Géotechnique des ouvrages souterrains

comportements post rupture

Thierry YOU,

géostock

CFMR/AFTES 2006

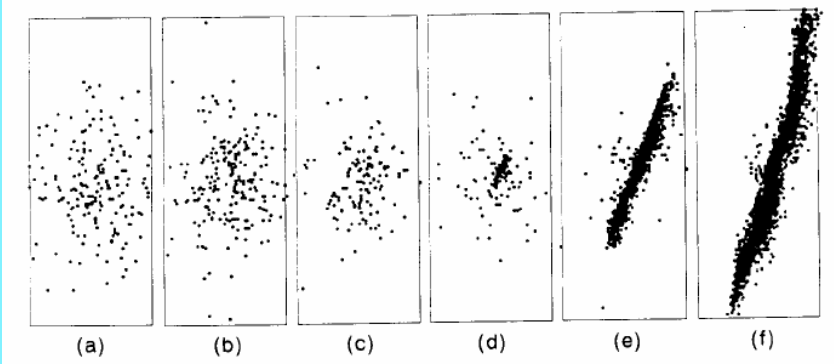
Géotechnique des ouvrages souterrains

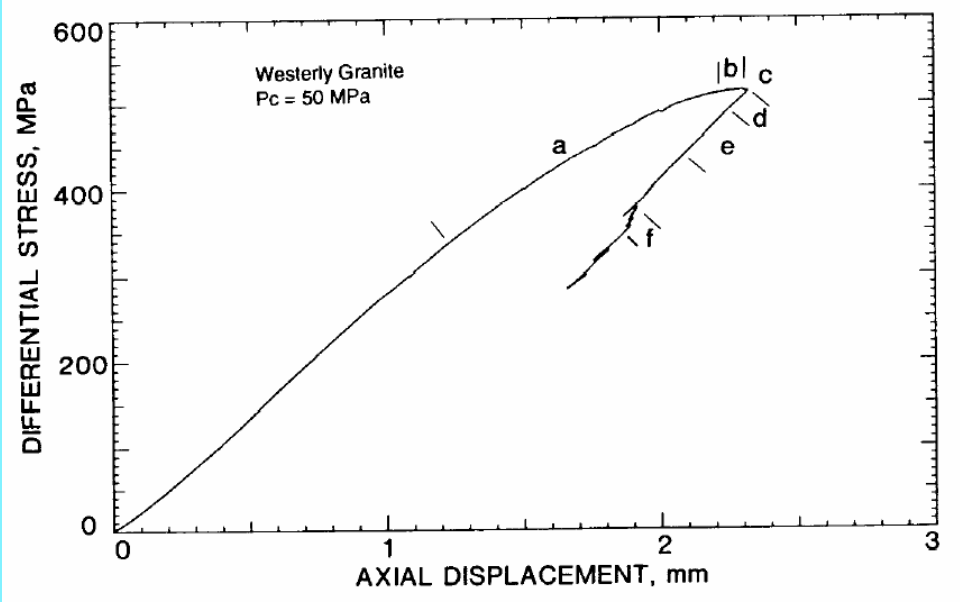
comportements post rupture

- Laboratoire
- Retours d'expérience
- Conclusions

géostock

Augmentation contrainte axiale

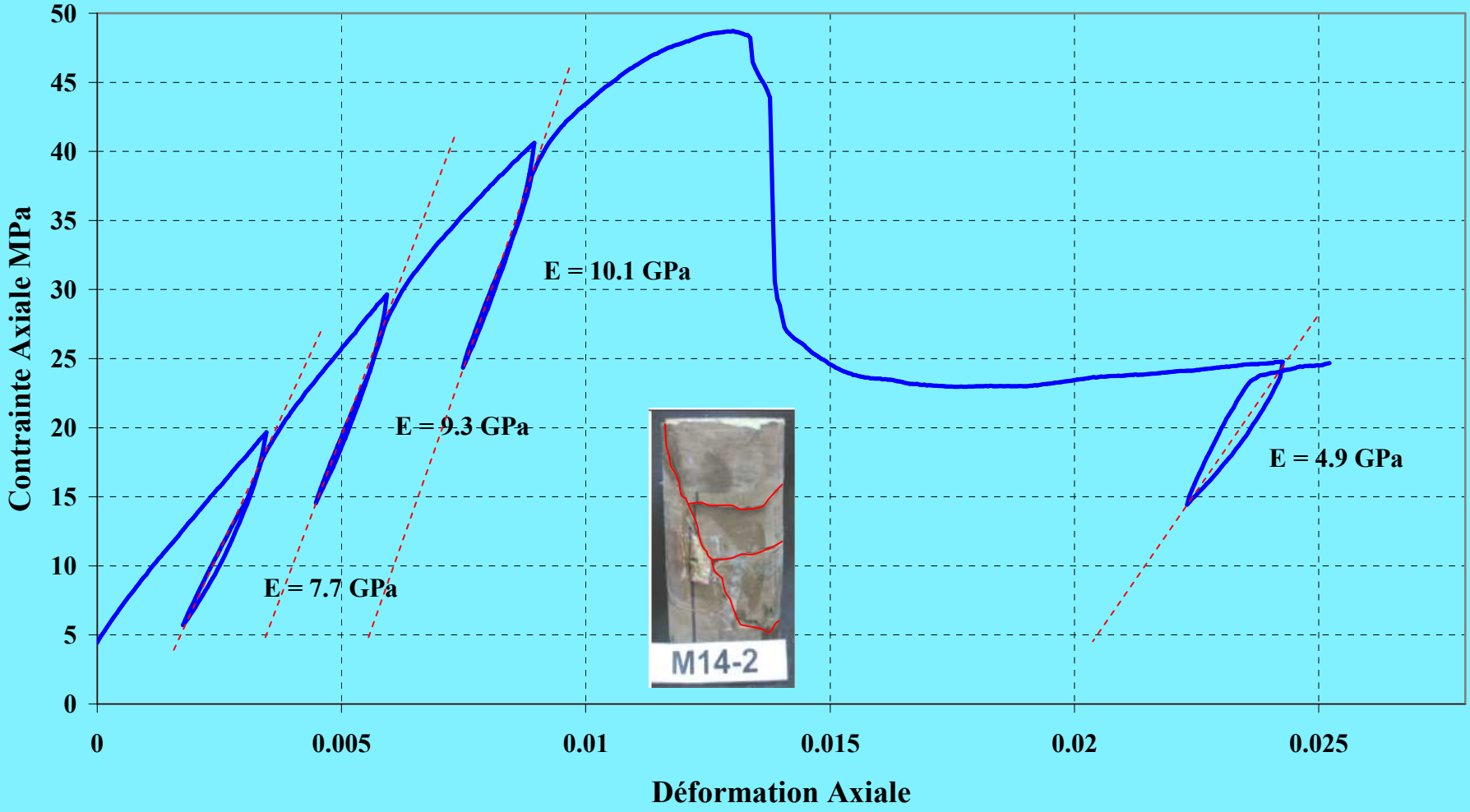




D'après Lockner et al. *Observations of quasi-Static fault growth from acoustic emissions*, in *Fault Mechanics and Transport Properties of Rocks*, B. Evans and T.-F. Wong ed., 1992

géostock

ESSAI TRIAXIAL LABO SUR ECHANTILLON MARNE
Vitesse de déformation = 2.10^{-6} s^{-1}
Pression de confinement = 4 MPa



