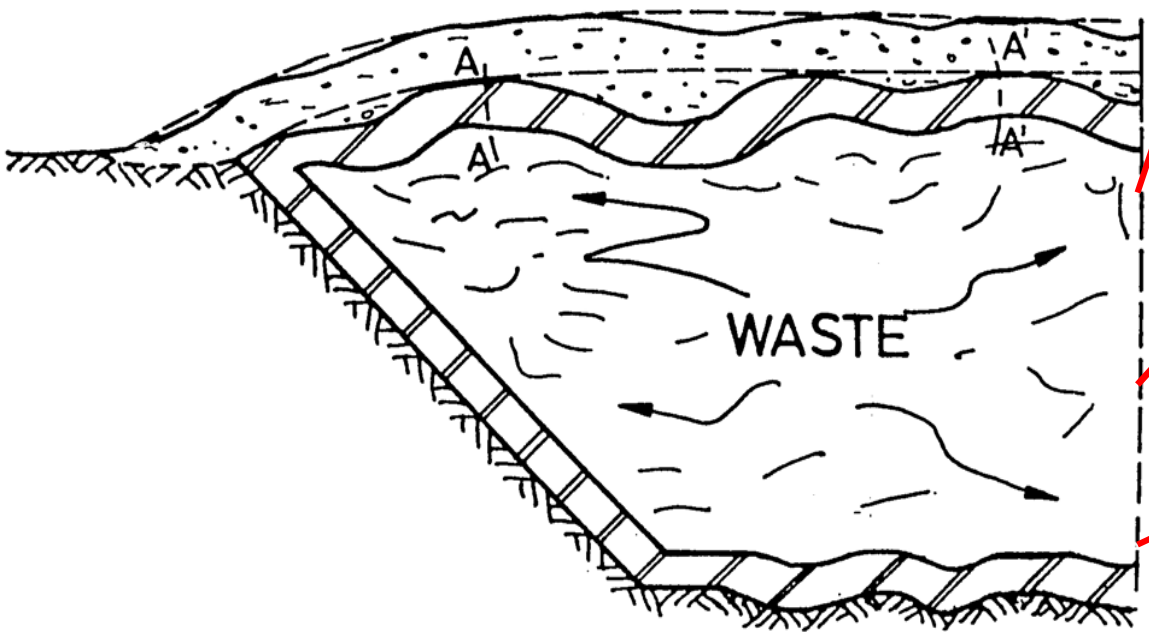
CENTRIFUGE MODEL STUDIES ON CLAY LINERS OF LANDFILLS

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Associate Professor,
Department of Civil Engineering
IIT Bombay
INDIA

Non-uniform settlements

- Heterogeneous composition of MSW

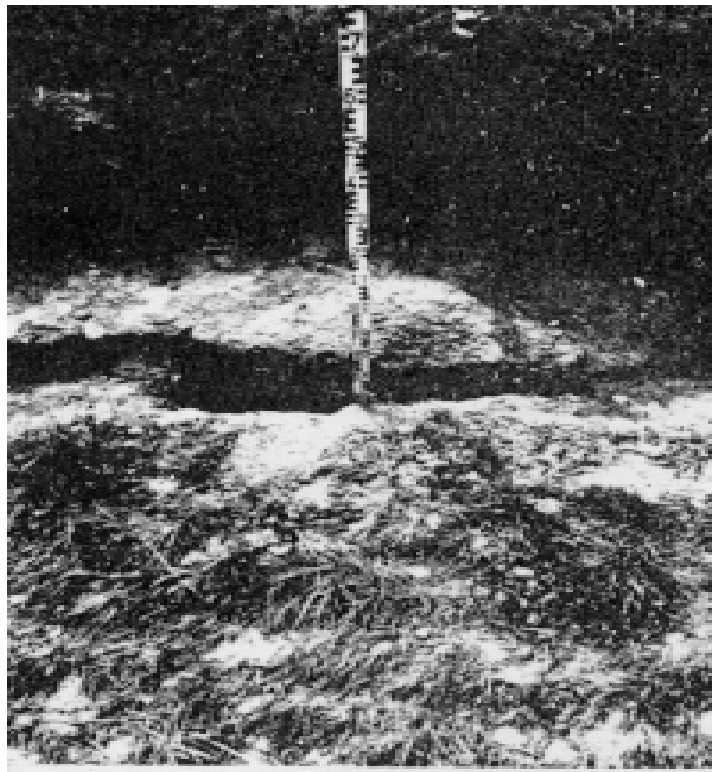




Cracking of landfill capping systems

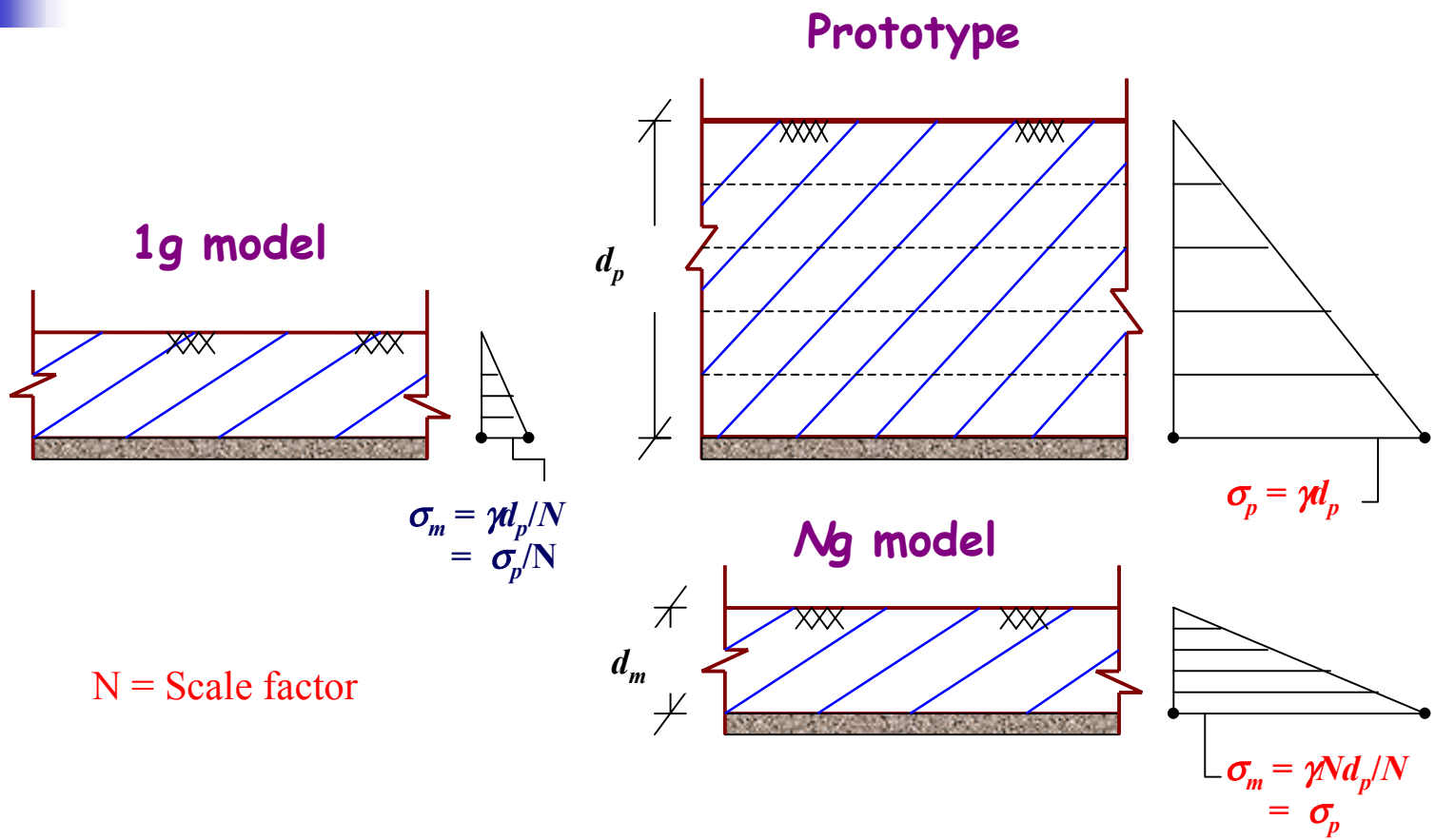
Floersheim-Weilbach landfill, Germany





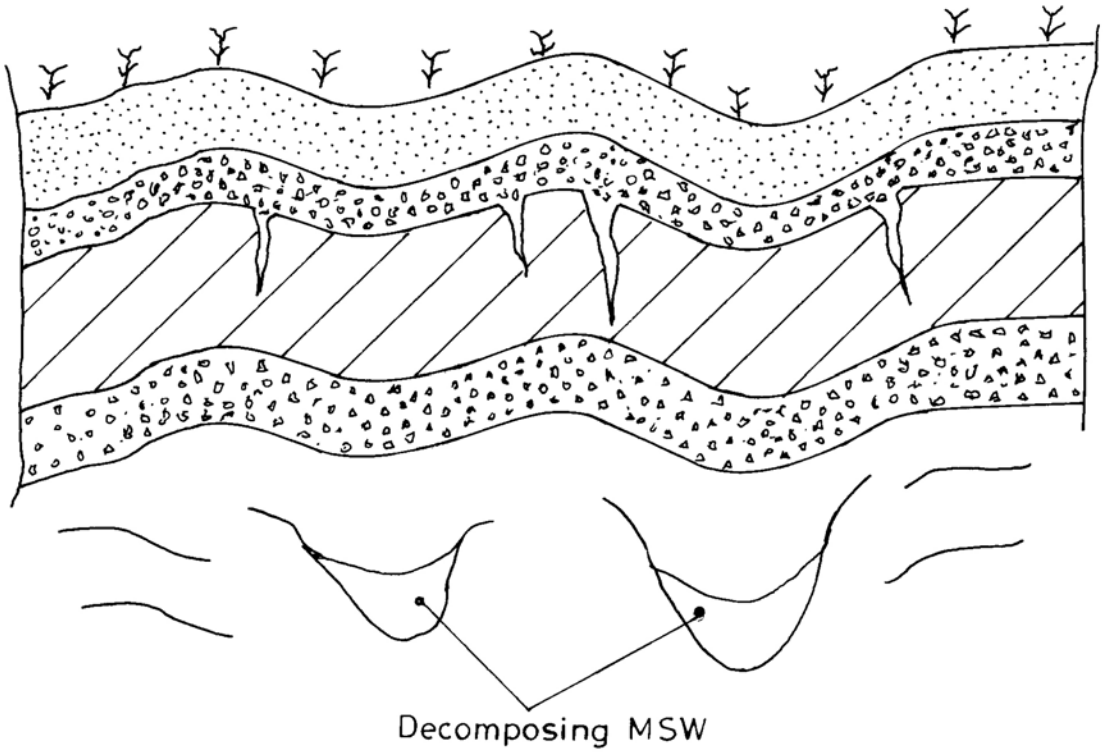
After Meißner and Ringelb (1987)

