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Anexos

Anexo 1: Modelagem da barragem Breapampa em FLAC

```
config gwflow dynamic extra 20
;-------------------------------------------------------
-
;Geração da malha e propriedades do material
;-------------------------------------------------------
-
grid 49,35
gen  0.0,3740.0  0.0,3756.0  30.0,3756.0  30.0,3740.0  i=1,7
j=1,4
gen  30.0,3740.0  30.0,3756.0  55.0,3751.8  55.0,3740.0002
ratio 0.91,1.0 i=7,14 j=1,4
gen 55.0,3740.0002 55.0,3751.8 117.8,3748.4 117.8,3740.0002
i=14,34 j=1,4
gen     117.8,3740.0002     117.8,3748.4     148.36,3748.0
148.36,3740.0 ratio 1.07,1.0 i=34,44 j=1,4
gen  148.36,3740.0  148.36,3748.0  178.0,3748.0  178.0,3740.0
i=44,50 j=1,4
gen  117.8,3748.4  86.2,3780.0  90.76,3780.0  148.36,3748.0
ratio 1.07,0.98 i=34,44 j=4,30
gen 55.0,3751.8 83.2,3780.0 86.2,3780.0 117.8,3748.4 ratio
1.0,0.98 i=14,34 j=4,30
gen 30.0,3756.0 78.3,3780.0 83.2,3780.0 55.0,3751.8 ratio
0.91,0.98 i=7,14 j=4,30
gen 78.3,3780.0 81.7,3781.7 83.2,3781.7 83.2,3780.0 ratio
0.91,1.0 i=7,14 j=30,36
gen 83.2,3780.0 83.2,3781.7 86.2,3781.7 86.2,3780.0 i=14,34
j=30,36
gen 86.2,3780.0 86.2,3781.7 87.7,3781.7 90.76,3780.0 ratio
1.07,1.0 i=34,44 j=30,36
mark j=4
mark i=34 j=4,30
mark i=14 j=4,30
mark i=14,34 j=30
;-------------------------------------------------------
-
; Condição de contorno
;-------------------------------------------------------
-
fix x i=1 j=1,4
fix x i=50 j=1,4
fix x y j=1
group 'Fundacao:Rocha' i=1,49 j=1,3
```

```
call 'Grupo.fis'; Def. grupos e modelos do corpo da
barragem segundo o tipo de material
Grupo
model elastic group 'Fundacao:Rocha'
prop density=2548.0 bulk=3.21429E9 shear=2.21311E9 group
'Fundacao:Rocha'
prop por=0.19 perm=1.02E-12 group 'Fundacao:Rocha'
save_Malha.sav

;-------------------------------------------------------
-
;Condição inicial da análise
;-------------------------------------------------------
-
model null group 'Barragem:Nucleo'
model null group 'Barragem:Espaldar'
set gravity=9.81
set flow=off
water density=1000.0
set dyn=off
set echo=off
call 'Ininv.fis'
set wth=3748 k0x=0.5 k0z=0.5
ininv
history 999 unbalanced
solve
save Cond_Inic.sav
;-------------------------------------------------------
-
;Processo da construção
;-------------------------------------------------------
-
call 'Constu.fis'
Constu
save Contrução.sav

;-------------------------------------------------------
-
;análise dinâmico após a construção sem enchimento
;-------------------------------------------------------
-
call 'change_shear.fis'
set p_ratio=0.3
change_shear
water bulk=2.0E8
set dyn=on
set =small
call 'Table201.dat'
initial xdisp 0 ydisp 0
initial xvel 0 yvel 0
set echo=off
call 'strain_hist.fis'
strain_hist
set echo=off
```

```
call 'reldispx.fis'
reldispx
history 4 dytime
history 5 vsxy i=23, j=10
history 6 str_23_10
history 7 reldispx
history 8 reldispy
history 9 xaccel i=23, j=1
history 10 xaccel i=23, j=4
history 11 xaccel i=23, j=10
history 12 xaccel i=23, j=36
history 13 xaccel i=10, j=15
