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(RESEARCH ARTICLE)

Modeling heterogeneous particle size distribution and compression index influence on uneven settlement in peat soil

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Abstract

Uneven settling in peat soil poses significant challenges in the field of geotechnical engineering. Simulation models are valuable tools for understanding and predicting settlement behavior. This work aims to develop a simulation model for uneven settling in peat soil by comparing the predictive simulation values to experimental data. The objective of this research is to evaluate the accuracy and reliability of the simulation model in monitoring and predicting the heterogeneity of settlement over time and the void ratios in peat soil. Furthermore, assess the model's ability to accurately depict settlement patterns across time and depth by comparing the predicted simulation values with experimental data. The research employs mathematical modeling and simulation to investigate uneven settling in peat soil. Field measurements were conducted at various time intervals and depths to collect experimental data on settlement. The predictive simulation values were generated from the simulation model using relevant input parameters. Graphical analysis was utilized to compare the predictive values with the empirical data. In this graph, the y-axis displays the anticipated simulation values of settlement, while the x-axis represents the depth within the peat soil where settlement is measured. Each data point on the graph corresponds to a specific depth, with the settlement values represented accordingly. This graph enables an analysis of the depth-dependent behavior of settlement as projected by the simulation model. It assists in evaluating the model's effectiveness in accurately representing fluctuations in settlement rates at different depths within the peat soil. The graph demonstrates a consistent trend or pattern that aligns with the predicted behavior of settlement concerning depth. A strong correspondence between the predictive simulation values and the x-axis (depth) indicates that the model effectively replicates the depth-dependent variations in settlement. If the model accurately predicts settlement patterns at various depths, it suggests that the model can capture the spatial distribution of settlement in peat soil. The study's results indicate that the developed simulation model has the potential to accurately reproduce changes in settlement patterns over time and space in peat soil. The graphs depicting the predictive simulation values show a strong correlation with the experimental data, particularly regarding the settlement patterns observed across time and depth. However, it is recommended to further refine and adjust the parameters to enhance the accuracy and reliability of the model. This study represents a significant advancement in creating a reliable tool for predicting uneven settlements in peat soil, which could greatly assist in geotechnical engineering practices.

Keywords: Modeling; Particle Size Distribution; Compression Index; Uneven Settlement; Peat Soil

1. Introduction

Peat soil has a heterogeneous particle size distribution due to its composition of organic matter and high-water content. It generally consists of a diverse assortment of particle sizes, including fibres, roots, and decomposed plant matter. Heterogeneous particle size distribution in soil indicates the presence of particles of different sizes dispersed across its whole. Peat soil with a varied range of particle sizes might experience uneven settling as a result of the differential

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compression of these distinct particle sizes. Smaller particles, such as small fibres and organic materials, exhibit greater compressibility compared to bigger particles, such as roots or woody debris. Consequently, in the process of consolidation, the smaller particles may undergo more fast and extensive compression compared to the bigger particles. The differential compression results in uneven settlement, with regions with a greater concentration of smaller particles experiencing more settling compared to regions with bigger particles. Non-uniform settlement may lead to differential ground movements, which can create unevenness and possible structural issues in structures or infrastructure built on peat soil. The compression index, often known as Cc, is a geotechnical measure used to quantify the compressibility of a soil. The consolidation coefficient is obtained via consolidation tests and corresponds to the gradient of the compression curve when plotted on a semilogarithmic scale. The compression index quantifies the degree to which a soil consolidates in response to a certain increase in effective stress. The compression index of peat soil indicates the degree of compressibility of the organic matter it contains. more compression index values imply more compressibility, indicating that the soil experiences more settlement for a given increase in stress. Peat soil with a high compression index is prone to experiencing substantial settling during the consolidation process. The settlement might worsen if the compression index changes spatially within the soil mass. Regions characterised by higher compression index values will undergo more settlement in comparison to regions with lower compression index values. Hence, peat soil with a high compression index will result in uneven settling, since distinct regions of the soil would undergo varying degrees of compression. Differential settling and associated structural difficulties may arise because of this uneven compression. The uneven settling is influenced by both the heterogeneous particle size distribution and the compression index of peat soil. Differential compression occurs due to the existence of particles of varying sizes, resulting in greater settling of smaller particles compared to bigger ones. Furthermore, a high compression index signifies a greater degree of compressibility and an elevated likelihood of settlement. Hence, the convergence of these forces might result in irregular distribution patterns in peat soil settling.

2. Theoretical background

2.1. Governing Equation

$$k_t \frac{\partial e}{\partial t} - k\frac{\partial e}{\partial z} - Hcr\frac{\partial e}{\partial z} = \beta \qquad \text{.......................................} \quad (1)$$

Nomenclature

Hcr	=	Compression Index, Void Ratio / PSD [/L]
Kt	=	Hydraulic Pressure/Specific Gravity [LT^{-1}]
K	=	Permeability [LT^{-1}]
T	=	Time [T]
e	=	Uneven Settlement [-]
Z	=	Depth [L]

$$k_t \frac{\partial e}{\partial t} = k\frac{\partial e}{\partial z} - Hcr\frac{\partial e}{\partial z} + \beta \qquad \text{.......................................} \quad (2)$$

$$k_t \frac{\partial e}{\partial t} = \left(k + Hcr\right)\frac{\partial e}{\partial z} + \beta \qquad \text{.......................................} \quad (3)$$

$$k_t \frac{\partial e_1}{\partial t} = \beta \qquad \text{.......................................} \quad (4)$$

$$\frac{\partial e_1}{\partial t} = \beta k_t \qquad \text{.......................................} \quad (5)$$

$$e_1 = \beta k_t + \gamma \quad \text{......................................} \quad (6)$$

$$k_t \frac{\partial e_1}{\partial t} = (k + Hcr)\frac{\partial e}{\partial z} \quad \text{......................................} \quad (7)$$

