COMPRESSIBILITY OF PEAT

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OVERVIEW

- Construction of embankments on peat deposits
  - study compressibility of peat material
    - calculating amounts and rates of settlement
  - effect of peat fabric, inherently cross-anisotropic
    - more accurate design predictions from numerical analysis
  - assess accuracy of existing empirical correlations

TEST MATERIALS

Bog peats from Carrick on Shannon

- Very soft, strongly degraded, **fine fibrous peat** (H6*)
- Soft, spongy, slightly degraded, **coarse fibrous peat** (H3*)

(* von Post classification system)

Sampling method: undisturbed borehole cores

100mm dia. fixed piston sampler, sharp 12 degree cutting edge

Depth (m)	Soil description and classification (BS5930, 1999)	w_l (%)	w_p (%)	I_p (%)	G_s	*In-situ* properties			
						w_o (%)	e_o	γ (kN/m^3)	γ_d (kN/m^3)
1.5	Fine fibrous PEAT	710	380	330	1.41	712	10.3	9.5	1.2
1.2	Coarse fibrous PEAT	470	280	190	1.53	554	9.5	9.5	1.5

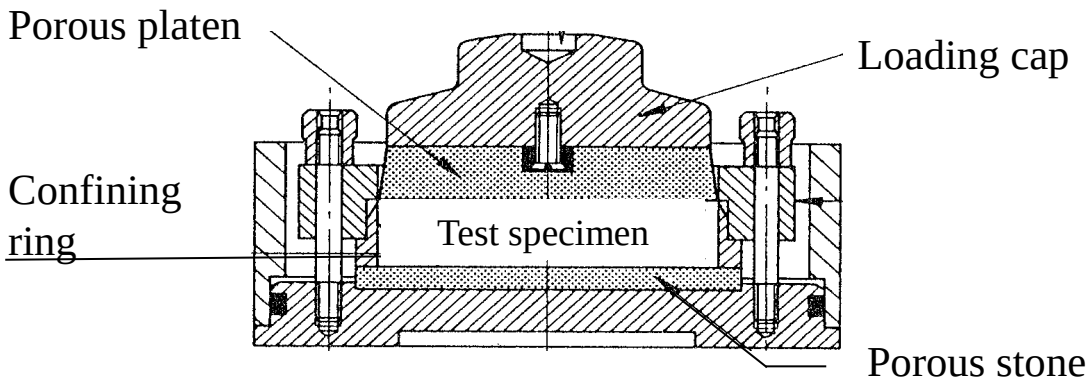
w_l is the liquid limit; w_p plastic limit; I_P plasticity index;
w_o in situ water content; e_o in situ void ratio;
γ bulk unit weight; and γ_d dry unit weight

Water content *w*, mass of porewater to mass dry solid particles, as %

COMPRESSIBILITY PROPERTIES

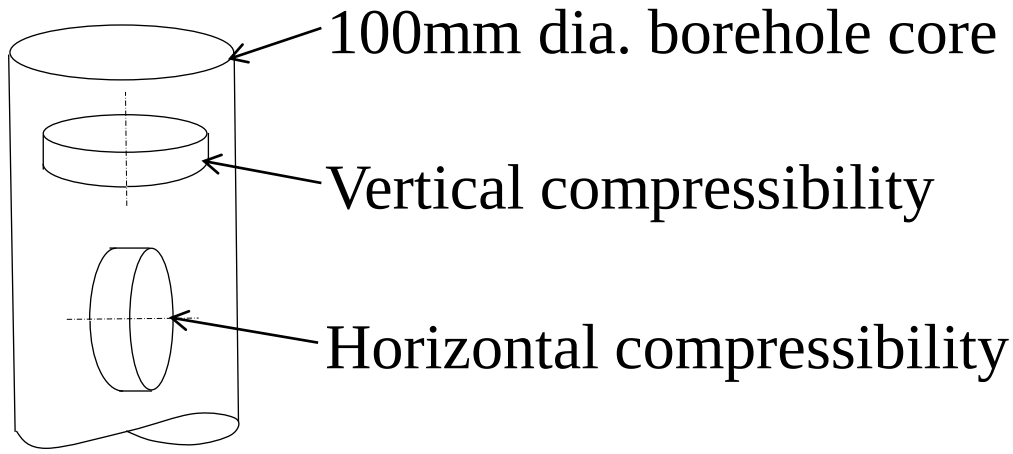
- TEST APPARATUS:

