The design and implementation of the auxiliary calculation system for geotechnical engineering index and parameters

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Abstract. A program based on Visual Basic for the auxiliary calculation and statistical analysis of geotechnical engineering index and parameters is introduced in this paper. The application methods and skills of the program are illustrated with examples. This program contains 10 main calculation modules of geotechnical, a total of 23 different index calculation methods were integrated in it. Through this program, users only need to input the original data of geotechnical engineering tests of different projects and plots, and can quickly conduct the statistical analysis of geotechnical engineering parameters in a certain area, and can also compare the significance of differences among various factors. It is simple to operate, and the results are accurate and reliable, which can greatly improve the efficiency of parameter calculation and calibration in the practice of geotechnical engineering, and ensure the accuracy and precision of the calculation results.

1. Introduction
In the design and construction of foundation or geotextile structures, it is necessary to track and check the geotechnical engineering parameters[1]. Geotechnical characteristic parameters are of great significance to the overall safety performance, economic and social benefits of engineering construction projects. It plays a very important role throughout the process of engineering construction [2]. In geotechnical engineering and the related professional fields, there will be a lot of index parameter dispose and analysis work during the process of survey, design, construction and management. This is a necessary step to evaluate and proofread the safety and stability of the project. However, most of the geotechnical engineering physical and mechanical indicators have quite a few experimental methods to obtain the parameters, different test methods also need to use different calculation formulas, which will lead to a large number of different, complex parameter calculation formulas that should be remembered by the technical personnel. In general, the parameter distribution of a block is not invariable, and the data of a single borehole cannot explain the problems accurately. At this time, sorting and statistical analysis of geotechnical engineering parameters and revealing their internal regularity can better provide guidance and technical parameter support for engineering construction[3].

Visual Basic is a kind of object-oriented visual programming tool with event-driven programming mechanism. It adopts "Visual Design" and "Object-Oriented Design" technology, which greatly improves the efficiency of software development. The input and output interface also adopts the standard of Windows, and the maintenance and expansion of software are also very convenient. In recent years, Visual Basic has been gradually applied to the data development in various industries and fields, such as agriculture, sports, traffic, material and hospital management [4-8].
In order to shorten the time of parameter calculation and proofreading, increase the accuracy of parameter proofreading, avoid parameter error and omit, and improve the production efficiency, a set of calculation system Geoindex_TIGIS is designed and developed in this paper, which is based on the Visual Basic language under Microsoft Visual Studio. The programmatic integration of geotechnical engineering index and parameters into an application system. On the one hand, it can facilitate technical personnel and related practitioners to choose the calculation index and corresponding calculation method according to their own calculation requirements, calculation under this system is convenient and fast, which can greatly improve the work efficiency. On the other hand, after the calculation program is instrumentalized, it can solve the problem that manual calculation is prone to error, so as to ensure the accuracy and the precision of calculation results.

2. The structure of Geoindex_TIGIS

The Geoindex_TIGIS system consists of 10 calculation sub-modules, which are water content calculation, density calculation, specific gravity of soil and particles, boundary water content, relative density test, bearing ratio, compaction test, permeability test, consolidation test, and triaxial compression test. In the different calculation modules, it also contains the calculation subsystems of various test methods. The moisture content module includes drying method, alcohol combustion method and specific gravity method, the specific gravity module of soil particles includes specific gravity bottle method, floating weighing method and siphon tube method, the density module includes ring knife method, wax sealing method, sand filling method and water filling method, and the limit moisture content module includes liquid plastic limit combined measuring instrument method, dish type instrument method, rolling method and shrinking dish method. Permeation tests are divided into constant head method and variable head method, triaxial compression tests including UU test, UC test and CC test, etc. The module Settings of Geoindex_TIGIS system are shown in Figure 1 below.

![Figure 1. Geoindex_TIGIS system structure.](image)

In order to better display the application effect of the system, the "Compaction Test" module in the Geoindex_TIGIS system is selected to introduce the operating code and operation effect of the system. In engineering construction of roads, dams, airports, retaining walls, buried pipelines and building foundation pit backfill, designers often encounter the problem of compaction of filling soil. After mining handling, the original structure of the soil is destroyed. The fill soil without compaction is low strength, it cannot be used directly as earthen structure or foundation. Compaction or vibration compaction is necessary to conduct in order to obtain the reliable foundation soil. The compaction test is an indispensable and important test in the backfilling, which provides data support for the field construction of rolling[9-10].
2.1. Basic operation Equations
Compaction tests were carried out on the samples of the same soil with different water content, and the compaction curves were obtained, on which the maximum dry density and the optimal water content can be calculated out. The dry density of the sample should be calculated according to the following equation.

\[ \rho_d = \frac{\rho}{1 + 0.01\omega} \]  

Where, \( \rho_d \) is the dry density, \( \rho \) is the wet density of a sample at a point, and \( \omega \) is the moisture content. Compaction curves at different locations were obtained to obtain different maximum dry density and optimal water content for statistical analysis. Sample mean and standard deviation were calculated by the following equations:

\[ \mu = \frac{\sum X_i}{N} \]  
\[ \sigma = \sqrt{\frac{\sum (X_i - \mu)^2}{N}} \]  

\( \mu \) is the sample mean value, which is used to reflect the discrete characteristics of geotechnical engineering indicators. \( \sigma \) is the sample variance, which is used to reflect the central trend of these parameters. \( X_i \) is each single value, and \( N \) is the total size.