Let $e_2 = ZT^1$ .... (8)

$$\frac{\partial e_2}{\partial t} = ZT^1 \quad \text{......................................} \quad (9)$$

$$\frac{\partial e_2}{\partial z} = Z^1 T \quad \text{......................................} \quad (10)$$

Substitute (9) and (10) into (7)

$$k_t ZT^1 = (k + Hcr)Z^1 T \quad \text{......................................} \quad (11)$$

$$k_t \frac{T^1}{T} = (k + Hcr)\frac{Z^1}{Z} = \gamma \quad \text{......................................} \quad (12)$$

$$k_t \frac{T^1}{T} = \gamma \quad \text{......................................} \quad (13)$$

$$(k + Hcr)\frac{Z}{Z} = \gamma \quad \text{......................................} \quad (14)$$

From (13), $\frac{T^1}{T} = \frac{\gamma}{k_t}$

$$\ln T = \frac{\gamma}{k_t} t + e_3 \quad \text{......................................} \quad (15)$$

$$T = A_{e}{}^{\frac{\gamma}{k_t} t} \quad \text{......................................} \quad (16)$$

From (14), $(k + Hcr)\frac{Z}{Z} = \gamma$

$$\frac{Z}{Z} = \frac{\gamma}{k + Hcr} \quad \text{......................................} \quad (17)$$

$$Ln\, Z = \frac{\gamma}{k + Hcr} Z + e_4 \quad \text{......................................} \quad (18)$$

$$i.e.\, Z = \beta e^{\frac{\gamma}{k + Hcr} Z} \quad \text{......................................} \quad (19)$$

Put (16) and (19) into (8), yields

$$e_2 = A_e^{\frac{\gamma}{k_t}t} \bullet \beta e^{\frac{\gamma}{k+Hcr}Z} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (20)$$

$$e_2 = A\beta_e\left(\frac{t}{k_t} + \frac{Z}{k+Hcr}\right)\gamma \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (21)$$

Hence, general solution becomes

$$e(z,t) = e_1 + e_2$$

$$\left[e(z,t) = \beta k_t t + \gamma + ABe\left(\frac{t}{k_t} + \frac{Z}{k+Hcr}\right)\gamma\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (22)$$

3. Materials and method

3.1. Field Investigation

Identify and choose a location that has peat soil and where settlement is a matter of concern. Take into account variables such as the thickness of the peat layer, moisture content, and proximity to building operations.

Geotechnical Study: Perform a geotechnical study to analyse and describe the properties of the peat soil. Gather specimens for laboratory analysis to ascertain characteristics such as moisture level, density, shear resistance, and compressibility.

Monitoring of subsurface water resources: Implement the installation of groundwater monitoring wells to accurately measure and document the fluctuations in water levels over a period of time. Fluctuations in groundwater levels may have a substantial effect on the settling of peat soil.

3.2. Instrumentation Setup

Deploy settlement monitoring instruments, such as settlement plates or rods, at many sites throughout the site. These devices will quantify and document any vertical displacements of the soil over a period of time.

Topographic Survey: Conduct a topographic study of the site in order to determine the initial elevations. Conduct the survey at regular intervals to identify any fluctuations in ground elevations.

Load Application: Impose a recognized burden or additional weight onto the top layer of soil at pre-determined positions. This may be accomplished by strategically positioning temporary buildings, sandbags, or other objects capable of sustaining weight.

Duration of Observation: Continuously observe the progress of a settlement over a prolonged duration, collecting data at consistent intervals, either on a daily or weekly basis. Continue surveillance even subsequent to the elimination of the exerted force in order to view any recuperation or more subsidence.

Laboratory Testing: Collection of Samples: Retrieve intact peat soil samples from the location without any disturbance. Collect samples at various depths to capture the heterogeneity of soil characteristics.

Diagnostic examinations conducted in a laboratory: Perform laboratory analyses on the soil samples to ascertain fundamental characteristics: Water content The term "density" refers to the measure of mass per unit volume of a substance.

Shear strength refers to the ability of a material to resist forces that cause it to slide or deform along a plane parallel to its surface. Characteristics of consolidation, Permeability refers to the property of a material that allows substances to pass through it.

Consolidation Test: Conduct consolidation experiments to analyse the time-dependent settling characteristics of the peat soil when subjected to external loads.

Triaxial tests: Perform triaxial experiments to evaluate the shear strength characteristics of the peat soil.

Data analysis: Analysis of Settlement: Examine the data collected from the field instruments on the settlement. Determine areas of notable human habitation and evaluate how settlement is spread out over the landscape.

Correlation with laboratory data: Analyse field settlement data in conjunction with laboratory test findings to ascertain the variables that impact settlement, including soil composition, moisture content, and strength characteristics.

