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Feasibility of RCC Structure Resting on Backfilled Soil

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Abstract: Backfilled land for Reinforced Concrete Cement (RCC) structures emerges as a sustainable solution. However, the inherent differences between naturally deposited soil and backfilled soil necessitate a comprehensive assessment of its index and engineering properties. This project employs core cutter and water content tests, supplemented by direct shear tests, to evaluate the suitability of backfilled soil for construction purposes. Furthermore, bearing capacity analysis is conducted utilizing Terzaghi's equation at minimum cost to ascertain the load-bearing capabilities of various foundation types. The incorporation of the bearing capacity table from the Indian building code facilitates the determination of requisite bearing capacities tailored to different soil types. Through this project, a systematic approach to utilizing backfilled soil for RCC structures is proposed, addressing both environmental concerns and the imperative for sustainable urban development of India.
Keywords: Terzaghi's Equation, Shallow Foundation, Bearing Capacity, Angle of Internal Friction, Cohesion Water Content, Dry Density, Backfilled soil, etc.

I. INTRODUCTION

There are challenges associated with determining the actual behavior of soil foundation due to its when subjected to an imposed loading. this research work was aimed at modelling the soil bearing capacity with specific consideration of index properties parameters of soil, shear strength parameters and relative varied depths, by employing Terzaghi's equations. To considerably overcome complexities, and spontaneous variabilities associated with natural soil foundation and natural bearing capacity was determined as output with relatively high level of accuracy. [5]. The study highlights the issue of subsidence in backfilled opencast mines through a meticulous understanding of different case studies of construction on mine spoil. The prime focus of the study apart from structural and construction aspects includes the behavior of heterogeneous mine spoil. Collapse settlement and hydro compression are discussed to develop an understanding of failure in backfill [3]. Opencast mining techniques generally create waste land after mining activity is over. Rising population and land scarcity demand rehabilitation of these backfilled opencast mines. Hence, some strategy needs to be devised for constructing low rise buildings counteracting challenges like heterogeneity of the backfilled soil leading to differential settlement/collapse settlement and the low bearing capacity of fill soil. [3].

Shallow foundations are one of the most common types of foundations for buildings, retaining walls and other structures. The shallow footings are typically designed to transfer the loads safely from the superstructure to the supporting soil such that the settlements are in acceptable limits as per the design and construction codes. The bearing capacity of the shallow foundations is conventionally estimated using the approaches originally presented by Terzaghi and Meyerhof assuming the soil is in a state of saturated condition [8]. Disturbed samples or remolded samples can be used to determine the index property of the soil. Index properties are also known as the indicative of engineering properties such compressibility, permeability and shear strength. The test required for determination of engineering properties is elaborate and time consuming. Sometimes, the geotechnical engineer is interested to have some rough assessment of the engineering properties without conducting elaborate tests. This is only possible when index properties of soil determined. [1].

A. Terzaghi's Equation

The Terzaghi Bearing Capacity Equation provides a simplified approach to estimating the maximum load-carrying capacity of a shallow foundation based on the properties of the soil and the dimensions of the foundation. Bearing capacity factors Nc, Nq, and Nγ depend on the values of angles of internal friction (φ) The values of Nc, Nq, and Nγ depends on angle of internal friction and are taken as per the table given in chart

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BEARING CAPACITY FACTORS

ϕ (Degrees)	N_c	N_q	N_γ
0	5·14	1·00	0·00
5	6·49	1·57	0·45
10	8·35	2·47	1·22
15	10·98	3·94	2·65
20	14·83	6·40	5·39
25	20 72	10·66	10 88
30	30·14	18·40	22·40
35	46 12	33·30	48 03
40	75·31	64·20	109·41
45	138·88	134·88	271·76
50	266·89	319·07	762·89

Fig -1: Values of Terzaghi's bearing capacity factors (IS 6403:1981)

a) Square Footing

$Qu = 1.3cNc + \gamma DNq + 0.4\gamma BN\gamma$

b) Strip Footing

$Qu = cNc + \gamma DNq + 0.5\gamma BN\gamma$

Where,

γ = Unit weight of soil

C = Cohesion of soil

D = Depth of footing

B = Width of footing

B. Site Selection

In this research we are taken backfilled lake. The lake is filled with solid material and course grain soil, fine soil, waste material and gravel by visual analyzation.