géostock

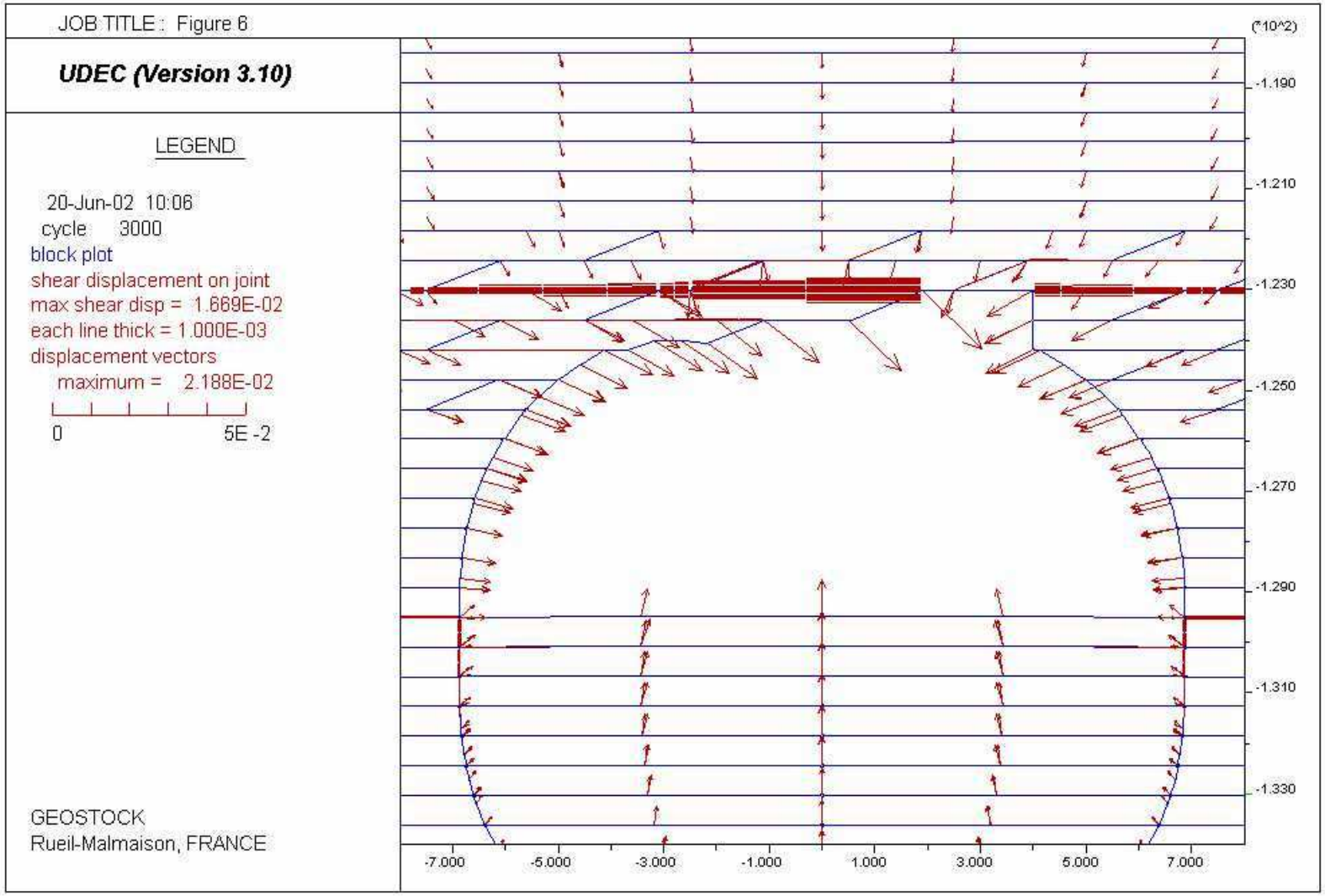
SYDNEY

géostock

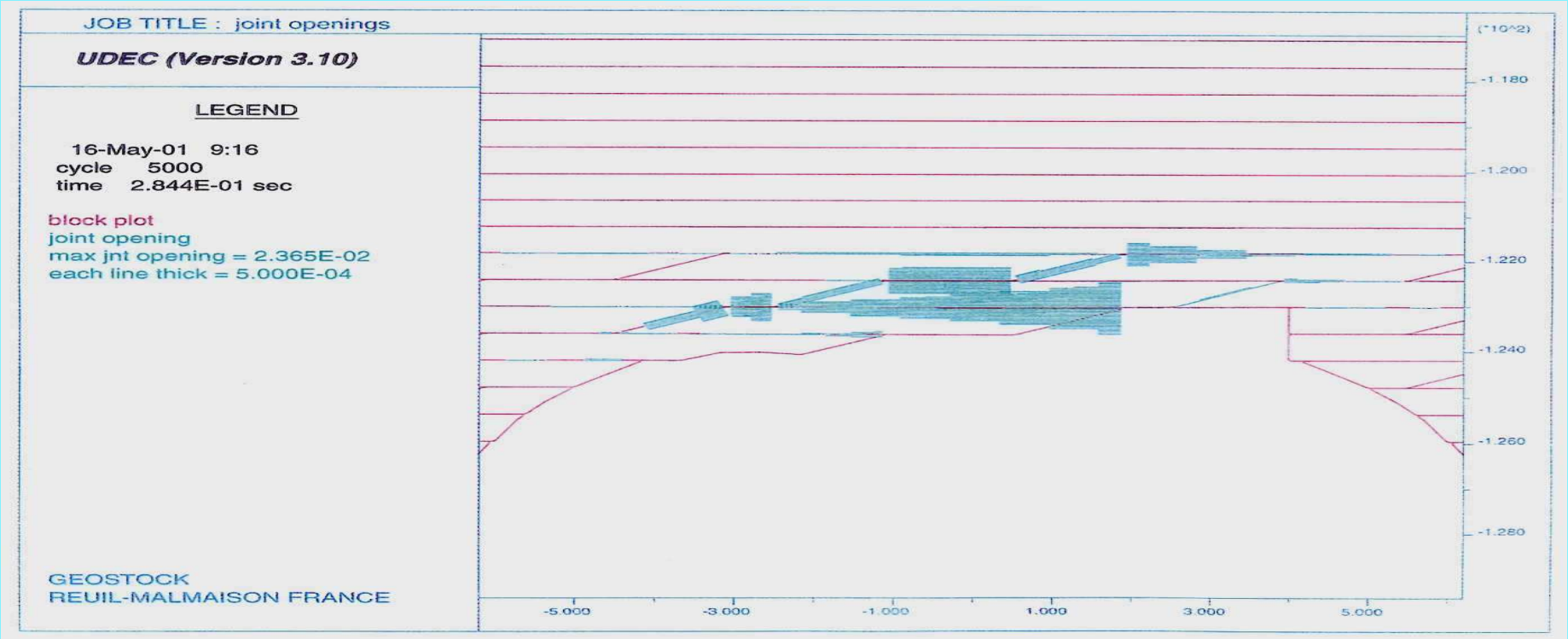
ROCK FALL EXPLANATIONS (20+)

- A large number of explanations were put forward by the parties involved, many of them with ulterior motives: unsuitable section, inappropriate and damaging explosive, poor workmanship (drilling, bolting, etc.), untested rock bolts, too differed bolt grouting, poor site organisation, unsuitable numerical and structural models, underdesigned rockbolts, inappropriate bolting patterns, unsuitable excavation sequence, poor and inefficient quality control, lack of design methodology (EC7), lack of monitoring and inspection, unforeseen stress release, random vertical joints, lack of spot bolt decision on visible instabilities, inclined defects in sheet facies, too high water pressure imposed in the fissures, etc.
- At that stage, none of the specified monitoring measures that had been prepared for design validation (geological joint mapping, convergence measurement, profile mapping, pull-out test, etc.), that certainly would have helped as new design basic data, had been implemented.
- Maintaining roof integrity was crucial for stability, as was established latter (You et al. Johannesburg ISRM2003)

