# ENHANCEMENT OF ONE-DIMENSIONAL CONSOLIDATION PROCESS IN GEOMATERIALS USING ELECTROKINETIC APPROACH

Thesis submitted in partial fulfillment for the
Award of Degree

**Doctor of Philosophy**

By

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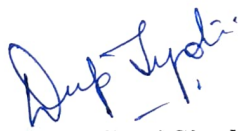

**Deep Jyoti Singh**

*Dedicated to my*

*little princess*

# *GARGI NANDPURI*

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# LIST OF SYMBOLS

| | |
|---|---|
| $C_c$ | Compression index |
| $a_v$ | Coefficient of compressibility |
| $m_v$ | Coefficient of volume change |
| $p_c$ | Preconsolidation pressure |
| $C_r$ | Recompression index |
| $C_v$ | Coefficient of consolidation |
| $C_\alpha$ | Coefficient of secondary consolidation |
| ASTM | American Society of Testing and Material |
| MS | Marine soil |
| BCS | Black cotton soil |
| RM | Red mud |
| LS | Varanasi local soil |
| PP | Pore pressure |
| PPR | Pore pressure ratio |
| DC | Direct current |
| D/H | Diameter to height |
| DAQ | Data Acquisition System |
| $\sigma'$ | Effective stress |
| $\sigma$ | Total stress |
| $u$ | Pore pressure |
| LIR | load increment ratios |

| | |
|---|---|
| k | Permeability |
| t | Time |
| z | vertical height of that location |
| H | maximum drainage path length. |
| $H_o$ | Initial thickness of specimen |
| $T_v$ | Time factor |
| $U_z$, $\overline{U}$ | Degree of consolidation |
| $\Upsilon_w$ | Unit weight of water |
| ΔH | Dial gauge readings |
| $\Delta e$ | Change in void ratio |
| $\Delta\sigma$ | Stress increment |
| $e_0$ | Initial void ratio |
| LL | Liquid limit |
| PI | Plasticity index |
| $G_s$ | Specific gravity |
| $r_e$ | Rate of change of average void ratio |
| Ɛ | Vertical strain |
| $Ɛ_{av}$ | Average strain |
| $\zeta$ | Consolidation ratio, |
| $z_o$ | Original coordinate |
| $\beta$ | Dimensionless normalized strain rate parameter |
| A | Cross-sectional area |
| $k_e$ | Electro-osmotic permeability |

| | |
|---|---|
| $i_e$ | Constant voltage gradient |
| $q_h$ | Flow induced by hydraulic gradient |
| $k_h$ | Hydraulic permeability |
| $i_h$ | Hydraulic gradient |
| $E$ | Electric gradient difference |
| $E(x)$ | Voltage at the location *x* |
| $E_m$ | Maximum voltage |
| $H_2O$ | Water molecule |
| $e^-$ | Electron |
| $H^+$ | Hydrogen ion |
| $OH^-$ | Hydroxide ion |
| $O_2$ | Oxygen gas |
| $H_2$ | Hydrogen gas |
| AC | Alternating current |
| NaCl | Sodium chloride |
| $CaCl_2$ | Calcium chloride |
| EKG | Electrokinetic geosynthetics |
| EVD | electrical vertical drain |
| V/m | Voltage gradient |
| $k_i$ | Electroosmotic coefficient of water transport |
| $Cu_e$ | Copper electrode |
| $Cu_s$ | Copper precipitate in solution |
| LC | Least count |

| | |
|---|---|
| LVDT | Linear variable differential transducer |
| BP | Back pressure |
| OMC | Optimum moisture content |
| MDD | Maximum dry density |
| V | Voltage in volts |
| $H_o$ | Initial specimen height |
| $H_s$ | Height of solids |
| $H_f$ | Final specimen height |
| EKCL | Electrokinetic coupled constant loading |
| EKCRS | Electrokinetic constant rate of strain |
| ILMS-C | Marine soil with incremental loading on conventional oedometer |
| ILMS-M | Marine soil with incremental loading on Modified oedometer |
| CLMS-M | Marine soil with constant loading on Modified oedometer |
| EKCLMS | Marine soil with electrokinetic coupled constant loading on Modified oedometer |
| CRSMS | Marine soil with constant rate strain loading on modified oedometer |
| EKCRSMS | Marine soil with electrokinetic coupled constant rate strain loading on Modified oedometer |
| ILBCS-C | Black cotton soil with incremental loading on conventional oedometer |
| ILBCS-M | Black cotton soil with incremental loading on Modified oedometer |
| CLBCS-M | Black cotton soil with constant loading on Modified oedometer |
| EKCLBCS | Black cotton soil with electrokinetic coupled constant loading on Modified oedometer |
| CRSBCS | Black cotton soil with constant rate strain loading on modified oedometer |
| EKCRSBCS | Black cotton soil with electrokinetic coupled constant rate strain loading on Modified oedometer |
| ILRM-C | Red mud with incremental loading on conventional oedometer |

| | |
|---|---|
| ILRM-M | Red mud with incremental loading on Modified oedometer |
| CLRM-M | Red mud with constant loading on Modified oedometer |
| EKCLRM | Red mud with electrokinetic coupled constant loading on Modified oedometer |
| CRSRM | Red mud with constant rate strain loading on modified oedometer |
| EKCRSRM | Red mud with electrokinetic coupled constant rate strain loading on Modified oedometer |
| ILLS-C | Varanasi local soil with incremental loading on conventional oedometer |
| ILLS-M | Varanasi local soil with incremental loading on Modified oedometer |
| CLLS-M | Varanasi local soil with constant loading on Modified oedometer |
| EKCLLS | Varanasi local soil with electrokinetic coupled constant loading on Modified oedometer |
| CRSLS | Varanasi local soil with constant rate strain loading on modified oedometer |
| EKCRSLS | Varanasi local soil with electrokinetic coupled constant rate strain loading on Modified oedometer |
| CBR | California bearing ratio |