Welcome to the Fall issue of the BSI Newsletter!

In this issue’s Technical Corner we will discuss some of the new features available with the release of FB-MultiPier v4.10. In our Discussions with.. article, Dr. Jae Chung talks about “Classifications ‘linear’ and ‘nonlinear’ analyses in FB-MultiPier”.

The articles 'Technical Corner' and 'Discussions with..’ are open for input from all readers. If you have a topic that you think should be discussed, let us know. Did you create a great model with features that you want to share? Everyone is welcome to submit articles for possible inclusion in subsequent issues. Please contact BSI at BSI@ce.ufl.edu with your ideas.

What's New at BSI

It is with regret that we announce that Greg Fazenbaker is leaving BSI. Greg has been an integral part of BSI for a number of years. His contributions to the development of BSI are greatly appreciated and his input to future work will be missed. To our customers, Greg was also ‘the voice on the phone’. We wish him well in his future endeavors. Cary Peterson, who has been part of the BSI team for some time now, has taken over the help desk, among other responsibilities.

We would like to announce the release of the new FB-MultiPier v4.10. The program is available for download from the BSI website. The new version contains fixes to the latest reported bugs and also includes a number of new features. The new features include a soil data input table, extra members on the piles, display of the soil curves along the pile length and more.

We also introduce a number of short tutorials that are available on our website. The tutorials demonstrate the use of different features of the program including the new ones. The aim of these tutorials is to introduce the users of all levels to several features of the program. We will add new tutorials regularly to better communicate and explain the use of our program.

Technical Corner - New Features

Soil Table | Printable Graph Dialog | Enhanced Extra Member Capability

Based on user feedback, we have added several exciting new features to FB-MultiPier 4.10, including the Soil Table, Printable Graph Dialog, and enhanced Extra Member capability.

Soil Table - This is a highly efficient way of inputting soil data. One huge advantage to using the table method is the ability to view all soil layers, across all soil sets, simultaneously. This virtually eliminates the time-consuming 'back and forth method' of data input (See also tutorial Soil Table).

To access the table, (Figure T1) click the 'Table' Button on the Soil Page. Table pages are divided by model type - Lateral, Axial, Torsional, and Tip. Properties relating to each soil model are entered on their respective pages. These pages are intelligent in the sense that, they only request soil data relevant to the currently selected model. For example, if the selected lateral model is 'Sand (O'Neill)', only the Internal Friction Angle and Subgrade Modulus would be enabled in the table. Each model page also features a 'Plot' button which displays the curve for that page's model type.
There is also a global page where control resides for the number of soil sets, soil layers, and layer elevations. The traditional method of soil data input is still available in FB-MultiPier.

Printable Soil Graph Dialog - Until version 4.10, soil curves were only available for the top and bottom of each soil layer. Now, curves (Figure T2) are also available at the elevation of each pile node within the soil. And multiple curves can be displayed on one plot, simplifying comparison across multiple elevations (See also tutorial Printable Soil Graph).

There are two ways to access this new feature.

Method 1: Click on a pile node in the Soil Edit Window. The nodes are now displayed along the pile length. This will launch the Printable Soil Graph Dialog, displaying the curve for that node’s elevation, for the currently selected model type (Lateral, Axial, Torsional). Additional curves can be added to the plot window by selecting elevations from the 'Elevations' list. This list of elevations consists of the elevations at the top and bottom of the currently selected soil layer, plus the elevation at every pile node within that layer. To access elevations across the entire soil set, select 'All Layers' from the 'Soil Layer' combo box. This allows soil curves between different layers to be compared.

Method 2: Click the 'Plot' button on the 'Soil Page'. The curves for the currently selected model type, at the top and bottom of the currently selected soil layer, will be displayed.

Extra Members - Several enhancements have been made to the capability of the program to allow extra members. Extra members can now be applied to piles nodes, and can use preexisting pile (or pier) cross sections. The only restrictions on an extra member's placement in the model is that they cannot cross the plane of the pile cap, and they cannot connect two nodes along the same pile.

The ‘Extra Member Page’ (Figure T3) has been changed to accommodate the now broader use of these members. To create an extra member, choose a cross section from the 'Cross Section Menu'. This menu is organized into 3 parts: Extra Member cross sections, Pier cross sections, and Pile cross sections. Then, click the 'Add' button to create the element, which will adopt the selected cross section. Then choose the member's I and J nodes, and click 'Update'.

Creation of new extra members has been shifted from the 'Pier Page' to the 'Extra Member Page'. Select the 'Edit/Create Extra Member Cross Section' menu item. To view results for these extra members, the
interface has also been updated.

To view the forces for a member, open the 3D Results Window. Right click to launch the popup menu. Then select 'Picking Forces Control'. Click on an extra member. (If an extra member overlaps another element, the element is drawn in blue, and with a rougher texture). Choose ‘Extra Member’ from the popup menu. Member forces (Figure T4) will be displayed in the 'Element Forces' Dialog.