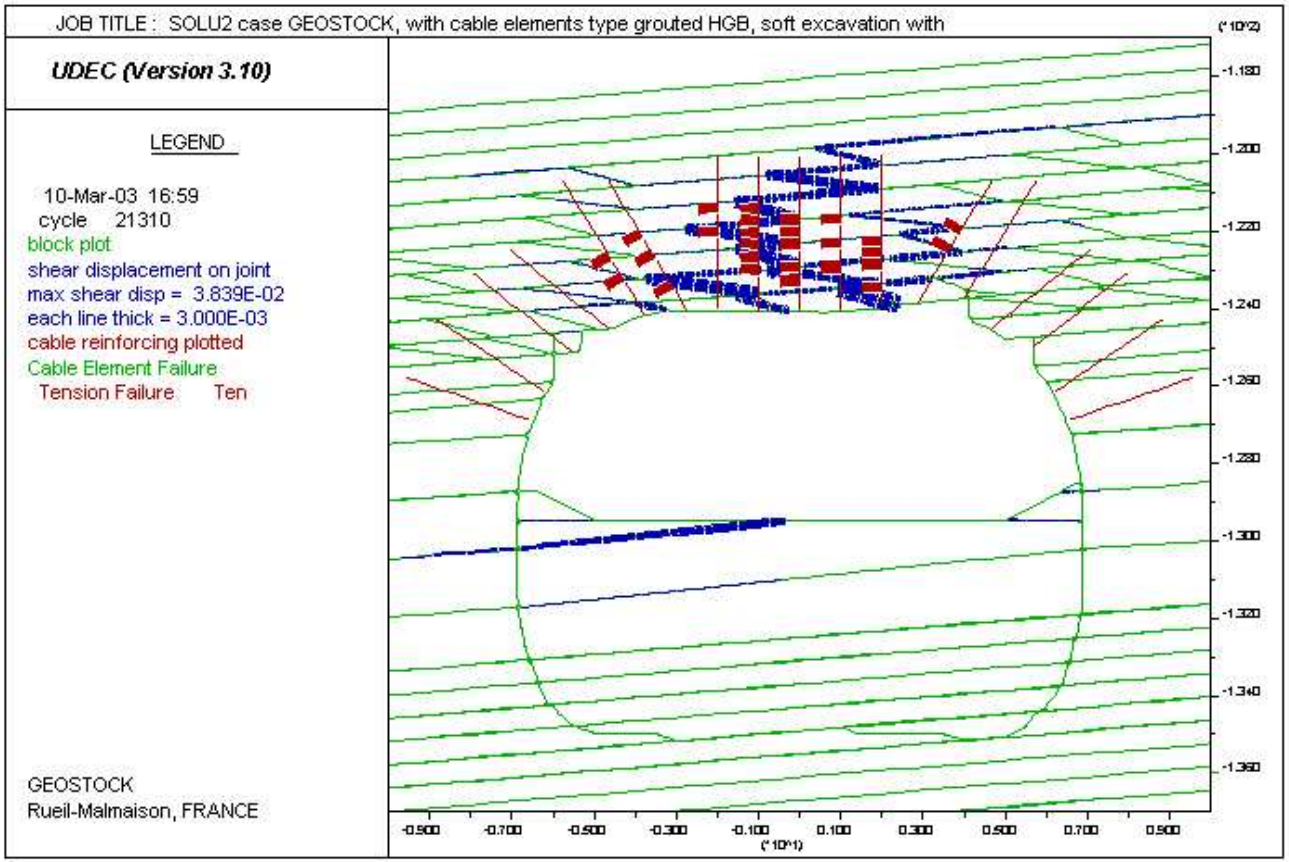
SYDNEY - UDEC



géostock


JOB TITLE : joint openings
UDEC (Version 3.10)
LEGEND
16-May-01 9:16
cycle 5000
time 2.844E-01 sec
block plot
joint opening
max jnt opening = 2.365E-02
each line thick = 5.000E-04
GEOSTOCK
REUIL-MALMAISON FRANCE
(*10^2)
-1.180
-1.200
-1.220
-1.240
-1.260
-1.280
-5.000
-3.000
-1.000
1.000
3.000
5.000

géostock


JOB TITLE : SOLU2 case GEOSTOCK, with cable elements type grouted HGB, soft excavation with
UDEC (Version 3.10)
LEGEND
10-Mar-03 16:59
cycle 21310
block plot
shear displacement on joint
max shear disp = 3.839E-02
each line thick = 3.000E-03
cable reinforcing plotted
Cable Element Failure
Tension Failure Ten
GEOSTOCK
Rueil-Malmaison, FRANCE
(*10^2)
-1.180
-1.200
-1.220
-1.240
-1.260
-1.280
-1.300
-1.320
-1.340
-1.360
-0.900
-0.700
-0.500
-0.300
-0.100
0.100
0.300
0.500
0.700
0.900
(*10^1)