II. DATA COLLECTION

The parameters considered include depth of the foundation, index properties of soil and shear strength parameters (i.e. soil unit weight γ (KN/m^3) , cohesion(c) , angle of internal friction ($\emptyset$). Three set of data were complied based on depth increment.

Core cutter (IS 2720 part 28 1974) for Bulk density & Dry density

a. Bulk Density

$$Yb = \frac{Ws - Wc}{Vc}$$

b. Dry density

$$\gamma d = \frac{100\gamma b}{100 + w}$$

Water Content (IS 2720 Part 2: 1973) for Moisture Content

$$W - \frac{W2 - W3}{W3 - W1} \times 100$$

Direct shear test result for *(IS 2720 Part 13: 1986) maximum shear stress.* Table 1 gives observations of normal load and maximum shear force of the specimens of soil tested in shear box, 36 cm^2 in area under drained conditions and determined values of C and $\emptyset$

Table -1: Box Shear Test Results

Sample No	Sr No.	Depth (m)	Normal Stress (kg/cm2)	Shear Stress Max (kg/cm2)
1	1	0.5	0.5	6.36
	2	0.5	1.0	10.01
	3	0.5	1.5	15.91
2	1	1.0	0.5	8.19
	2	1.0	1.0	12.27
	3	1.0	1.5	17.27
3	1	1.5	0.5	8.62
	2	1.5	1.0	12.73
	3	1.5	1.5	17.74

Table -2: Required Data For Calculating Bearing Capacity

Sample No	Cohesion (C)	Angle Of Internal Friction(∅)	Water Content (%)	Bulk Density (Yb) (Kg/cm^3)	Dry Density (Yd) (Kg/cm^3)
1	2	42^0	17.61	1.48	1.25
2	4	40^0	15.03	1.8	1.59
3	4	41^0	12.53	1.58	1.40

Table -3: The bearing Capacity of soil using index properties of soil (Strip footing)

Sample No	Depth	Bearing Capacity
1	0.5	351.894
2	1	459.539
3	1.5	601.020

Table -4: The bearing Capacity of soil using index properties of soil (Square footing)

Sample No	Depth	Bearing Capacity
1	0.5	363.301
2	1	546.00
3	1.5	741.409

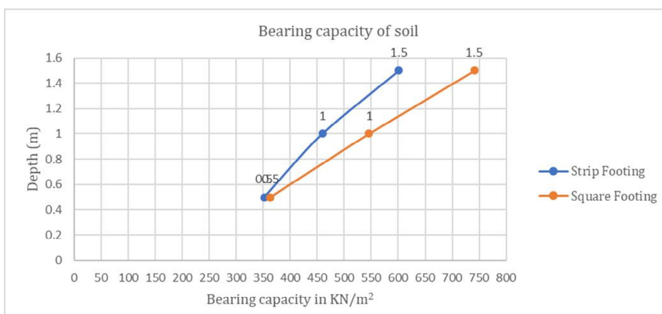

Chart -1: variation of bearing capacity of soil at type of footing and depth of soil

III. CONCLUSIONS

The conclusion of the project report emphasizes the importance of assessing the index and engineering properties of backfilled soil for constructing RCC structures. It highlights the use of core cutter, water content, and direct shear tests to evaluate its suitability, along with bearing capacity analysis using Terzaghi's equation at minimum cost. By incorporating the Indian building code the required Bearing capacity of soil is 440 KN/m^2

A. For Square Footing

We determine the bearing capacity:
For 0.5m depth - 363 KN/m^2,
For 1.0m depth – 546 KN/m^2 &
For 1.5m depth - 741.409 KN/m^2

B. For Strip Footing

We determine the bearing capacity:
For 0.5m depth - 351.894 KN/m^2
For 1.0m depth - 459.53 KN/m^2