Relevance of Centrifuge modeling technique

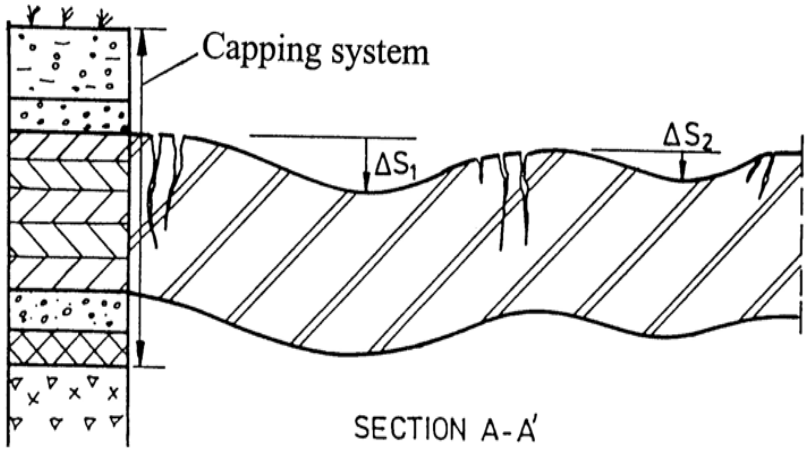


N = Scale factor

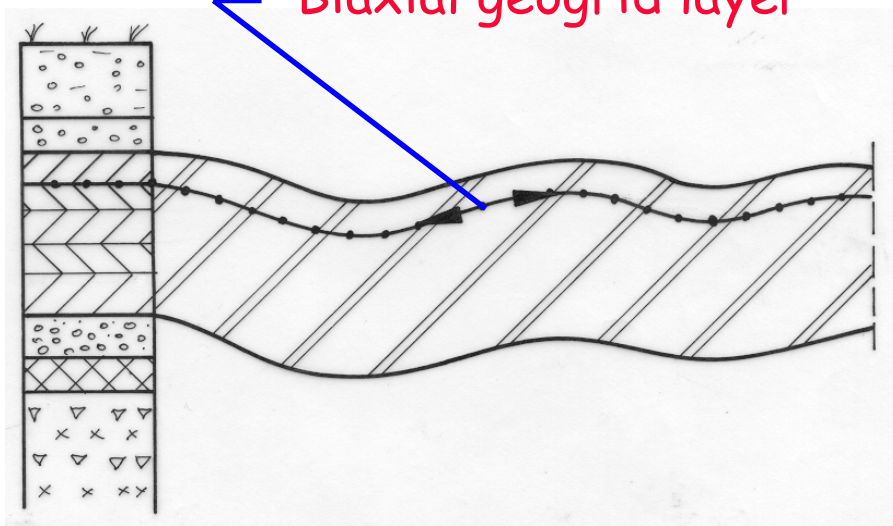
Landfill capping system subjected to non-uniform settlements



