HYDROELASTIC ANALYSIS OF A RECTANGULAR TANK

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ABSTRACT

A hydroelastic analysis of a rectangular tank is performed using MSC/NASTRAN. Natural frequencies of slosh modes and hydroelastic modes are evaluated, and are compared with results from other approaches as well as analytical values.

INTRODUCTION

Using a MSC/NASTRAN DMAP procedure developed to implement a new fluid-structure formulation [1], a hydroelastic analysis of a liquid-filled rectangular tank is performed. By “hydroelastic” analysis, we are mainly interested in the fluid’s influence on the structural response and not the detailed motion of the fluid.

There are generally two steps in the process of hydroelastic analysis. The first is to calculate the natural frequencies of the slosh modes assuming the rigid tank. The second is to assess the fluid’s influence on the structure. For the slosh modes of the rectangular tank, a few studies have been performed using various approaches [2][3][4]. In this paper, slosh mode frequencies are obtained using a different approach. The results from the approach are compared with corresponding values from other approaches as well as the analytical values. As for the hydroelastic analysis of rectangular tank, not many previous works are readily available. This is in part due to difficulties with estimating the analytical mode frequencies [5]. In this paper, we assume that one pair of facing walls and the bottom of the rectangular tank are rigid, and the remaining pair of facing walls are simply supported. For the hydroelastic modes of the rectangular tank, analytical natural frequencies of the in-phase and out-of-phase modes can be estimated by the energy method [6].

PROBLEM DEFINITION

Consider a rectangular tank, whose geometry is given by the width $a = 0.5$ m, the length $b = 0.7$ m, and the height $h = 0.4$ m, as shown in Figure 1. The topless tank is completely filled with a fluid with the density $\rho = 1000$ Kg/m^3. The top surface of the fluid is in a state of free surface. The tank geometry and the fluid property are the same as those in References [2][3][4].

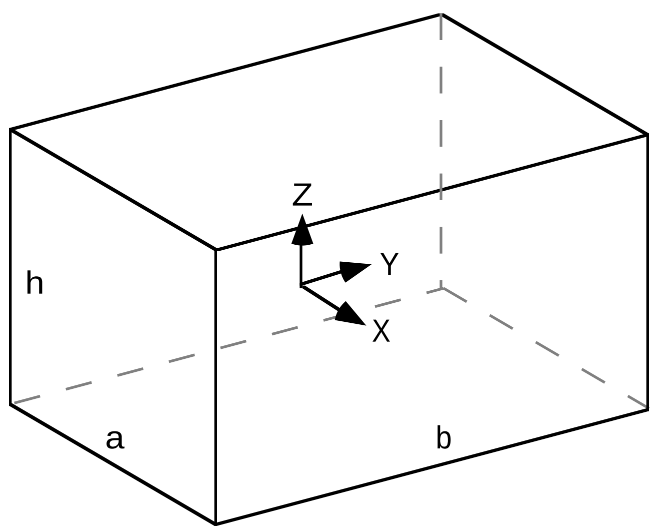

Figure 1: A Rectangular Tank

The rectangular tank has Young’s modulus $E = 2 \times 10^{11}$ pa, Poisson’s ratio $\nu = 0.3$, the thickness $t = 0.005$ m, and the density $\rho_m = 7970$ Kg/m^3. The Y-face tank walls and the bottom are considered to be rigid, and the X-face tank walls are assumed to be simply supported. The mesh size for both the fluid and the structure was 0.1 m. The MSC/NASTRAN (V68.2) listing for this problem is included in Appendix.

SLOSH MODE CALCULATIONS

Approaches

In MSC/NASTRAN fluid-structure interaction formulation [2][3], artificial springs are used in defining the free surface stiffness. It also requires artificial plate elements covering the fluid free surface. The formulation is cumbersome, since many bulkdata entries for the artificial springs and plate elements have to be generated. It can be shown that this approach is equivalent to the "mixed" formulation [7], which uses the lumped area formulation for the free surface stiffness matrix and the consistent area formulation in the free surface "mass" matrix.

In the formulation used in this paper [1], slosh modes are calculated using the consistent free surface area matrix [7]. The formulation yields more accurate slosh mode frequencies than the "mixed" formulation using the artificial springs. It also eliminates the need to generate the CELAS2 and CQUAD4 entries.

