



ASSESSMENT OF HYDRAULIC PROPERTIES OF TECHNOSOILS CONSTRUCTED WITH WASTE MATERIALS USING BEERKAN INFILTRATION EXPERIMENTS

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CONTEXT

- Construction of Technosoils using waste materials for greening applications such as parks, gardens, trees lines
- Sustainable Urban Approach:
 - Instead of using excavated soils from arable land for building soils for urban greening
 - Using urban waste materials such as demolition waste: excavated soil waste, brick manufacturing waste, track ballast waste, sludge waste and green waste
- SITERRE Project
 - Funded by the French Environment and Energy Management Agency (ADEME)

OBJECTIVES

- Construction of Technosoils at lysimeter scale
- Study of different mixtures of waste material as Technosoil
- Study of the feasibility of the project by :
 - Hydraulic properties characterization
 - Plant development monitoring
 - Soil composition, water and nutrient monitoring

METHODOLOGY

- Construction of two types of Technosoils
 - Growing Material
 - Skeleton Materials
- Study of different mixtures of waste materials in two sites in France :
 - Angers
 - Homécourt



METHODOLOGY

○ Growing Material GM:

- 58 % wt. brick waste
- 42 % wt. sewage sludge and green waste



Brick (0-40 mm)



Sewage
Sludge

○ Skeleton Materials SM:

- CG: concrete, green and excavated soils waste (Homécourt)
- RG: demolition rubble, green and excavated soils waste
- BS: track ballast, sewage sludge
- Reference soil (arable soil + chaceldony) used by the city of Angers



Excavated
soil



Concrete
waste (0-10 mm)



Demolition
rubble (0-40 mm)



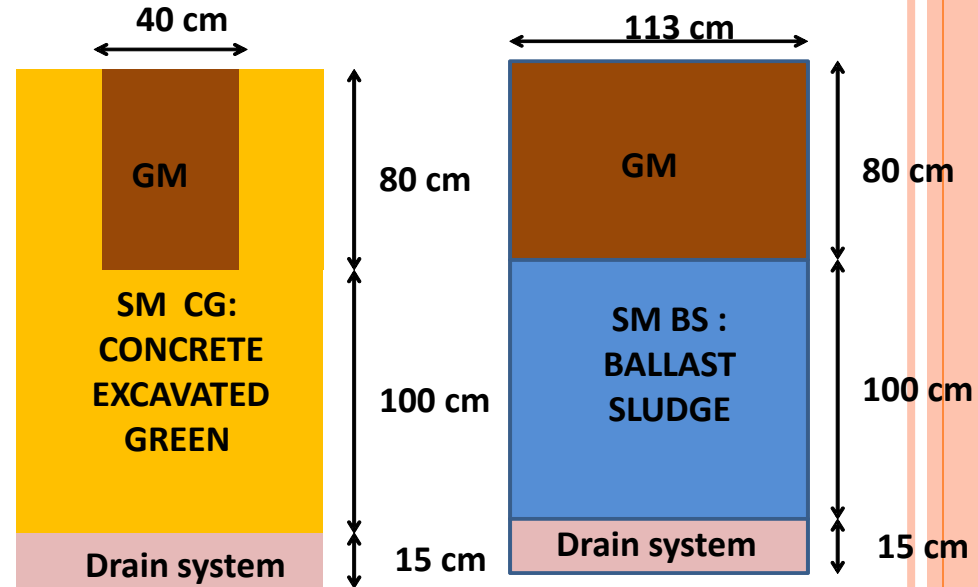
Track ballast
(0-40 mm)