For 1.5m depth - 601.020 KN/ m^2

From above results we conclude that, the results at 0.5m depth for Square and Strip footing values are above 440 KN/ m^2, so it is not suitable as per requirement of National Building Code

Therefore, both footings are feasible for RCC structure at the depth of 1m and 1.5m only as per National Building code (1983)

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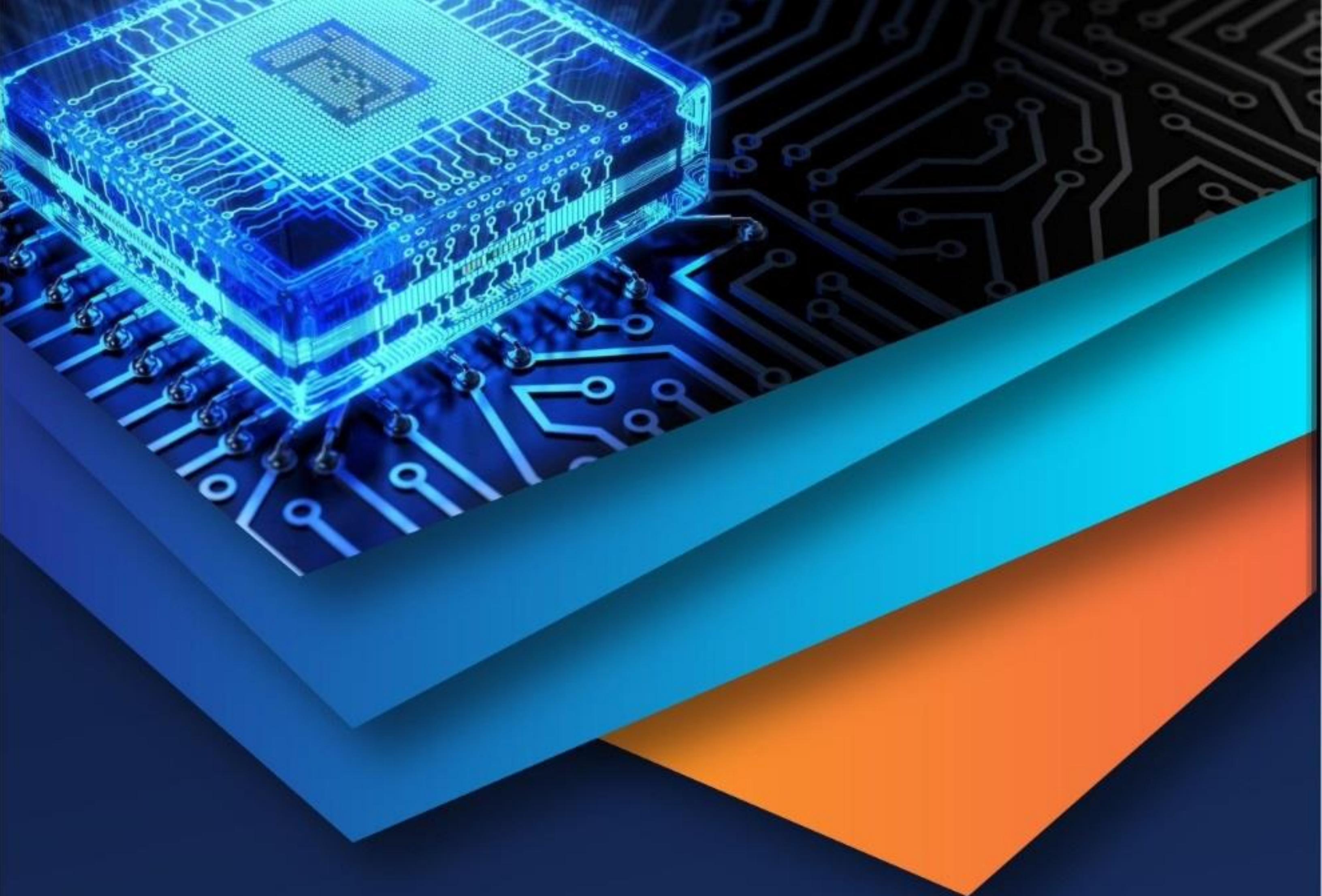

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