Reinforcement inclusion effect



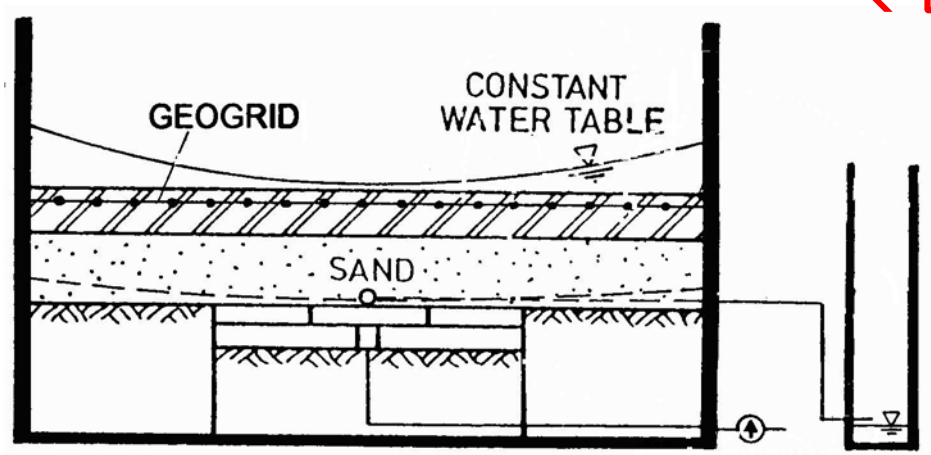
Improved capping system →

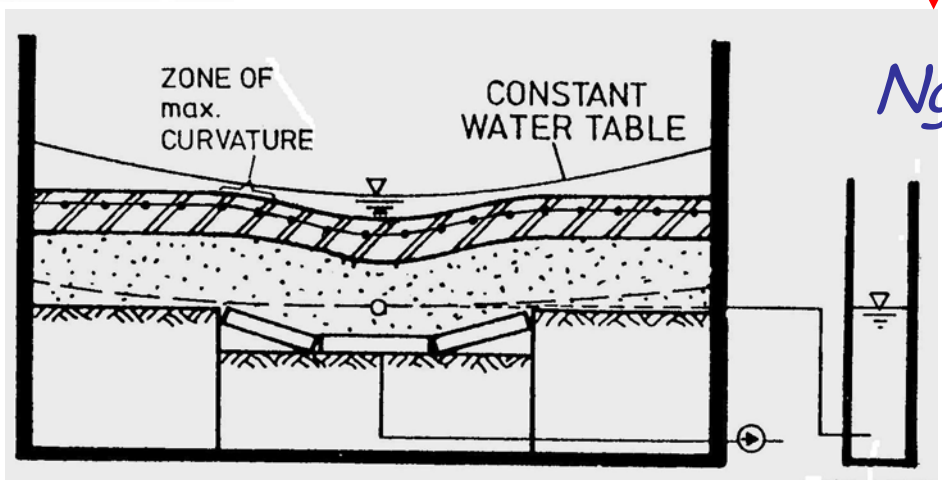


A method for inducing non-uniform settlements in centrifuge model

←Before inducing non-uniform settlements

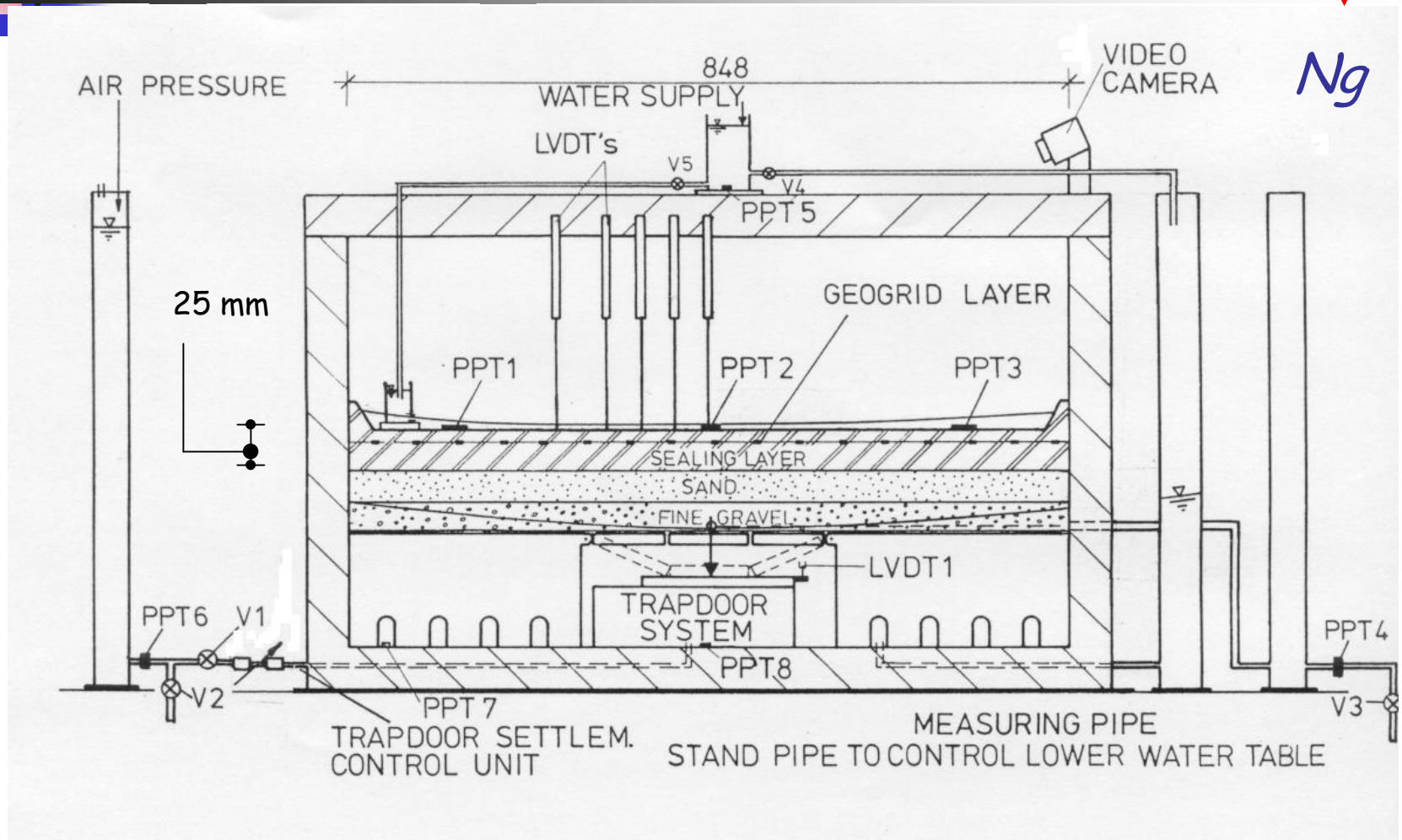
Ng



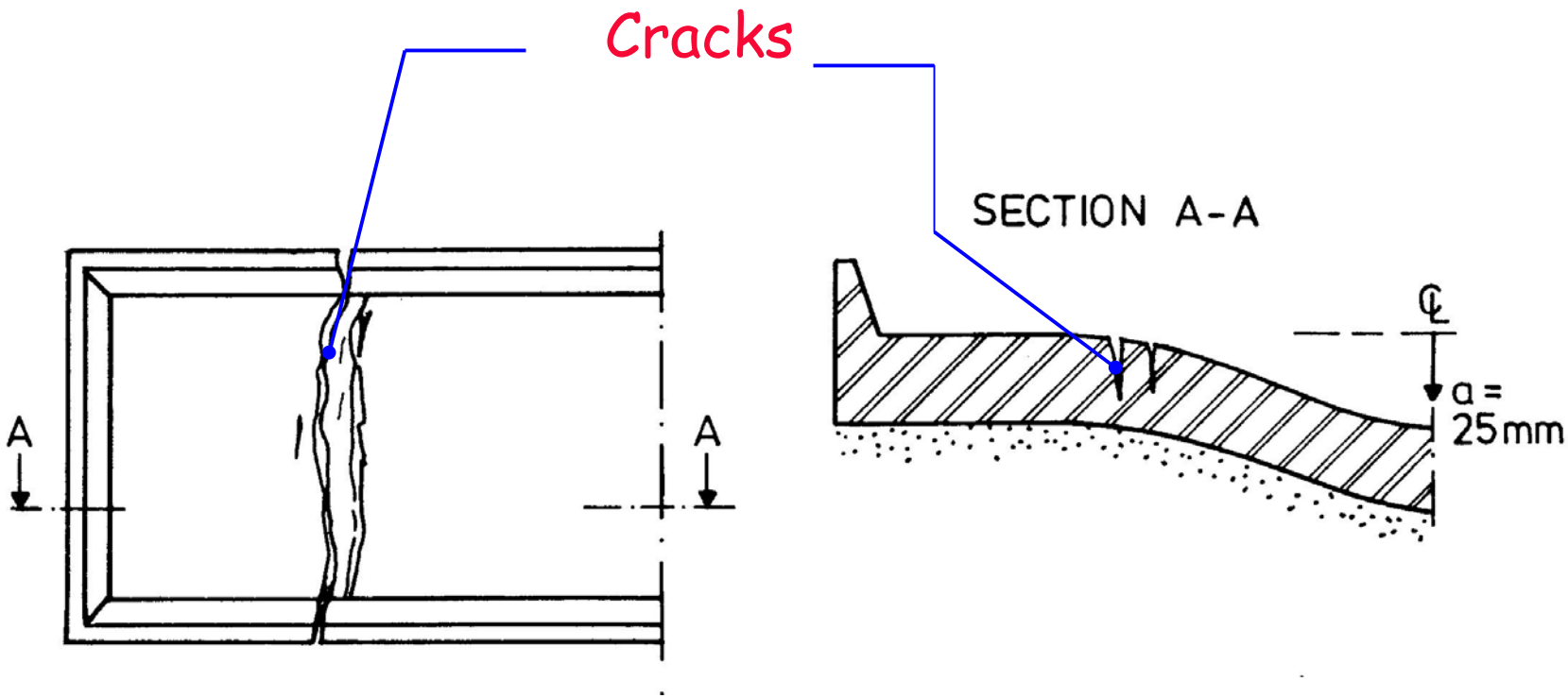


After inducing → non-uniform settlements