  Oedometer consolidation cell

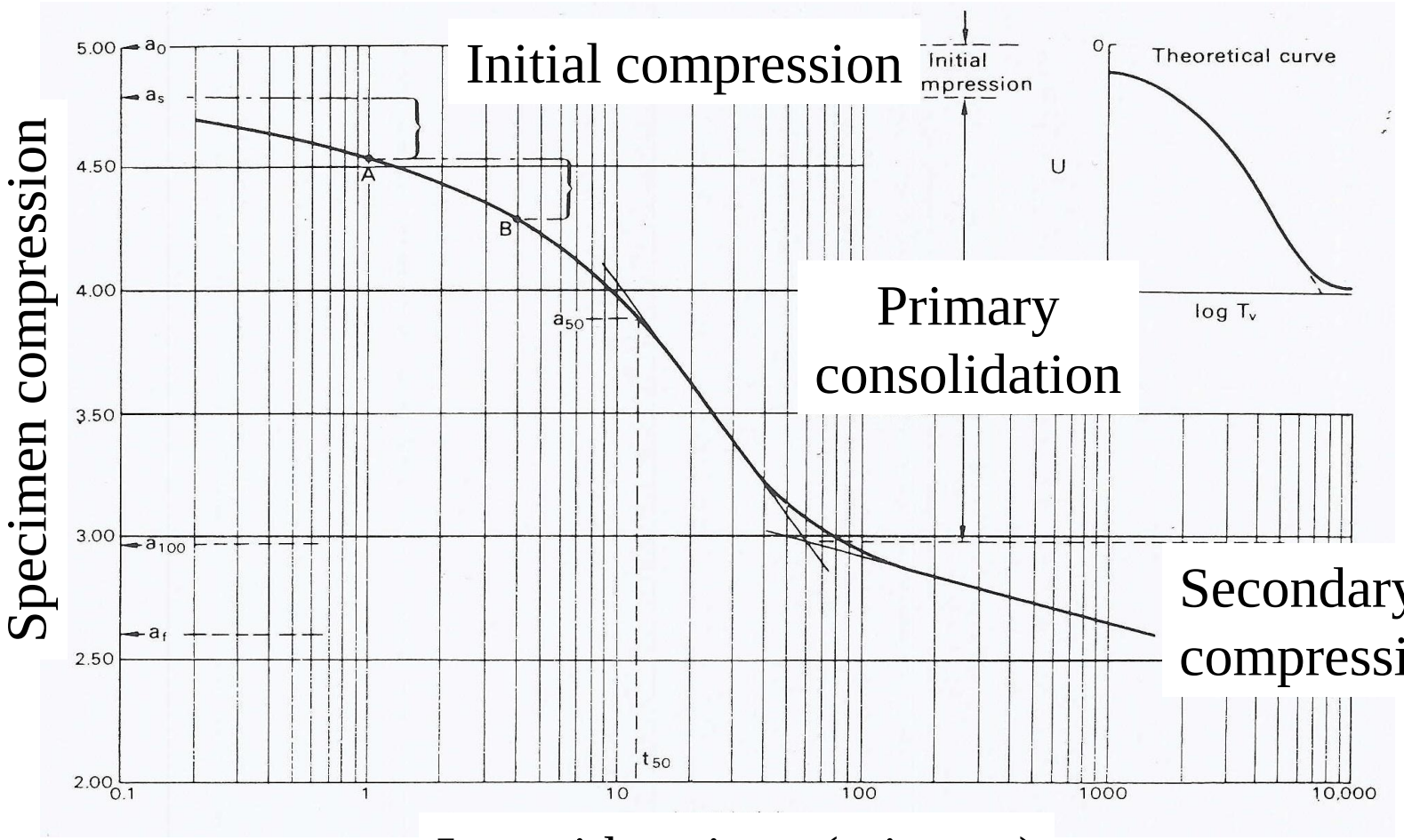


Test specimen dimensions: 76mm dia. x 19mm high

Specimen preparation
