Correlation of Compression Index with Index Properties of Soil Samples from Several Places in Chattogram, Bangladesh.

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Abstract - *In Engineering application, physical properties (liquid limit, plastic limit, plasticity index) and mechanical property (Compression Index, Cc) of soil have been found to be imperative to determine. As the soil properties fluctuate from place to place and mostly unpredictable, it is essential to inspect the properties of soil for different locations. Again, performing laboratory experiments to determine the value of Cc is cumbersome and it triggers at developing a predictive equation for compression index in terms of the index properties. This study is an initiative to determine the index properties and Compression Index (Cc) of soil samples taken at several locations in Chattogram city and their correlation. Undisturbed soil samples were taken at eight different points for the desired laboratory tests. Specific Gravity test have been conducted to report more detail information of the soil samples. Moisture content of the soil samples have also been measured as water content interfere with the soil properties. From the results it is observed that, the value of Compression Index (Cc) increases with the increase in liquid limit. Correlation test between this two parameters conforms the relationship.*

Key Words: **Liquid limit, Plastic limit, Plasticity Index (PI), Compression Index (Cc), Disturbed and undisturbed soil sample, Correlation.**

1. INTRODUCTION

This Soil is a complex system [1] which although does not give birth to life, is considered as the incubator for the living world [2]. It is a heterogeneous mixtures of air, water, mineral particles, organic ingredients, and living organisms [3, 4]. Properties of soil and their influences on the strength and sustainability of the structure needs to be assessed to avoid any unavoidable errors in effort and materials costly construction work. In Geotechnical Engineering, Atterberg limit (liquid limit LL, plastic limit PL) test is olden concept of testing soils in the era of advanced testing methods still it plays an important role in evaluation of cohesive soil properties i.e. how cohesive soil behavior (physical properties) changes with water content. Liquid limit helps to estimate the water content at which the soil initiates to flow

and the plastic limit test is the assessment of the alteration of the soil sample to brittleness or ductility [5, 6]. On the other hand, the compression index (Cc) (mechanical property) supports to guess the amount of settlement that will take place in the respective area. Correlation of Plasticity index (difference between Liquid Limit and Plastic Limit) with compression index is essential to be examined to study how plasticity index will affect compressibility of soil. But it is highlighted that this approach is not anticipated as a substitute for completer site exploration, sampling and testing [7]. Undisturbed soil samples help to determine more accurate data while disturb samples may lead to some errors as the soil condition (both soil structure and moisture content) is not protected. Collection of undisturbed soil samples is quite challenging due to certain constraints like time, cost or diversity of soil deposits. In this paper attempt was made to generate a correlation of the compression index with the index properties with a view to reducing the experimental time and budget for the similar type of soil samples.

1.2 Background Studies

As determination of compression index by Oedometer test is more expensive and time consuming compared to the determination of plasticity index by Atterberg Limit test, former researchers have made correlation of compressibility characteristics with index properties [8]. Researchers have used different parameters like liquid limit [9,10] natural moisture content [11], void ratio [12] to correlate with compression index to lessen the challenges of conducting laboratory test. Zaman, M. W. et al. [7] studied various correlations of the index properties with compression index of soil samples with an intention to reduce experimental time and cost and to predict the soil type. Widodo, S. and Ibrahim A. [13] performed a research on the correlation of compression index (Cc) with the index properties, void ratio and liquid limit. In a study of Ibrahim NM et al. [14] it is shown that when the value of plasticity index (PI) increases, the compression index (Cc) will also be increased. Jain VK, Dixit M and Chitra R [15] performed experiments on 44 soil samples and concluded that plasticity index and compression index have significant level of correlation while Vinod and Bindu [16] conducted their research on 18

samples to generate a predictive equation for compression index. Again, Sorensen and Okkels [17] experimented on 62 soil samples to estimate the compression index involving moisture content and plasticity index. Also, in the study of Kifae [18] empirical relationships compressibility behavior and index properties have been identified. Thinh, Tuan, Bien, and Ha [19] conducted a research on finding correlation of Cc and LL in coastal region of Vietnam and Cambodia while in a paper of Prasad [20], attempt had been made to correlate Cc with other soil index properties. Mandhour [21] in his study presented that Cc can be predicted based on the soil indices. Akayuli and Ofosu [22] aim at establishing empirical models relating Cc and index properties of soil. Also, Ng, Chew and Lazim [23] studied on estimation of consolidation features from index properties. Giri [24] developed correlation of Cc with other soil index properties with a view to making consolidation parameters determination easier. Dianty and Wu [25] examined in their paper the relationship between the Cc and soil plasticity material to develop preliminary assessment of settlement. Yoon and Kim [26] proposed correlation model to estimate Cc from soil parameters like water content, void ratio, liquid limit.

