Hydraulic Conditions for Rill Initiation on Steep Slopes

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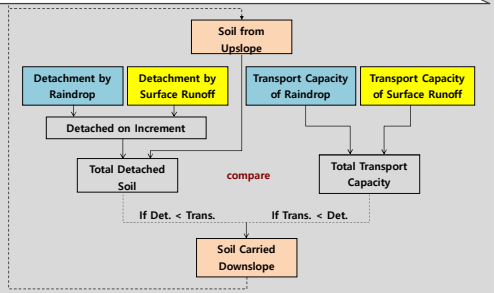
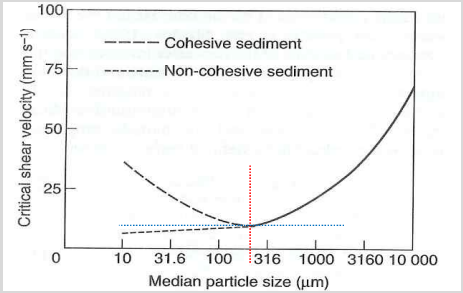
Rill Erosion in the Field

Soil Erosion Process (Meyer and Wischmeier, 1969)



Critical Shear Velocity (Savat, 1982)



- Re in overland flow : Re < 75 (Morgan, 1980), Re < 40 (Pearce, 1976)
  100<Re<1200 (Parsons, Abramhams and Luk,1990)
- Fr in overland flow : Fr < 0.5 (Morgan, 1980), Fr < 0.13 (Pearce, 1976)
  Fr < 0.5 (Parsons, Abramhams and Luk,1990)

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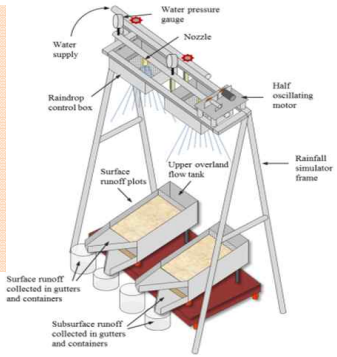
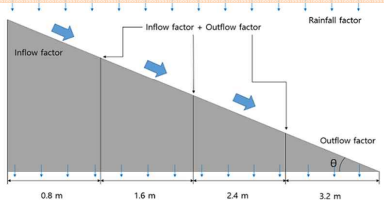
Introduction

- The formation of soil erosion includes the processes of detachment, entrainment, and transport of soil particles by surface runoff.
- Rills begins to appear when the erosion of surface runoff exceeds the resistance of soil particles.
- The steeper the slope, the smaller critical shear stress and the more active the rill incision (Yao et al, 2008).
- Soil particles on steep slope is more easily eroded than those on gentle slope because the surface soil has a high potential energy.
- In this study, simulation test of rainfall and inflow water was conducted to identify the characteristics of rill erosion development on steep slope.

Rainfall Simulator

- Rainfall simulator
  - Water supply by pump
  - VeeJet80100 nozzle to represent raindrops
  - Half oscillating spray to control rainfall
- Soil box
  - Soil box size : 0.6m(W)×0.8m(L)×0.3m (D)
  - Surface runoff plots to evaluate soil erosion
  - Tank to offer upper overland flow
  - Containers to collect surface and subsurface runoff





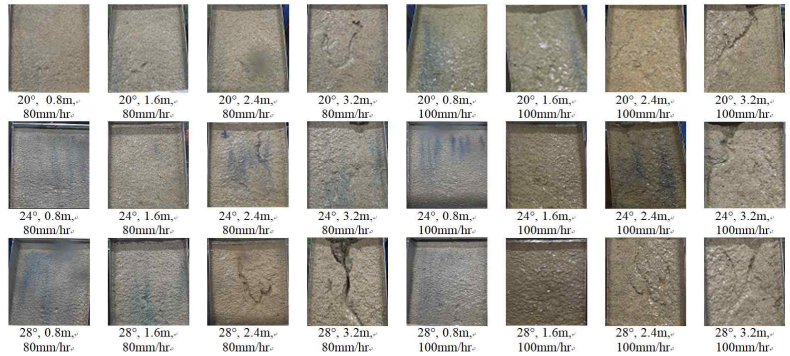
Parameters

Factors	Subfactors	Range
Rainfall	Rainfall intensity	60mm/hr, 100mm/hr
	Duration	10min
	Antecedent rainfall	less than 70mm/hr
Inflow	Type	Spray
	Runoff coefficient	0.8
Soil	Texture	sand
	Mean diameter	1.83mm
	Bulk density	1.78g/cm³
	Organic content	2.05±0.08%
	Share stress	0.310±0.045kg/cm²
	Moisture condition	saturation
Slope	Area	0.48m²
	Length	0.8m
	Steepness	20°, 24°, 28°

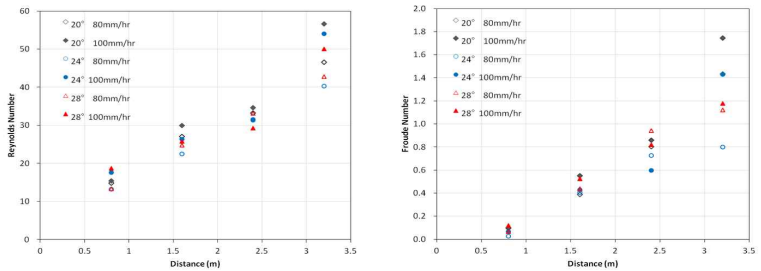
Inflow Conditions

Slope (°)	Rainfall intensity (mm/hr)	Segment distance (m)	Inflow (ml/sec)
20	80	0.8	0.0
		1.6	8.0
		2.4	16.4
		3.2	24.1
	100	0.8	0.0
		1.6	10.0
		2.4	20.1
		3.2	30.8
24	80	0.8	0.0
		1.6	7.80
		2.4	15.6
		3.2	23.4
	100	0.8	0.0
		1.6	9.8
		2.4	19.5
		3.2	29.2
28	80	0.8	0.0
		1.6	7.5
		2.4	15.1
		3.2	22.6
	100	0.8	0.0
		1.6	9.4
		2.4	18.8
		3.2	28.3

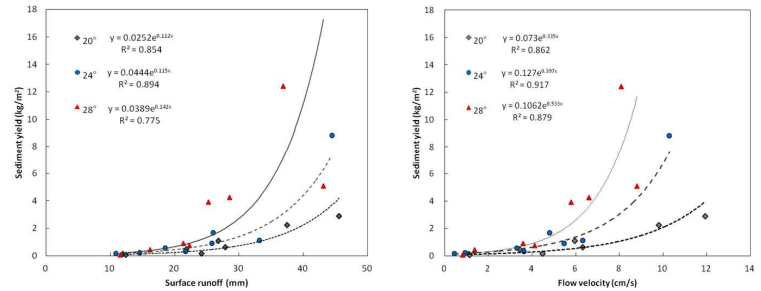
Rill development according to inflow



Hydraulic Characteristic



Relationship between Sediment yield and Flow Velocity



Conclusions

- Sediment yield for rill erosion increased significantly with increase of rainfall intensity, slope steepness, and segment distance.
- The initiation of the rill was developed when the segment distance was the range from 2.4 to 3.2m of high inflow rate and surface runoff.
- The critical shear velocity for rill initiation was the range from 3.5 to 8.75 cm/s that can transport particles of sandy soil.
- The rill initiation depended greatly on the inflow water rather than rainfall intensity.
- Sediment yield by interrill and rill from steep hillslope increased rapidly with increase of surface runoff and velocity.

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