study anisotropic compressibility

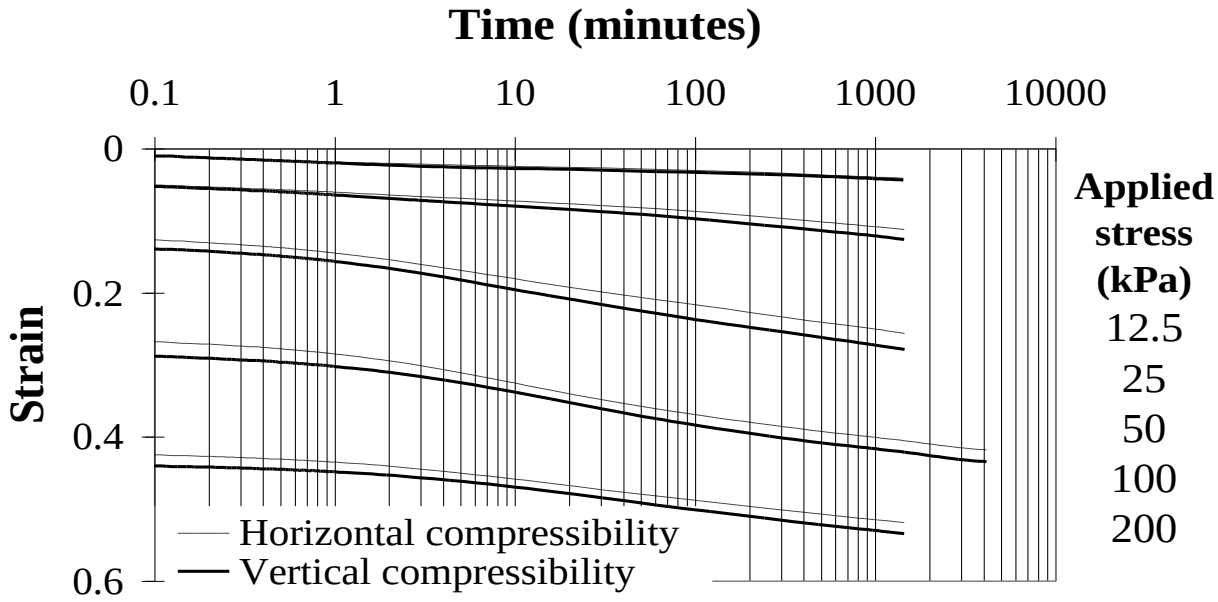


CONVENTIONAL ONE-DIMENSIONAL CONSOLIDATION CURVE

