

# The Use of WWW in Civil Engineering Application

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**Abstract**—Due to the convenience as well as versatility in the current popular use of WWW network, one can setup some appropriate engineering application programs in a server and allows remote users to access and execute them. Different from conventional engineering analysis program coding method, this study presents several problem solving techniques of engineering analysis programs in a server for web users. By using slope stability as well as retaining wall problems in civil engineering to demonstrate the validity of the methodologies used in this study, include data base process, interpolation interface, direct analysis, reverse analysis, and optimization design. This article takes the internet's superiority, not only changes traditional coding methods, and also provides users with a much more convenient, powerful and versatile tool as well as environment.

**Keywords**—Network analysis, data base, reverse operation, optimization

## 1. PREFACE

To analyze civil engineering related problems often requires large amount of computational resource and loading, it needs to calculate with complicated and tedious operations through different process procedures or suitable software. This kind of software usually setup in a computer for a single user, and can share neither its resource nor programs with others. The input data for most traditional engineering analysis programs includes material parameters, physical size or quantity terms of an object, and outputs a safety factor after goes through the computational process. A user should contrast some standard codes or his own demand to see if the obtained safety factor can meet the requirements; if not, he has to change some input data and executes the program again and again until satisfied result shows up. Furthermore, in case one need different application software to complete a job,

the transformation work of the required input and output data format to connect those software would become a great challenge or burden for the user. Also, traditional program usually cannot take a safety factor value as input to calculate some other specific parameter by reverse computation, and it is unfavorable in software and hardware maintenance as well as updating, and sharing data or information with others. To overcome those disadvantages, this study tries to make a server best to serve those web users with efficiency and convenience. In order to guarantee renewal and exactness of the application programs, this study handles the entire coding work and data base in a server, including revise program code, maintenance and operation. No matter what kind of operating system one has, as long as he can enter the system of this study through the browser of the Internet, all of those existing programs are ready to serve him. The most important thing is that this study enables a user to achieve greater plural ability to deal with problems as well as imagination.

## 2. SYSTEM SETUP

In recent years, the popularization and advance of the Internet makes it no longer limited to browse information only, there are so many variety websites were set up to content various demands, such as the E-mail service and network photo album, etc. With the progress of the network and computer hardware technology, there are many kinds of development tools available to set up Internet program, including HTML, Microsoft Visual Studio .NET, PHP and Java, etc.

This study used Microsoft Visual Studio.NET 2003 as a developing tool to code problem solving analysis programs. Visual Studio.NET supports three program languages such as Visual C ++, Visual Basic .NET, and Visual C# .NET. Its application program structure uses two stage compile skill, the first stage is to compile a procedure language into an intermediate language

IL (Intermediate Language) file. Second stage uses so called “Common Language Runtime” program to translate the optimized IL file into an executable machine code. That is to say no matter what language does it use, it must be able to translate into IL format. [1].

The key point in ASP.NET application program is the procedure making of webpage (Web Form), its structure is an all-purpose language that can be extended to carry out the stage (Common Language Runtime) of design program model, and creates webpage and turns on the browser dynamically at a server [2]. It uses the server function to allow one to set up the interface element of webpage, and then writes procedures to execute instructions. ASP.NET procedure can only be carried out in a server, as a browser requests the demand to open ASP.NET procedure from a server, the server will read this procedure from magnetic disc and carry out to change the result into a browser inclusive HTML file, and then convey HTML file to the browser that will translate HTML file into a webpage picture and appear in front of user's eyes.

There are two different process procedures proposed in this study, one is using a predefined database to interpolate a problem, the other is to solve a problem directly same as traditional programs. The use of database is to seek approximate solution by using interpolation method based on a set of predefined data and or database. Direct computation method is similar to traditional program, but the formal one can take a further step to handle different requirements. This system collects all database as well as programs in a server system. The server computer used in this study equips with Intel Pentium-4 3.0GHz CPU and 1GB RAM. It seems quite capable to serve several dozen users to access the system simultaneously without any noticeable system delay.

