Soft Spot™

Itasca Software Newsletter

Volume 1, Number 2

March 1993

In the SpotLight

Our first issue of Soft Spot has received a very favorable response from Itasca code users. We received several comments and suggestions, and even raised a small controversy (see Software Q / A).

In this issue we have added a new section, **Modelling Hints**, in which we provide advice to commonly asked questions. Also note that we have expanded our electronic mail service. We encourage you to communicate via either BBS or CompuServe, especially if you wish to send us a long data file.

I also call your attention to the enclosed announcement for two upcoming code seminars. These are scheduled as a result of the response to the software workshop questions we asked in our first newsletter. Please return the enclosed form if you wish to receive registration materials and a schedule for either seminar.

Roger D. Hart
Director, Software Services

Electronic Mail Service

We now offer two ways for users to send questions and files to us via electronic mail: Bulletin Board Service (BBS) and CompuServe.

You may access Itasca's BBS with the phone number **(1) 612-371-4715**. The instructions for using BBS are given in the *FLAC* User's Manual, Volume III, Appendix J.

Our CompuServe Mail Address is **74720,3535**. Please contact us if you would like additional information on BBS or CompuServe.

FLAC Version 3.22

The latest version of *FLAC*, Version 3.22, was distributed in March to owners of *FLAC* 3.2. This version contains several minor modifications based on user's comments and suggestions. We have also included revised pages to the *FLAC* User's Manual and a new *FISH* function to assist with model generation. Please contact your local code agent if you have not received FLAC 3.22.

Update on *FLAC-3D* Development

The first platform on which FLAC-3D will be available is Intel (386 or better) running Windows 3.1. Later releases will be targeted for RISC and Alpha machines. With this in mind, the graphical user interface (GUI) for FLAC-3D is taking shape amid deliberations regarding the best screen layouts and menu structures. We would like your ideas. How would you like to see the screens and menus structured?

Code Agent Information

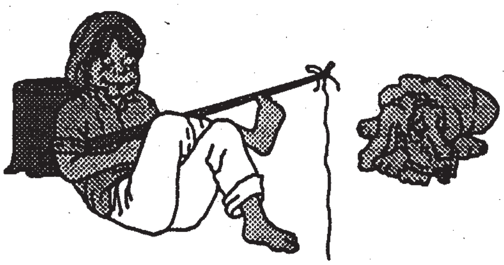
In addition to the code agent offices listed in our last newsletter, we wish to inform you of our German branch of Itasca Consultants, s.a., which was established in Bochum, Germany in January 1993. The address is:

Itasca Consultants, s.a. (German Branch)
c/o MeSy
Meesmannstr. 49
4630 Bochum, Germany
Phone and Fax: 49-234-9536620

Our code agent in Brazil, Roberto Kochen, has provided an additional fax number which is accessible 24 hours per day. That number is **(55) 11·829· 9418.**

Gone fishin'...

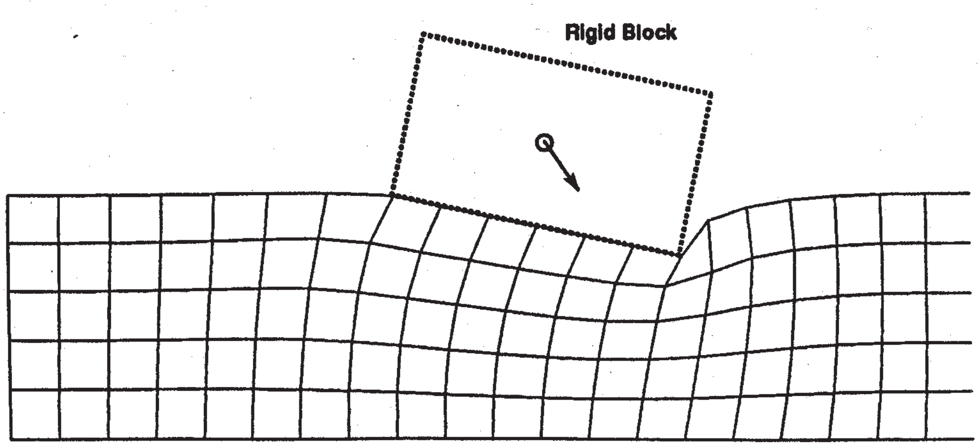
(Simple tricks with *FISH*)



