Case History Involving a Concrete Slab Placed on an Expansive Soil

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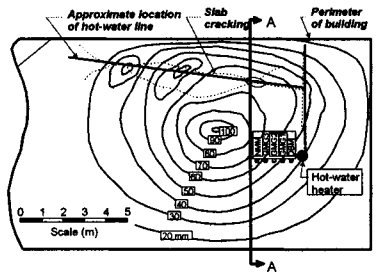
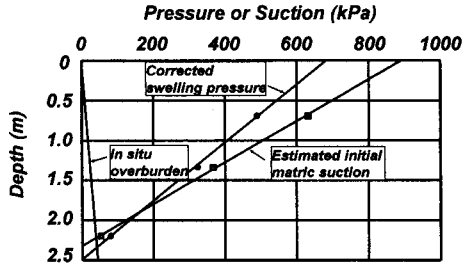
Floor Plan of Slab-on-Ground, Regina, SK., Canada

(Yoshida et al., 1983)



- ✓ Ground movements were monitored
- ✓ Water content changes were monitored
- ✓ Undisturbed samples were taken
- ✓ Constant oedometer tests were performed

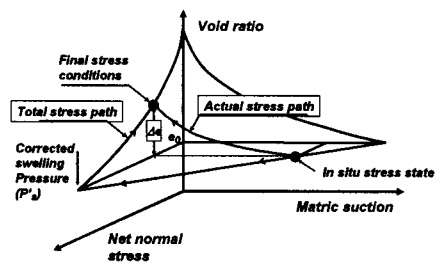
Corrected Swelling Pressure and Estimated Initial Suction



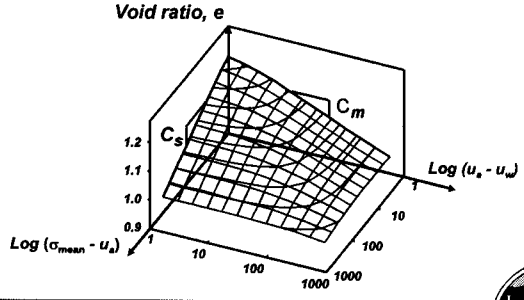
Constant-volume Oedometer Data (Yoshida et al. 1983)

Depth (m)	Initial void ratio, e_o	Swelling index, C_s	Corrected swelling pressure, P'_s (kPa)
0.69	0.927	0.095	490
1.34	0.985	0.081	325
2.20	0.974	0.094	81

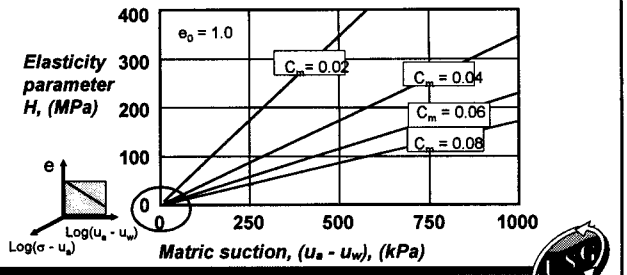
Stress Paths Followed in Conventional Methods for the Prediction of Heave



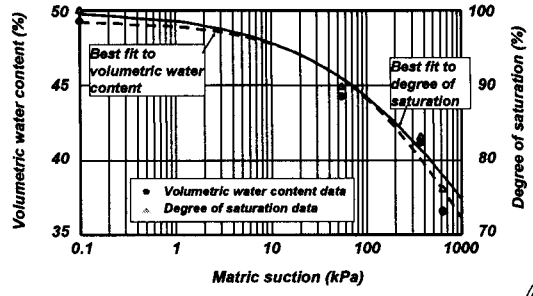
A Typical Void Ratio Constitutive Surface Plotted in Semi-log Scale



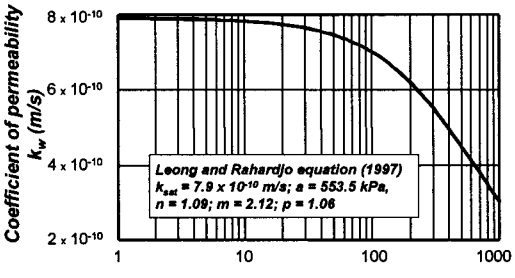
Relationship between Elasticity Parameter, H and Matric Suction for Various Values of Swelling Index, C_m



SWCC for Regina Clay



Computed Coefficient of Permeability Function for Regina Clay



Analysis Using 2D Computer Simulations

- Partial differential equation solver
- Incremental elasticity approach
- Automatic mesh generation and optimization
- Adaptive time step design and refinement
- Ensuring convergence when solving non-linear equations
- Allow material properties to be input in a variety of forms