### 3. ANALYSIS PROGRAMS FOR REMOTE USERS

There are always various algorithms available for solving engineering problems, such as solves mechanic formulae directly, interpolates by using some data obtained from several similar problems, and looks up into design charts etc. This study deals retaining wall as well as slope stability design problems with different methodologies. Three different methodologies proposed here to solve the above mentioned

engineering problems, include database process, direct computation, and reverse computation. The pro and con of these methods will be compared and discussed in the following sections.

#### 3.1. Database Interpolation for Slope Stability Analysis

Lin Ching feng [3] created an inquiry type webpage to deal with sanitary landfill design problem, and carried out by using a set of predefined database through interpolation process. Its advantage lies in allowing an user to set any arbitrary parameter as unknown, then utilizes the existing database to interpolate and obtains appropriate result that satisfies input data. Those databases can be manipulated by users if necessary. Figs.1 and 2 show the starting manual page and the result.

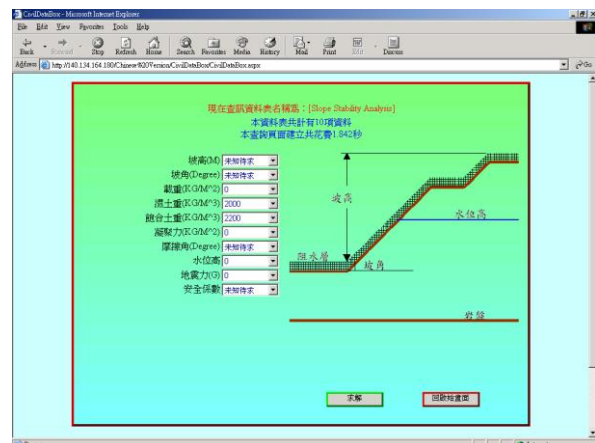


Fig. 1 The starting manual page for sanitary landfill design.

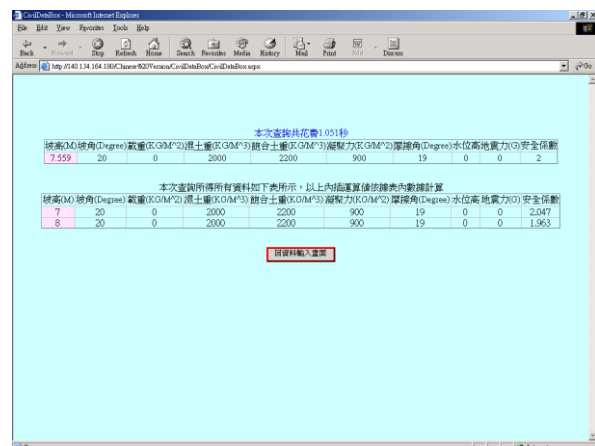


Fig. 2 Report of final result

In most mechanics problems, for one parameter the relationship among the resulting

values may not be linearly related to the input data with equal interval. For example as one linearly increase the input height of a retaining wall, its correlated safety factors may not response linearly. So it is unfeasible to get the corresponding safety factor value directly by using linear interpolation from database that was generated from a set of predefined parameters for the problem beforehand. To minimize the error, this study set several equal intervals for each parameter. As a problem with N number of assigned parameters, for every parameter this study tries to find out two corresponding parameters that are greater and less than the input ones. That is to say  $2^N$  problems are generated and  $2^N$  results can be found from the existing database. Convergence process is than taken to narrow down those results to a single final value. Linear interpolation is performed for each pair of the parameters and their associated input one. It implies that 2 (n+ 1) interpolation processes is required. The linear interpolation formula used in this study shows as in Eq.1:

$$sol = \left( \frac{sol \uparrow - sol \downarrow}{QUERY \uparrow - QUERY \downarrow} \right) \times (INPUT - QUERY \downarrow) + sol \downarrow$$