géostock

DESIGN METHODOLOGY FOR HYDROCARBON CAVERNS

INFLUENCE OF IN-SITU STRESSES ON LARGE SECTIONS

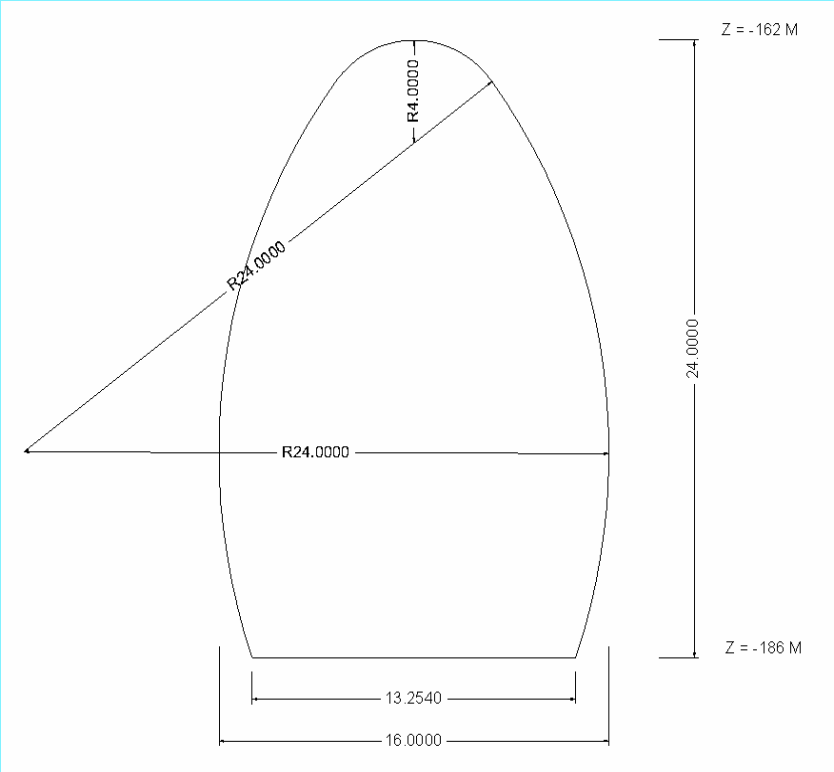
géostock

Top heading and bench 1

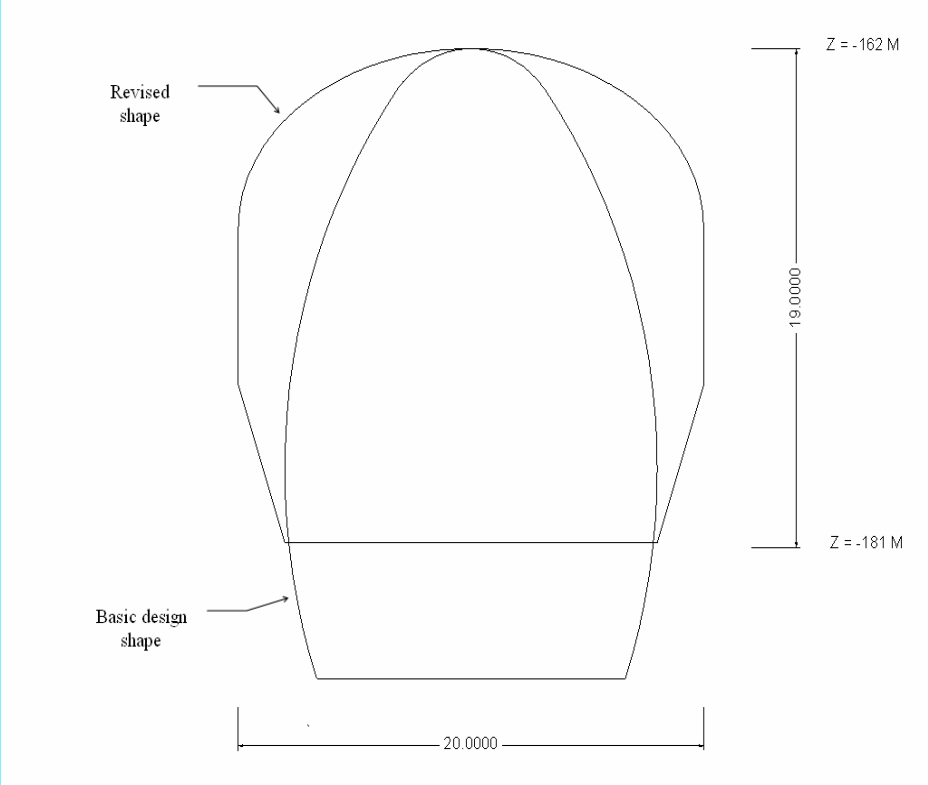
INFLUENCE OF IN-SITU STRESSES ON LARGE SECTIONS

VISAKHAPATNAM

BED egg-shape cross-section



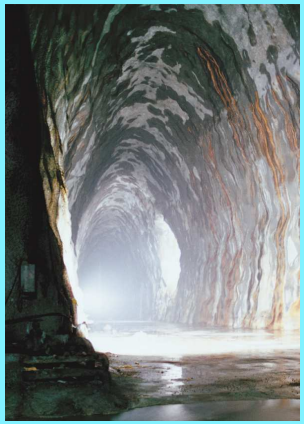
Revised basket-handle cross-section