Model test package [N = 50]

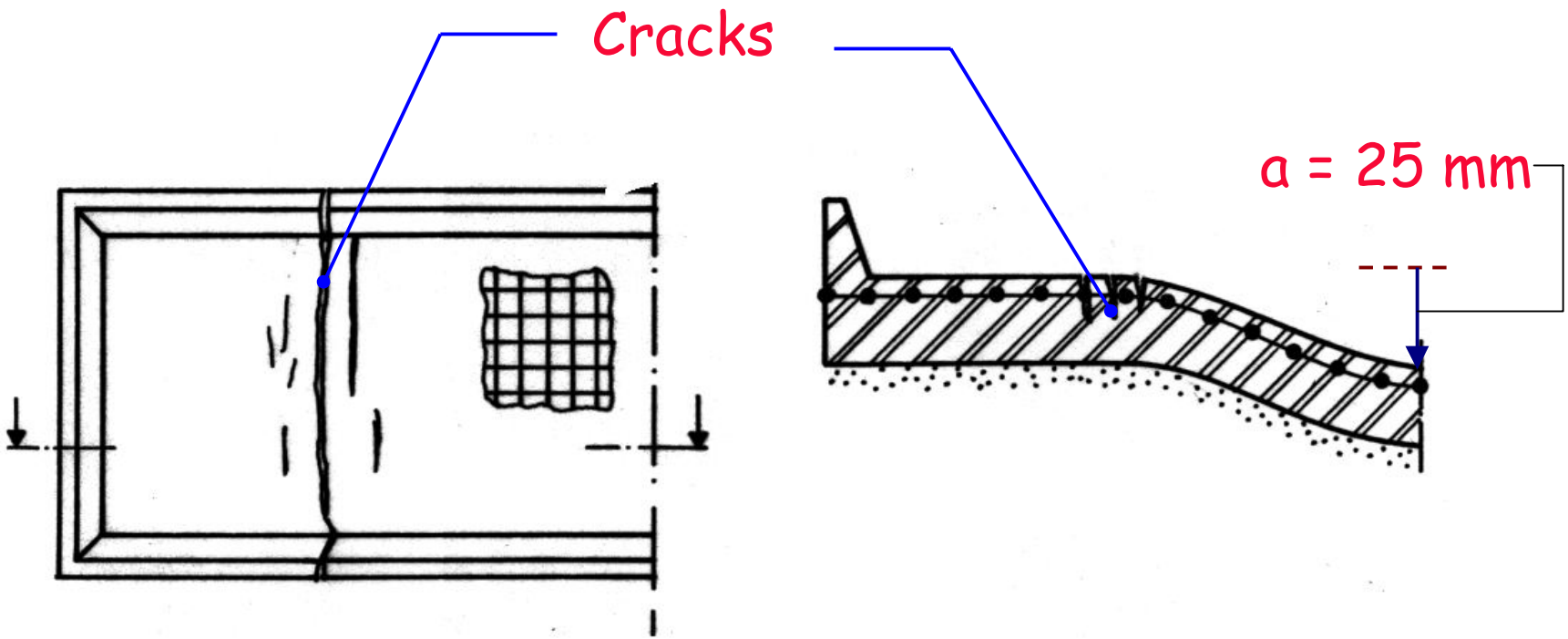


Un-reinforced clay liner



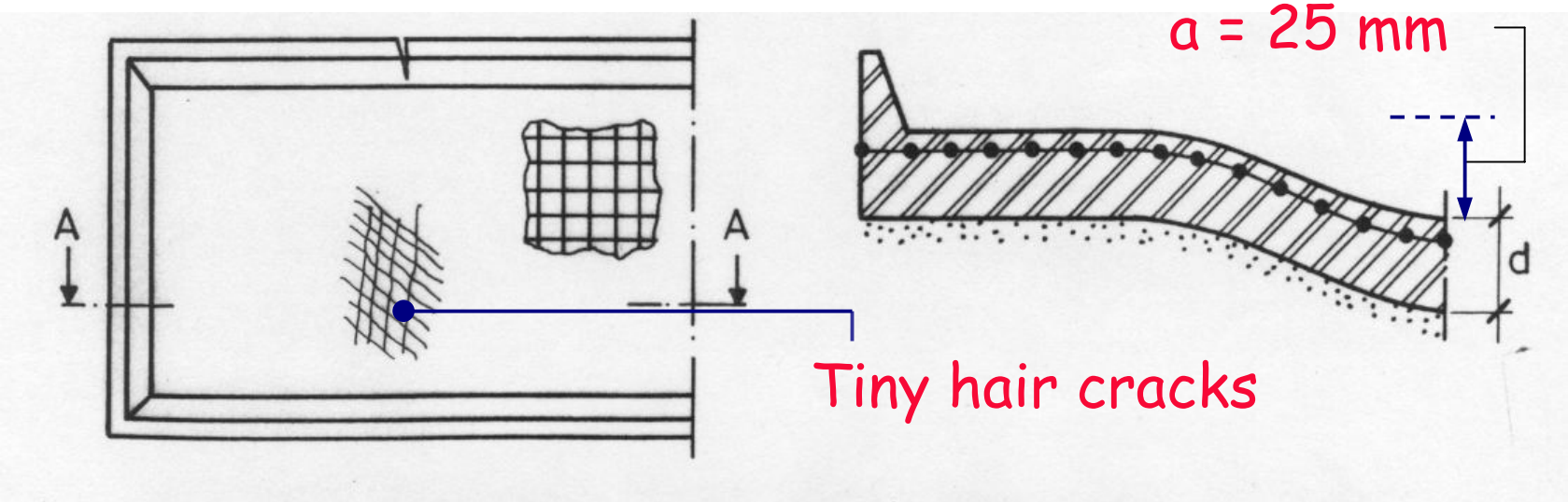
Occurrence of cracks after inducing a central settlement a = 10 mm

Reinforced clay liner [with weak geogrid]



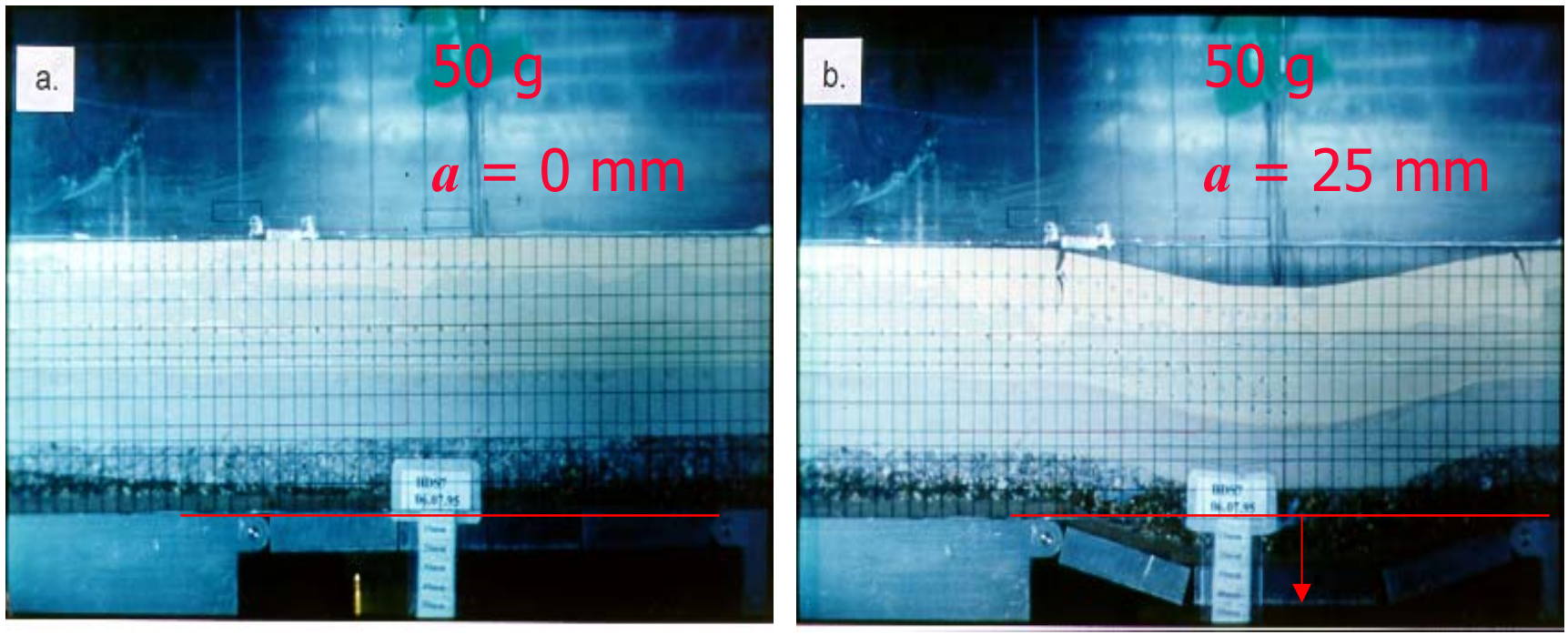
Different pattern of cracks

Reinforced clay liner [with medium stiff geogrid]

