BSI NEWSLETTER

Bridge Software Institute

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Welcome to the latest issue of the BSI Newsletter!

In this issue's Technical Corner we discuss dynamic relaxation as computed in FB-MultiPier.

The articles Technical Corner and Discussions 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

We are pleased to announce the release of FB-MultiPier v4.13 and FB-Deep v2.02. These programs are available for download from the BSI website. The new versions contain fixes to the latest reported bugs and also include a number of new features.

Technical Corner

Michael Davidson
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Structure

New Dynamic Relaxation feature in FB-MultiPier

When permanent loads are abruptly applied to bridge structures, dynamically amplified displacements and internal forces are generated. Instantaneous application of permanent loads, however, can lead to unduly amplified structural response. The dynamic relaxation feature in FB-MultiPier prevents unwarranted amplification (Figure 1). Here, load effects associated with permanent loads are initialized in the dynamic analysis by means of a static pre analysis. Meaning, two distinct analyses are conducted: a static analysis (with only permanent loads applied), and a dynamic analysis (with all loads applied). Statically, once the structure reaches equilibrium, the stiffness matrix and displacement vector are stored. These response quantities are then used to define the initial state for the dynamic analysis. Dynamically, permanent loads are imposed instantaneously; however, because permanent load stresses are already present, the abrupt loading does not cause unrealistic vertical oscillations.

Fig. 1 Dynamic Relaxation Concept

A demonstration case is presented to illustrate the effectiveness of the dynamic relaxation feature as a means of obtaining proper displacements when permanent loads are incorporated into a dynamic model. The model shown in Figure 1 was analyzed with self weight loading (a permanent load) using three methods: static analysis, dynamic analysis with relaxation, and dynamic analysis without relaxation. The predictions of vertical displacement at the center of the pier cap from the central pier (node 5 in the model) are shown in Figure 2b. Note that the vertical displacement histories are in good agreement only between the static and dynamic-with-relaxation analyses.

Inside this Issue

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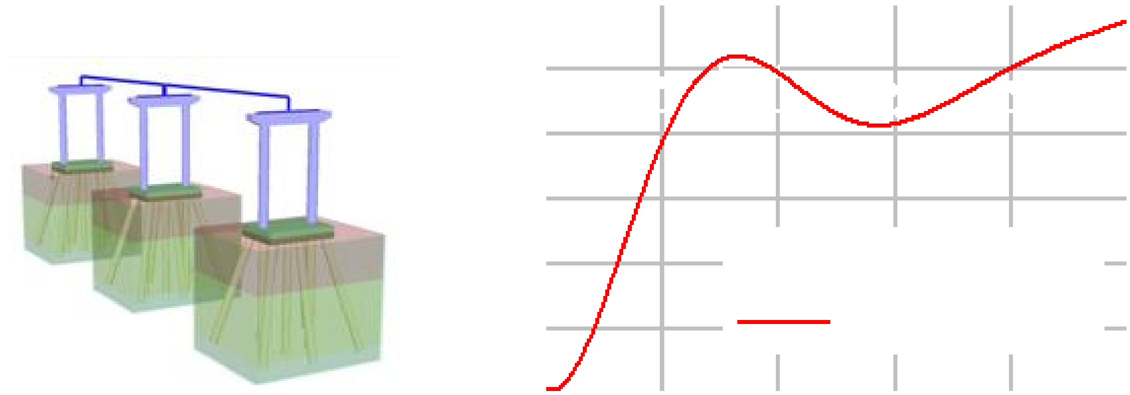
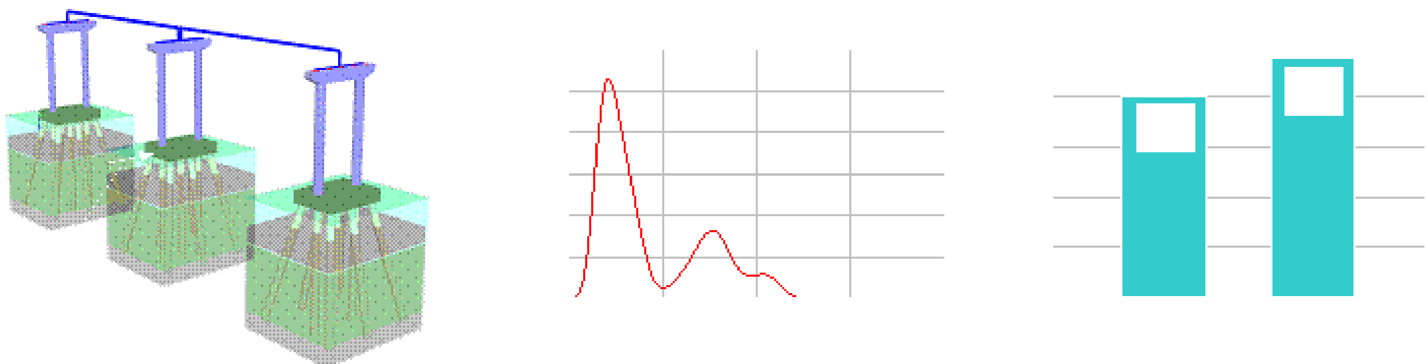