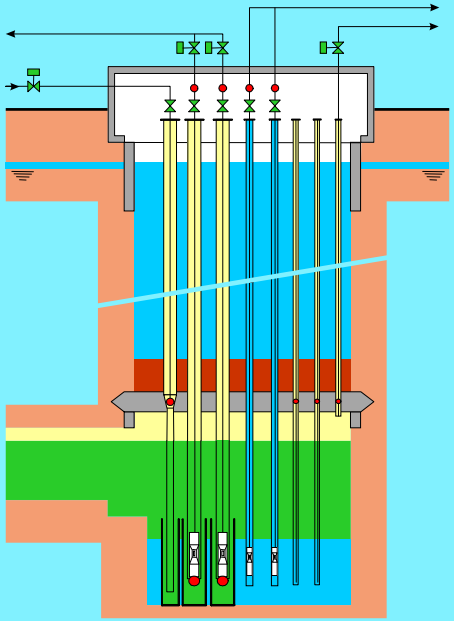
UNDERGROUND STORAGE IN MINED CAVERN

PRINCIPLES

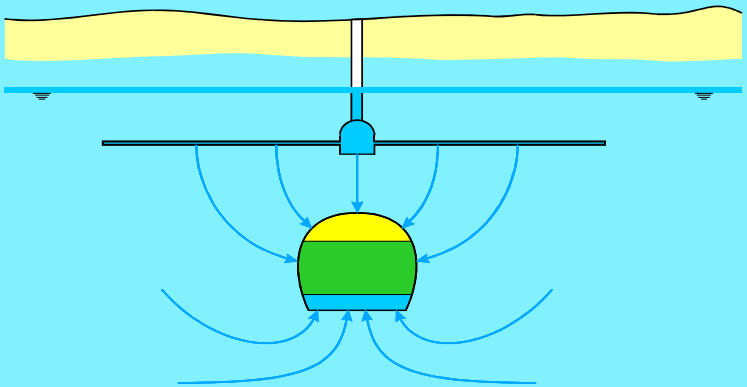
Stability



Operation



Hydrodynamic Containment

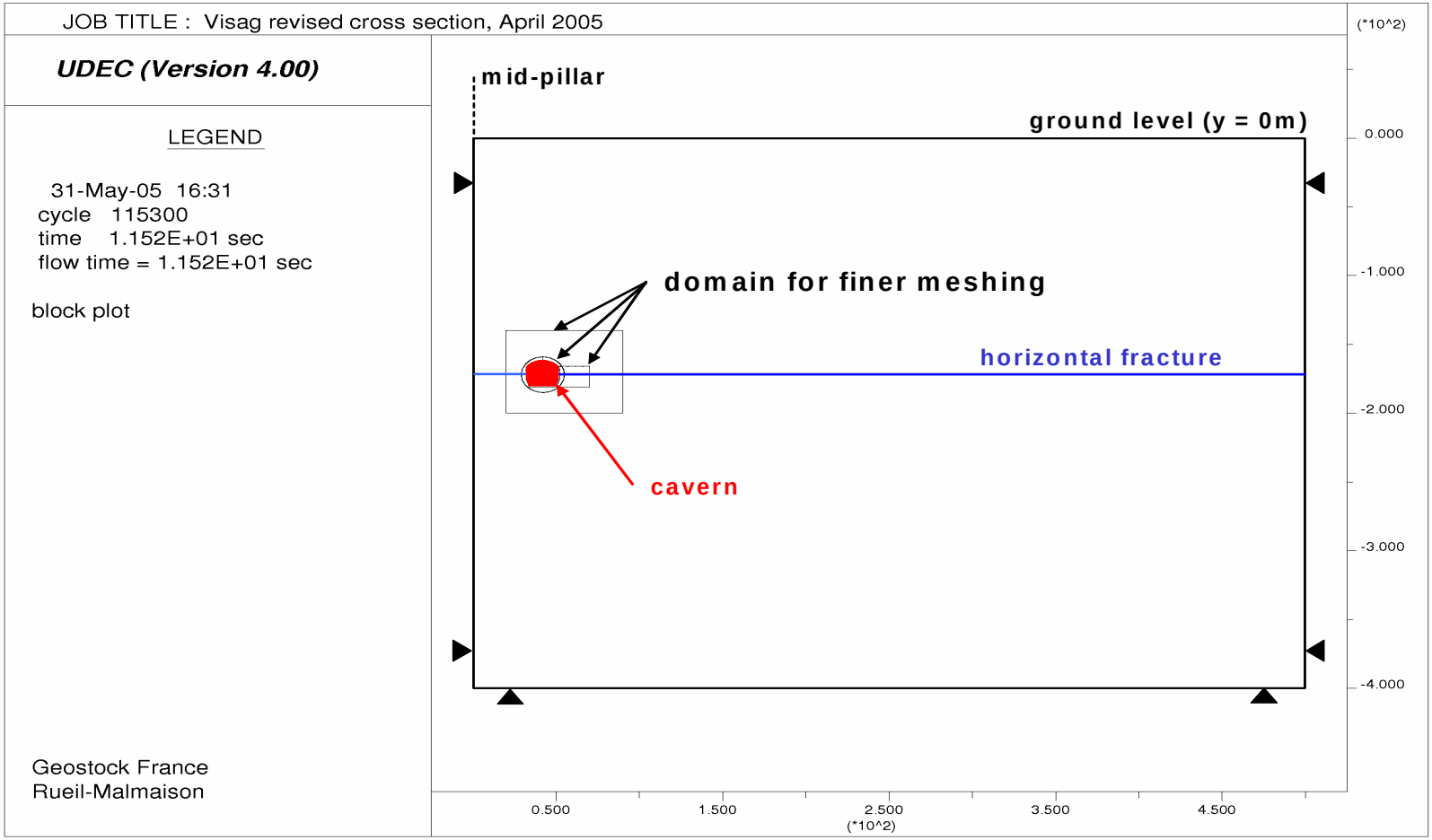


Neither a Mine, neither a Civil Construction, neither a Laboratory

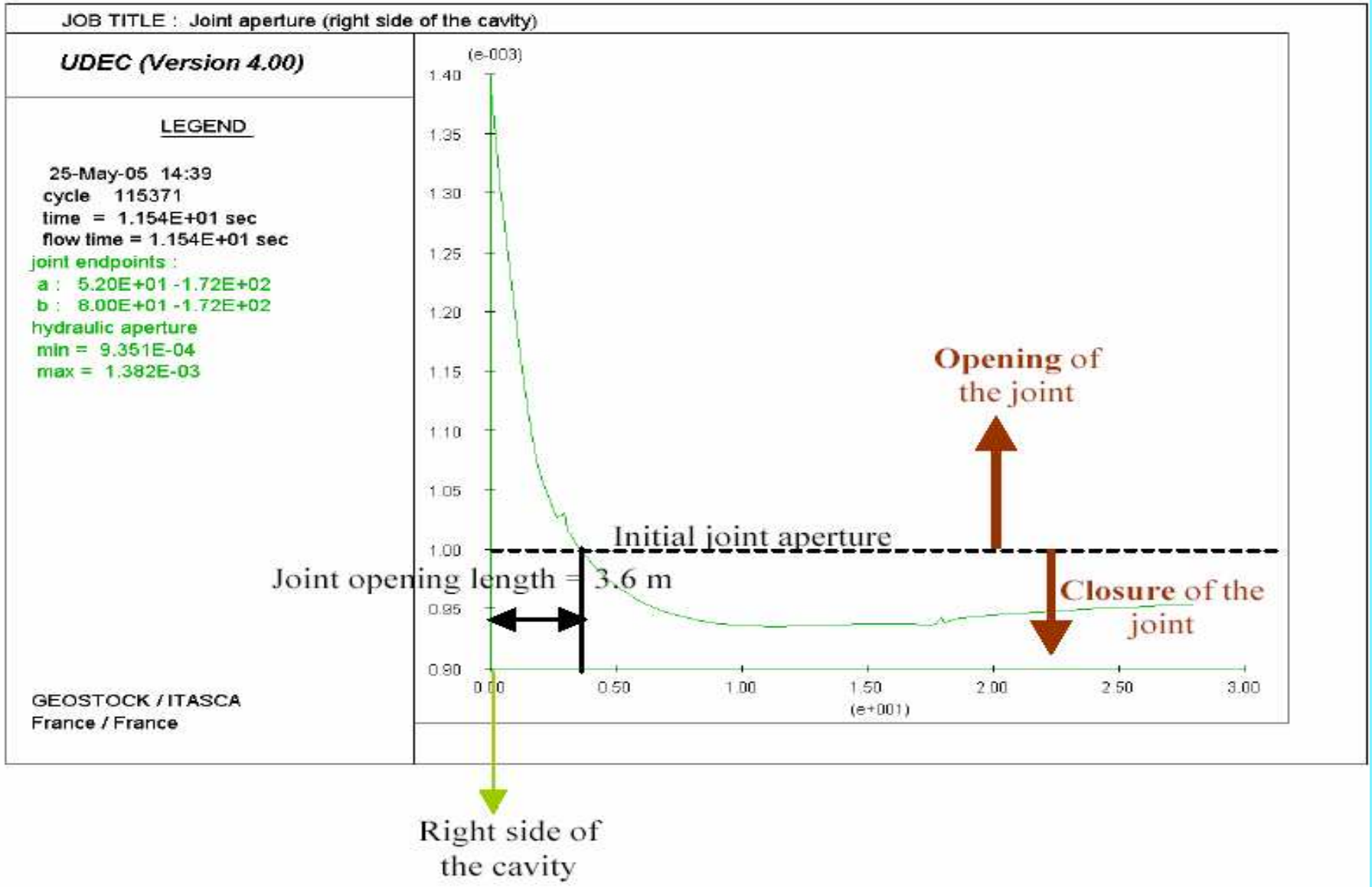
géostock

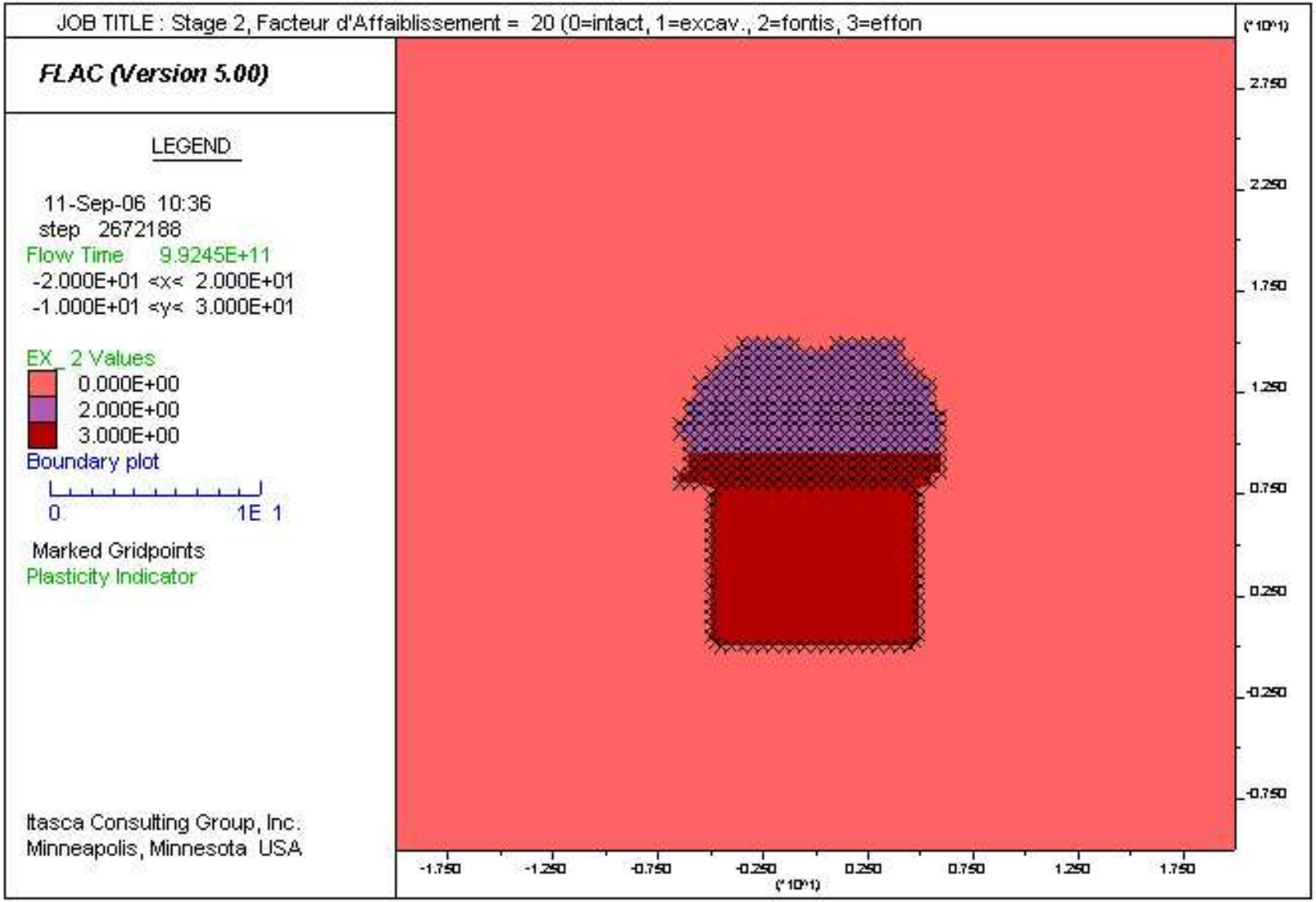
INFLUENCE OF IN-SITU STRESSES ON LARGE SECTIONS