Area Matrix Calculation

The area matrix calculation involves applying a pressure profile on the surface elements and calculating the resulting loads [8]. For a large fluid-structure interaction problem, this means multiple MSC/NASTRAN static solution runs. Also, thousands of PLOAD4 cards have to be generated [8][9]. In this implementation, MSC/NASTRAN DMAP module ACMG is used to compute the area matrix when the fluid and structure have identical meshes at the interface. Using the ACMG module eliminates the need for PLOAD4 cards and multiple MSC/NASTRAN static solution runs.

Analytical values

The analytical slosh frequencies f_{ij} for the rectangular tank are given by [10]

$$f_{ij}^2 = \frac{g}{4\pi}\sqrt{\left(\frac{i}{a}\right)^2 + \left(\frac{j}{b}\right)^2} \cdot \tanh\left[\pi h\sqrt{\left(\frac{i}{a}\right)^2 + \left(\frac{j}{b}\right)^2}\right] \tag{1}$$

where the gravity constant $g = 10$ m/sec^2 and i, j are the mode numbers in the X and Y directions, respectively.

Comparison of Slosh Frequencies

The slosh frequencies of the rectangular tank from the current procedure are compared with the corresponding analytical values and values from other references in Table 1. The Reference [4] values were for $g = 9.8$ m/sec^2, and were scaled accordingly in the table. A slosh mode shape corresponding to $i = 1, j = 1$ is shown in Figure 2. The table shows that the results from the current approach are more accurate than those using the "mixed" formulation [2][3] and the HYDRO/BEAMER approach [4]. The mesh sizes used in all approaches were the same.

Table 1. Slosh Frequencies in Rigid Rectangular Tank (in Hz)

Mode		Analytical	Current Procedure	Reference [2][3]	Reference [4]
i	j				
0	0	0.000	0.000		
0	1	1.037	1.048	1.065	1.068
1	0	1.253	1.276	1.318	1.327
1	1	1.396	1.423	1.496	1.525
0	2	1.507	1.559	1.667	1.694
1	2	1.666	1.732	1.914	1.989
2	0	1.784	1.908	2.175	
2	1	1.838	1.967	2.280	
0	3	1.847	1.994	2.317	
1	3	1.940	2.100	2.521	
2	2	1.978	2.136	2.604	

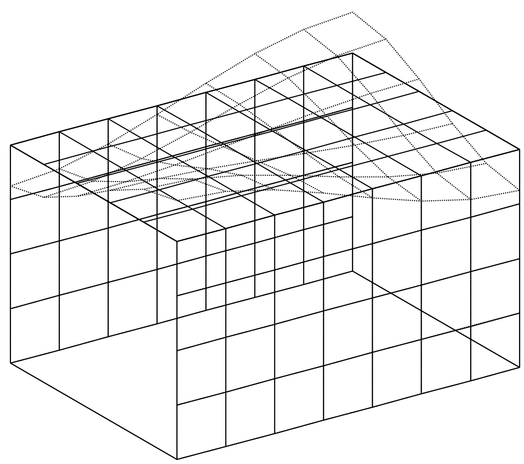

Figure 2: Slosh Mode Shape Corresponding to $i = 1$ and $j = 1$

HYDROELASTIC MODES

Empty Tank

The empty tank modes (simply supported plates) were calculated using MSC/NASTRAN. In Table 2, the natural frequencies of the empty tank modes are compared with the analytical frequencies given by [11]

$$f_{jk} = \frac{\pi}{2}\left\{\left(\frac{j}{b}\right)^2 + \left(\frac{k}{h}\right)^2\right\}\sqrt{\frac{Et^2}{12\rho_m(1-\nu^2)}} \qquad (2)$$

where j and k are the mode numbers in the Y and Z directions.

Table 2. Natural Frequencies of Empty Rectangular Tank (in Hz)

Mode Shape			
j	k	Analytical	NASTRAN
1	1	98.7	102.5
2	1	171.6	180.6
3	1	293.1	330.4
1	2	322.0	390.6

Analytical results for Hydroelastic Modes

Kito developed formula for the hydroelastic mode frequencies of the rectangular tank using the energy method [6]. For the rectangular tank in consideration, we have

$$\frac{\omega^2 h}{g} >> 1 \tag{3}$$

where ω is the circular natural frequency of the free vibration of the simply supported plates.