(a) Dead load only

(b) Comparison of analysis results

Figure 2. Three-pier bridge model subject to permanent loads: a) Structural configuration; b) Central pier, center pile cap (node 5) vertical displacement.

An additional demonstration case is presented to illustrate the importance of using dynamic relaxation for the purpose of accurately determining maximum structural demand. The model shown in Figure 3 was analyzed with self weight loading (a permanent load) and an externally applied lateral load (a transient load, shown in Figure 3b) using dynamic analysis with relaxation and dynamic analysis without relaxation. Structural response is compared for the two analysis types (Figure 3c), where predictions of maximum pile axial force are given for the central pier. The dynamic analysis without relaxation predicts a maximum pile axial force 20% greater than that predicted when dynamic relaxation is employed. If used for pile member design, such unduly amplified internal forces can lead to substantially greater construction costs that are unnecessary. Clearly, the dynamic relaxation feature should be employed to facilitate proper application of permanent loads in dynamic analyses.



(a)

(b)

(c)

Figure 3. 3-pier bridge model subject to permanent and transient loads: a) Structural configuration; b) Transient load-history; c) Maximum pile axial force.

Discussions with...

Henry Bollmann P. E.
Research Engineer, Bridge Software Institute

Pile To Pile Cap Connection

The "pinned" or "fixed" condition does not always adequately represent the pile to pile cap connectivity of an actual bridge substructure. Modeling both the flexural resistance and rigidity of the connection is important to the overall structural resistance and behavior of the foundation.