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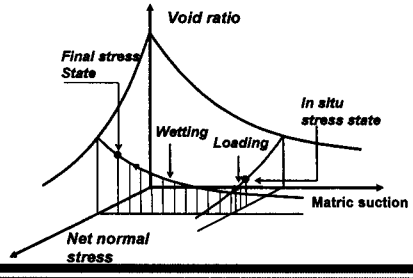
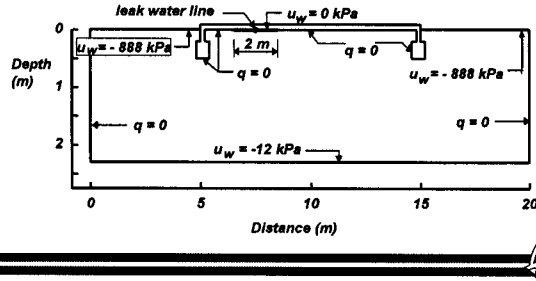
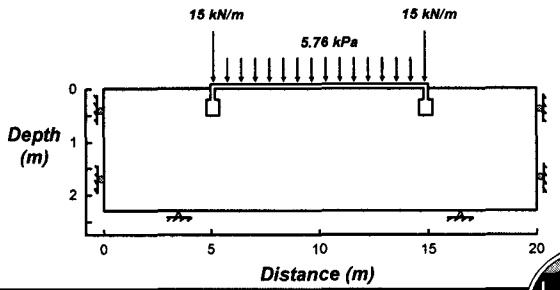
Stress Path Followed in the 2-D Seepage & Stress-Deformation Analysis



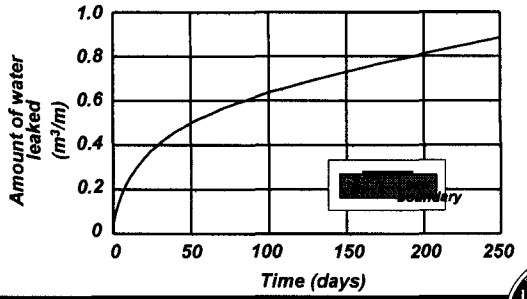
Geometry and Boundary Conditions for Seepage Analysis



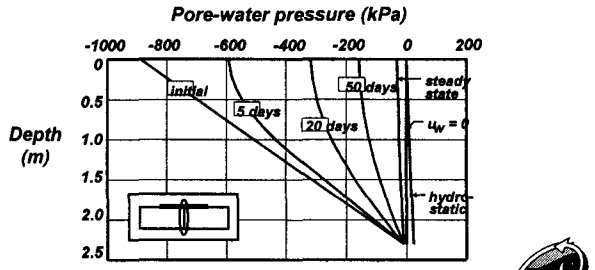
Boundary Conditions for Stress-Deformation Analysis



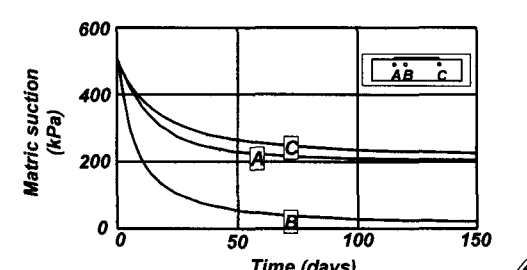
Total Amount of Water Leaked from Water Line



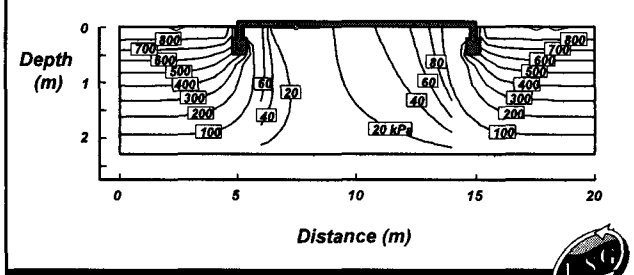
Pore-water Pressure Profiles (Matric Suction Profiles)