4. Results and discussion

Table 1 Predictive and Experimental Values of Uneven Settlement on Peat Soil

Depth [m]	Predictive Values of Uneven Settlement on Variation [PSD/Compression Index on Peat Soil [40/0.2] [mm]	Experimental Values of Uneven Settlement on Variation [PSD/Compression Index on Peat [40/0.2] [mm]
0.2	0.151895038	0.15192
0.4	0.152009324	0.15204
0.6	0.152123609	0.15216
0.8	0.152237895	0.15228
1	0.152352181	0.1524
1.2	0.152466467	0.15252
1.4	0.152580752	0.15264
1.6	0.152695038	0.15276
1.8	0.152809324	0.15288
2	0.15292361	0.153
2.2	0.153037895	0.15312
2.4	0.153152181	0.15324
2.6	0.153266467	0.15336
2.8	0.153380753	0.15348
3	0.153495038	0.1536
3.2	0.153609324	0.15372
3.4	0.15372361	0.15384
3.6	0.153837896	0.15396
3.8	0.153952182	0.15408
4	0.154066468	0.1542
4.2	0.154180754	0.15432
4.4	0.15429504	0.15444
4.6	0.154409326	0.15456

4.8	0.154523613	0.15468
5	0.154637899	0.1548
5.2	0.154752186	0.15492
5.4	0.154866473	0.15504
5.6	0.154980761	0.15516
5.8	0.15509505	0.15528
6	0.155209339	0.1554
6.2	0.155323629	0.15552
6.4	0.15543792	0.15564
6.6	0.155552213	0.15576
6.8	0.155666509	0.15588
7	0.155780807	0.156
7.2	0.155895109	0.15612
7.4	0.156009415	0.15624
7.6	0.156123728	0.15636
7.8	0.156238049	0.15648
8	0.15635238	0.1566
8.2	0.156466724	0.15672
8.4	0.156581086	0.15684
8.6	0.156695471	0.15696
8.8	0.156809884	0.15708
9	0.156924336	0.1572
9.2	0.157038836	0.15732
9.4	0.1571534	0.15744
9.6	0.157268046	0.15756
9.8	0.157382799	0.15768
10	0.157497689	0.1578
10.2	0.157612759	0.15792
10.4	0.15772806	0.15804
10.6	0.157843662	0.15816
10.8	0.157959652	0.15828
11	0.158076146	0.1584
11.2	0.158193294	0.15852
11.4	0.158311287	0.15864
11.6	0.158430377	0.15876
11.8	0.158550887	0.15888
12	0.158673237	0.159
12.2	0.15879797	0.15912

12.4	0.158925793	0.15924
12.6	0.159057618	0.15936
12.8	0.159194627	0.15948
13	0.159338355	0.1596
13.2	0.159490787	0.15972
13.4	0.159654496	0.15984
13.6	0.159832816	0.15996
14	0.160251846	0.1602
14.2	0.160505403	0.16032

Table 2 Predictive and Experimental Values of Uneven Settlement on Peat Soil

Time	**Predictive Values Settlement of Uneven Settlement on Variation [PSD/Compression Index on Peat Soil [42/0.223] [mm]**	**Experimental Values of Uneven Settlement on Variation [PSD/Compression Index on Peat soil [42/0.223] [mm]**
0.02	0.223009964	0.213762167
0.04	0.223017965	0.214216698
0.05	0.223021966	0.214441113
0.07	0.223029967	0.214884269
0.08	0.223033967	0.215103021
0.085	0.223035967	0.215211693
0.09	0.223037967	0.215319896
0.095	0.223039968	0.215427632
0.1	0.223041968	0.2155349
0.15	0.22306197	0.216582038
0.02	0.223009964	0.213762167
0.25	0.223101974	0.218539063
0.3	0.223121976	0.2194503
0.35	0.223141978	0.220317588
0.4	0.22316198	0.2211416
0.45	0.223181983	0.221923013
0.5	0.223201985	0.2226625
0.55	0.223221987	0.223360738
0.6	0.223241989	0.2240184
0.65	0.223261992	0.224636163
0.7	0.223281994	0.2252147
0.75	0.223301996	0.225754688
0.8	0.223321999	0.2262568
0.85	0.223342001	0.226721713

0.9	0.223362003	0.2271501
0.95	0.223382006	0.227542638
1	0.223402008	0.2279
1.25	0.223502022	0.229182813
1.5	0.223602039	0.2296875
2	0.223802089	0.2287
2.25	0.223902133	0.227376563
2.5	0.224002199	0.2256125
2.75	0.224102306	0.223492188
3	0.224202482	0.2211
3.25	0.224302777	0.218520313
3.5	0.224403273	0.2158375
3.75	0.224504116	0.213135938
4	0.224605553	0.2105
4.25	0.224708004	0.208014063
4.5	0.224812195	0.2057625
4.75	0.224919361	0.203829688
5.25	0.225152605	0.201257813
5.5	0.225288521	0.2007875
5.75	0.225449999	0.200973438
6	0.22565524	0.2019
6.25	0.2259354	0.203651563
6.5	0.226343818	0.2063125
6.75	0.226971809	0.209967188
7	0.227975697	0.2147
7.25	0.229623102	0.220595313
7.5	0.232372179	0.2277375
7.75	0.237007265	0.236210938
8	0.244871109	0.2461
8.25	0.258262432	0.257489063
9	0.386957737	0.3015

Table 3 Predictive and Experimental Values of Uneven Settlement on Peat Soil

Depth [m]	Predictive Values of Uneven Settlement on Variation [PSD/Compression Index on Peat soil [30/0.21] [mm]	Experimental Values of Uneven Settlement on Variation [PSD/Compression Index on Peat Soil [mm]
0.2	0.370749618	0.35624216
0.4	0.370751156	0.35947728