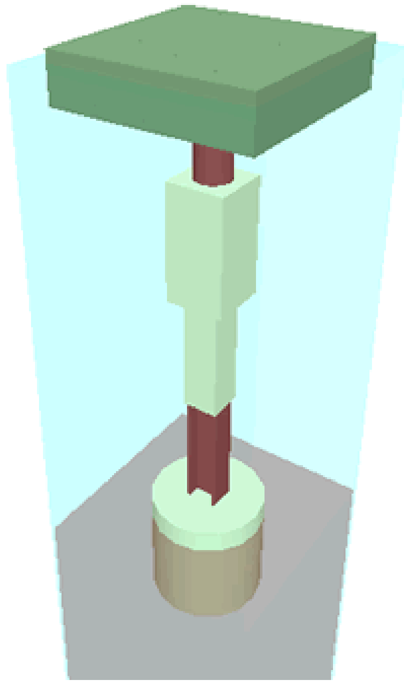
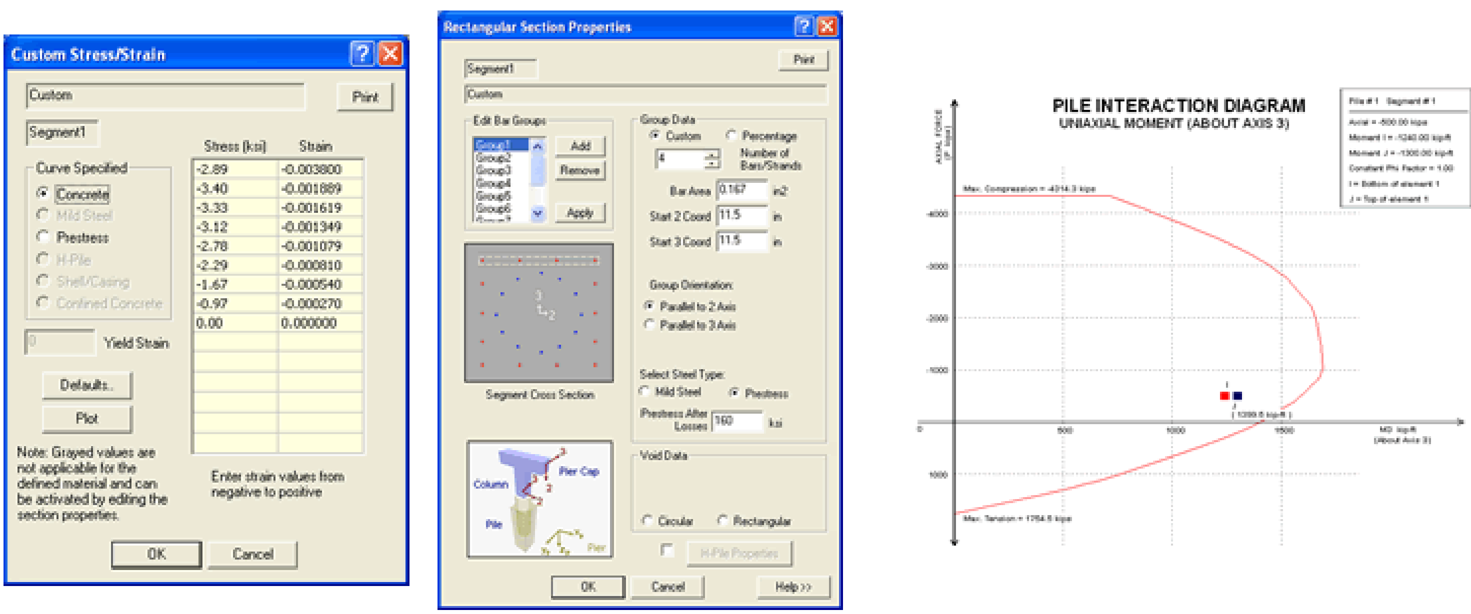


Fig. 4

"Almost" any connection condition can be modeled with FB-MultiPier because the program allows for the modeling of multiple cross-sections (Fig 4) and user defined stress-strain curves for material properties (Fig 5a). If "full section properties" are specified then the program will account for second order effects, concrete cracking, steel yielding and the resulting changes in stiffness. One can also obtain an elastic solution as the program computes the elastic stiffness properties if the "linear" option is selected. There are usually multiple approaches to modeling a pile connection detail.

A typical problem encountered is modeling the fixity/capacity condition of a pretensioned pile that may not be embedded deep enough into a cap to assume full bending capacity of the pile. The section shown in (fig 5b) represents a 30 inch square prestressed pile with void concrete filled and reinforced with mild steel. The prestressing steel has been reduced in quantity from the standard to just 16 strands, in order to account for the lack of strand development near the member end . Based upon the pile embedment the engineer may, by trial and error, adjust material parameters until the desired strength interaction curve is achieved (fig 5c).



(a) custom stress-strain curve	(b) cross-section properties	(c) moment-interaction diagram

Fig 5

Pile section lengths and node number selection must be coordinated so that a pile section contains at least two nodes.

Tips...

Cary Peterson
Tech Support, Bridge Software Institute

Technical support questions.

When requesting technical support for any BSI software, it is recommended to email the input file (.in file for FB-MultiPier and Atlas or .spc file for FB-Deep) to the BSI address bsi@ce.ufl.edu along with a brief explanation and any supporting documentation of the issue. This will allow the support staff to provide the users prompt tech support.

Checking program version.

It is important that users have the current most up to date version of the BSI software. Thus we recommend that users regularly visit the home page of the BSI website BSI. To check current version of program installed on the computer, open the program and go to Help > About to see the version number you currently have.

BSI Program Status

FB-MultiPier V4.13   Download a FREE demo today!
Released: November 24, 2009 - 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 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 bridge. For more information about FB-MultiPier, click here.

FB-Deep V2.02   Download a FREE demo today!
Released: December 12, 2009 - 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.

Atlas V6.02
Released: September 24, 2009 - Limited Web Support Available

Atlas is a finite element analysis program that is used for the design/analysis of cable supported traffic signal systems. The Atlas program models dual cable supported systems including single-point or two-point attachments and suspended box systems. For more information about Atlas, click here.

Contact BSI

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