2. MATERIALS AND METHOD
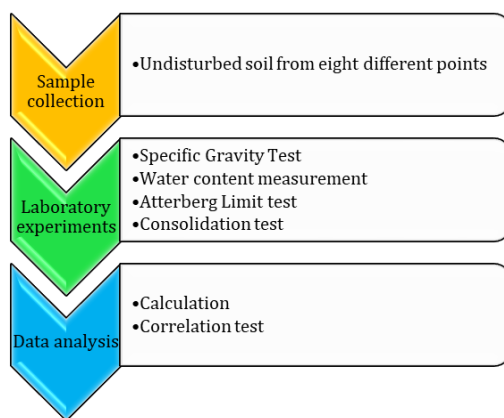
The overall work procedure is shown in Figure 1.

Fig -1: Work steps for the research

2.1 Test Materials

Total eight undisturbed soil samples were collected from various depths and indicated by S1, S2, S3, S4, S5 and S6, S7 and S8 for experiment in the laboratory. These samples were extracted by thin-wall tube (Shelby) sampler which is commonly used to get relatively uninterrupted samples of cohesive soils. According to ASTM D 4220 [27], samples must be stored standing in a sheltered environment to avoid freezing, dehydration, and variation of the moisture content.

2.2 Experimental Programs

In the laboratory, Specific Gravity test has been performed following ASTM D0854 [28]. ASTM D 4318 [29]

was followed for determining liquid limit, plastic limit and plasticity index. Water content measurements has been done by gravimetric method.

Compression Index (Cc) has been determined by one-dimensional consolidation test (Oedometer Test) following ASTM D 2435 [30]. Desiccator was used to store the soil samples for further tests so that they could not get in touch with air by any chance.

3. RESULTS AND DISCUSSION

Soil type and their corresponding value of specific gravity is shown in table 1.

Table -1: Soil types and specific gravity of soils at different test points

Test point	Soil type	Specific gravity
S1	Light grey stiff silty clay	2.590
S2	Grey very soft silty clay	2.629
S3	Grey firm silty clay	2.626
S4	Light grey firm silty clay	2.602
S5	Deep grey firm silty clay	2.576
S6	Brown stiff silty clay	2.635
S7	Grey very soft silty clay	2.624
S8	Grey soft Silty Clay	2.654

Table 2 contains the other parameters value of the soil samples.

Table -2: Soil parameters from experiments

Test point	Moisture content (%)	Compression Index, Cc	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
S1	28.63	0.393	35.325	11.759	23.566
S2	30.78	0.405	37.847	23.125	14.722
S3	31.96	0.449	44.985	17.745	27.240
S4	32.82	0.453	46.738	23.844	22.894
S5	31.99	0.422	43.759	22.989	20.770
S6	24.24	0.386	32.780	10.783	22.997
S7	27.98	0.423	40.895	21.982	18.913
S8	33.69	0.413	36.976	24.790	12.186