history 14 xaccel i=40, j=15
history 15 xvel i=23, j=1
history 16 xvel i=23, j=4
history 17 xvel i=23, j=10
history 18 xvel i=23, j=36
history 19 xvel i=10, j=15
history 20 xvel i=40, j=15
history nstep 400
set step=4000000
save dinamic_A1.sav

;aplicação do carregamento dinâmico
apply ffield
ini dy_damp hyst sig3 1.014 -0.5592 -1.2507 region 22 23;
Núcleo
ini dy_damp hyst sig3 1.065 -0.695 -1.995 region 8 14;
Enrocamento
ini dy_damp rayleigh 0.002 0.75 stiffness i 7 44 j 5 36
apply sxy -4014746.0 hist table 201 from 1,1 to 50,1
apply xquiet  from 1,1 to 50,1
apply yquiet  from 1,1 to 50,1
set echo off
call 'savefs.fis'
savefs
set echo off
call 'calFS.fis'
set nsample=50 nstep=1
calFS
save dinamic_A2.sav

set multistep=on
solve dytime 40.0
save dinamic_A3.sav

;-------------------------------------------------------------
-
;Processo de enchimento
;-------------------------------------------------------------
-
Restore 'Contrução.sav'
apply pp 0.0 var 0.0 392400.0 from 7,30 to 1,1
fix  pp i 34 j 4 30
```

```
fix  pp i 34 50 j 4
prop por=0.38 k11=1.02E-10 k22=1.22E-12 region 21 9
prop por=0.34 perm=4.69E-8 region 8 12
history 1 pp i=11, j=5
history 2 pp i=24, j=5
history 3 gwtime
set mechanical=off
set flow=on
water bulk=2000000.0
set fastwb=on
set step=500000
solve
apply pressure 0.0 var 0.0 235440.0 from 7,30 to 1,4
set mechanical=on
set flow=off
water bulk=0.0
solve
save enchim.sav

;-------------------------------------------------------------
-
;análise dinâmico após o enchimento
;-------------------------------------------------------------
-
call 'change_shear.fis'
set p_ratio=0.3
change_shear
water bulk=2.0E8
set dyn=on
set=small
call 'Table201.dat'
initial xdisp 0 ydisp 0
initial xvel 0 yvel 0
set echo=off
call 'strain_hist.fis'
strain_hist
set echo=off
call 'reldispx.fis'
reldispx
set echo=off
call 'inipp.fis'
inipp
set echo=off
call 'excpp.fis'
excpp
history 4 dytime
history 5 vsxy i=23, j=10
history 6 str_23_10
history 7 reldispx
history 8 reldispy
history 9 excpp
history 10 pp i=23, j=5
history 11 esyy i=23, j=5
history 12 xaccel i=23, j=1
```

```
history 13 xaccel i=23, j=4
history 14 xaccel i=23, j=10
history 15 xaccel i=23, j=36
history 16 xaccel i=10, j=15
history 17 xaccel i=40, j=15
history 18 xvel i=23, j=1
history 19 xvel i=23, j=4
history 20 xvel i=23, j=10
history 21 xvel i=23, j=36
history 22 xvel i=10, j=15
history 23 xvel i=40, j=15
history nstep 800
set step=4000000
save dinamic_B1.sav

;aplicação do carregamento dinâmico
apply ffield
ini dy_damp hyst sig3 1.014 -0.5592 -1.279  i=7 43, j=4 35
ini dy_damp rayleigh 0.002 0.75 stiffness i 7 44 j 5 36
apply sxy -4014746.0 hist table 201 from 1,1 to 50,1
apply xquiet  from 1,1 to 50,1
apply yquiet  from 1,1 to 50,1
set echo off
call 'savepp.fis'
savepp
set echo off
call 'getExcesspp.fis'
set nsample=50 nstep=1
getExcesspp
save dinamic_B2.sav


set multistep=on
solve dytime 40.0
save dinamic_B3.sav
```

Anexo 2: Modelo para camadas do deposito de solo não linear

Coluna 1- SHAKE-2000.

