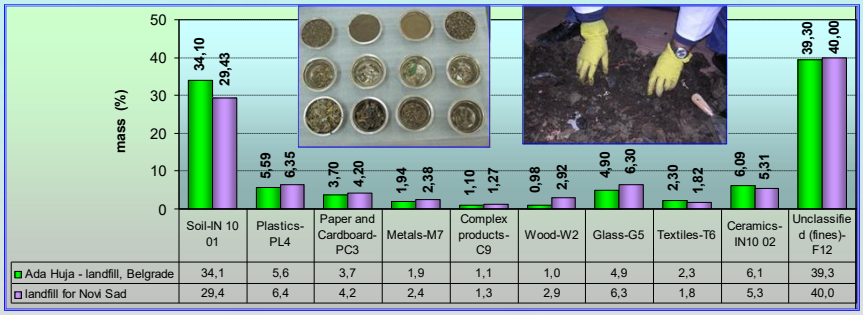
SUMMARY: In this paper the results obtained by laboratory testing of municipal waste materials from two different sanitary landfills in Serbia are presented. For defining parameters of shear strength linear shear strength equation was used, which is determined from mobilized shear stresses at horizontal displacement of Δl = 14 mm - for each of normal stresses (σ'_n = 25, 50 and 100 kPa). Also, an interpretation of the test results was made for nonlinear shear strength envelope with logarithmic and hyperbolic functions.

INTRODUCTION: Shear strength parameters for municipal solid waste have been obtained in different ways that are divided into three groups: laboratory tests on small and large samples using standard or special-design equipment, in situ tests and assessments of the shear strength parameters based on back analyses of the landfill slope stability. Published approaches to the interpretations of test results still differ, based on various assumptions. Shear strength of municipal solid waste has been much studied and the reported results are mainly those of laboratory tests on samples of different sizes: Landva & Clark (1986), Gabr & Valero (1995), Manassero et al. (1996), Eid et al. (2000), Pelkey et al. (2001), Dixon & Jones (2005), Langer (2005), Zekkos (2005), Zekkos et al. (2007), Kavazanjian (2006), Athanasopoulos et al. (2008), Bray et al. (2009), Stark et al. (2009), and many others.

Laboratory tests samples

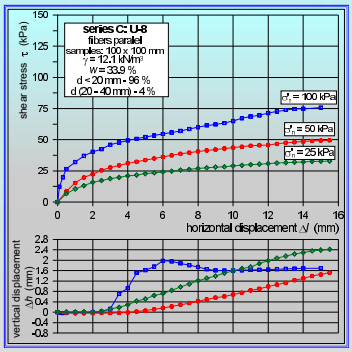


Identification and classificaton data for test samples

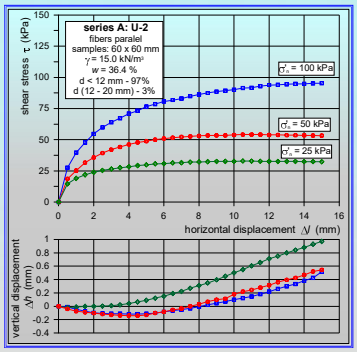
series	sample labels	w (%)	γ (kN/m³)	G_s (-)	e (-)
A	U-1	37.2	10.6	2.2	1.848
	U-2	36.4	15.0		1.000
	U-3	27.2	17.5		0.599
B	U-4	39.8	11.1	2.0	1.519
	U-5	35.0	12.1		1.231
	U-6	36.9	13.4		1.043
C	U-7	30.9	10.0	2.05	1.683
	U-8	33.9	12.1		1.268
	U-9	32.9	14.3		0.905
D	U-10	28.7	10.0	2.05	1.638
	U-11	29.7	11.6		1.292
	U-12	31.8	14.0		0.930

Waste samples were prepared from the Belgrade (Series A) and Novi Sad (Series B) and the mixture from the two landfills (Series C and D). Samples from series A, B and C were compressed in horizontal layers, similarly to the waste deposition on the landfills. Samples of series D had reinforcing particles oriented at an angle 90⁰ to the horizontal plane of shearing in the shear box.