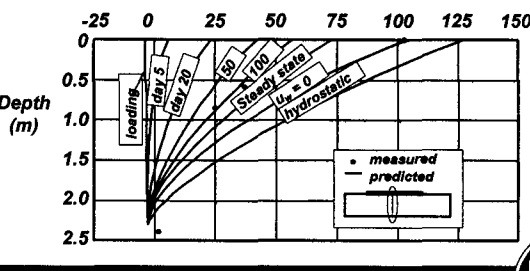
Matric Suction Changes With Time



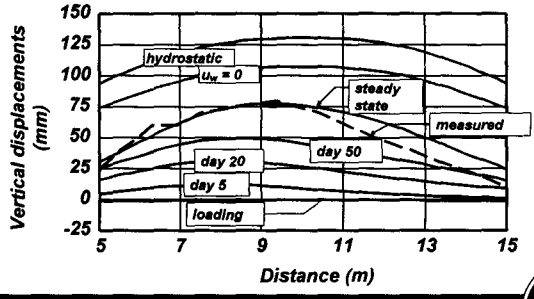
Matric Suction Distribution at Steady State Conditions



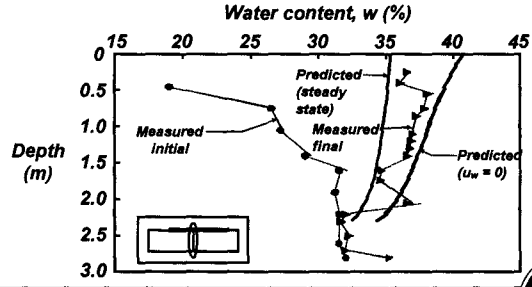
Measured and Predicted Vertical Displacements near the Center of the Slab



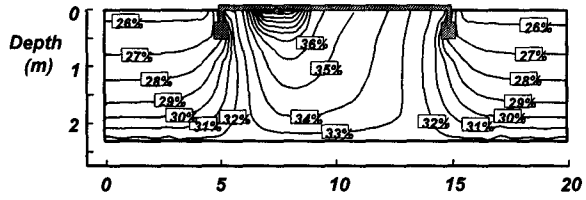
Measured and Predicted Vertical Displacements at Surface of the Slab



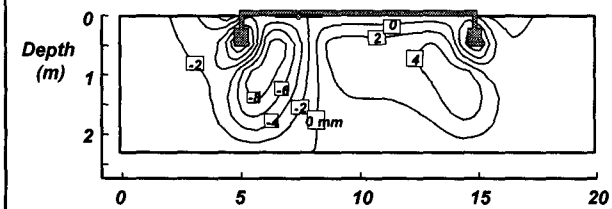
Measured and Predicted Water Content with Depth near Center of the Slab



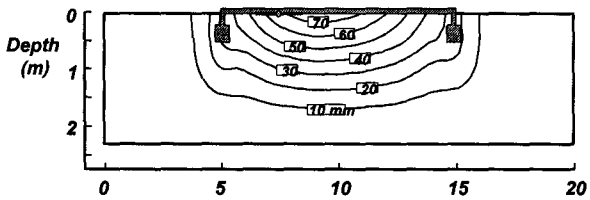
Distribution of Water Content at Steady State Conditions



Distribution of Horizontal Displacements at Steady State Conditions

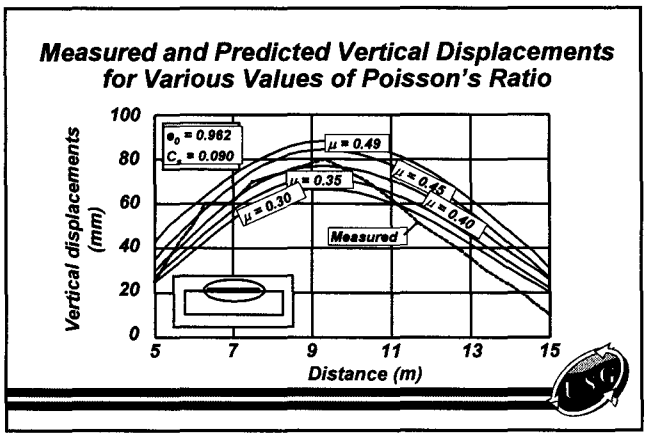


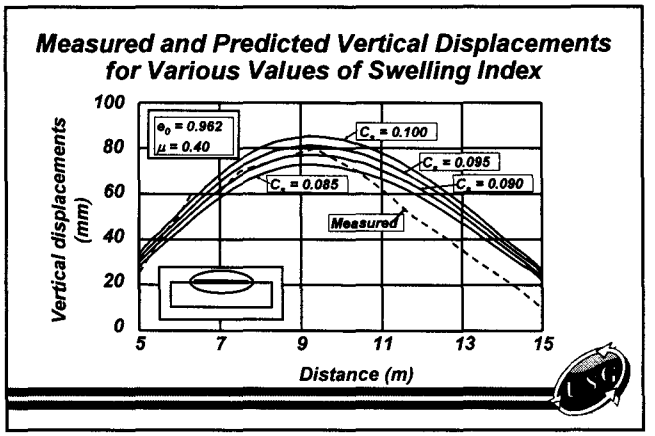
Distribution of Vertical Displacements at Steady State Conditions