We may need to determine the effect of forces applied to a rigid block attached to a deformable stratum (e.g. a foundation block acted on by lateral forces). It is inefficient to represent the block with very stiff structural elements, because numerical convergence will be very slow. A *FISH* function can be written to control a specified group of gridpoints. Forces from the *FLAC* grid are translated into block-centroid forces and a moment. Resulting block velocities are conveyed back to the gridpoints. The block velocities are related to block forces by a relaxation factor, **alpha,** which is similar to the servo "gain" in the *FISH* function SERVO.FIS.

WARNING! The value of **alpha** is critical; the solution process goes unstable if **alpha** is too large.

```
def block
   while_stepping
   fx = fxap
   fy = fyap
   mom = 0.0
   loop i (i1,i2)
      fx   = fx + xforce(i,jgp)
      fy   = fy + yforce(i,jgp)
      ymom = yforce(i,jgp)*(x(i,jgp)-xc)
      xmom = xforce(i,jgp)*(y(i,jgp)-yc)
      mom  = mom + ymom - xmom
   end_loop
   xdot = alpha * fx
   ydot = alpha * fy
   tdot = alpha * mom
   loop i (i1,i2)
      xvel(i,jgp) = xdot - (y(i,jgp)-yc) * tdot
      yvel(i,jgp) = ydot + (x(i,jgp)-xc) * tdot
   end_loop
end
grid 20 5
mod elas
set i1=8 i2=14                    ; gridpoint connections to block
set xc=10 yc=7                    ; centroid location of block
set fxap=0.5e9 fyap=-0.5e9        ; applied forces
set alpha=1e-10                   ; relaxation factor
fix x y j=1
fix x i=1
fix x i=21
fix x y i=i1,i2 j=6
prop dens 2000 sh 1e8 bu 2e8
step 100
plot hold grid mag
ret
```



FISH Support

There are a wide variety of applications for *FISH* functions in *FLAC*. We encourage users to write their own routines and send them to us to share with other users.

FISH functions can become quite complex and may require assistance from experienced programmers to develop. Please contact us if you have a particular feature that you would like to see implemented as a *FISH* function (e.g. a particular material constitutive model or a special grid generation routine). If the function, or something similar, is available, we will send it to you. We would also like to offer our services to develop special *FISH* functions for you. Please contact us if you would like to discuss the development of a special FISH function.

MODELLING HINTS

Minimizing Transient Effects on a Static Analysis

FLAC, UDEC and *3DEC* can simulate both a sudden (e.g. explosion-induced) excavation and a gradual (e.g. pick-and-shovel) excavation. In a nonlinear, inelastic material, the result of the first type of excavation can be quite different from that of the second.

Excavation can be simulated either by changing a boundary condition or by removing elements from a model. Transient effects are controlled by the rate at which the excavation is made in the model. For example, a *FISH* function can be used in *FLAC* to control the rate at which a boundary force is relaxed. The data file below illustrates this for the excavation of a cylindrical hole in a Mohr-Coulomb medium (see Section 2.3 in Volume II of the *FLAC* User's Manual).

```
g 30 30
mo mohr
call hole.fis
set rmin=1 rmul=10 ratio=1.1
hole
prop shear=2.8e9 bulk=3.9e9 dens=2500
prop coh=3.45e6  fric=30    tens=0
ini sxx=-30e6 syy=-30e6 szz=-30e6
fix y j 1
fix x j 31
apply sxx=-30e6 syy=-30e6 i 31
hist unbal
def relax
   if step < nstep then
     relax = (float(nstep-step))^4/float(nstep)^4
   else
     relax = 0.0
   end_if
end
set nstep 3000
apply press 30e6 hist relax i 1
step 4000
ret
```

The *FISH* function RELAX is applied as a history to the internal pressure. The pressure is gradually reduced (by a quartic function) from 30 MPa to zero. In this example, the tensile strength is set to zero. If the excavation were made suddenly (i.e. leave out the command **apply press 30e6 hist relax i 1**), then the zones immediately adjacent to the hole will fail in tension, due to the development of transient tensile stresses. The gradual reduction minimizes transient effects and no tensile failure occurs. Note that, in Section 2.3 of Volume II, the tensile strength of the material was arbitrarily set to a value higher than the transient tensile stresses.