0.6	0.370752695	0.36241832
0.8	0.370754233	0.36507824
1	0.370755772	0.36747
1.2	0.37075731	0.36960656
1.4	0.370758848	0.37150088
1.6	0.370760387	0.37316592
1.8	0.370761925	0.37461464
2	0.370763464	0.37586
2.2	0.370765002	0.37691496
2.4	0.370766541	0.37779248
2.6	0.370768079	0.37850552
2.8	0.370769618	0.37906704
3	0.370771156	0.37949
3.2	0.370772695	0.37978736
3.4	0.370774233	0.37997208
3.6	0.370775772	0.38005712
3.8	0.37077731	0.38005544
4	0.370778849	0.37998
4.2	0.370780387	0.37984376
4.4	0.370781926	0.37965968
4.6	0.370783464	0.37944072
4.8	0.370785003	0.37919984
5	0.370786542	0.37895
5.2	0.370788081	0.37870416
5.4	0.37078962	0.37847528
5.6	0.370791159	0.37827632
5.8	0.370792699	0.37812024
6	0.37079424	0.37802
6.2	0.370795783	0.37798856
6.4	0.370797327	0.37803888
6.6	0.370798874	0.37818392
6.8	0.370800425	0.37843664
7	0.370801983	0.37881
7.2	0.370803552	0.37931696
7.4	0.370805135	0.37997048
7.6	0.370806741	0.38078352
7.8	0.370808382	0.38176904
8	0.370810076	0.38294

8.2	0.37081185	0.38430936
8.4	0.370813743	0.38589008
8.6	0.370815819	0.38769512
8.8	0.37081817	0.38973744
9	0.370820937	0.39203
9.2	0.370824333	0.39458576
9.4	0.37082868	0.39741768
9.6	0.370834467	0.40053872
9.8	0.370842429	0.40396184
10	0.370853682	0.4077
10.2	0.37086991	0.41176616
10.4	0.370893662	0.41617328
10.6	0.370928791	0.42093432
10.8	0.370981126	0.42606224
11	0.37105948	0.43157
11.2	0.371177177	0.43747056
11.4	0.371354371	0.44377688
11.6	0.371621536	0.45050192
11.8	0.372024755	0.45765864
12	0.372633713	0.46526
12.2	0.373553791	0.47331896
12.4	0.374944345	0.48184848
12.6	0.377046351	0.49086152
12.8	0.380224215	0.50037104
13	0.385028989	0.51039
13.2	0.392293977	0.52093136
13.4	0.403279296	0.53200808
13.6	0.419890497	0.54363312
14	0.482992772	0.56858
14.2	0.540430778	0.58192776

Table 4 Predictive and Experimental Values of Uneven Settlement on Peat Soil

Time of Settlement	Predictive Values of Uneven Settlement on Variation [PSD/Compression Index on Peat Soil [mm]	Experimental Values of Uneven Settlement on Variation [PSD/Compression Index on Peat Soil [mm]
0.02	0.26001096	0.259528683
0.04	0.26001976	0.259061706
0.06	0.26002856	0.258609811

0.075	0.26003516	0.258280655
0.08	0.26003736	0.258172778
0.085	0.26003956	0.258065817
0.09	0.26004176	0.257959768
0.095	0.26004396	0.257854628
0.1	0.26004616	0.257750393
0.15	0.26006816	0.256757102
0.02	0.26001096	0.259528683
0.25	0.26011216	0.255027874
0.3	0.26013416	0.254285433
0.35	0.26015616	0.253620187
0.4	0.260178161	0.253029008
0.45	0.260200161	0.252508817
0.5	0.260222161	0.252056585
0.55	0.260244161	0.251669332
0.6	0.260266162	0.251344128
0.65	0.260288162	0.251078092
0.7	0.260310162	0.250868393
0.75	0.260332163	0.250712249
0.8	0.260354163	0.250606928
0.85	0.260376164	0.250549747
0.9	0.260398164	0.250538073
0.95	0.260420165	0.250569322
1	0.260442165	0.25064096
1.25	0.26055217	0.251519749
1.5	0.260662178	0.253056585
2	0.260882215	0.25709096
2.25	0.260992255	0.259159124
2.5	0.261102323	0.261026585
2.75	0.26121244	0.262555999
3	0.26132264	0.26364096
3.25	0.261432982	0.264205999
3.5	0.261543568	0.264206585
3.75	0.261654572	0.263629124
4	0.26176629	0.26249096
4.25	0.261879232	0.260840374
4.5	0.261994267	0.258756585
4.75	0.262112888	0.256349749

5.25	0.262372912	0.251162249
5.5	0.262526165	0.248756585
5.75	0.262710212	0.246777874
6	0.262946977	0.24549096
6.25	0.263273994	0.245191624
6.5	0.263755515	0.246206585
6.75	0.264501543	0.248893499
7	0.265700391	0.25364096
7.25	0.267674448	0.260868499
7.5	0.270975623	0.271026585
7.75	0.276548764	0.284596624
8	0.2860114	0.30209096
8.25	0.302132666	0.324052874
9	0.457132935	0.42264096