.....Eq.1

The  $sol \downarrow$  and  $sol \uparrow$  symbols represent the result searching from the less parameter  $QUERY \downarrow$  and the greater parameter  $QUERY \uparrow$  as compare to the original input one. (N +1) time's interpolation is needed for a N parameter problem. Because linear interpolation is used in implementing the process, some error may occur and accumulate. The required computer process time and resulting error are quite acceptable as proved by Lin Ching feng [3]. One major drawback of this method is that large amount of problems ( $2^{N \times M}$ , M is the number of the equal intervals for a parameter, and it may not the same among different parameters) solving has to be executed to generate appropriate database.

### 3.2. Slope Stability Analysis Program

Chen Hong fu [1] created a webpage for solving slope stability as well as retaining wall related geotechnical engineering design problems. There are many different types of problems included in the webpage, for each type of problem he coded analysis program and also the related process procedure for network interface.

This system allows multi-users to access simultaneously by using WWW, and each of them may execute different problems. This procedure included various analysis cases such as the stress path CD (CU) test, retaining wall design, plane failure slope stability analysis, and in field loading test etc.

For different problem it may require different process to meet its need. This study is able to satisfy the requirement for each problem such as displays graphical output, recursive iteration processing, table look-up processing, and formulation generation etc. For all different cases, one of the design principles is to set the layout of the related graphical display of input or output information appears consistency in the webpage, that is to say, standardization. The whole information system has an identical interface that makes users can operate by the same method while browsing webpage information content on its website. Figs. 3 to 7 illustrate the web pages for stress path analysis, CD test, cantilever retaining wall design, and plane failure slope stability; and also their associated calculate characteristic and interface briefly.

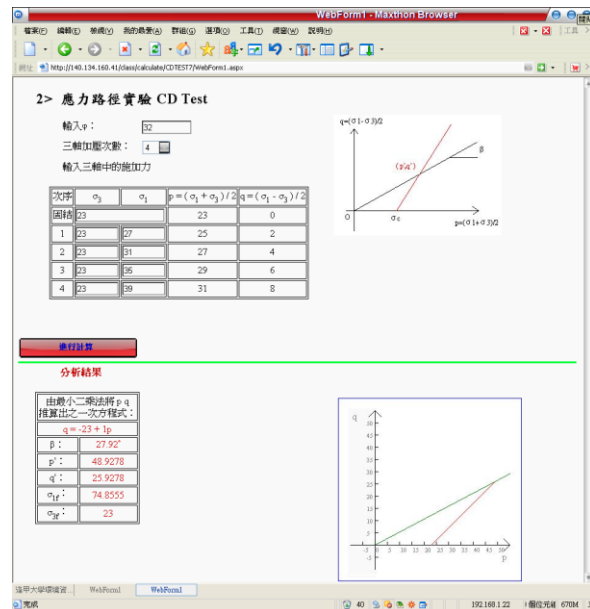


Fig. 3 CD test. Upper part is input, and lower one is output.

The output graph processing of this interface is to utilize every user input largest and smallest stresses to calculate p and q values, each pair of p and q values forms a point in the figure, and then by using linear regression method one can create a line for further use. [1].