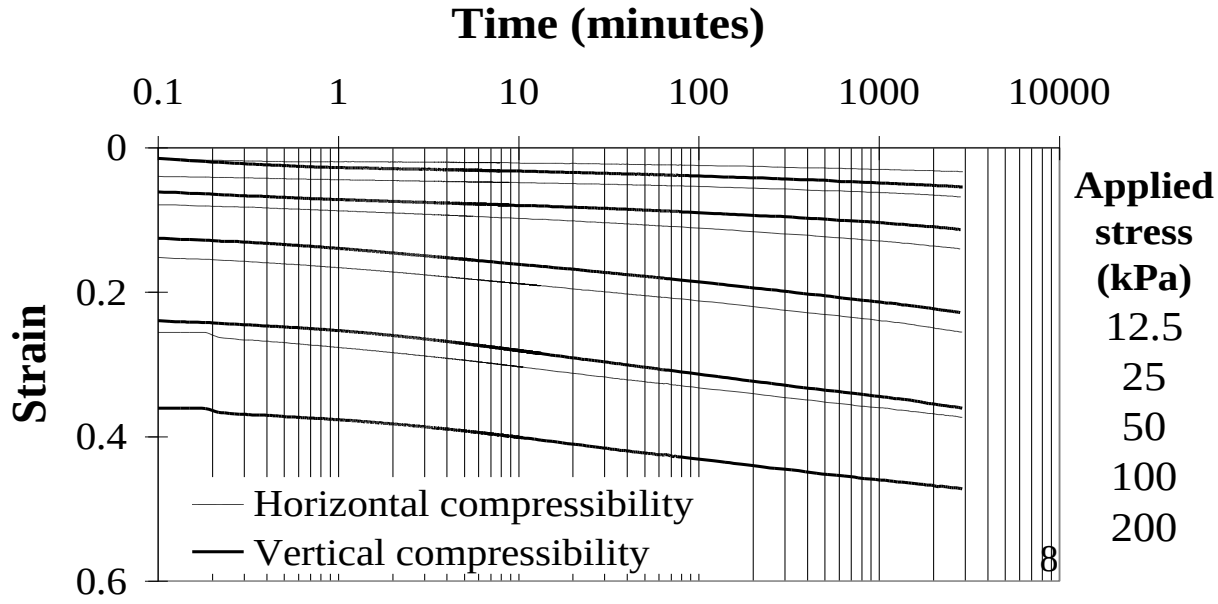


SAMPLE TEST RESULTS

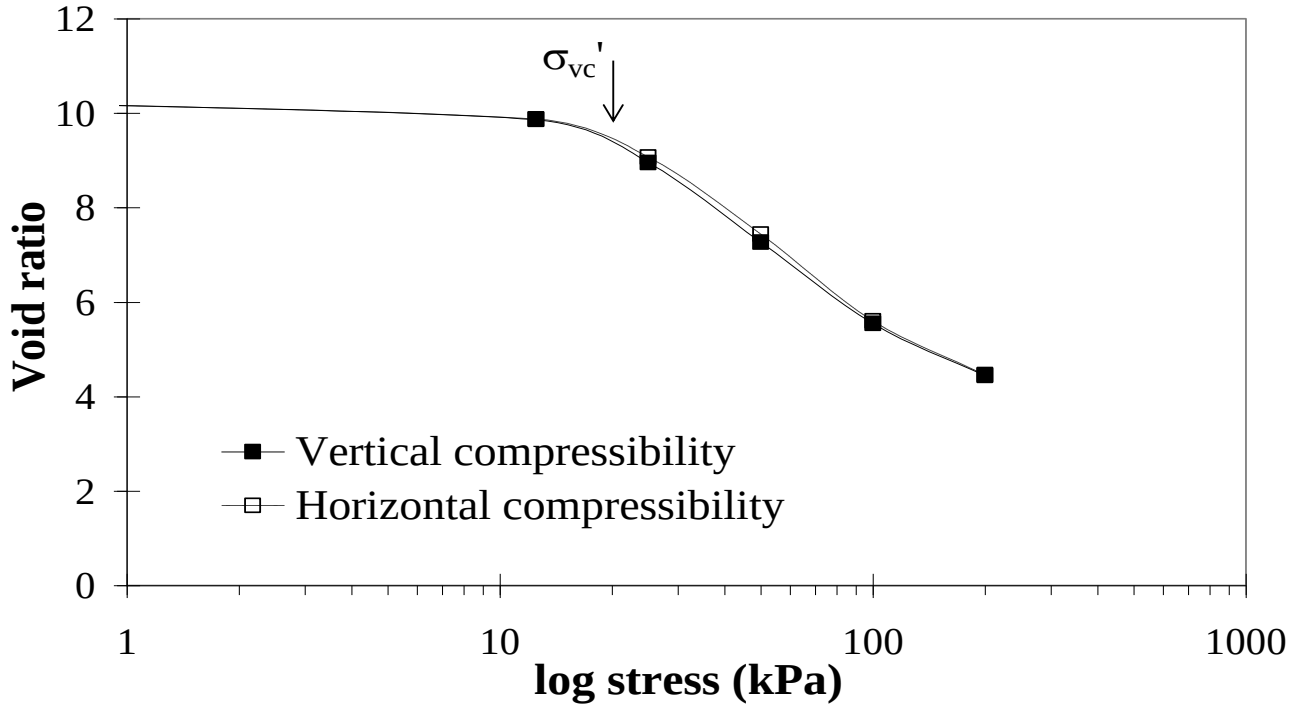
Fine peat material, largely isotropic compressibility