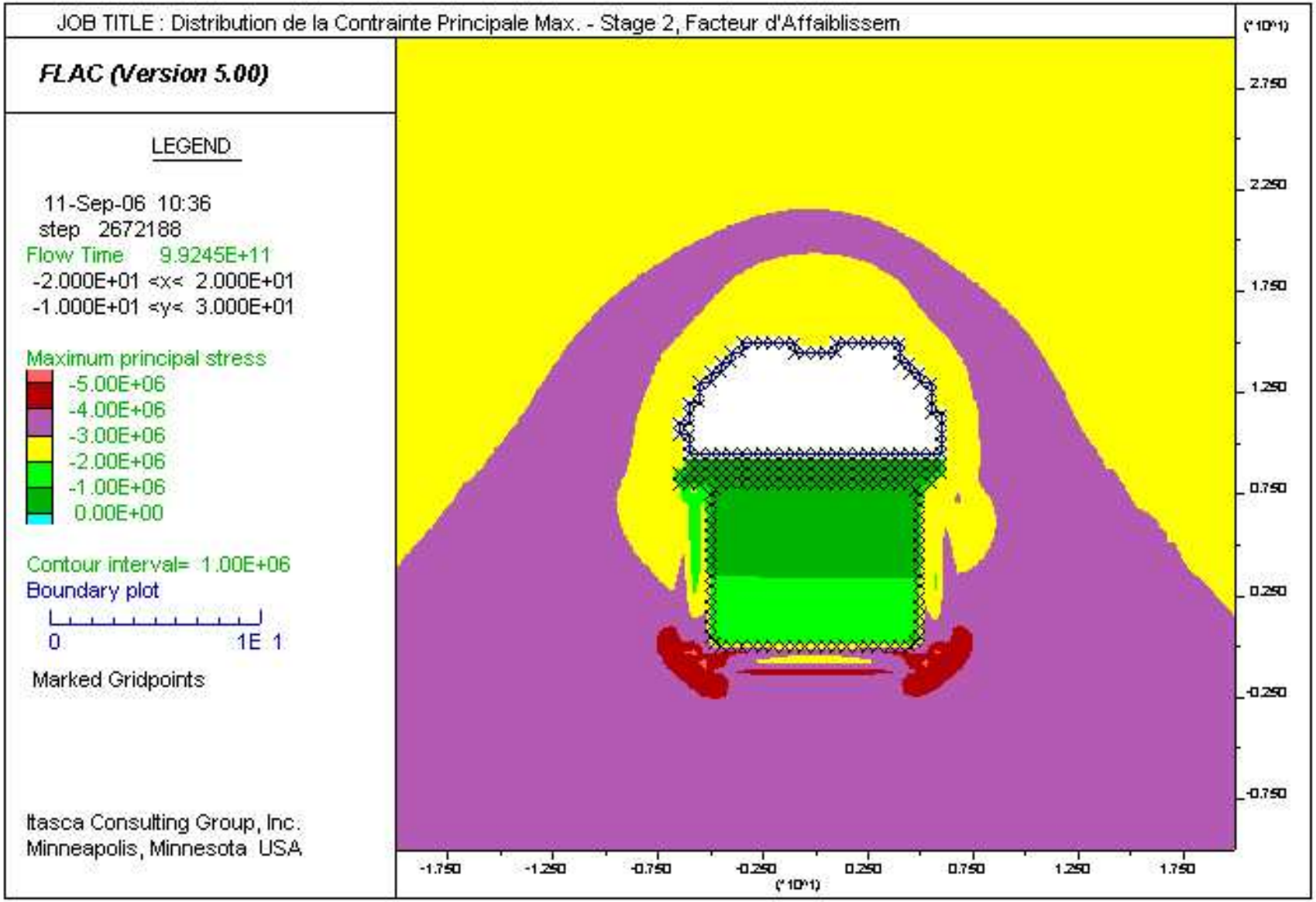
Basic parameters and model geometry used for the numerical analysis