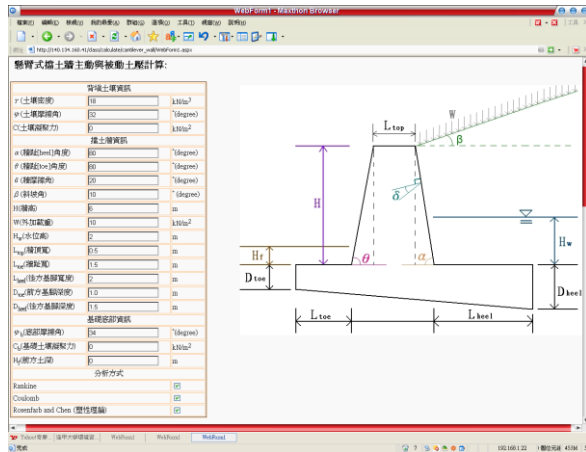


Fig. 4 The input page for cantilever retaining wall

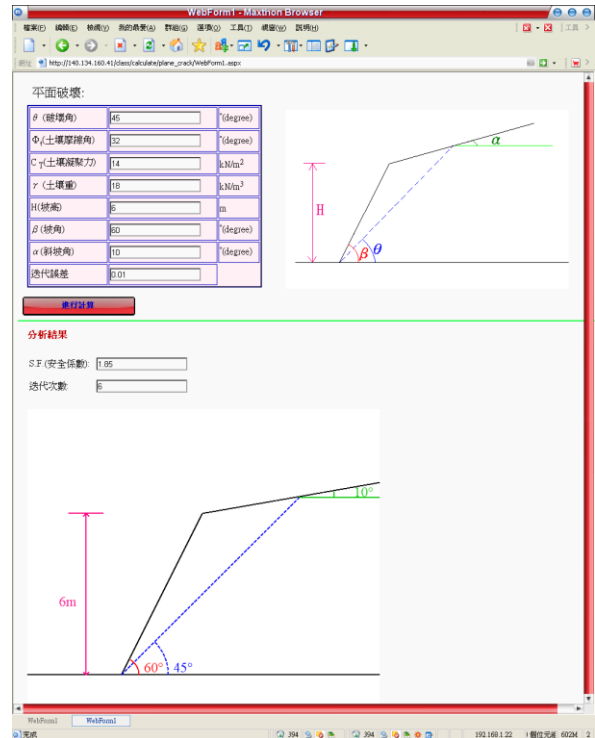


Fig. 7 The input and output of plane slope failure

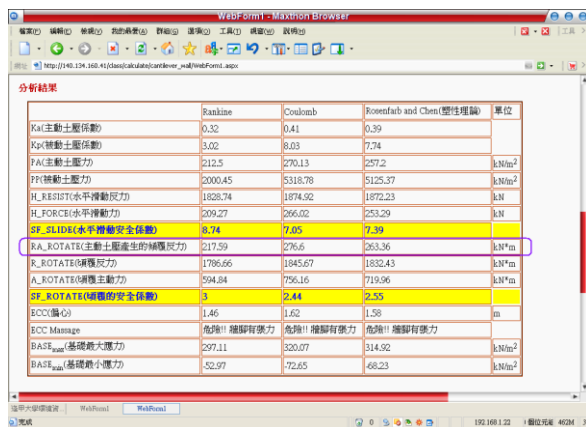


Fig. 5 The output values of the Fig.4

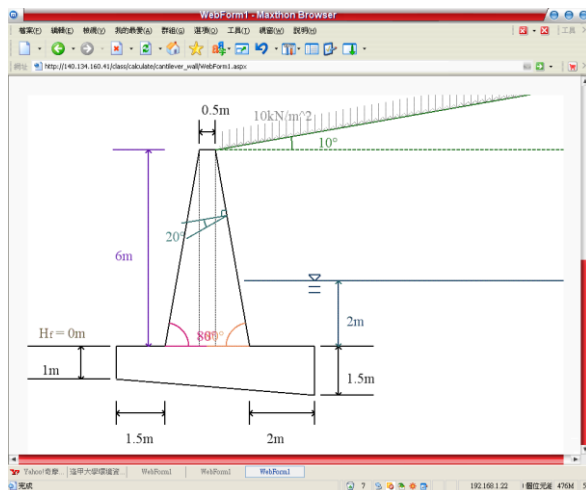


Fig. 6 The graphical display output of the Fig.4

For plane slope failure problem as Fig.7, recursive iteration process has to be used to solve the problem. The allowable error can be assigned by a user to decide the iteration number in solution solving process [1]. The shortcoming of this method lies in the same as by using traditional analysis method that is the only unknown it can solve is safety factor.