Coarse peat material, strongly anisotropic



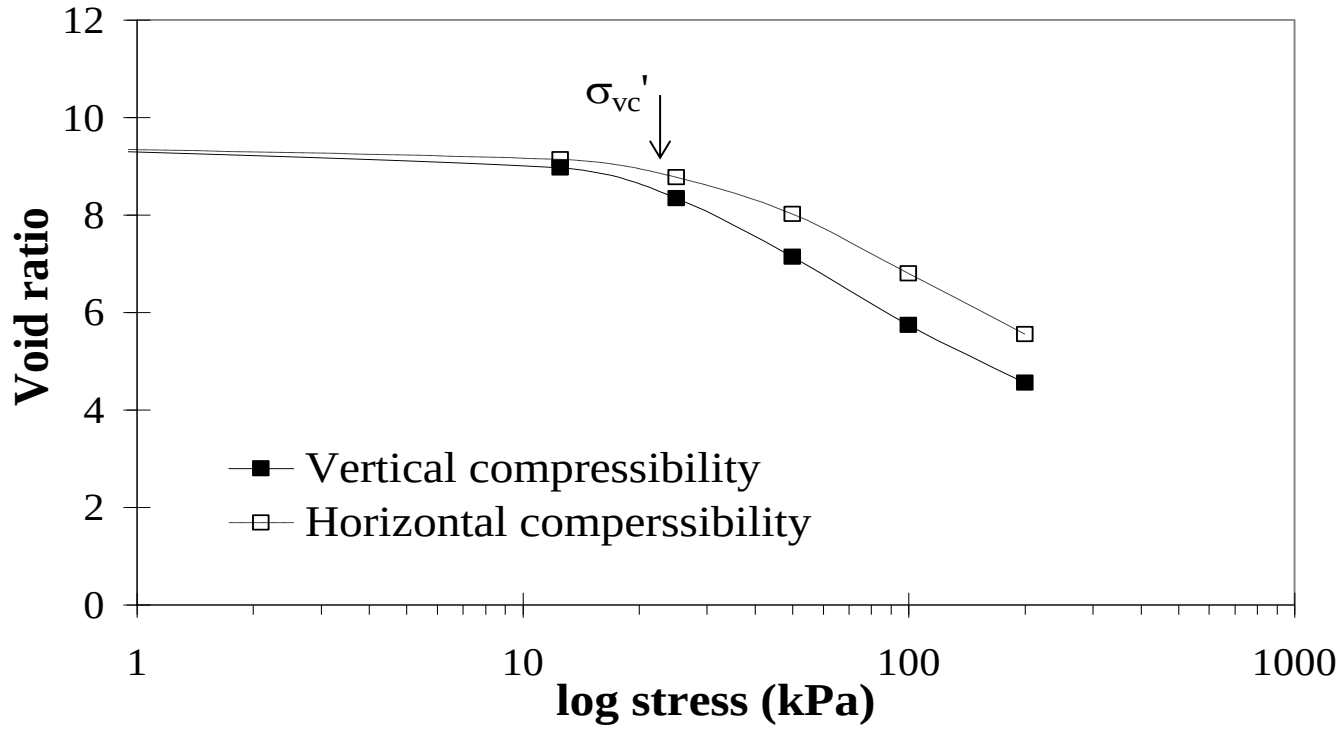
SUMMARY OF COMPRESSIBILITY DATA



Fine peat material

Void ratio, volume of void space to volume of solid particles

σ_{vc}´ is the preconsolidation (yield) pressure



Coarse peat material

- AMOUNT OF CONSOLIDATION SETTLEMENT determined using the compression index value

	Compression index		Preconsolidation pressures (kPa)		σ_{vo}'
	C_{cv}	h : v ratio	σ_{vc}'	σ_{hc}'	(kPa)
Fine peat	6.0	1.0	20	22	0
Coarse peat	4.7	0.9	21	32	0

v = vertical, and h = horizontal, load directions

- Fine peat material, isotropic but greater compressibility overall
- Cross-anisotropic reinforcement in the coarse peat material due to organic fibers
- Preconsolidation (yield) pressure significantly greater than actual insitu vertical stress (σ_{vo}')
  - combined effects of fiber reinforcement and sampling disturbance (preloading)