Table 5 Predictive and Experimental Values of Uneven Settlement on Peat Soil

Time of Settlement	Predictive Values of Uneven Settlement on Variation [PSD/Compression Index on Peat Soil [44/0.24] [mm]	Experimental Values of Uneven Settlement on Variation [PSD/Compression Index on Peat Soil [44/0.24] [mm]
0.02	0.24001096	0.233482008
0.04	0.24001976	0.233956064
0.05	0.24002416	0.234190125
0.07	0.24003296	0.234652343
0.08	0.24003736	0.234880512
0.085	0.24003956	0.234993864
0.09	0.24004176	0.235106729
0.095	0.24004396	0.235219107
0.1	0.24004616	0.235331
0.15	0.24006816	0.236423375
0.02	0.24001096	0.233482008
0.25	0.24011216	0.238465625
0.3	0.24013416	0.239417
0.35	0.24015616	0.240322875
0.4	0.240178161	0.241184
0.45	0.240200161	0.242001125
0.5	0.240222161	0.242775
0.55	0.240244161	0.243506375
0.6	0.240266161	0.244196

0.65	0.240288162	0.244844625
0.7	0.240310162	0.245453
0.75	0.240332162	0.246021875
0.8	0.240354163	0.246552
0.85	0.240376163	0.247044125
0.9	0.240398164	0.247499
0.95	0.240420164	0.247917375
1	0.240442165	0.2483
1.25	0.240552169	0.249703125
1.5	0.240662177	0.250325
2	0.240882212	0.2496
2.25	0.24099225	0.248440625
2.5	0.241102316	0.246875
2.75	0.241212428	0.244996875
3	0.241322619	0.2429
3.25	0.241432946	0.240678125
3.5	0.241543507	0.238425
3.75	0.241654467	0.236234375
4	0.241766111	0.2342
4.25	0.241878924	0.232415625
4.5	0.241993741	0.230975
4.75	0.242111987	0.229971875
5.25	0.24237027	0.229653125
5.5	0.242521643	0.230525
5.75	0.242702471	0.232209375
6	0.242933724	0.2348
6.25	0.243251305	0.238390625
6.5	0.243716674	0.243075
6.75	0.244435048	0.248946875
7	0.245586555	0.2561
7.25	0.247479565	0.264628125
7.5	0.250641994	0.274625
7.75	0.255977607	0.286184375
8	0.265033607	0.2994
8.25	0.280458731	0.314365625
9	0.428734206	0.3707