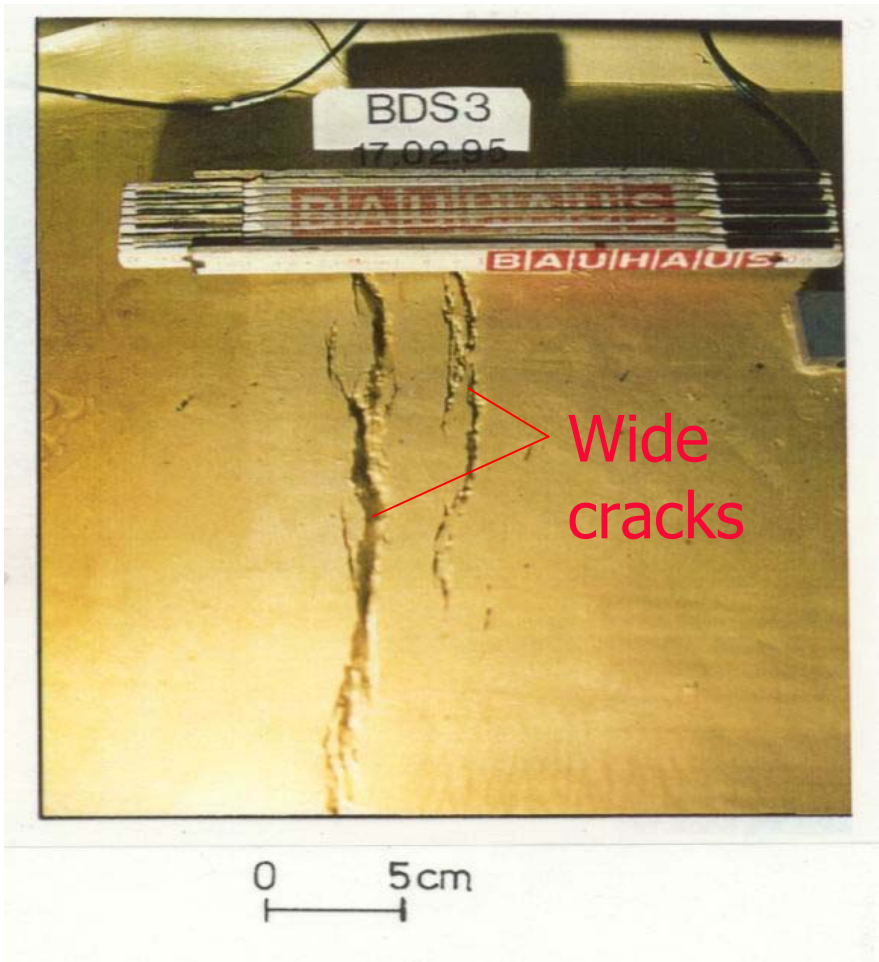


Crack free surface even at large deformations

Cross-section of model clay liner during flight



Surface of clay liner with and without reinforcement inclusion

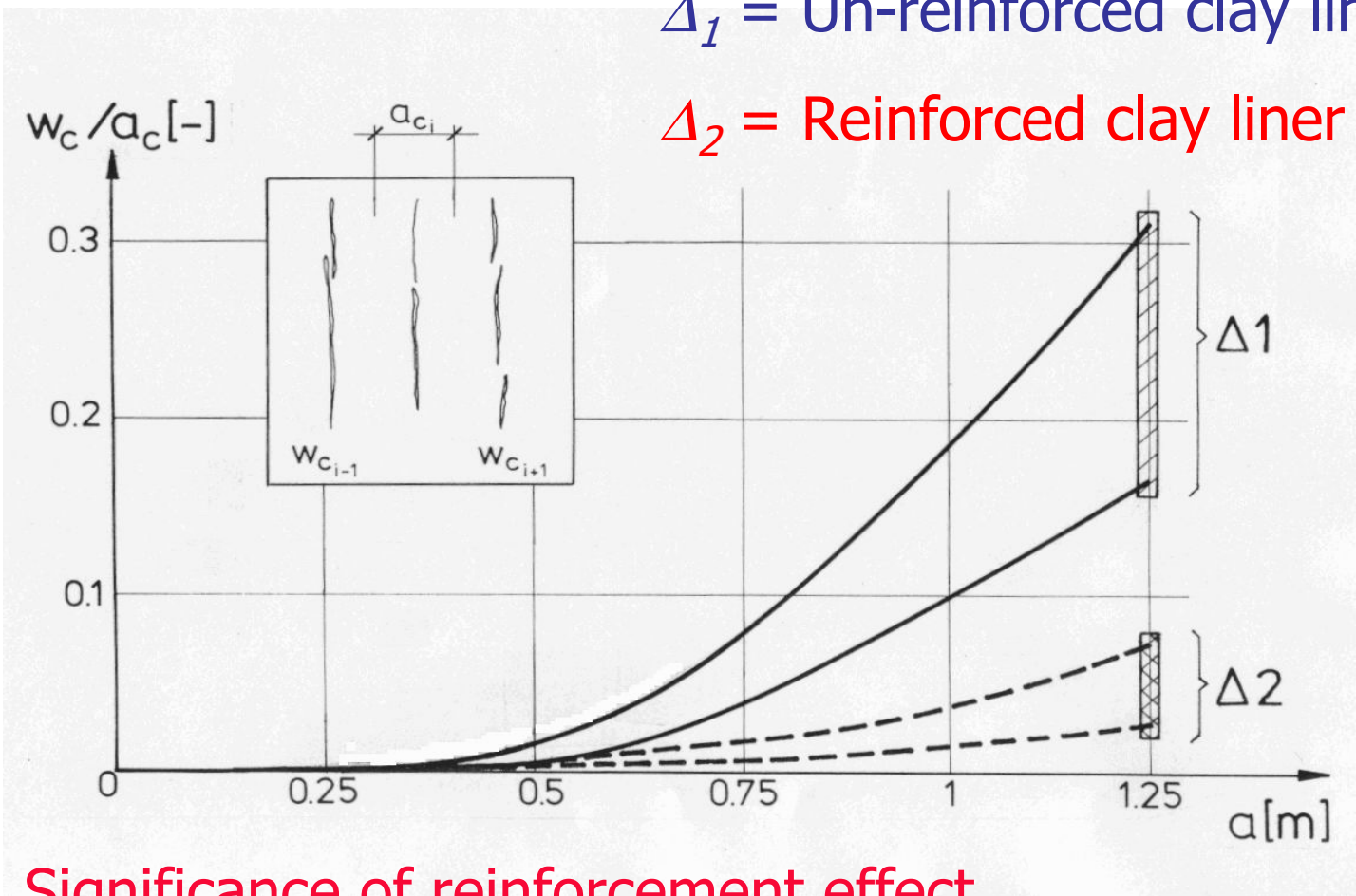




Development of crack widths on the surface of the clay liner

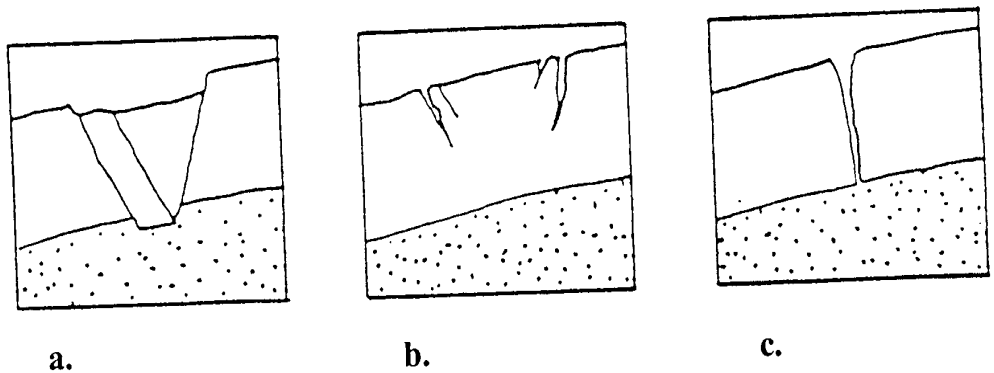
Δ_1 = Un-reinforced clay liner

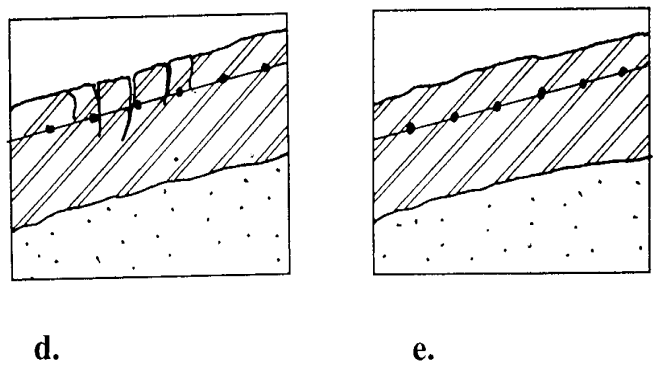
Δ_2 = Reinforced clay liner



→ Significance of reinforcement effect

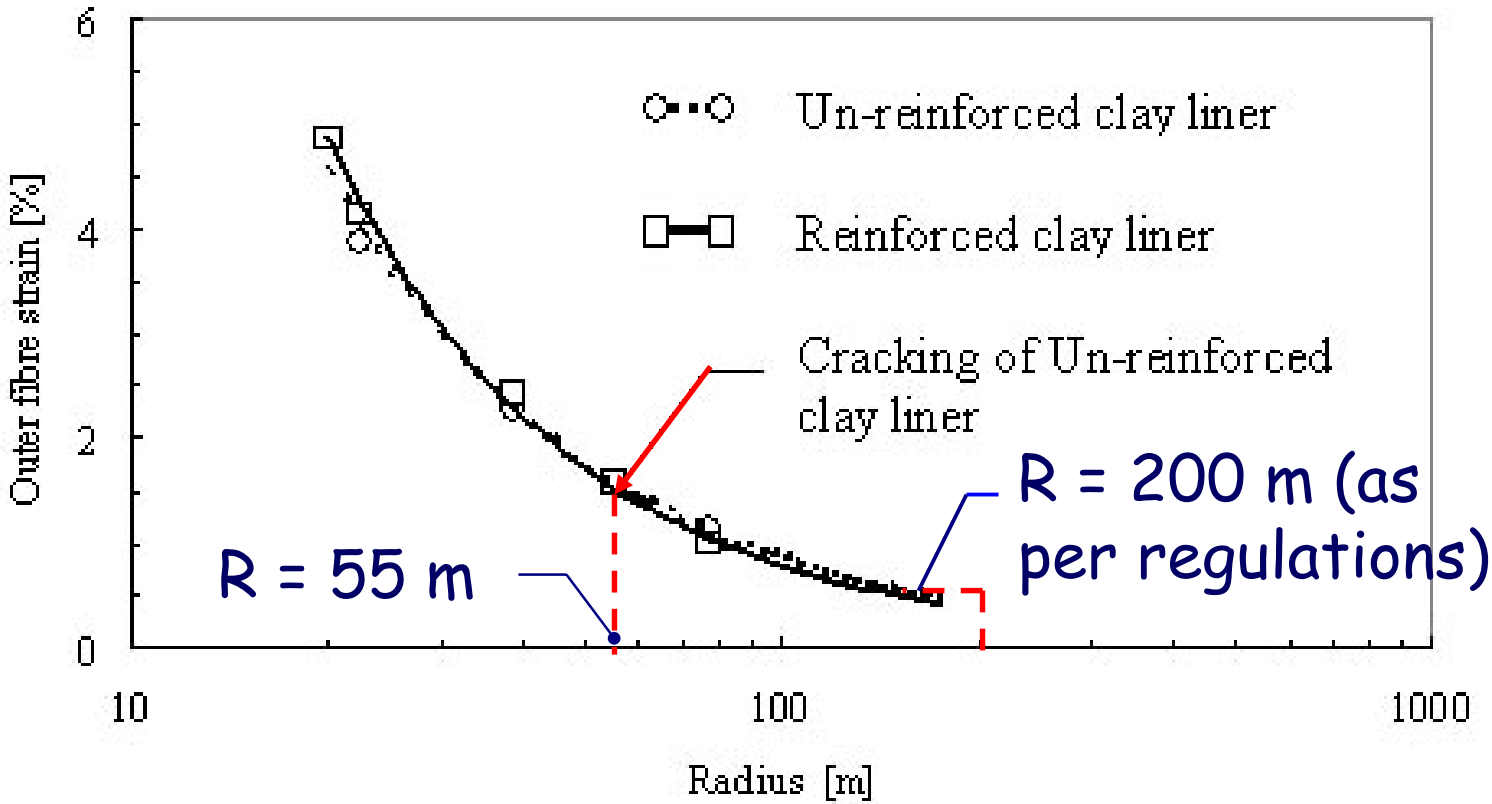
Typical cross-sections of model clay liners with and without reinforcement inclusion