```
Option 1 - Dynamic Soil Properties Set No. 1
   1
   3
   9   Gravel Avg. G/Gmax - GRAVEL, Average (Seed et al.
1986)
0.0001   0.0003   0.001   0.003   0.010   0.030   0.10   0.30
1.00
1.0000   0.9700   0.870   0.730   0.550   0.370   0.20   0.10
0.05
   9    Gravel Damping for GRAVEL, Average (Seed et al.
1986)
0.0001   0.0003   0.001   0.003   0.010   0.030   0.10   0.30
1.00
0.8000   1.0000   1.900   3.000   5.400   9.600   15.4   20.8
24.6
   20      Soil PI=15 G/Gmax - Soil with PI=15, OCR=1-15
(Vucetic & Dobry, JGE 1/91)
0.0007  0.0009  0.001  0.002  0.003  0.004  0.006  0.008
0.01    0.02    0.03   0.04   0.08   0.10   0.20   0.30
0.40    0.60    0.8    1.0
1.00    0.995   0.990  0.970  0.950  0.925  0.875  0.85
0.815   0.72    0.65   0.6    0.455  0.405  0.29   0.22
0.190   0.14    0.11   0.095
   20      Soil  PI=15  Damping-Soil  with  PI=15,  OCR=1-8
(Vucetic & Dobry, JGE 1/91)
0.003  0.004  0.005  0.006  0.008  0.01  0.02  0.03  0.04
0.05   0.07   0.1    0.2    0.3    0.4   0.5   0.6   0.7
0.8    1.0
2.5    2.8    3.2    3.5    4.1    4.5   6.4   7.6   8.4
9.2    10.3   11.5   14.3   15.9   17    17.6  18.3  18.8
19.3   19.9
    8    Rock        G/Gmax - ROCK (Schnabel 1973)
0.0001  0.0003  0.001  0.003  0.010  0.030  0.100  1.0
1.0     1.0     0.99   0.95   0.9    0.81   0.725  0.55
    5    Rock        Damping for ROCK (Schnabel 1973)
0.0001  0.001  0.010   0.10   1.0
0.40    0.80   1.50    3.0    4.6
    3    1    2    3
Option 2 - Soil Profile Set No. 1
    2
    1   17     Soil Profile No.  1
    1       1        1.7                  0.05            24
189.4
```

```
    2       2        2                      0.05           20
245.2
    3       2        2                      0.05           20
279.6
    4       2        2                      0.05           20
303.9
    5       2        2                      0.05           20
322.6
    6       2        2                      0.05           20
338.5
    7       2        2                      0.05           20
353.2
    8       2        2                      0.05           20
367.3
    9       2        2                      0.05           20
381.3
   10       2        2                      0.05           20
395.2
   11       2        2                      0.05           20
408.9
   12       2         1.94                  0.05           20
422.3
   13       2         1.94                  0.05           20
434.3
   14       2         1.94                  0.05           20
444.2
   15       2         1.94                  0.05           20
451.8
   16       2         1.94                  0.05           20
456.1
   17       3                               0.02           25
931.9
Option 3 - Input Motion:
    3
 3996 8192       0.01    (6F15.8)
C:\Users\raico\Desktop\SHAKE\Columna1\S2007F_0_40.eq
         1                   25    4    6
Option  4  -  Assignment  of  Object  Motion  to  a  Specific
Sublayer Set No. 1
    4
   17    0
Option 5 - Number of Iterations & Strain Ratio Set No. 1
    5
        10       0.65
Option  6  -  Computation  of  Acceleration  at  Specified
Sublayers Set No. 1
    6
    1  2    3    4    5    6    7    8    9   10   11   12   13   14
15
    0  1    1    1    1    1    1    1    1    1    1    1    1    1
1
    1  0    0    0    0    0    0    0    0    0    0    0    0    0
0
```

```
Option 6 - Computation of Acceleration at Specified
Sublayers Set No. 2
    6
   16   17   17
    1    1    0
    0    0    0
Option 7 - Computation of Shear Stress or Strain Time
History Set No. 1
    7
    8    1    1      2048          Stress History Layer No.
1
    8    0    1      2048          Strain History Layer No.
1
Execution will stop when program encounters 0
    0
```

Coluna 1-FLAC 2D.