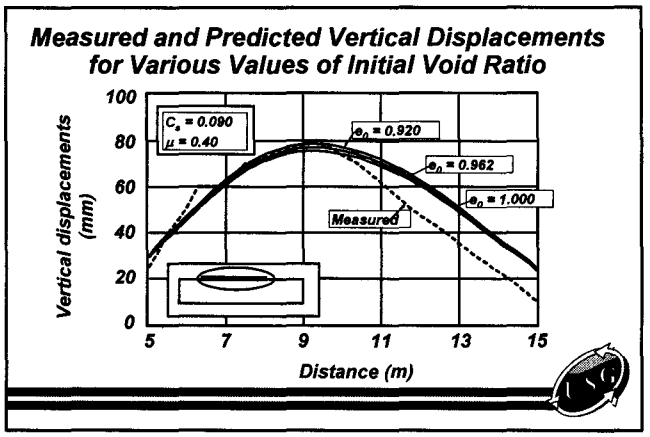


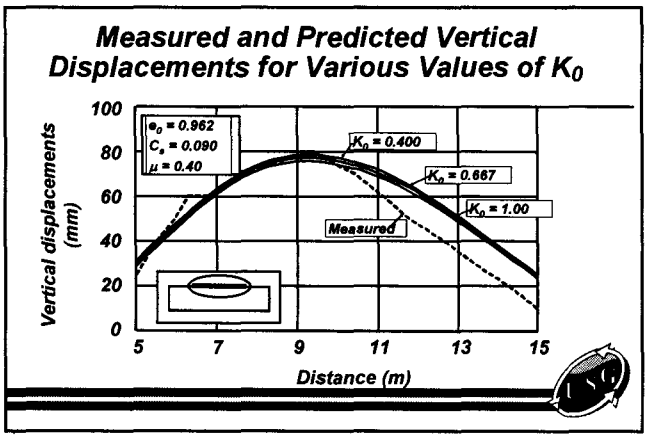
Values of Parameters Used in the Parametric Study

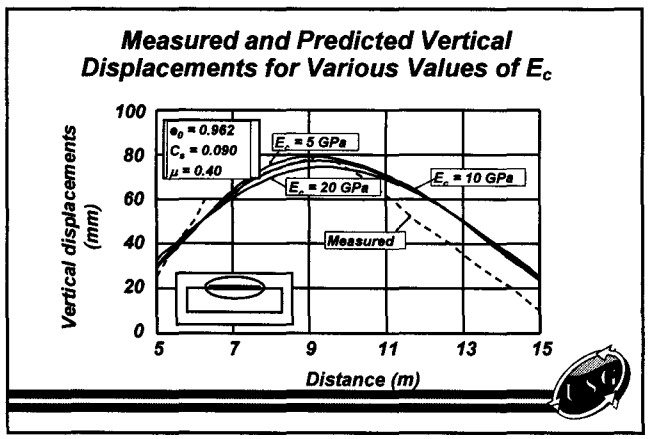
Parameter	Lower values	Base value	Upper values
Poisson's ratio	0.30, 0.35	0.40	0.45, 0.49
Swelling index, C_s	0.085	0.090	0.095, 0.10
Initial void ratio, e_o	0.920	0.962	1.000
Coeff. of earth pressure, K_o	0.400	0.667	1.000
Concrete modulus, E_c (Gpa)	5	10	20











Results of the Parametric Study

Parameter	Range	Variation of Predicted Heave (%)
Poisson's ratio	0.35 – 0.45	+/- 7
Swelling index, C_s	0.085 – 0.095	+/- 5
Initial void ratio, e_0	0.92 – 1.00	+/- 2
Coeff. K_0	0.4 – 1.0	+/- 2
Concrete modulus	5 – 20	+/- 3

Conclusions

1. *Heave associated with expansive soils can be analyzed as a two-dimensional, combined seepage and stress-deformation analysis*
2. *All soil properties take the form of nonlinear unsaturated soil property functions*
3. *Adaptive mesh generation techniques need to be used due to nonlinearity associated with the solution*
4. *Interpretive plots can be obtained to assist the engineer in solving problems*