Random Deviations of Parameters
(from Michael Coulthard, CSIRO)

Users who experiment with **rdev** in *FLAC* or **urand** and **grand** in *FISH* or joint set variability via **JSET** in *UDEC* soon discover that they get the same results each time they start the program up. My experience is that most users have not realized that they can also do Monte Carlo simulations by running the same data set successively after **NEW** commands, i.e., the random number seed is initialized only when the code is loaded. The following data should be enough to get them going:

```
  set log on
  call randens.dat
  new
  call randens.dat
  ret

randens.dat:
  gr 5,5
  m e
  prop dens=200 rdev=200
  pr dens
  ret
```

ITASCA:"THE TRUE SOURCE"

"We do not know the source of the Mississippi" is a note written on some of the first maps of North America, drawn by French explorers of the late 17th and early 18th centuries. Several renowned explorers of the early 19th century had incorrectly identified the source, or headwater of the river, to be Cass Lake and other lakes in the region that is now northern Minnesota, U.S.A. It was not until 1832 that an expedition, led by mineralogist Henry Rowe Schoolcraft, finally found the source. During the voyage, Schoolcraft had asked the pastor with the expedition to suggest an appropriate classical name for the "true source," so that he would be ready, should they be successful. Drawing on a rusty knowledge of Latin, the pastor suggested "VERITAS CAPUT" for the words "truth" and "head." Deciding that this was too long, Schoolcraft combined the central syllables from the two words, and so chose "ITASCA" as the name to be given to the lake which he later identified as the true source of the Mississippi River.

Software Q/A

Two users questioned the statement we gave in the last Soft Spot that Young's modulus E becomes undefined for a material with Poisson's ratio υ of 0.5, while bulk modulus K is still finite at $\upsilon = 0.5$. Consequently, we offer the following comments.

We need two independent elastic constants. There *is* a choice. We don't even need to relate our choice to physical tests ... the choice is between sets of constants that are used in the equations that connect stress and strain. There is an infinite number of possible pairs of constants. Consider just two possibilities: (K,G) and (E,υ).

Our contention is that the pair (K,G) makes sense for all elastic materials that do not violate thermodynamic principles. The pair (E,υ) does not make sense for certain admissible materials. At one extreme we have materials that resist volumetric change but not shear and at the other extreme materials that resist shear but not volumetric change. The first type of material corresponds to finite K and zero G, and the second to zero K and finite G. However the pair (E,υ) is not able to characterize either the first or the second type of material. If we exclude the two limiting cases (conventionally, $\upsilon = 0.5$ and $\upsilon = -1$), the equations

$$3K\,(1 - 2\upsilon) = E \qquad\qquad 2G(1 + \upsilon) = E$$

relate the two sets of constants. These equations hold however close we approach (but not reach) the limiting cases. We do not need to relate them to physical tests that may or may not be feasible ... the equations are simply the consequence of two possible ways of defining coefficients of proportionality. So, we have to choose. Suppose we have a material in which the resistance to distortion progressively reduces, but in which the resistance to volume change remains constant. The (E,υ) camp says that $\upsilon \rightarrow 0.5$ in this case. The equation $3K(1 - 2\upsilon) = E$ must still be satisfied. There are two possibilities (argued on *algebraic* grounds, not physical): either E remains finite (and non-zero) and K tends to an arbitrarily large value, or K remains finite and E tends to zero. The first possibility we rule out because there is a limiting compressibility to all known materials. This leaves the second, in which E is varying drastically, even though we supposed that the material's principal mode of elastic resistance was unchanging. We deduce that the parameters (E,υ) are inadequate to express the material behavior.

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