### 3.3 Reverse Process and Optimization

In the traditional formula, the safety factor is always an unknown to be solved for. This study allows a user to set any parameter as unknown and then solve it; this kind of reverse process seems more like in reality in the engineering design work. In case the result of this process is unacceptable, further process can be taken that is optimization process. That is to assure the final result can meet the user's demand [4]. Fig. 8 illustrates the webpage for retaining wall design.



Fig. 8 The webpage for retaining wall design.

This system adopts the least squares method [5] [6] in the reverse process to generate appropriate formula for searching solution; Optimization design is handled by using interpolation method to find the closest one.

For retaining wall design problem, the demo example here is to take the wall height (H) as an unknown, that is to say finding this value by using the proposed reverse process in this study. It is quite contrast to the traditional program that can only accept safety factor as a unknown to be solved. The process procedures of this study described as follows: Four assumed heights of the wall are made, then four safety factors can be obtained by using traditional analysis method. A formula equation as in Equation 2 can be generated by using least square correlated the relationship among the four heights and safety

factors. Those three constant terms can be defined as C0、C1、and C2 in the equation. Any safety factory value can be input as X in the equation, then the associated wall height Y can be computed by using the Eq.2.

$$Y=C0+C1*X+C2*X2.....Eq. 2$$

In the optimization process, any parameter can be picked as unknown to be solved. This system will set a reasonable range for this parameter and makes n partition divide equally in the range, every partition can then be executed by a tradition analysis program to compute the associated safety factor value. The relationship between safety factor and wall height is generated as Eq.2 by using least square method. Obviously, the n partition value set will influence the accuracy of the final result, the larger value it used for n the more accurate result can be expected; however, more computer time is required.

coefficient per group will be compared with safety coefficient that the user input into, most close to that group of safety coefficient that users input being asked by optimization on the principle that not smaller than users the inputting value.

#### 4. CONCLUSIONS

This study proposed different methodologies to code engineering analysis programs in a server and can be accessed by remote users via WWW. This new concept can be helpful for engineers or students in engineering design、research、teaching、or even learning. The progress of network environment and hardware/software tools, this study tries to stimulate programmers as well as users to have some innovate change and enhance imagination strength [7]. The conclusions of this research are summed up as follows:

1) Three different analysis methodologies were proposed in this study. All of them equipped with highly graphical and interactive interface with efficient and friendly input as well as output. The generated webpage is available for multi-users as well as remote access. As long as one can use internet network browser, he can get into the web server to execute all of the programs inside the server, no any extra software and or hardware is required.

2) All of these three analysis programs were design to be similar in I/O process、manual

page , and graphical display etc. To have friendly operation as well as environment in this system, users can carry out different analysis problems with similar process steps.

3) Slope stability analysis program allows one to interactive use it, i.e, reverse process as well as optimization functions. Feedback mechanism is offered in this program, especially it can display the geometrical figure of a problem after finishes all of the required parameter input. In addition, in order to prevent the user from inputting unreasonable data and received wrong result after process, this program equipped with some checking process, and offer information to let the user understand while making a mistake.

4) Database process system is used in this system. To set up database for an engineering analysis problem usually requires lots of computer time and effort. However, while using database to inquire a solution is very fast, and also versatile functions can be applied.

5) There are nine different engineering problems is setup in this system include: Skempton water pressure parameter, stress path CD and CU test, gravity and cantilever types retaining wall, infinite long slope stability for embankment, plane failure slope, Taylor's chart for slope stability, and in field plane loading.

6) The inverse operation and optimization processes emphasize different calculation thinking while analyzing a problem, when the obtain safety factor value is unacceptable after inverse operation, one can then try to use the

optimization for further process. The user can change a particular parameter and keep going.

7) The schemes proposed in this study is innovate in Civil engineering relate fields, the authors believe these methods perhaps will be the future trend in some way.

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The inverse operation and optimization are analyzed:  
<http://140.134.160.41/class/calculate/CCACHE2007/WebForm1.aspx>