```
config dynamic extra 5
;-------------------------------------------------------
-
;Geração da malha e propriedades do material
;-------------------------------------------------------
-
grid 1,33
model elastic
model elastic i=1
gen 0 0 0 31.4 1 31.4 1 0 i 1 2 j 1 34
gen 0 0 0 1.94 1 1.94 1 0 i 1 2 j 1 4
gen 0 1.94 0 9.7 1 9.7 1 1.94 i 1 2 j 4 12
gen 0 9.7 0 29.7 1 29.7 1 9.7 i 1 2 j 12 32
gen 0 29.7 0 31.4 1 31.4 1 29.7 i 1 2 j 32 34
prop bulk 190.140e6 she 87.757e6 den 2446 i=1 j=32 33
prop bulk 265.632e6 she 122.599e6 den 2039 i=1 j=30 31
prop bulk 345.380e6 she 159.406e6 den 2039 i=1 j=28 29
prop bulk 407.887e6 she 188.256e6 den 2039 i=1 j=26 27
prop bulk 459.651e6 she 212.147e6 den 2039 i=1 j=24 25
prop bulk 506.287e6 she 233.671e6 den 2039 i=1 j=22 23
prop bulk 550.964e6 she 254.291e6 den 2039 i=1 j=20 21
prop bulk 596.074e6 she 275.111e6 den 2039 i=1 j=18 19
prop bulk 642.319e6 she 296.455e6 den 2039 i=1 j=16 17
prop bulk 689.852e6 she 318.393e6 den 2039 i=1 j=14 15
prop bulk 738.397e6 she 340.799e6 den 2039 i=1 j=12 13
prop bulk 787.727e6 she 363.566e6 den 2039 i=1 j=10 11
prop bulk 833.238e6 she 384.571e6 den 2039 i=1 j=8 9
prop bulk 871.692e6 she 402.316e6 den 2039 i=1 j=6 7
prop bulk 901.788e6 she 416.210e6 den 2039 i=1 j=3 5
prop bulk 919.073e6 she 424.188e6 den 2039 i=1 j=1 3
;-------------------------------------------------------
-
;Condição de contorno e historias
;-------------------------------------------------------
-
fix y
hist 1 unbal
```

```
hist 2 dytime
call 'his_xacc.fis'
his_xacc
call 'his_sxy.fis'
his_sxy
hist nstep 100
;-------------------------------------------------------
-
;Aplicação do carregamento dinâmico com amortecimento
histerético default
;-------------------------------------------------------
-
hist 100 read S2007_40.his
apply xacc 1.0 hist 100 j=1
apply yacc 0.0 j=1
ini dy_damp hyst default -3.025 0.6637 j 1 31; Núcleo
ini dy_damp hyst default -4.001 0.2853 j 32 33; Enrocamento
set dynamic on
set step 400000
history 999 unbalanced
solve dytime 40
;-------------------------------------------------------
-
;Aplicação do carregamento dinâmico com amortecimento
histerético default + 0.2% Rayleigh
;-------------------------------------------------------
-
hist 100 read S2007_40.his
apply xacc 1.0 hist 100 j=1
apply yacc 0.0 j=1
ini dy_damp hyst default -3.025 0.6637 j 1 31; Núcleo
ini dy_damp hyst default -4.001 0.2853 j 32 33; Enrocamento
ini dy_damp rayleigh 0.002 0.75 stiffness
set dynamic on
set step 400000
history 999 unbalanced
solve dytime 40
;-------------------------------------------------------
-
;Aplicação do carregamento dinâmico com amortecimento
histerético sig3
;-------------------------------------------------------
-
hist 100 read S2007_40.his
apply xacc 1.0 hist 100 j=1
apply yacc 0.0 j=1
ini dy_damp hyst sig3 1.014 -0.5592 -1.2507 j 1 31; Núcleo
ini dy_damp hyst sig3 1.065 -0.695 -1.995 j 1 31;
Enrocamento
set dynamic on
set step 400000
history 999 unbalanced
solve dytime 40
```

```
;-------------------------------------------------------
-
;Aplicação do carregamento dinâmico com amortecimento
histerético sig3 + 0.2% Rayleigh
;-------------------------------------------------------
-
hist 100 read S2007_40.his
apply xacc 1.0 hist 100 j=1
apply yacc 0.0 j=1
ini dy_damp hyst sig3 1.014 -0.5592 -1.2507 j 1 31; Núcleo
ini dy_damp hyst sig3 1.065 -0.695 -1.995 j 1 31;
Enrocamento
ini dy_damp rayleigh 0.002 0.75 stiffness
set dynamic on
set step 400000
history 999 unbalanced
solve dytime 40
```