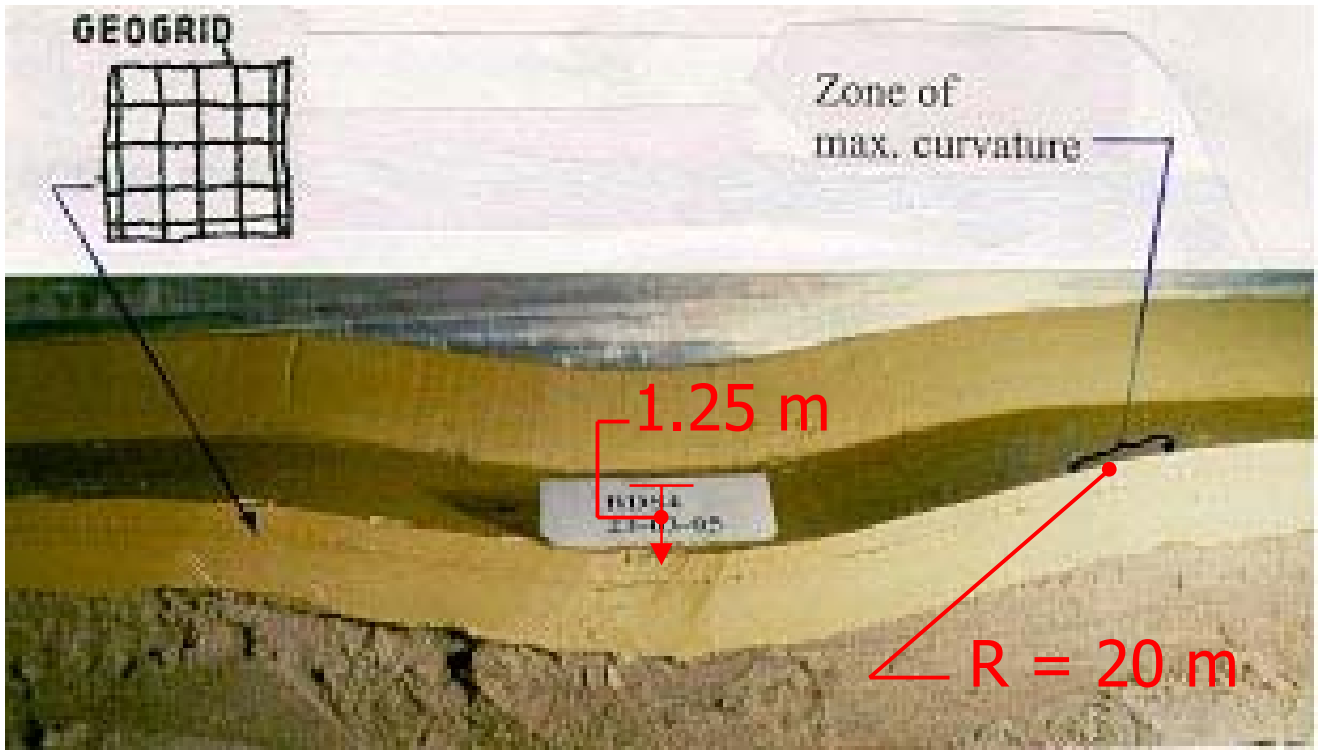


Reinforcement of clay liner proves to be an efficient solution

Variation of outer fibre strain with radius of curvature



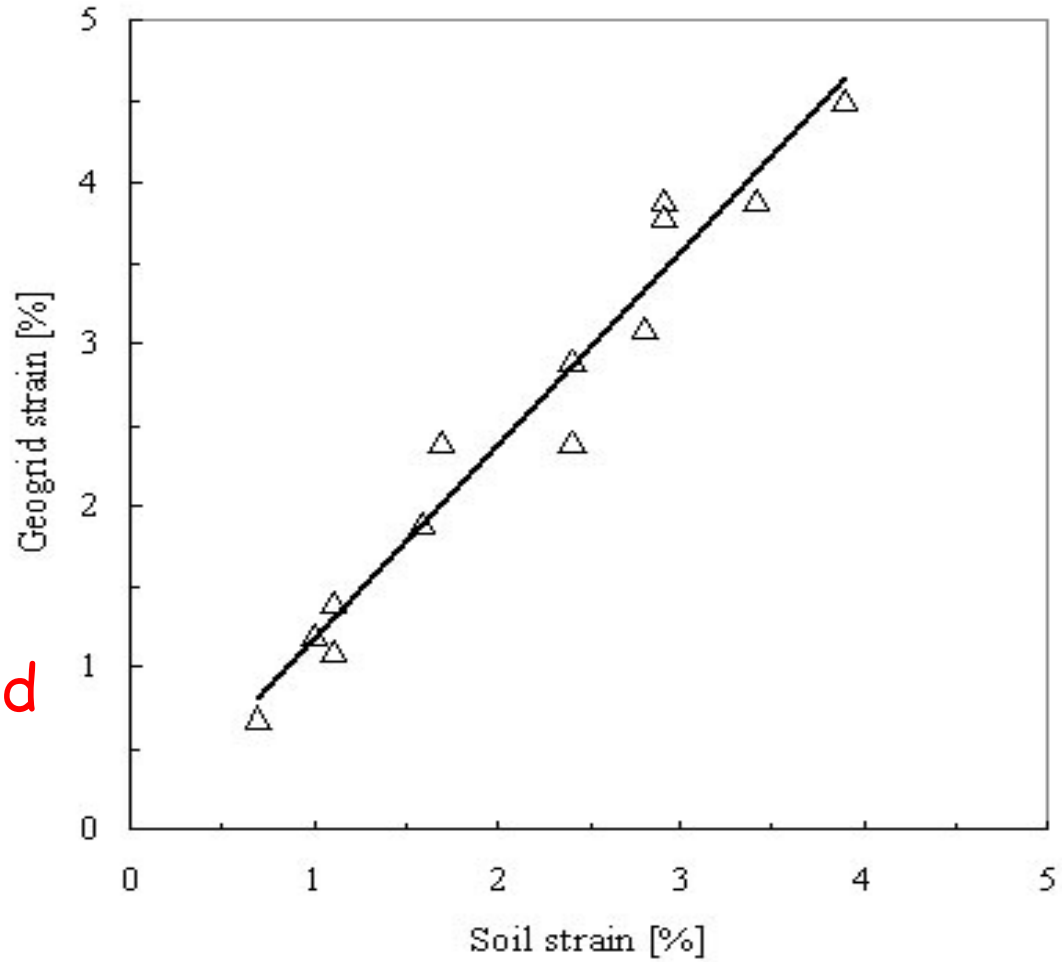
Deformed geogrid reinforced clay liner



Strains in soil and geogrid

Requirement of compatibility

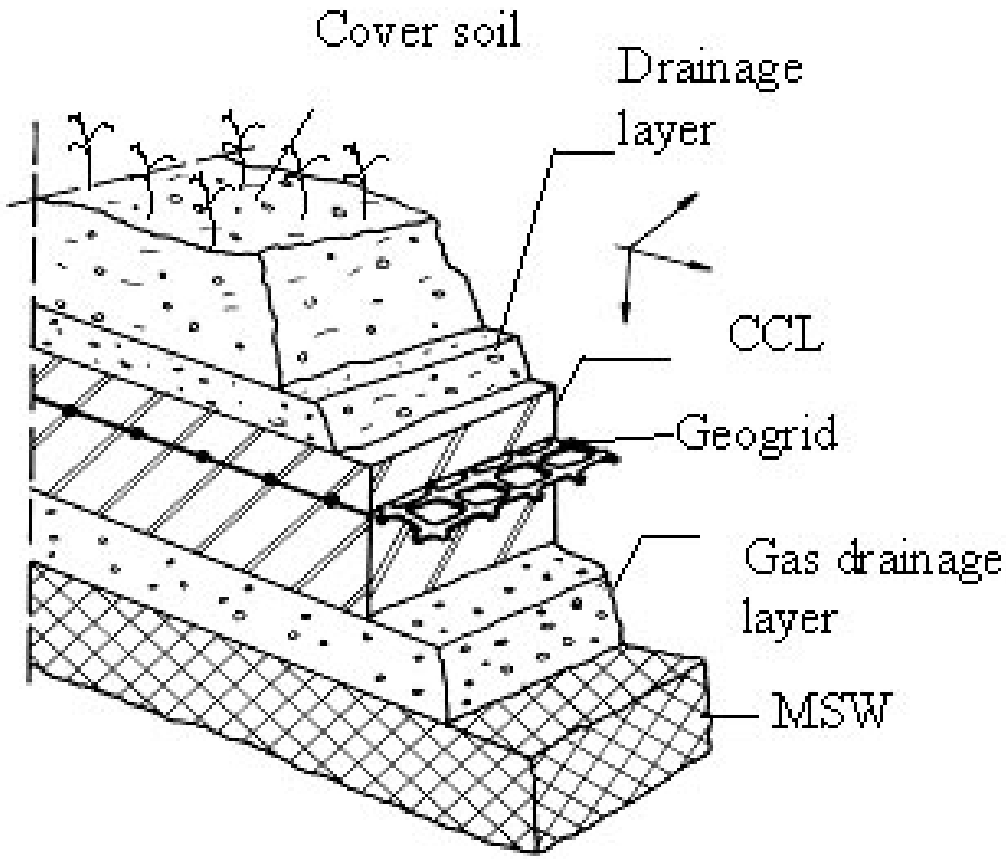
between soil and geogrid



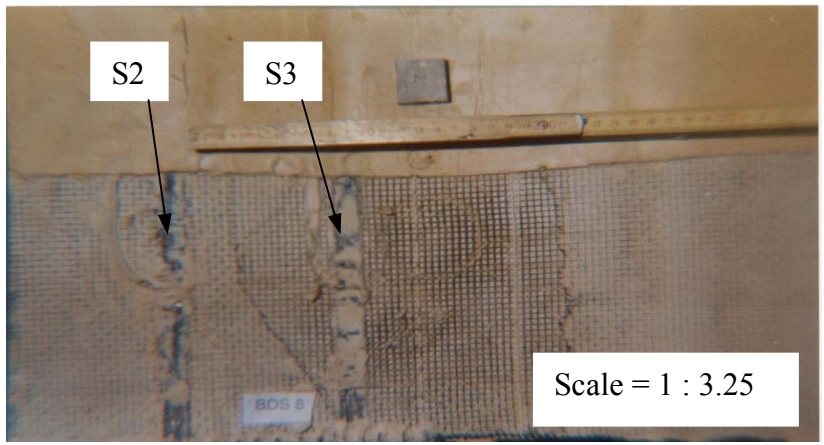
Deformed model geogrid reinforced clay liner at the end of the centrifuge test

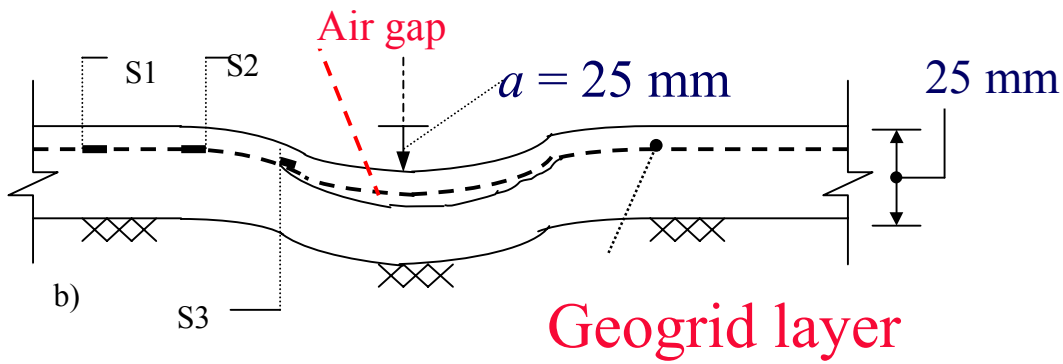


An improved capping system [GRCL]

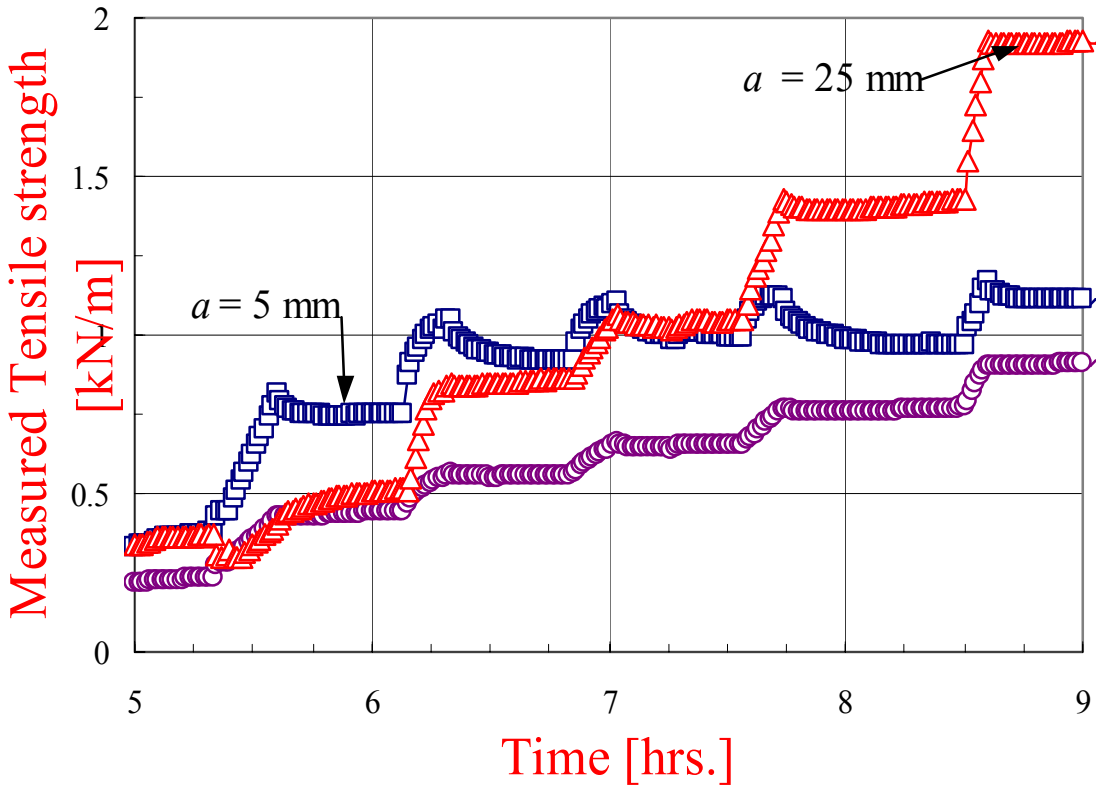


Deformed model geogrid within the clay liner

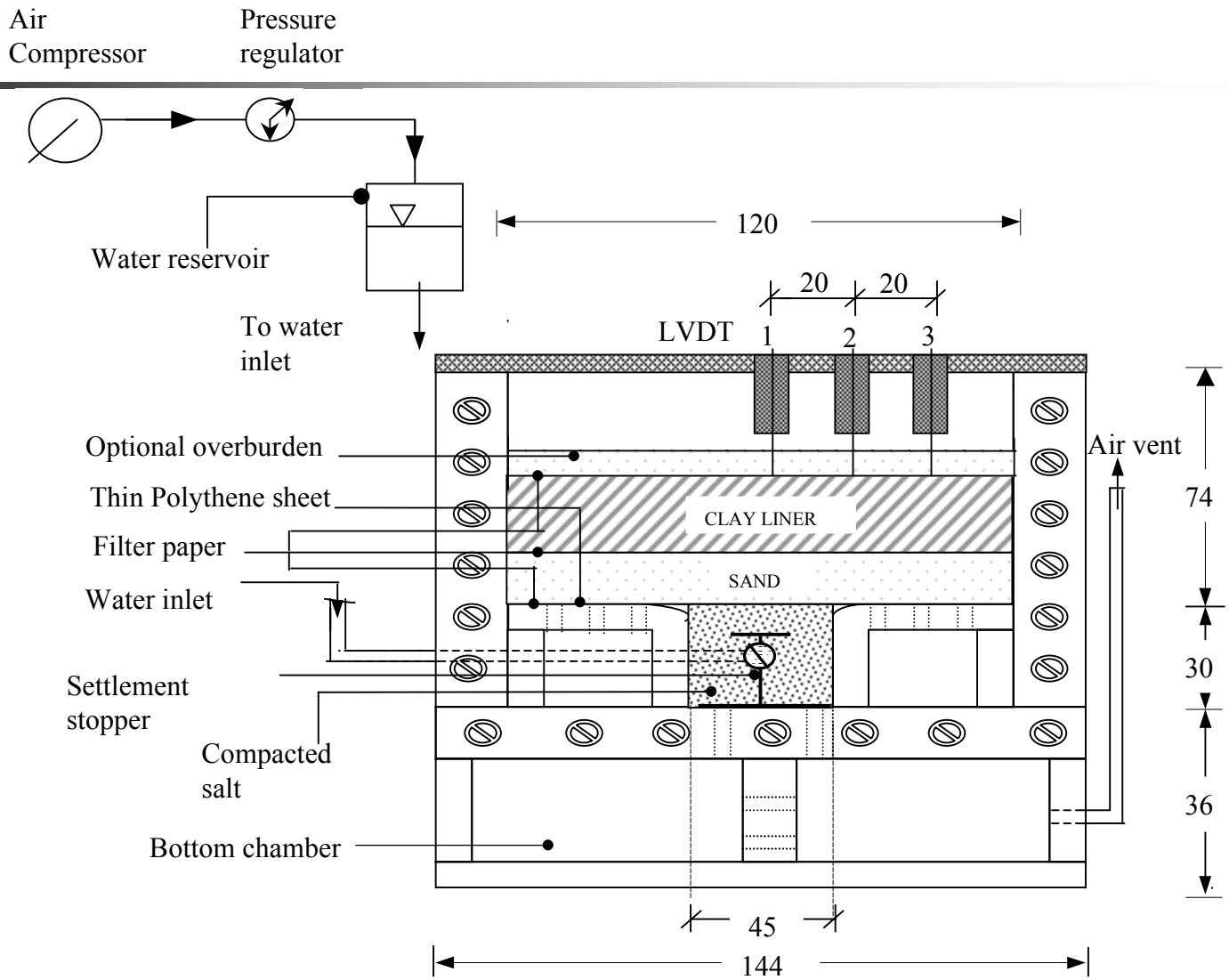




Measured variation of tensile strength in model geogrid with time



Development of simple set-up for inducing non-uniform settlements in a small centrifuge