(a) In-phase mode

The side walls are assumed to vibrate in-phase with the mode shape given by

$$w = W \ \sin my \ \sin sz \ \sin \omega t \ , \quad m = \frac{\pi}{b}, \ s = \frac{\pi}{h} \tag{4}$$

and the kinetic energy per each wall is given by

$$T_m = \frac{1}{2} \ [\, W \cos \omega t \,]^2 \ M_{mv} \tag{5}$$

where

$$M_{mv} = \frac{1}{4} \ M_m = \frac{1}{4} \ \rho_m \ t \ b \ h \tag{6}$$

The kinetic energy of the fluid allotted to one side wall is given by

$$T_w = \frac{1}{2} \ [\, W \omega \cos \omega t \,]^2 \ M_{wv} \tag{7}$$

where $M_{wv} = \rho_w \ V \ \bar{M}$ is a factor, and $V = a\,b\,h$ is the volume of the tank, and the coefficient of virtual mass $\bar{M}$ is given by

$$\bar{M} = \frac{4}{\pi^2} \sum_i \sum_j \left\{ \frac{1}{(i^2-1)(j^2-1)} \right\}^2 \epsilon \ \frac{\tanh\left(\frac{1}{2} n_{ij} a\right)}{n_{ij} a} \quad \left(i = 0, 2, 4, \cdots ; \ \ j = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \cdots \right) \tag{8}$$

where $\epsilon = 4$ if $i \neq 0$, but $\epsilon = 2$ if $i = 0$, and

$$n_{ij}a = \pi\sqrt{\left(\frac{i\,a}{b}\right)^2 + \left(\frac{j\,a}{h}\right)^2} \tag{9}$$

Let the frequency of free vibration of the wall be denoted by f and the frequency of free vibration of the same wall in contact with water be denoted by $f^{'}$. Then the energy method gives

$$f^{'} = \frac{f}{\sqrt{1+\lambda}}\ , \quad \lambda = \frac{M_{wv}}{M_{mv}} \tag{10}$$

(b) Out-of-phase mode

The out-of-phase mode in which the two facing walls are vibrating in opposite phase is treated in a similar manner. The coefficient of virtual mass $\bar{M}$ for this case is given by

$$\bar{M} = \frac{4}{\pi^2}\sum_i\sum_j\left\{\frac{1}{(i^2-1)(j^2-1)}\right\}^2 \epsilon\,\frac{\coth\left(\frac{1}{2}n_{ij}a\right)}{n_{ij}a} \quad \left(i = 0, 2, 4, \cdots;\ \ j = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \cdots\right) \tag{11}$$

By using the coefficient of virtual mass, equation (11), in the formula in the previous section, the natural frequency of the out-of-phase mode is similarly obtained. Comparing equations (8) and (11), the virtual mass for the out-of-phase mode is greater than that for the in-phase mode, since for any positive value of x,

$$\coth x > \tanh x \tag{12}$$

Consequently, the natural frequency for the out-of-phase mode is lower than that for the in-phase mode.

Numerical results for Hydroelastic Modes

The first two coupled fluid-structure mode frequencies are listed in Table 3. The out-of-phase and in-phase modes of the fluid-filled rectangular tank correspond to the empty tank mode with $j = 1, k = 1$, and are shown in Figures 3 and 4, respectively. The frequency for the out-of-phase mode is indeed lower than that for the in-phase mode. The slosh frequencies for the coupled fluid-structure model were almost the same as the rigid container slosh frequencies listed in Table 1, and are not included in Table 3. The table also shows the analytical frequencies by the energy method, as discussed above. The coupled fluid-structure frequencies are in reasonable agreement with the corresponding analytical frequencies by the energy method, considering the coarse meshes used.

Table 3. Hydroelastic Mode Frequencies of Liquid-Filled Rectangular Tank (in Hz)

Mode Shape	Energy Method	Current Approach
In-phase	45.5	49.8
Out-of-phase	37.7	42.2