2.2. The program code
In order to realize calculation of dry density under different water content and obtain the maximum dry density and optimal water content of soil samples, the following code is needed to calculate dry density under different water content.

```vbnet
Dim i As Integer
Dim p, w, p_d As Single
Dim max_p_d As Double
Private Sub Command1_Click()
    For i = 0 To 5
        p = Val(Text1(i).Text)
        w = Val(Text2(i).Text)
        p_d = p / (1 + 0.01 * w)
        Text3(i).Text = Format(p_d, "0.00")
    Next i
    max_p_d = Val(Text3(0).Text)
    For i = 1 To 5
        If Val(Text3(i).Text) > max_p_d Then
            max_p_d = Val(Text3(i).Text)
            max_w = Val(Text2(i).Text)
        End If
    Next
    Text7.Text = max_p_d
    Text8.Text = max_w
End Sub
```

Run the program, get the following calculation interface, as shown in figure 2. The maximum dry density and optimal moisture content can be calculated out automatically.
Figure 2. Calculation interface of maximum dry density and maximum moisture content.

For some large land parcel, it is necessary to systematically analyze the compaction indexes in the plot area. Therefore, the following program is designed to conduct statistical analysis on the compaction indexes obtained from different drilling holes, so as to understand the regional distribution characteristics of parameters and predict the distribution rules of regional parameters.

```vba
Private Sub Command4_Click()
    For i = 0 To 5
        p = Val(Text4(i).Text)
        w = Val(Text5(i).Text)
        p_d = p / (1 + 0.01 * w)
        Text6(i).Text = Format(p_d, "0.00")
    Next i
    max_p_d = Val(Text6(0).Text)
    For i = 1 To 5
        If Val(Text6(i).Text) > max_p_d Then
            max_p_d = Val(Text6(i).Text)
            max_w = Val(Text5(i).Text)
        End If
    Next i
    Text9.Text = max_p_d
    Text10.Text = max_w
End Sub
```

```vba
Private Sub Command3_Click()
    Dim MyData(12, 1) As Double
    For i = 0 To 5
        MyData(i, 0) = Val(Text2(i).Text)
        MyData(i, 1) = Val(Text3(i).Text)
    Next i
    For i = 7 To 12
        MyData(i, 0) = Val(Text5(i).Text)
        MyData(i, 1) = Val(Text6(i).Text)
    Next i
    With MSChart1
        .TitleText = "dry_density-water content"
        .Plot.Axis(VtChAxisIdX).ValueScale.Maximum = 26
        .Plot.Axis(VtChAxisIdY).ValueScale.Maximum = 1.7
        .Plot.Axis(VtChAxisIdY).ValueScale.Minimum = 1.5
        MSChart1.Plot.AutoLayout = False
    End With
End Sub
```
In order to understand the parameters variation rule of different area, the drawing at the same time, calculate the mean maximum dry density, optimum moisture content, and the maximum dry density and moisture content of the standard deviation. In order to understand the analysis of characteristics of area soil compaction discreteness and central tendency, which provide soil for engineering design and on-site construction compaction of a more comprehensive accurate information.

![Statistical analysis interface of mean and standard deviation.](image)

3. Example effect display
In order to show the calculation program more intuitively, the test data is input into the calculation program (Figure 1). After the overall calculation, the running result is shown in Figure 4.
4. Conclusion
The analysis and evaluation of geotechnical engineering index parameters is a very important process in the design, construction, operation and accident analysis of engineering construction. However, due to its numerous formulas and complicated calculation, it is easy to get wrong results due to human factors during the analysis. The calculation program is designed and written by Visual Basic software, the user only needs to input the original data of the test, the system can automatically analyze the variance of the test results, and statistical analysis and comparison of the significant difference of each factor, in addition, the program is a special calculation program, when the program is written after completion. The computer program in the operating system Windows and Visual Basic6.0 compiled, the user can compile it to "exe "file, or packaged as an installation file to disk or to publish the installation over the Internet. Users only need to download it to the computer, and it then can be convenient to be used, which will greatly reducing the difficulty of use and improve the work efficiency.

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