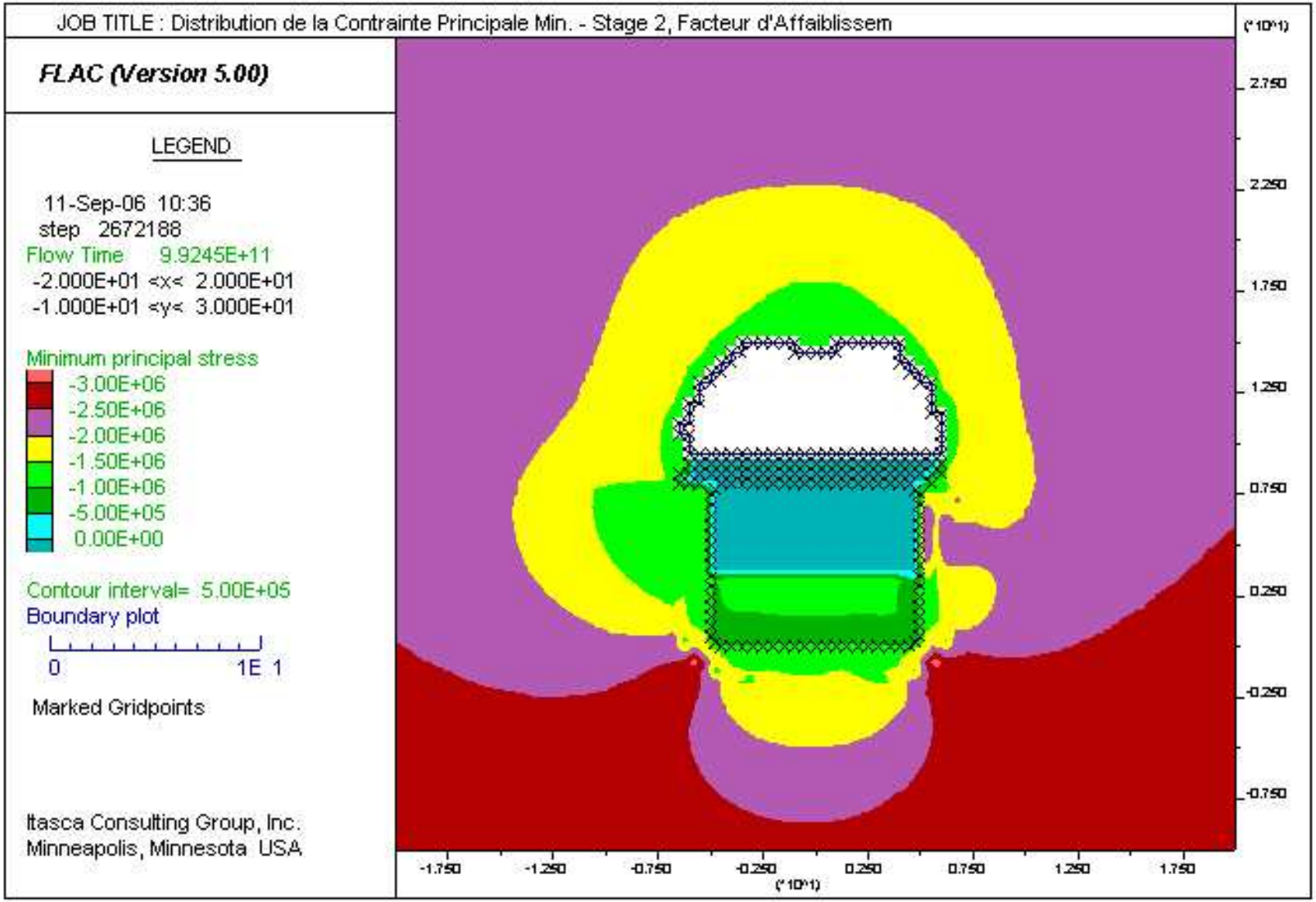


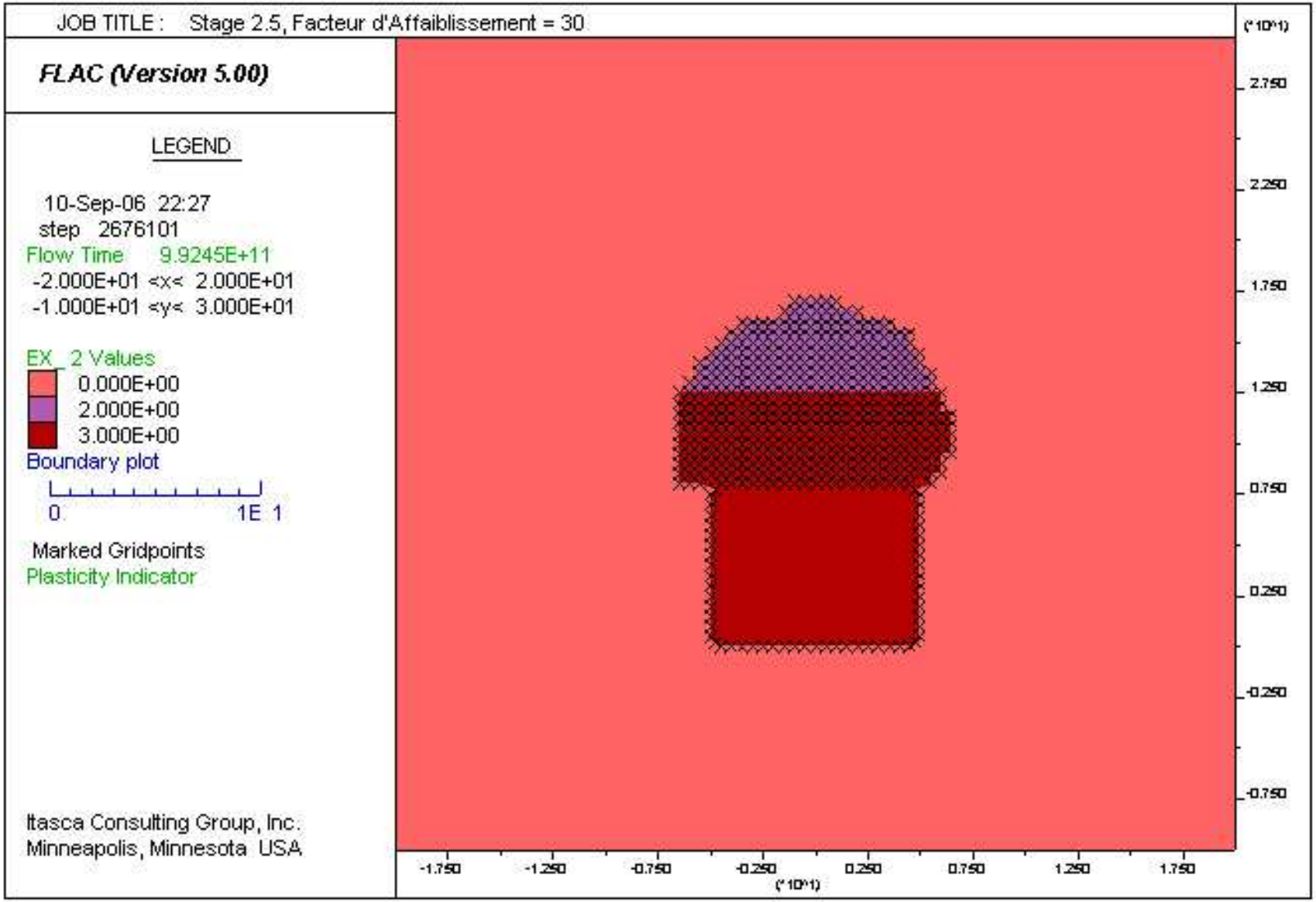
Joint aperture for the rounded shape after product filling