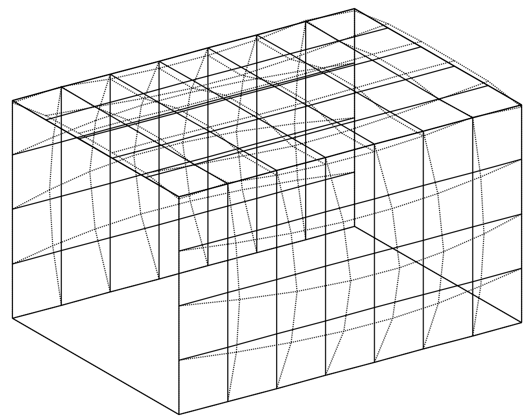

Figure 3: Out-of-phase Rectangular Tank Structure Mode

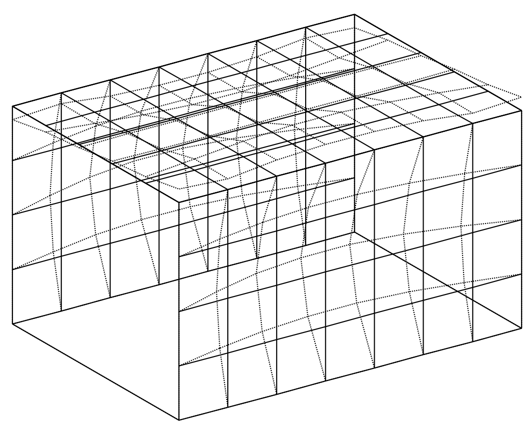

Figure 4: In-phase Rectangular Tank Structure Mode

CONCLUDING REMARKS

This paper presented a hydroelastic analysis of a rectangular tank. A new fluid-structure interaction formulation using a MSC/NASTRAN DMAP program has been used. It has been shown that the implementation is concise and efficient. Also, when compared with various formulations and analytical results, the slosh frequencies obtained using the formulation are more accurate than other approaches. In addition, hydroelastic modes of the rectangular tank are calculated and compared with analytical results obtained using the energy method.

The procedure used in this paper provides insight into hydroelastic analysis of fluid-structure interaction problems. We hope that the attached MSC/NASTRAN input listing would be beneficial to analysts who want to start in the area of fluid-structure interaction.

REFERENCES

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[9]. Structural Dynamics Research Corporation, “Hydro User’s Guide, Version 1,” 1992.

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APPENDIX. MSC/NASTRAN LISTING FOR A RECTANGULAR TANK

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ASSIGN  MASTER ='mesh1.MASTER',TEMP
ASSIGN  DBALL  ='mesh1.DBALL',TEMP
ASSIGN  USRSOU ='mesh1.USRSOU',TEMP
ASSIGN  USROBJ ='mesh1.USROBJ',TEMP
INIT    DBALL,LOGICAL=(DBALL(50000))
$
ID TEST,NAST
SOL 103
TIME 135
DIAG 8,13
INCLUDE 'hydro_msc.dmap'
CEND
$
TITLE = LIQUID FILLED RECTANGULAR TANK WITH TWO FLEXIBLE SIDE WALLS
$
SPC = 2000
METHOD(FLUID) = 5
METHOD(STRUCTURE) = 10
SET 99 = 20000 THRU 30457
DISP = 99
$
OUTPUT(PLOT)
PLOTTER=NAST
CSCALE=1.5
PAPER SIZE 23.0 BY 28.0
SET 1=ALL
SET 2=PLOTEL
SET 3=PLOTEL,CQUAD4
PTITLE= RECTANGULAR TANK
$
AXES X,Y,Z
VIEW 34.27,23.17,90.
MAXIMUM DEFORMATION 0.075
FIND SCALE,ORIGIN 1,SET 1
FIND SCALE,ORIGIN 2,SET 2
FIND SCALE,ORIGIN 3,SET 3
$PLOT SET 1,ORIGIN 1
$PLOT SET 1,ORIGIN 1,LABEL GRID POINTS,SHAPE
$PLOT SET 1,ORIGIN 1,LABEL ELEMENTS,SHRINK,SHAPE
PLOT MODAL DEFORMATION 0, 1 THRU 52, PEN 2,SET 1, ORIGIN 1$
$
$
BEGIN BULK
$
$
PARAM,  NEWSEQ -1
PARAM   GRDPNT  0
PARAM   USETPRT 0
PARAM   COUPMASS 1
PARAM   AUTOSPC YES
```