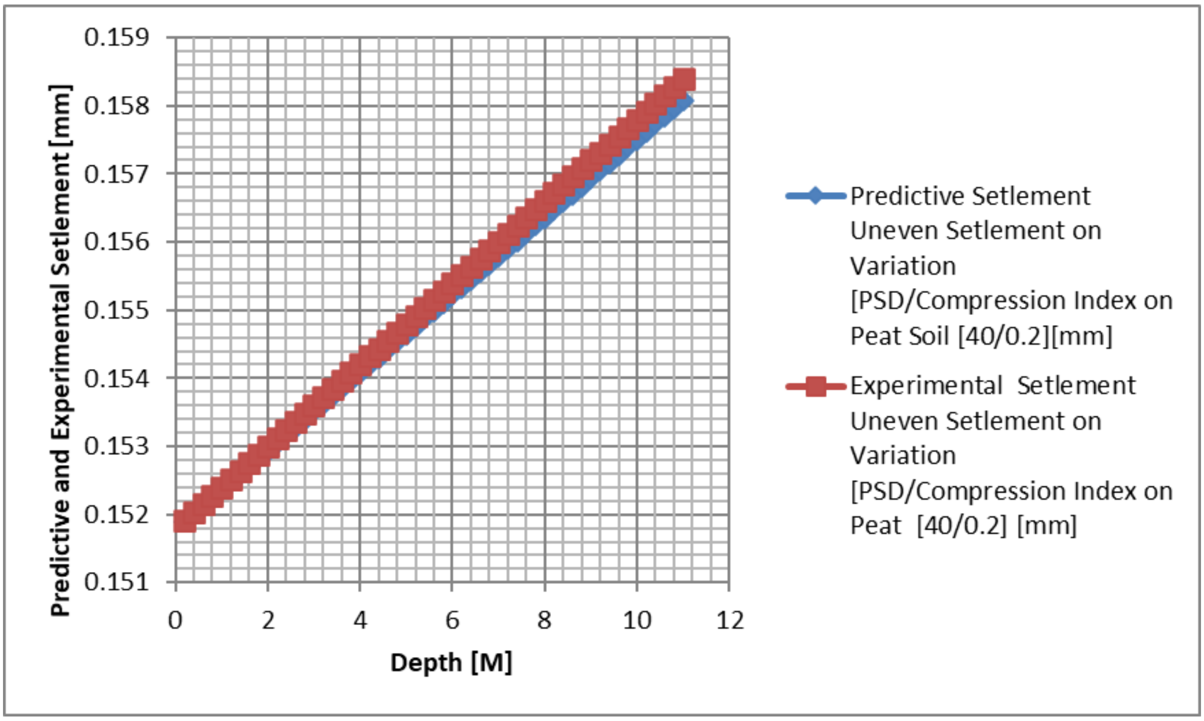

Figure 1 Predictive and Experimental Values of Uneven Settlement on Peat Soil

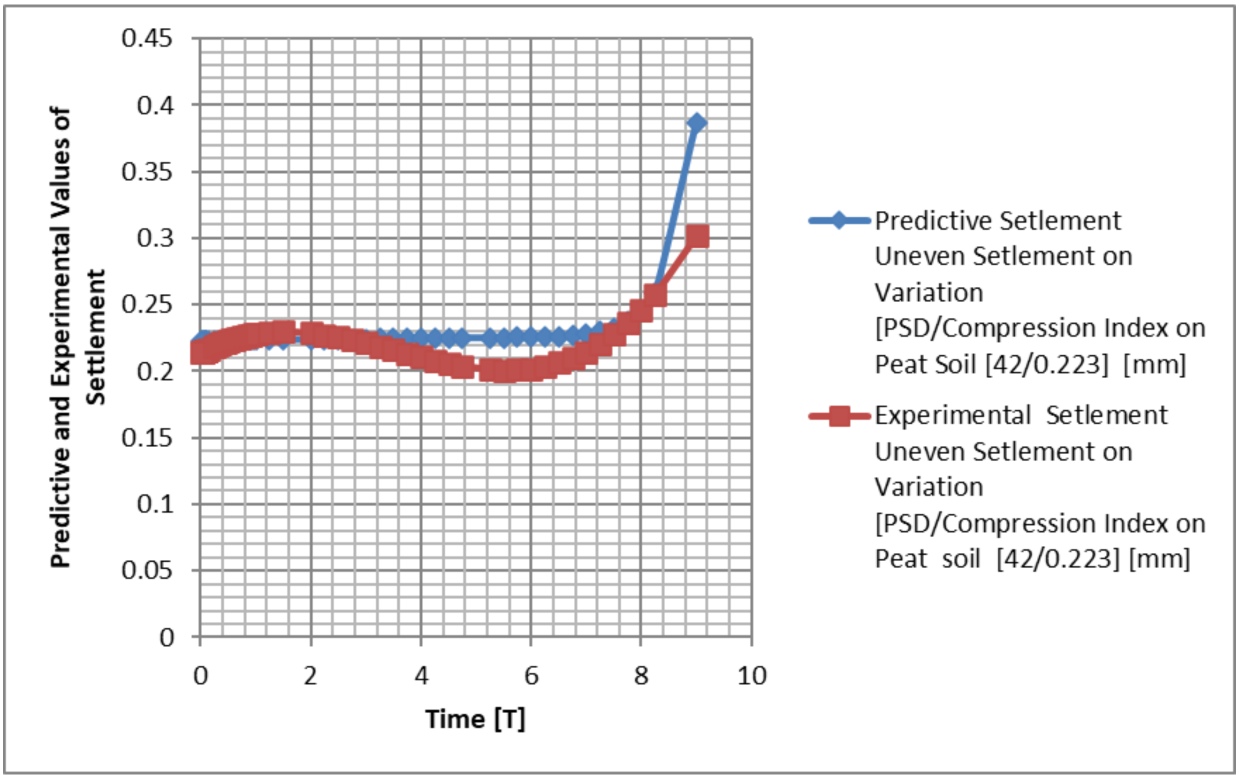

Figure 2 Predictive and Experimental Values of Uneven Settlement on Peat Soil

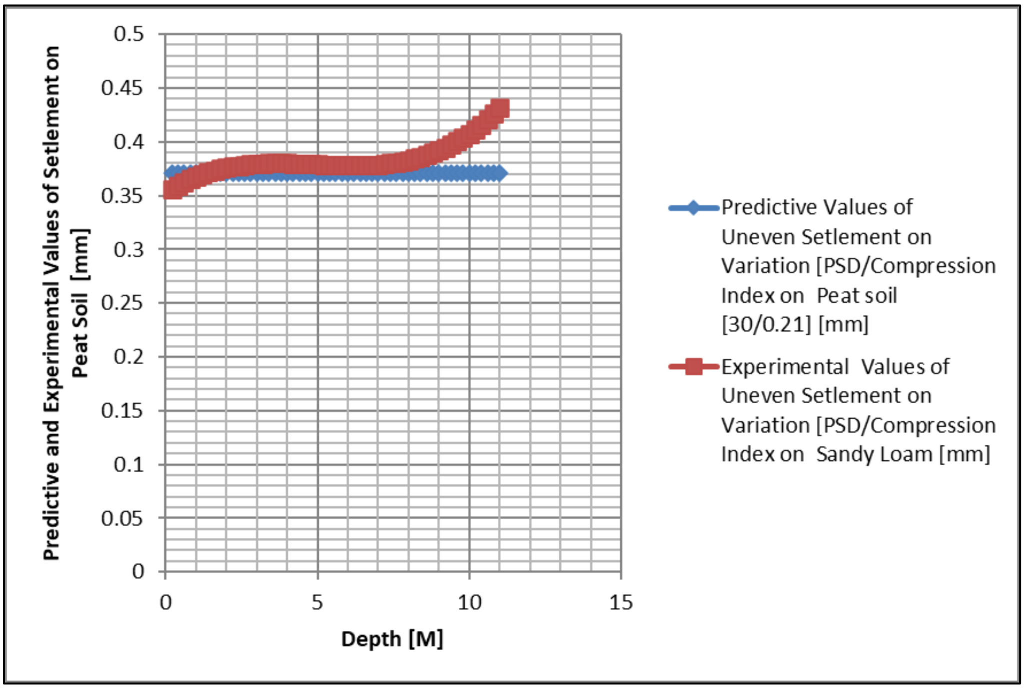

Figure 3 Predictive and Experimental Values of Uneven Settlement on Peat Soil

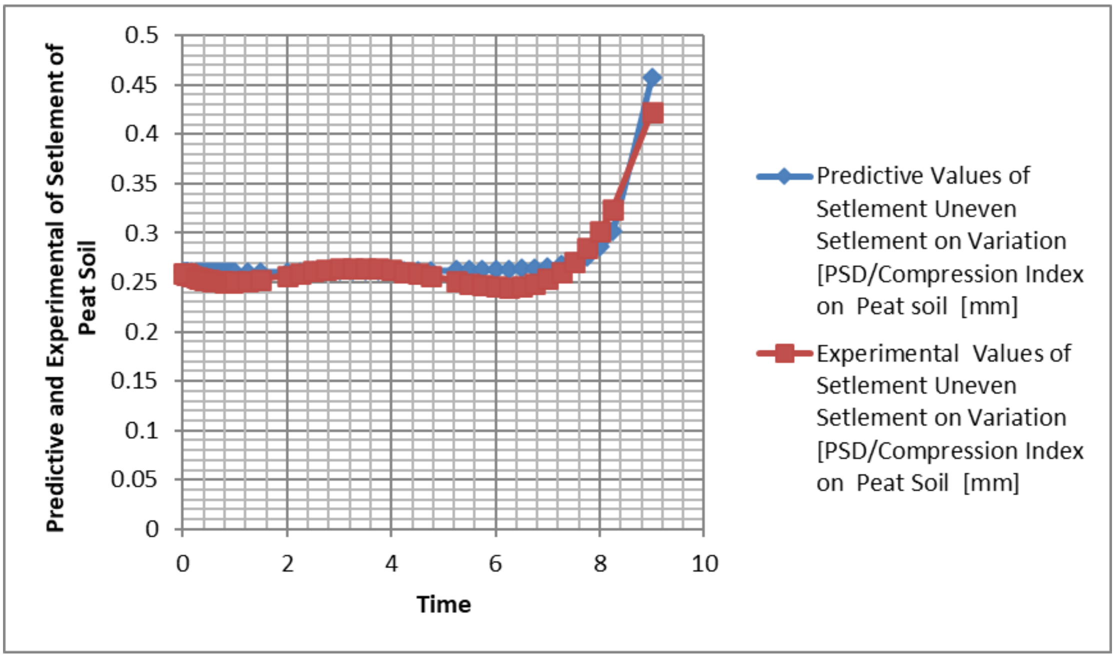

Figure 4 Predictive and Experimental Values of Uneven Settlement on Peat Soil

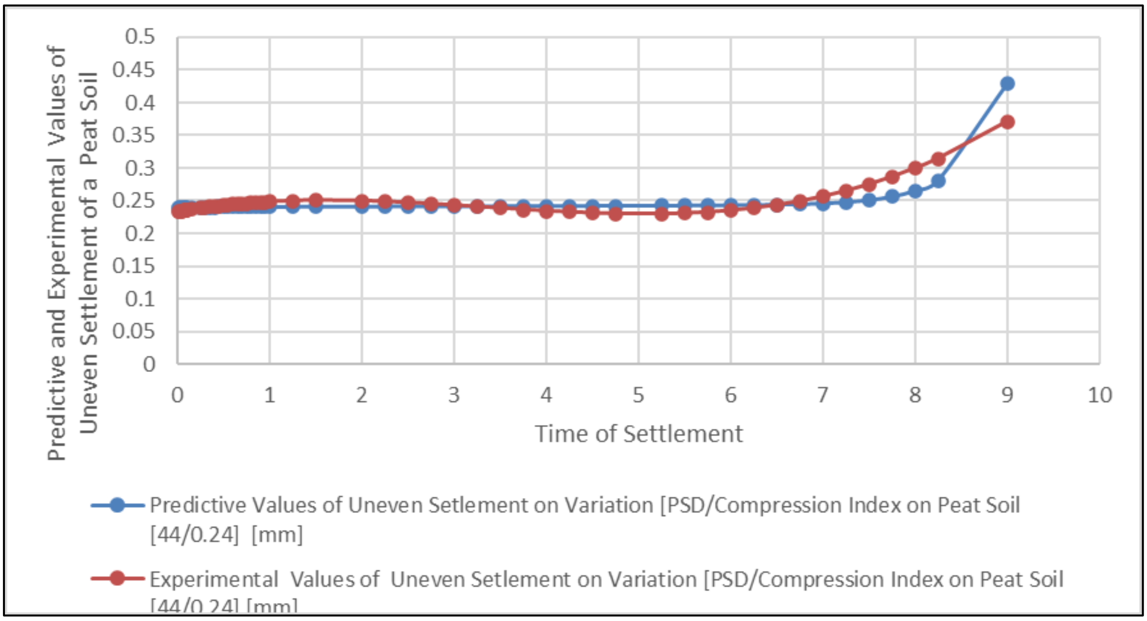

Figure 5 Predictive and Experimental Values of Uneven Settlement on Peat Soil

Heterogeneous Particle Size Distribution: Peat soil consists of organic materials and has a significant water content. It often comprises a diverse assortment of particle sizes, including fibres, roots, and decomposed plant matter. Heterogeneous particle size distribution in soil indicates the presence of particles of different sizes distributed uniformly across its whole. Peat soil with a varied range of particle sizes might experience uneven settling as a result of the differential compression of these distinct particle sizes. Smaller particles, such as small fibres and organic materials, exhibit greater compressibility compared to bigger particles, such as roots or woody debris. Consequently, while consolidating, the smaller particles may compress more quickly and to a bigger degree than the larger ones. The differential compression results in uneven settlement, with regions with a greater concentration of smaller particles experiencing more settling compared to regions with bigger particles. Differential ground movements caused by non-uniform settlement may lead to unevenness and possible structural issues in structures or infrastructure built on peat soil. The compression index, often known as Cc, is a geotechnical measure used to quantify the compressibility of a soil. The consolidation coefficient is obtained via consolidation tests and corresponds to the gradient of the compression curve when plotted on a semilogarithmic scale. The compression index is a measure of the extent to which a soil consolidates in response to a certain increase in effective stress. The compression index in peat soil indicates the degree of compressibility of the organic matter found within it. A higher compression index signifies more compressibility, indicating that the soil experiences more settlement in response to a given increase in stress. Peat soil with a high compression index is prone to experiencing substantial settling during the consolidation process. The settlement might worsen if there are spatial variations in the compression index within the soil mass. Regions with higher compression index values will undergo more settlement in comparison to regions with lower compression index values.