Green waste

METHODOLOGY

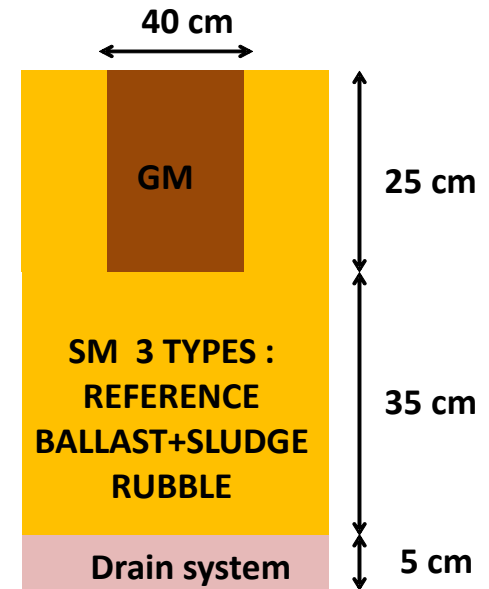
- Homécourt site : 2 lysimeters



- Beerkan infiltration experiments performed:
 - GM : 1 + 1
 - SM : 2 + 0

METHODOLOGY

- Angers Site : 9 lysimeters

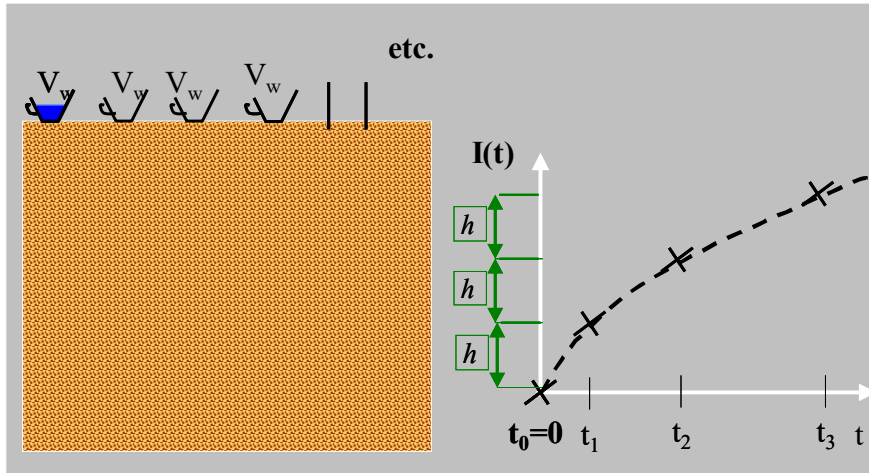


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- Beerkan infiltration experiments performed:
 - GM : 2
 - Reference: 2 ; BS: 2 ; RG: 3

METHODOLOGY

○ BEERKAN INFILTRATION:



- BEST METHOD (Lassabatere et al., 2006) :
 - Inversion of particle size distribution
 - Cumulative infiltration curve
 - →Hydraulics properties such as:
 - K_s : saturated hydraulic conductivity
 - h_g : capillarity length

RESULTS AND DISCUSSIONS

○ GROWING MATERIAL

GM	BEERKAN INFILTRATION INVERSION	θ_s (-)	n (-)	hg (cm)	Ks (cm/h)
	Homécourt - Mean	0,692	2,24	1,85	19,7
	Angers - Mean	0,771	2,22	5,9	9,9

○ STRUCTURAL MATERIALS

SM	BEERKAN INFILTRATION INVERSION	θ_s (-)	n (-)	hg (cm)	Ks (cm/h)
	Referans - Mean	0,312	2,36	5,10	18,25
	BS : Ballast + Sludge	0,358	2,25	7,20	14,40
	RG : Rubble Demoliton Excavated soil + Green waste	0,417	2,25	3,63	3,40
	CG: Concrete Waste Excavated Soil + Green Waste	0,484	2,31	10,23	6,57

RESULTS AND DISCUSSIONS

○ Growing material

- Evaporation experiment in laboratory (Yilmaz , 2015) :
 - $\theta_s = 0.63$; $h_g = 12.8$ cm ; $K_s = 29.0$ cm/h
- Disk infiltrometer experiments in situ (Yilmaz, 2016) :

GM	DISK INFILTRATOR INFLTRATION INVERSION (2016)	θ_s (-)	hg (cm)	Ks (cm/h)
	Homécourt - Mean	0,692	6,13	21,95
	Angers - Mean	0,771	2,95	26,35

GM	BEERKAN INFILTRATION INVERSION	θ_s (-)	hg (cm)	Ks (cm/h)
	Homécourt - Mean	0,692	1,85	19,70
	Angers - Mean	0,771	5,90	9,85

CONCLUSION

- Technosoils built from waste materials
 - High macroporosity → soil aeration
 - Hydraulic properties → between sand and loam
 - Yilmaz et al., 2016 ; chemical analysis + root distribution of trees
- Possible to use such technosoils for greening applications



CONCLUSION

- Beerkan infiltration method is well suited to characterize hydraulics properties of Technosoils built with coarse materials
 - Easy to set-up
- Results are consistent with those obtained by the disk infiltrometer method
 - Difficulty when soil surface has coarse material
 - Long duration of experiments



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THANK YOU FOR YOUR ATTENTION !

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