```
PARAM   DENSITY 1000.
PARAM   GRAVITY 10.
$
$  STRUCTURAL DOFS ( FREE )
$
SPC1     2000   12456   20400   THRU    20457
$
$  STRUCTURAL DOFS ( WETTED )
$
SPC1     2000   23      30000   30007   30050   30057
SPC1     2000   23      30400   30407   30450   30457
SPC1     2000   1       30000   THRU    30057
SPC1     2000   1       30400   THRU    30457
SPC1     2000   1       30100   30200   30300
SPC1     2000   1       30107   30207   30307
SPC1     2000   1       30150   30250   30350
SPC1     2000   1       30157   30257   30357
$
SPC1     2000   4       30000   THRU    30457
$
$  FLUID DOFS ( FREE )
$
CSET1           10400   THRU    10457
$
$  FLUID DOFS ( WETTED )
$
BSET1           10101   THRU    10106
BSET1           10151   THRU    10156
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BSET1    1      30151   THRU    30156
BSET1    1      30251   THRU    30256
BSET1    1      30351   THRU    30356
$
$  STRUCTURAL DOFS (FLUID SLOSH MODES)
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QSET1    3      20400   THRU    20457
$
$  Definition of fluid nodes in the wetted and free surface areas
$
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+ST11    10000   THRU    10007   10050   THRU    10057   10452   10453   +ST12
+ST12    10100   THRU    10107   10150   THRU    10157   10454   10455   +ST13
+ST13    10200   THRU    10207   10250   THRU    10257   10456   10457   +ST14
+ST14    10300   THRU    10307   10350   THRU    10357
$
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$  Definition of structural nodes in the wetted and free surface areas
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SET1     200     20400   THRU    20445   20446   20447   20450   20451   +ST21
+ST21    30000   THRU    30007   30050   THRU    30057   20452   20453   +ST22
+ST22    30100   THRU    30107   30150   THRU    30157   20454   20455   +ST23
+ST23    30200   THRU    30207   30250   THRU    30257   20456   20457   +ST24
+ST24    30300   THRU    30307   30350   THRU    30357
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GRID	10405	-.25	.15	.2
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GRID	10414	-.15	.05	.2
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GRID	30357	.25	.35	.1	0
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CHEXA   3       10      10002   10003   10013   10012   10102   10103   +M00002
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CHEXA   7       10      10006   10007   10017   10016   10106   10107   +M00006
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CHEXA   14      10      10016   10017   10027   10026   10116   10117   +M00013
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CHEXA   24      10      10032   10033   10043   10042   10132   10133   +M00023
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CHEXA   51      10      10121   10122   10132   10131   10221   10222   +M00050
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CHEXA   71      10      10200   10201   10211   10210   10300   10301   +M00070
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CHEXA   105     10      10246   10247   10257   10256   10346   10347   +M00104
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CHEXA   107     10      10301   10302   10312   10311   10401   10402   +M00106
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CHEXA   108     10      10302   10303   10313   10312   10402   10403   +M00107
+M00107 10413   10412
CHEXA   109     10      10303   10304   10314   10313   10403   10404   +M00108
+M00108 10414   10413
CHEXA   110     10      10304   10305   10315   10314   10404   10405   +M00109
+M00109 10415   10414
CHEXA   111     10      10305   10306   10316   10315   10405   10406   +M00110
+M00110 10416   10415
CHEXA   112     10      10306   10307   10317   10316   10406   10407   +M00111
+M00111 10417   10416
CHEXA   113     10      10310   10311   10321   10320   10410   10411   +M00112
+M00112 10421   10420
CHEXA   114     10      10311   10312   10322   10321   10411   10412   +M00113
+M00113 10422   10421
CHEXA   115     10      10312   10313   10323   10322   10412   10413   +M00114
+M00114 10423   10422