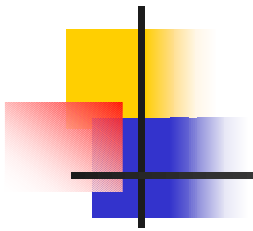


Model clay liner at the end of the centrifuge test



Conclusions

- The effective usage of a centrifuge modeling technique to model the deformation behaviour of clay liners is demonstrated.
- GRCLs can withstand much greater tensile strains without loosing its sealing efficiency.
- Centrifuge model test results on reinforced clay liners shows significantly improved performance



IIT Bombay Centrifuge…

Activities at NGCF, IITBombay, India



250 g-t beam centrifuge



Sudarshan during flight

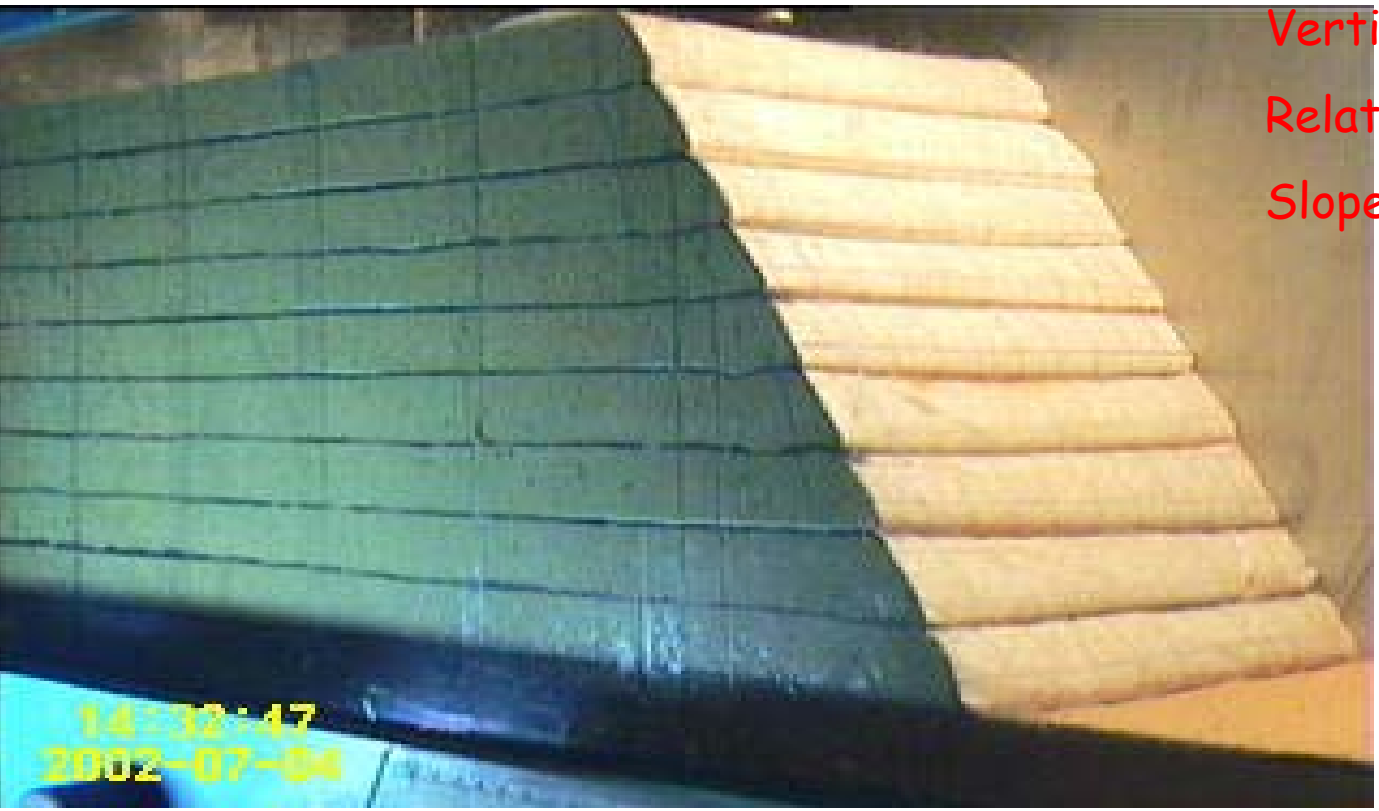
Specifications

Parameter	Details
Maximum radial acceleration	200g
Maximum pay load	2.5 t
Capacity	250 g-t
Radius	*4.5 m
Model area	-1.0 m x 1.2 m (0.66 m height) - 0.76 m x 1.2 m (1.2 m height)
* measured from central axis of shaft to the top surface of the swinging basket	

On-going projects

- Deformation behaviour of sheet-pile walls
- Behaviour of mineral liner subjected to non-uniform settlements
- Geosynthetic reinforced sand slopes
- Slope stabilization by using piles

Model geosynthetic reinforced slope



Vertical spacing = 30 mm;

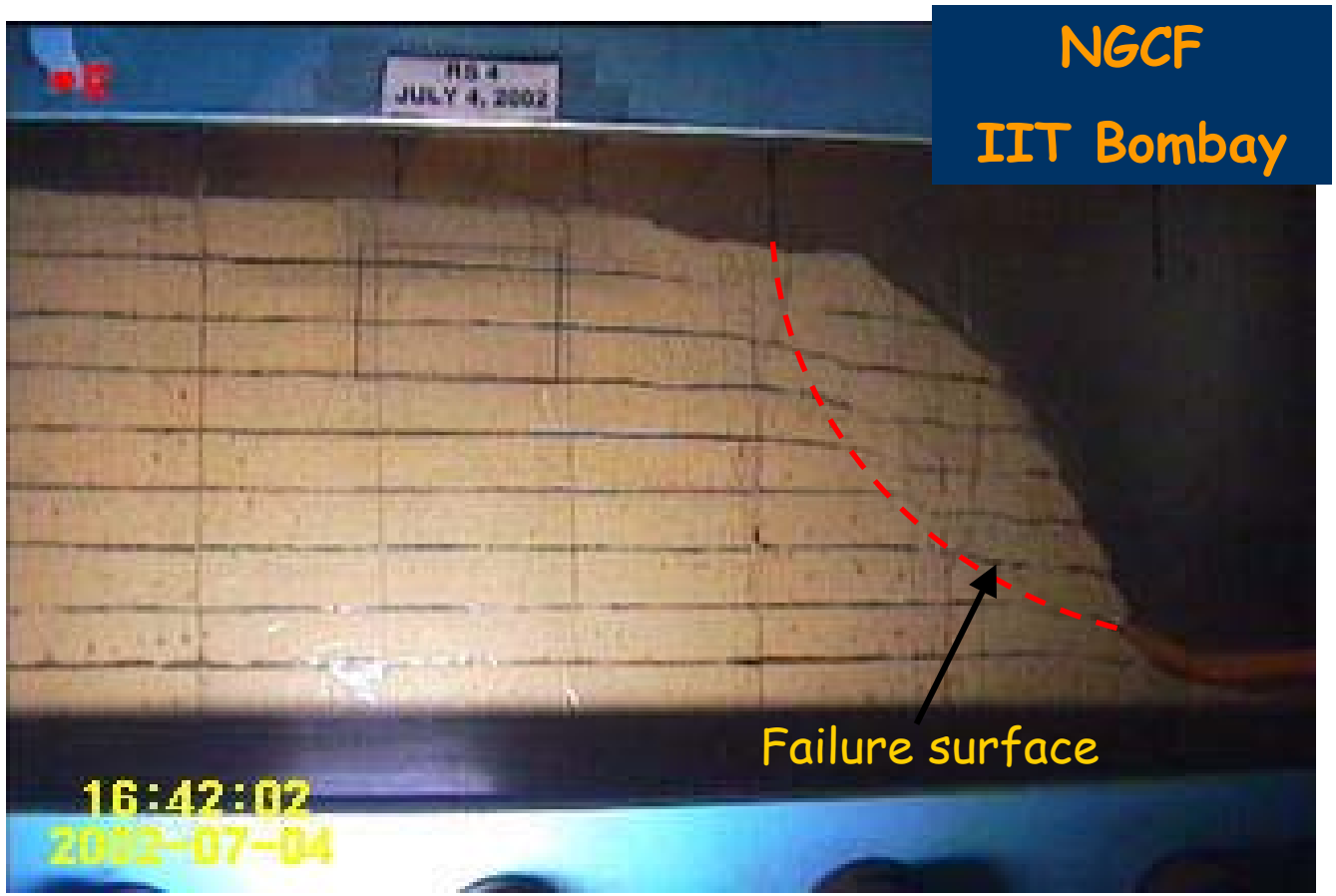
Relative Density = 45 %;