From the experimental findings, correlation between the soil parameters have been originated and presented in graphical form.
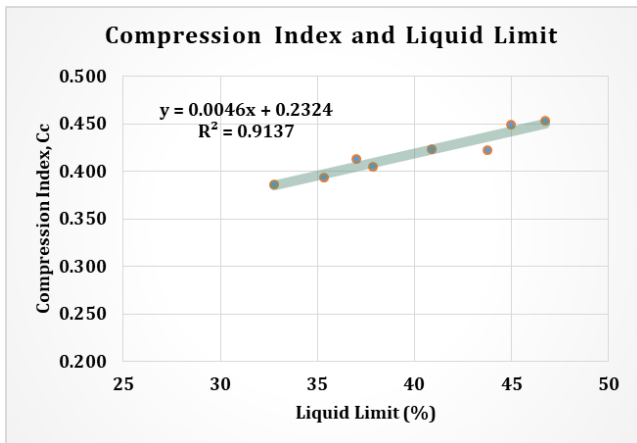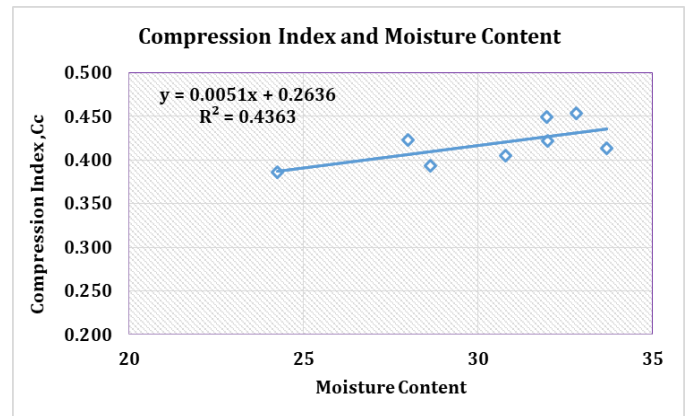
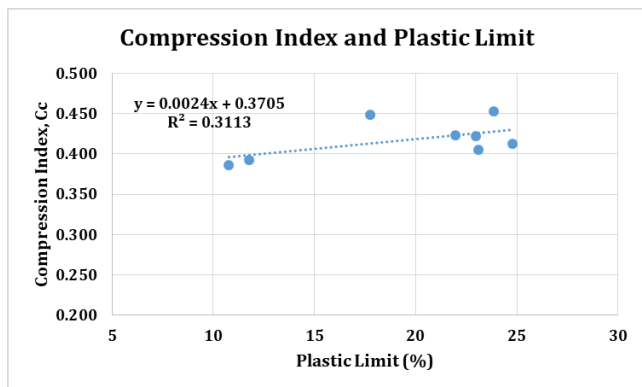Chart 1: Compression index vs. liquid limit.

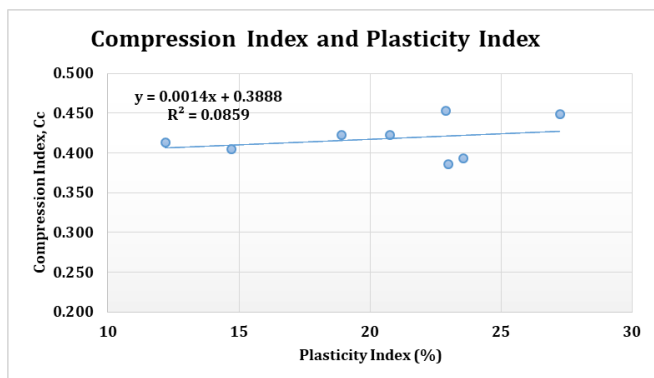Chart 2: Compression index vs. plastic limit.

Chart 3: Compression index vs. plasticity index.

Chart 1 represents the graph of Cc vs. moisture content while chart 2 is the graph for Cc vs. liquid limit plot. Again in chart 3, graph has been plotted for Cc vs. plastic limit and finally in chart 4 Cc vs. plasticity index have been plotted. The results were verified using the value of R^2, the goodness of fit. Among these four correlations the value of R^2 for Cc vs. liquid limit shows the highest strength of association (.9137).

Chart 4: Compression index vs. moisture content.

Though literature shows that the other soil parameters like moisture content, plastic limit, and plasticity index have strong correlation with the compression index, in this study it is found that for some types of soil, the relationship is not so strong. It may be due to errors in laboratory settings of the experiments or sample handling.

3. CONCLUSIONS

The relation generated in this study will help to predict the compression index of similar type soil samples quickly and simply without conducting the time consuming and costly consolidation test. Thus it will bring a lot of conveniences for the engineers in this field though for larger scale project, tests should have been done properly. Again, soil properties can be influenced by any other materials present in the soil and so, soil from place to place can vary in nature. Careful decisions on soil condition should be made after proper investigation of soil.

AUTHOR CONTRIBUTIONS

Sabrin Ara (Lecturer) conducted this research and wrote the manuscript. Mohammad Salah Uddin (Graduate student) helped in data analysis and revised the manuscript. Md. Nurul Hasan Showkat (Graduate student) helped in conducting the experiments and collecting data.

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BIOGRAPHIES

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