CHEXA   116     10      10313   10314   10324   10323   10413   10414   +M00115
+M00115 10424   10423
CHEXA   117     10      10314   10315   10325   10324   10414   10415   +M00116
+M00116 10425   10424
CHEXA   118     10      10315   10316   10326   10325   10415   10416   +M00117
+M00117 10426   10425
CHEXA   119     10      10316   10317   10327   10326   10416   10417   +M00118
+M00118 10427   10426
CHEXA   120     10      10320   10321   10331   10330   10420   10421   +M00119
+M00119 10431   10430
CHEXA   121     10      10321   10322   10332   10331   10421   10422   +M00120
+M00120 10432   10431
CHEXA   122     10      10322   10323   10333   10332   10422   10423   +M00121
+M00121 10433   10432
CHEXA   123     10      10323   10324   10334   10333   10423   10424   +M00122
+M00122 10434   10433
CHEXA   124     10      10324   10325   10335   10334   10424   10425   +M00123
+M00123 10435   10434
CHEXA   125     10      10325   10326   10336   10335   10425   10426   +M00124
+M00124 10436   10435
CHEXA   126     10      10326   10327   10337   10336   10426   10427   +M00125
+M00125 10437   10436
CHEXA   127     10      10330   10331   10341   10340   10430   10431   +M00126
+M00126 10441   10440
CHEXA   128     10      10331   10332   10342   10341   10431   10432   +M00127
+M00127 10442   10441
CHEXA   129     10      10332   10333   10343   10342   10432   10433   +M00128
+M00128 10443   10442
CHEXA   130     10      10333   10334   10344   10343   10433   10434   +M00129
+M00129 10444   10443
CHEXA   131     10      10334   10335   10345   10344   10434   10435   +M00130
+M00130 10445   10444
CHEXA   132     10      10335   10336   10346   10345   10435   10436   +M00131
+M00131 10446   10445
CHEXA   133     10      10336   10337   10347   10346   10436   10437   +M00132
+M00132 10447   10446
CHEXA   134     10      10340   10341   10351   10350   10440   10441   +M00133
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+M00133 10451   10450
CHEXA   135     10      10341   10342   10352   10351   10441   10442   +M00134
+M00134 10452   10451
CHEXA   136     10      10342   10343   10353   10352   10442   10443   +M00135
+M00135 10453   10452
CHEXA   137     10      10343   10344   10354   10353   10443   10444   +M00136
+M00136 10454   10453
CHEXA   138     10      10344   10345   10355   10354   10444   10445   +M00137
+M00137 10455   10454
CHEXA   139     10      10345   10346   10356   10355   10445   10446   +M00138
+M00138 10456   10455
CHEXA   140     10      10346   10347   10357   10356   10446   10447   +M00139
+M00139 10457   10456
$
PSOLID  10      10                                      PFLUID
MAT10   10              1000.   1524.
$
PSHELL  20      20      0.001   20
MAT1    20      1.-3            0.3
$
CQUAD4  301     30      30000   30001   30101   30100
CQUAD4  302     30      30001   30002   30102   30101
CQUAD4  303     30      30002   30003   30103   30102
CQUAD4  304     30      30003   30004   30104   30103
CQUAD4  305     30      30004   30005   30105   30104
CQUAD4  306     30      30005   30006   30106   30105
CQUAD4  307     30      30006   30007   30107   30106
CQUAD4  308     30      30100   30101   30201   30200
CQUAD4  309     30      30101   30102   30202   30201
CQUAD4  310     30      30102   30103   30203   30202
CQUAD4  311     30      30103   30104   30204   30203
CQUAD4  312     30      30104   30105   30205   30204
CQUAD4  313     30      30105   30106   30206   30205
CQUAD4  314     30      30106   30107   30207   30206
CQUAD4  315     30      30200   30201   30301   30300
CQUAD4  316     30      30201   30202   30302   30301
CQUAD4  317     30      30202   30203   30303   30302
CQUAD4  318     30      30203   30204   30304   30303
CQUAD4  319     30      30204   30205   30305   30304
CQUAD4  320     30      30205   30206   30306   30305
CQUAD4  321     30      30206   30207   30307   30306
CQUAD4  322     30      30300   30301   30401   30400
CQUAD4  323     30      30301   30302   30402   30401
CQUAD4  324     30      30302   30303   30403   30402
CQUAD4  325     30      30303   30304   30404   30403
CQUAD4  326     30      30304   30305   30405   30404