Slope inclination = 63°

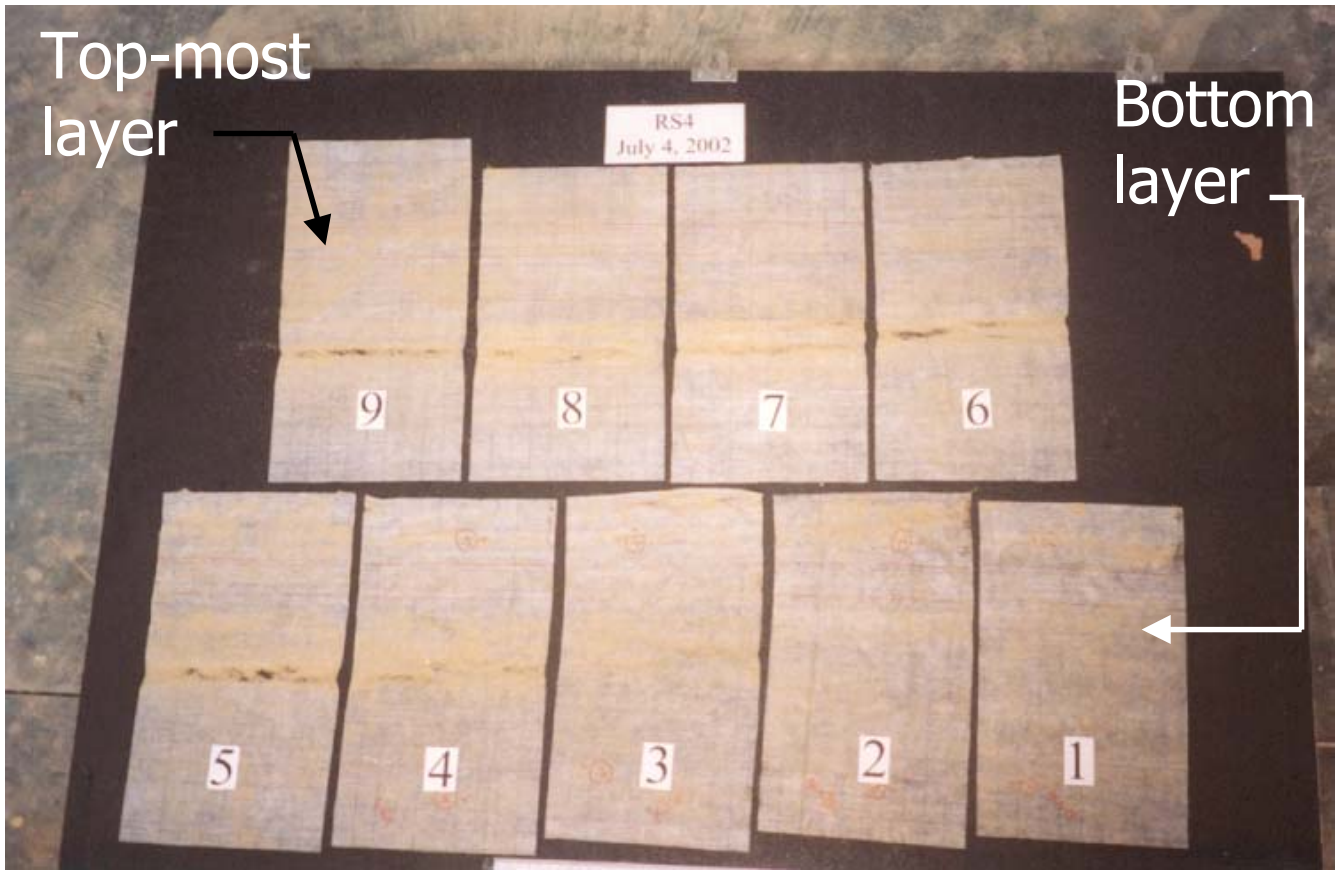
Model reinforced slope at 1g



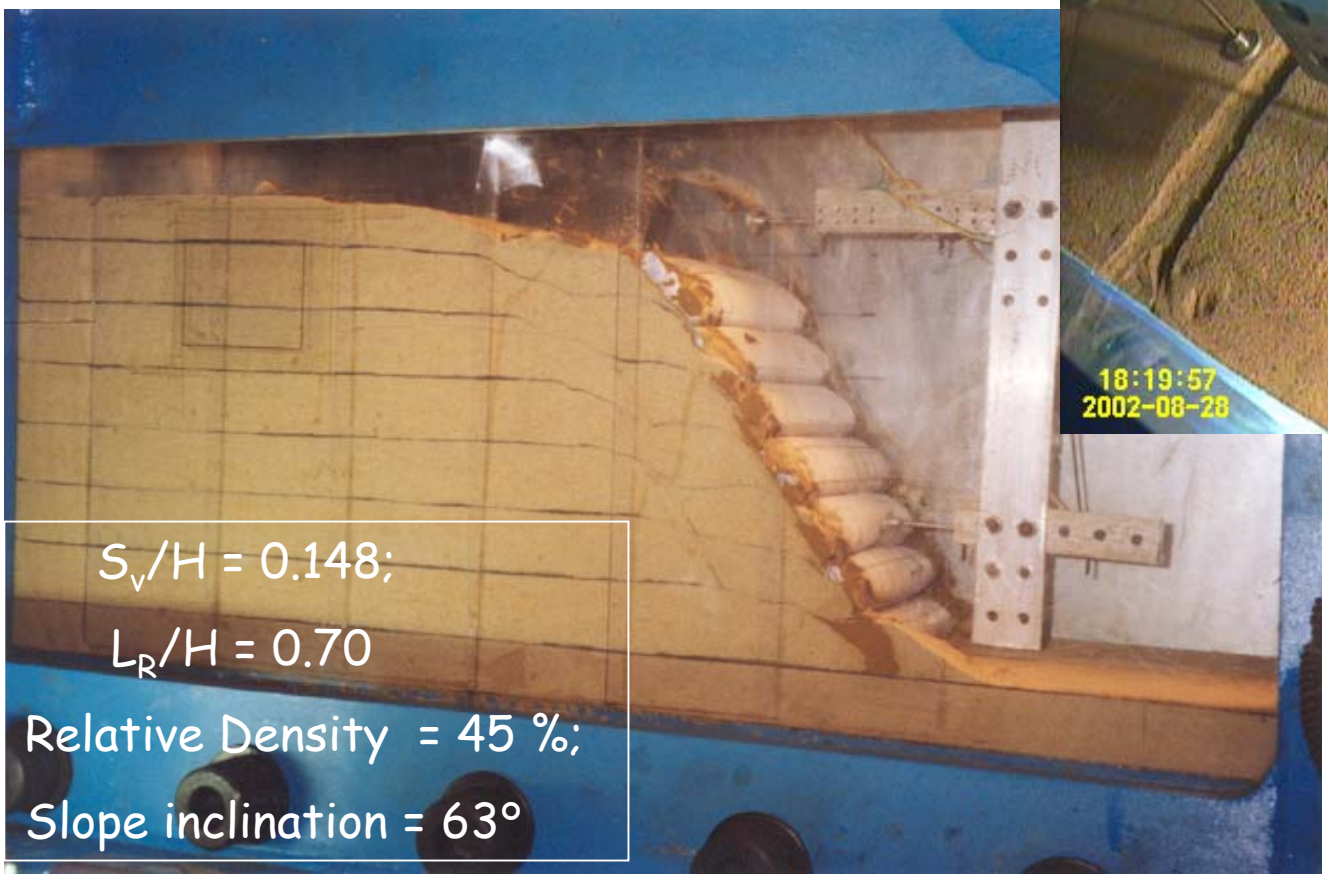
Model reinforced slope at 15g



Observed ruptures in reinforcement layers



Typical pull-out failure mode in RS6a





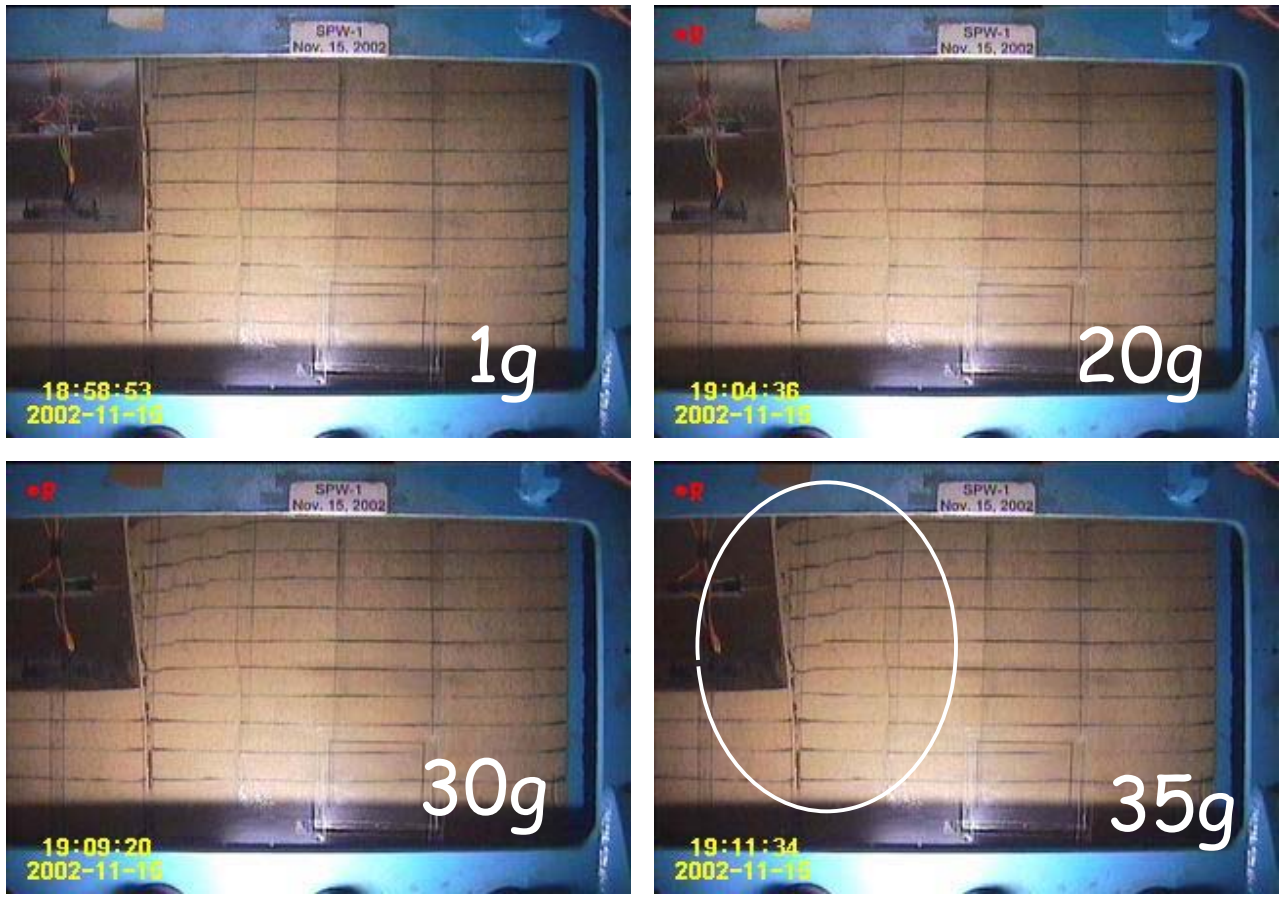
$S_v/H = 0.148$;

$L_R/H = 0.70$

Relative Density = 45 %;

Slope inclination = 63°

Deformation of cantilever sheet pile wall during the centrifuge test





Thank you