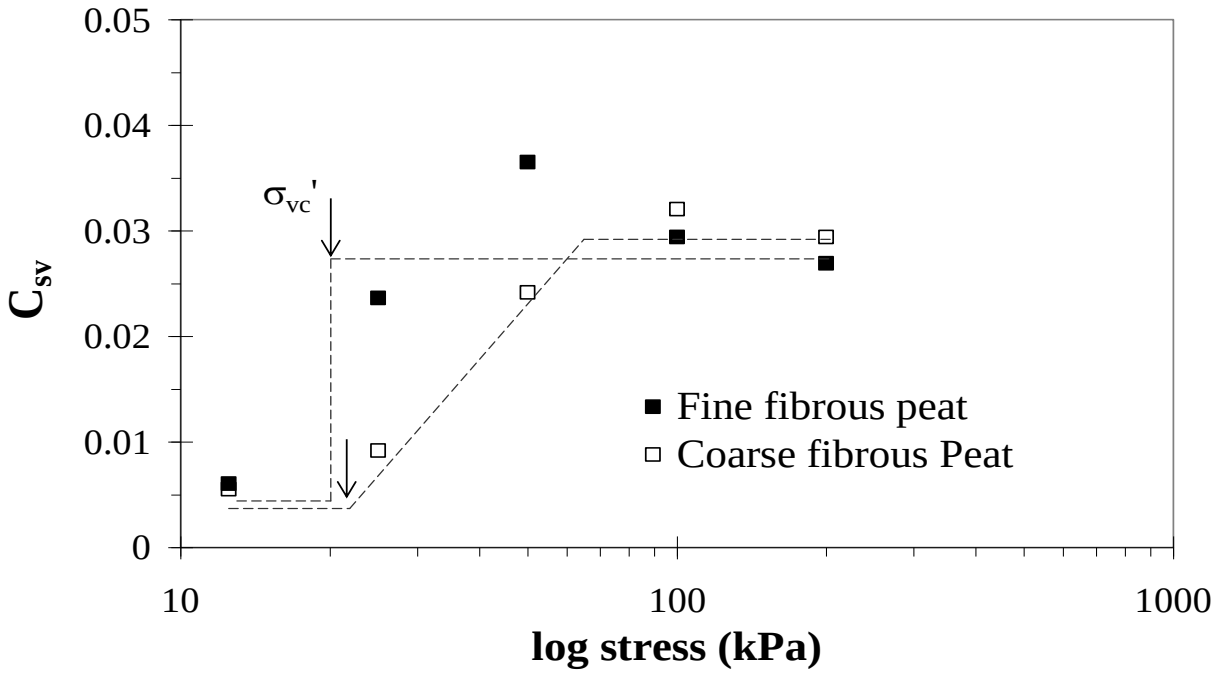
$\Rightarrow$ calculations using lab data will under predict amount of field settlements

AMOUNT AND RATE OF LONG-TERM 'CREEP' SETTLEMENT

- Secondary compression
  - deformation of the solid particles themselves,
  - dominant mechanism causing settlement
  - calculate settlement rates using coefficient of secondary compression C_s, values

	C_{sv}	h : v ratio	C_{sv}	h : v ratio	C_{sv}	h : v ratio	C_{sv}	h : v ratio	C_{sv}	h : v ratio	Mean ratio
Fine peat	0.006	1.0	0.024	1.0	0.036	0.9	0.029	1.0	0.027	1.1	1.0
Coarse peat	0.006	0.6	0.009	0.6	0.024	0.6	0.032	0.8	0.029	1.0	0.7
Stress range	0→12.5 kPa		12.5→25 kPa		25→50 kPa		50→100 kPa		100→200 kPa		

v = vertical, and h = horizontal, load directions



C_{sv}, coefficient of secondary compression

step increase in settlement rate at preconsolidation pressure (but latter value was shown to be artificially high)

$\Rightarrow$ calculations using lab data will under predict rate of field settlement

EMPIRICAL CORRELATIONS

- Predicting compression index C_c, values from soil index properties

$$C_c = 0.009\,(w_l - 10)$$ Terzaghi and Peck (1967) Eq. 1

$$C_c = 0.0065\, w_o$$ Hobbs (1986) Eq. 2

$$C_c = 0.0115\, w_o$$ Azzouz et al. (1976) Eq.3

w_l is the liquid limit, and w_o the in situ water content

Compression index	Fibrous peat	
Predicetd value	Fine	Coarse
Terzaghi and Peck (1967)	6.3	4.1
Hobbs (1986)	4.6	3.6
Azzouz et al. (1976)	8.2	6.4
Measured value	5.8	4.6

Given that lab data will underpredict field settlements, C_c values from Azzouz et al. (1976) will most likely agree with field compressibility

Hobbs (1986) correlation too conservative

SUMMARY

Embankment construction on peat deposits

- Settlement predictions based on lab data conservative
  - Highly compressible material,

  $\Rightarrow$ Sampling disturbance causes preloading of the test specimen

- Likely empirical correlation after Azzouzz et al. (1976) most representative of field compressibility

- Strongly degraded (fine) peat material, largely isotropic compressibility
- Slightly degraded (coarse) material, strongly cross-anisotropic

- Step increase in compressibility at pre-consolidation pressure

THANK YOU