CQUAD4  327     30      30305   30306   30406   30405
CQUAD4  328     30      30306   30307   30407   30406
CQUAD4  351     30      30050   30051   30151   30150
CQUAD4  352     30      30051   30052   30152   30151
CQUAD4  353     30      30052   30053   30153   30152
CQUAD4  354     30      30053   30054   30154   30153
CQUAD4  355     30      30054   30055   30155   30154
CQUAD4  356     30      30055   30056   30156   30155
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CQUAD4  357     30      30056   30057   30157   30156
CQUAD4  358     30      30150   30151   30251   30250
CQUAD4  359     30      30151   30152   30252   30251
CQUAD4  360     30      30152   30153   30253   30252
CQUAD4  361     30      30153   30154   30254   30253
CQUAD4  362     30      30154   30155   30255   30254
CQUAD4  363     30      30155   30156   30256   30255
CQUAD4  364     30      30156   30157   30257   30256
CQUAD4  365     30      30250   30251   30351   30350
CQUAD4  366     30      30251   30252   30352   30351
CQUAD4  367     30      30252   30253   30353   30352
CQUAD4  368     30      30253   30254   30354   30353
CQUAD4  369     30      30254   30255   30355   30354
CQUAD4  370     30      30255   30256   30356   30355
CQUAD4  371     30      30256   30257   30357   30356
CQUAD4  372     30      30350   30351   30451   30450
CQUAD4  373     30      30351   30352   30452   30451
CQUAD4  374     30      30352   30353   30453   30452
CQUAD4  375     30      30353   30354   30454   30453
CQUAD4  376     30      30354   30355   30455   30454
CQUAD4  377     30      30355   30356   30456   30455
CQUAD4  378     30      30356   30357   30457   30456
$
PSHELL  30      30      0.005   30
MAT1    30      2.0+11          0.3     7.97+3
$
PLOTEL  201     20400   20401
PLOTEL  202     20401   20402
PLOTEL  203     20402   20403
PLOTEL  204     20403   20404
PLOTEL  205     20404   20405
PLOTEL  206     20405   20406
PLOTEL  207     20406   20407
PLOTEL  208     20410   20411
PLOTEL  209     20411   20412
PLOTEL  210     20412   20413
PLOTEL  211     20413   20414
PLOTEL  212     20414   20415
PLOTEL  213     20415   20416
PLOTEL  214     20416   20417
PLOTEL  215     20420   20421
PLOTEL  216     20421   20422
PLOTEL  217     20422   20423
PLOTEL  218     20423   20424
PLOTEL  219     20424   20425
PLOTEL  220     20425   20426
PLOTEL  221     20426   20427
PLOTEL  222     20430   20431
PLOTEL  223     20431   20432
PLOTEL  224     20432   20433
PLOTEL  225     20433   20434
PLOTEL  226     20434   20435
PLOTEL  227     20435   20436
PLOTEL  228     20436   20437
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PLOTEL	229	20440	20441
PLOTEL	230	20441	20442
PLOTEL	231	20442	20443
PLOTEL	232	20443	20444
PLOTEL	233	20444	20445
PLOTEL	234	20445	20446
PLOTEL	235	20446	20447
PLOTEL	236	20450	20451
PLOTEL	237	20451	20452
PLOTEL	238	20452	20453
PLOTEL	239	20453	20454
PLOTEL	240	20454	20455
PLOTEL	241	20455	20456
PLOTEL	242	20456	20457
PLOTEL	251	20400	20410
PLOTEL	252	20410	20420
PLOTEL	253	20420	20430
PLOTEL	254	20430	20440
PLOTEL	255	20440	20450
PLOTEL	256	20401	20411
PLOTEL	257	20411	20421
PLOTEL	258	20421	20431
PLOTEL	259	20431	20441
PLOTEL	260	20441	20451
PLOTEL	261	20402	20412
PLOTEL	262	20412	20422
PLOTEL	263	20422	20432
PLOTEL	264	20432	20442
PLOTEL	265	20442	20452
PLOTEL	266	20403	20413
PLOTEL	267	20413	20423
PLOTEL	268	20423	20433
PLOTEL	269	20433	20443
PLOTEL	270	20443	20453
PLOTEL	271	20404	20414
PLOTEL	272	20414	20424
PLOTEL	273	20424	20434
PLOTEL	274	20434	20444
PLOTEL	275	20444	20454
PLOTEL	276	20405	20415
PLOTEL	277	20415	20425
PLOTEL	278	20425	20435
PLOTEL	279	20435	20445
PLOTEL	280	20445	20455
PLOTEL	281	20406	20416
PLOTEL	282	20416	20426
PLOTEL	283	20426	20436
PLOTEL	284	20436	20446
PLOTEL	285	20446	20456
PLOTEL	286	20407	20417
PLOTEL	287	20417	20427
PLOTEL	288	20427	20437
PLOTEL	289	20437	20447
PLOTEL	290	20447	20457

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PLOTEL  296      10000   10050
PLOTEL  297      10400   10450
PLOTEL  298      10007   10057
PLOTEL  299      10407   10457
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ENDDATA
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