Discussions with...
Dr. Jae Chung - Research Assistant Professor, University of Florida

Classifications "linear" and "nonlinear" analyses in FB-MultiPier

Comprehensive discussion of nonlinearity would require one complete volume of user's manual. The following brief discussion rather provides the difference between 'linear' and 'nonlinear' analysis options available in FB-MultiPier and presents some of the basic combinations for using FB-MultiPier analysis options.

In FB-MultiPier analysis, a problem is linear if a structure is characterized by a linear fundamental equilibrium for all possible choices of load and displacement variables. It is assumed that a linear structure can sustain any load and undergo any displacement magnitude without yielding and failure. For such
system, if the applied forces are doubled, the displacements and internal stresses also double. Furthermore, response to different load systems can be obtained by the principle of superposition whereas removing all loads returns the structure to the reference (e.g., the initial) position. Thus, perfect linear elasticity for any deformation and infinite material strength are assumed for such linear behavior to be applicable. Therefore, the term 'linear analysis' in FB-MultiPier defines that stresses and strains are related by a matrix of constants and thus both system stiffness and load are regarded as independent of displacement.

If linear pile (or pier) behavior analysis option is selected in the analysis page (Figure D1), then the user can either define 'Gross Properties' or 'Full Cross Section' for the section under the Pile/Pier Cross Section Type (Figure D2). If 'Gross Properties' is selected, the user must provide pre-calculated section properties (e.g., moment of inertia) to be used in the computation of the system stiffness in FB-MultiPier. However, if the 'Full Cross Section' option is selected, then these section properties are internally calculated using the geometric dimensions of the user input. In both 'Gross Properties' and 'Full Cross Section,' linear elastic material behavior is assumed since the user has chosen linear pile (or pier) behavior in 'Global Data' and thus only the parameters associated with linear elasticity are used in subsequent computation. Thus, the system stiffness remains constant throughout the computation.

In general, there are four sources of nonlinear behavior for nonlinear structural analysis. The corresponding nonlinear effects are identified by the terms material, geometric, force B.C. and displacement B.C. in which B.C. means 'boundary conditions.' However, in FB-MultiPier, 'nonlinear analysis' is strictly focused on material nonlinearity associated with changes in material properties such as elasto-plasticity. If 'nonlinear pile (or pier) behavior' is selected as an analysis option (Figure D1), then the user must define 'Full Cross Section' in the Pile (or Pier) Cross Section Type. Using the built-in nonlinear material models such as Hognestad's concrete model and elasto-plastic steel, stresses and strains are related by a strain-dependent matrix. Using the Newton-Raphson iterative method, the tangent stiffness matrix and load imbalance vector are updated after each cycle. The solution process seeks to reduce the load imbalance and consequently the corresponding displacement.

FB-MultiPier can also calculate the Demand to Capacity (D/C - performance) ratio for each section. The 'Demand' is basically the resultant force in the section after the analysis is completed. The interaction diagram is a graphical representation of the 'Capacity' of the section and it can be generated by
FB-MultiPier based on the cross section properties. However for FB-MultiPier to be able to compute and generate the interaction diagram and consequently the D/C ratio, the user must employ the 'Full Cross Section' properties for the particular section.

BSI Program Status

**FB-MultiPier V4.10**  Download a FREE demo today!
Released: Sep 17, 2006 - Continuing Development - Technical Support Available

FB-MultiPier is the successor to FB-Pier. In addition to all the capabilities of FB-Pier the FB-MultiPier program allows for the modeling of a whole bridge that consists of multiple piers that are connected with bridge spans. In addition to the multiple load cases and the AASHTO coefficients that are available in FB-Pier, the new program is capable of performing dynamic analysis for the whole bridge. For more information about FB-MultiPier, click here.

**FB-Deep V1.21**  Download a FREE demo today!
Released: March 11, 2005 - Continuing Development - Technical Support Available

The FB-Deep computer program is a Windows based program used to estimate the static axial capacity of drilled shafts and driven piles. The methodology is based upon Federal Highway Administration (FHWA) reports. FB-Deep guides the user through pile and shaft materials data, shape and dimensional inputs, soil properties, and boring log info. FB-Deep presents the data analysis in both clear graphical and text form. For more information about FB-Deep, click here.

**FB-Pier V3.21**
Released: October 15, 2004 - Final Release - Technical Support Available

This program has been replaced by FB-MultiPier and all sales or renewals will be directed to the FB-MultiPier program. FB-Pier is still available for download by valid licensed holders.

FB-Pier was designed for the analysis of bridge pier structures composed of nonlinear pier columns and cap supported on a linear pile cap and nonlinear piles/shafts with nonlinear soil. FB-Pier couples nonlinear structural finite element analysis with nonlinear static soil models for axial, lateral and torsional soil behavior to provide a robust system of analysis for coupled bridge pier structures and foundation systems. The program performs the generation of the finite element model internally given the geometric definition of the structure and foundation system as input graphically by the designer. For more information about FB-Pier, click here.

Contact BSI

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