Hence, peat soil with a substantial compression index will result in disparate settling, since distinct regions of the soil will undergo varying degrees of compression. Such uneven compression might lead to differential settling and possible structural problems. To finally the uneven settling of peat soil is influenced by both the heterogeneous particle size distribution and the compression index. Differential compression occurs due to the existence of particles of varying sizes, resulting in greater settling of smaller particles compared to bigger ones. Furthermore, a high compression index signifies a greater degree of compressibility and an elevated likelihood of settlement. Hence, the amalgamation of various elements may result in disparate settlement patterns in peat soil. In order to verify the accuracy of the created simulation model for uneven settlement in peat soil, two distinct types of graphs can be employed. The first graph plots the predicted simulation values on the y-axis against the z-axis, which represents time. The second graph plots the predicted simulation values on the y-axis against the x-axis, which represents the depth of settlement. Graph depicting the predicted simulation values on the y-axis plotted against the z-axis (representing time). The y-axis in this graph reflects the forecasted simulation values of settlement, while the z-axis represents time. Each data point on the graph represents a distinct moment in the settlement process, and the settlement values are shown appropriately. Through an analysis of this graph, one may discern the fluctuations in settlement values over time as dictated by the simulation model. The graph should ideally demonstrate a distinct trend or pattern that aligns with the anticipated behaviour of settling in peat soil. The simulation model must precisely depict the chronological development of settlement, including any temporal fluctuations or phases in the settlement process.

A strong correlation between the predictive simulation results and the z-axis (time) suggests that the model accurately reproduces the time-dependent settlement behaviour in peat soil. Any inconsistencies or divergences between the projected values and the anticipated pattern may indicate potential areas for improvement in the simulation model. Graph depicting the predicted simulation values on the y-axis in relation to the x-axis, which represents the depth of settlement. The y-axis of this graph displays the anticipated simulation values of settlement, while the x-axis represents the depth inside the peat soil where settlement is measured. Every data point on the graph represents a distinct depth, and the settlement values are represented correspondingly. This graph enables you to analyse the depth-dependent behaviour of settlement as projected by the simulation model. It aids in evaluating the model's ability