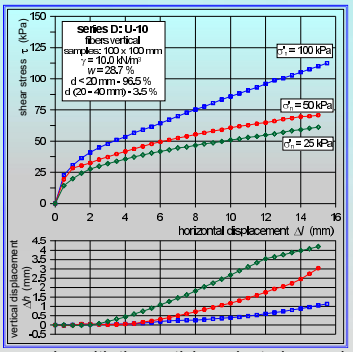
Direct shear test results



loose compacted samples ($\gamma \leq$ 12.1 kN/m³)

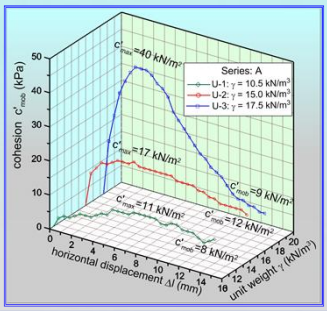


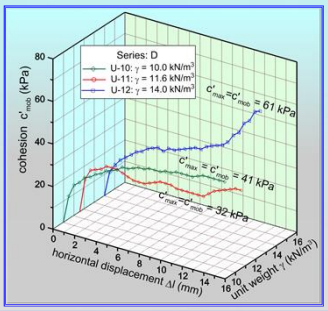
dense compacted samples ($\gamma \geq$ 13.4 kN/m³)

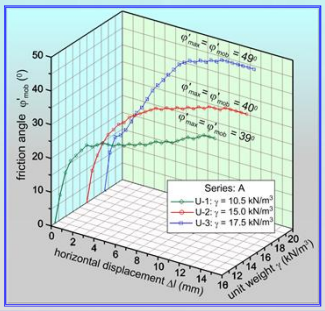


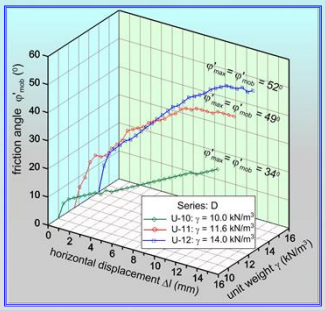
samples with the particles oriented normal to the shearing plane

Linear shape of the shear strength equation - mobilised cohesion and angle of internal frictionin relation to shearing displacement and unit weight









Nonlinear shape of the shear strength equation

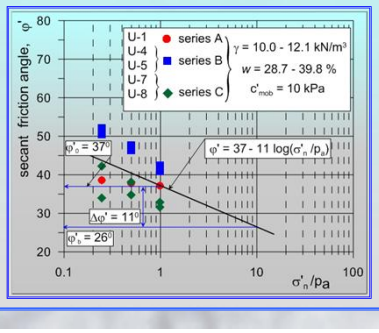
Equation of logarithmic shape for loose compacted waste

$$\tau_f = 10.0 + \sigma'_n \cdot \tan\left[37.0 - 11.0 \cdot \log\left(\frac{\sigma'_n}{p'_a}\right)\right]$$

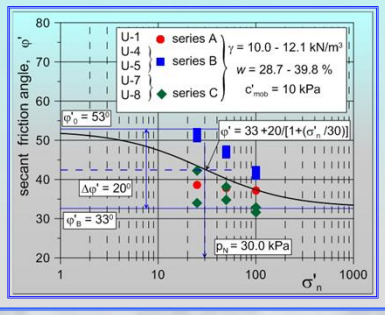
Equation of hyperbolic shape for loose compacted waste

$$\tau_f = 10.0 + \sigma'_n \cdot \tan\left(33 + \frac{20}{1 + \frac{\sigma'_n}{30}}\right)$$

logarithmic



hyperbolic



comparative review