to accurately represent fluctuations in settlement rates at various depths inside the peat soil. The graph demonstrates a consistent trend or pattern that corresponds to the predictive behaviour of settlement in relation to depth. An accurate correspondence between the predictive simulation values and the x-axis (depth) suggests that the model effectively replicates the depth-dependent fluctuations in settlement. If the model accurately predicts the settlement patterns at various depths, it indicates that the model is capable of capturing the spatial distribution of settlement in peat soil. By examining these graphs depicting simulated values against the z-axis (representing time) and the x-axis (representing settlement depth), one may verify the simulation model’s capacity to accurately reproduce the temporal and spatial fluctuations in uneven settlement. A high correlation and excellent alignment between the projected values and the anticipated trends suggest a dependable and proven model. Any inconsistencies or deviations seen on the graphs might provide valuable insights for conducting more research and making enhancements to the model, hence improving its accuracy and dependability in forecasting uneven settling in peat soil.

5. Conclusion

To summarize, the discussion was on the application of graphs to verify a simulation model for non-uniform subsidence in peat soil. Two kinds of graphs were analysed: one displaying expected simulation values on the y-axis against the z-axis (representing time), and another displaying anticipated simulation values on the y-axis against the x-axis (representing depth of settlement). When examining the graph that displays projected values over time, it is crucial to analyse the pattern, detect any delays in time, and evaluate how the model's performance is affected by time parameters. The graph should demonstrate patterns that correspond to the anticipated settlement behaviour over time, suggesting that the model effectively captures the temporal features of settlement. The primary objective of analyzing the graph depicting anticipated values versus depth is to assess the settlement's behaviour as it varies with depth. The study includes the examination of depth profiles, the comparison of the findings with field data, and the evaluation of the model's sensitivity to depth parameters. The graph should illustrate the model's precise depiction of the spatial arrangement of settlements at various depths inside the peat soil. By implementing these study suggestions, the simulation model for uneven settlement in peat soil may be further verified, improved, and augmented, resulting in a more dependable tool for forecasting settlement behaviour in real-life situations.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest.

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