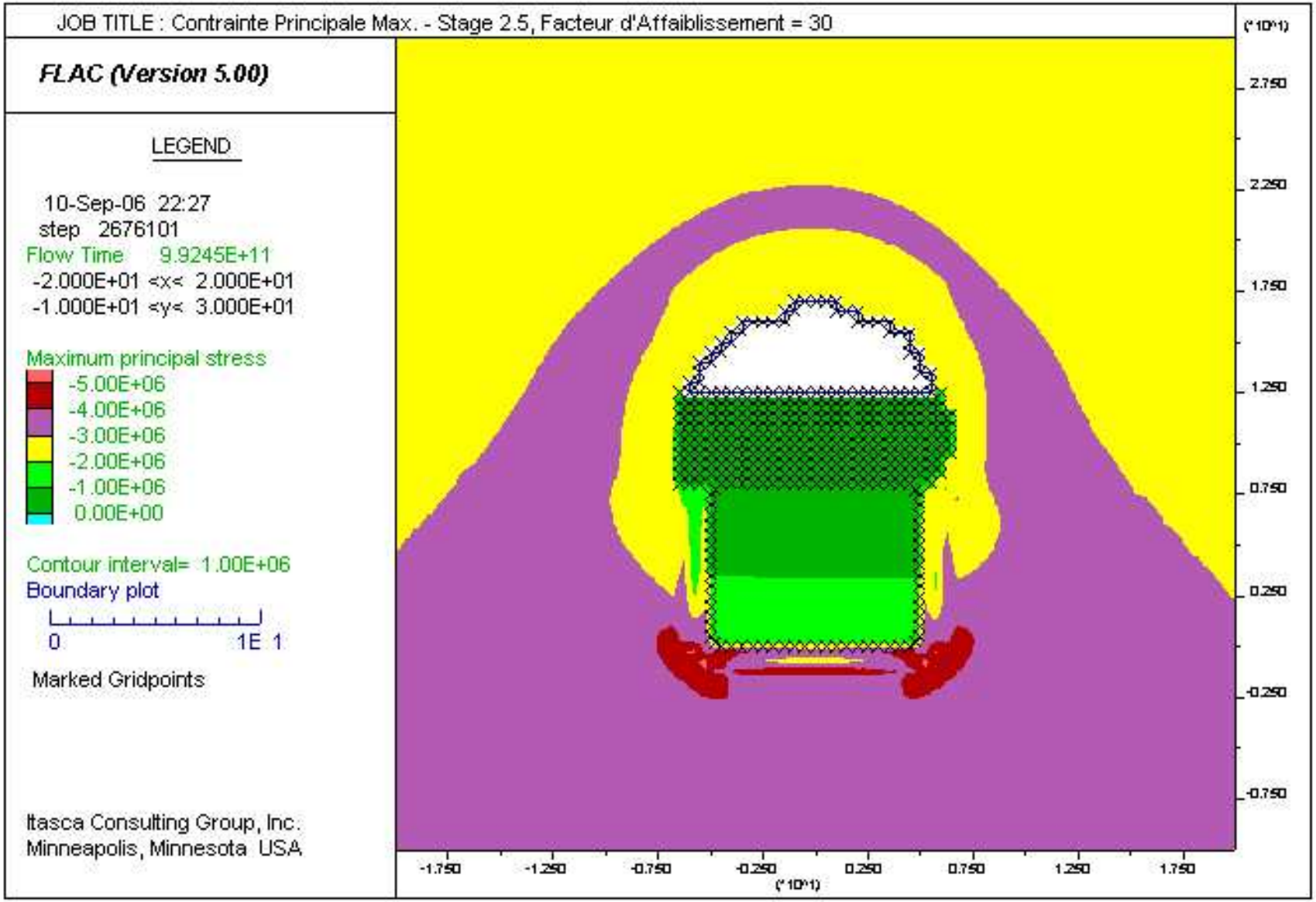


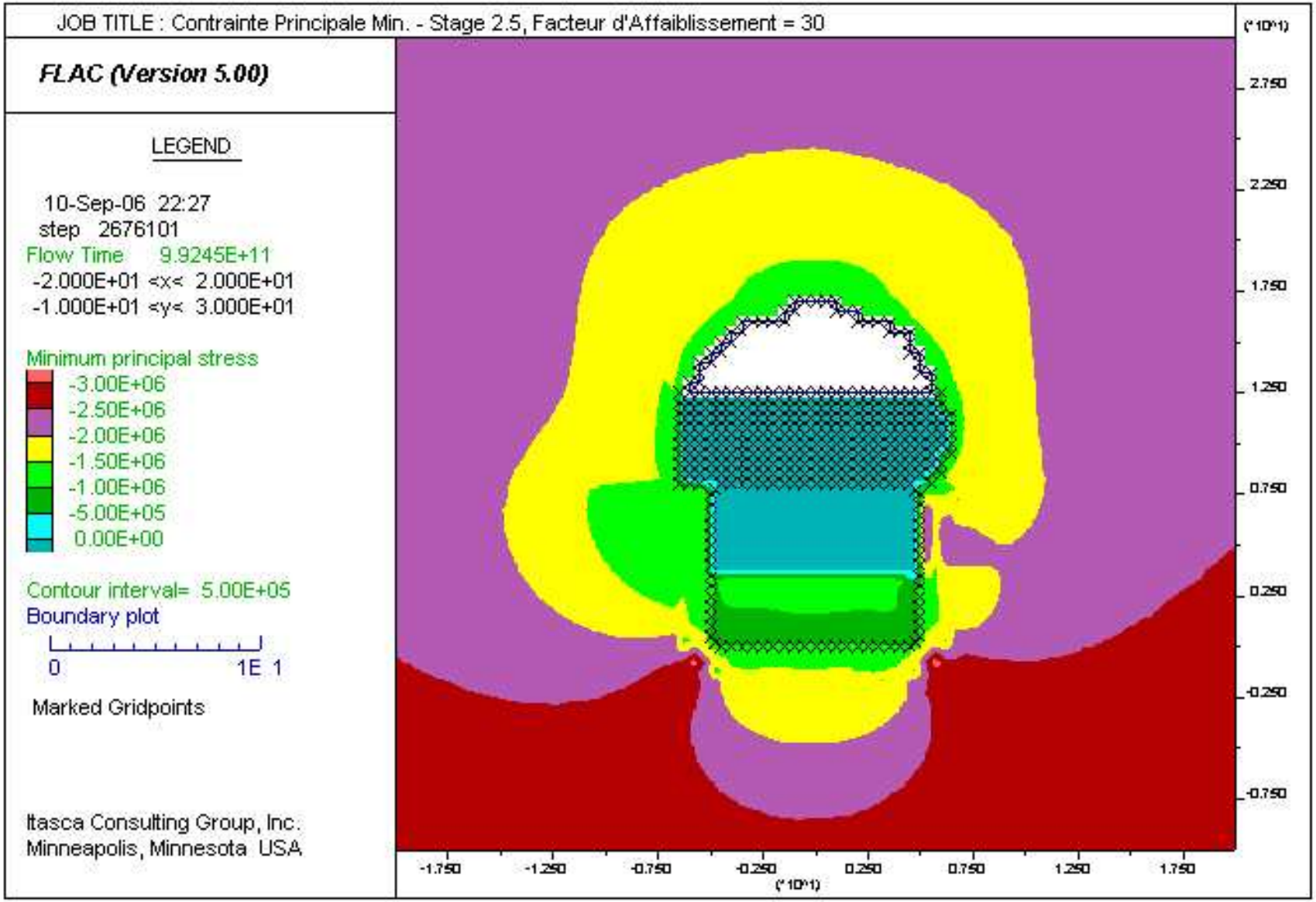

JOB TITLE : Stage 2, Facteur d'Affaiblissement = 20 (0=intact, 1=excav., 2=fontis, 3=effon
FLAC (Version 5.00)
LEGEND
11-Sep-06 10:36
step 2672188
Flow Time 9.9245E+11
-2.000E+01 <x< 2.000E+01
-1.000E+01 <y< 3.000E+01
EX 2 Values
0.000E+00
2.000E+00
3.000E+00
Boundary plot
0
1E 1
Marked Gridpoints
Plasticity Indicator
Itasca Consulting Group, Inc.
Minneapolis, Minnesota USA
(*10^1)
2.750
2.250
1.750
1.250
0.750
0.250
-0.250
-0.750
-1.750
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
(*10^1)


JOB TITLE : Distribution de la Contrainte Principale Max. - Stage 2, Facteur d'Affaiblissem
FLAC (Version 5.00)
LEGEND
11-Sep-06 10:36
step 2672188
Flow Time 9.9245E+11
-2.000E+01 <x< 2.000E+01
-1.000E+01 <y< 3.000E+01
Maximum principal stress
-5.00E+06
-4.00E+06
-3.00E+06
-2.00E+06
-1.00E+06
0.00E+00
Contour interval= 1.00E+06
Boundary plot
0
1E 1
Marked Gridpoints
Itasca Consulting Group, Inc.
Minneapolis, Minnesota USA
(*10^1)
2.750
2.250
1.750
1.250
0.750
0.250
-0.250
-0.750
-1.750
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
(*10^1)


JOB TITLE : Distribution de la Contrainte Principale Min. - Stage 2, Facteur d'Affaiblissem
FLAC (Version 5.00)
LEGEND
11-Sep-06 10:36
step 2672188
Flow Time 9.9245E+11
-2.000E+01 <x< 2.000E+01
-1.000E+01 <y< 3.000E+01
Minimum principal stress
-3.00E+06
-2.50E+06
-2.00E+06
-1.50E+06
-1.00E+06
-5.00E+05
0.00E+00
Contour interval= 5.00E+05
Boundary plot
0
1E 1
Marked Gridpoints
Itasca Consulting Group, Inc.
Minneapolis, Minnesota USA
(*10^1)
2.750
2.250
1.750
1.250
0.750
0.250
-0.250
-0.750
-1.750
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
(*10^1)


JOB TITLE : Stage 2.5, Facteur d'Affaiblissement = 30
FLAC (Version 5.00)
LEGEND
10-Sep-06 22:27
step 2676101
Flow Time 9.9245E+11
-2.000E+01 <x< 2.000E+01
-1.000E+01 <y< 3.000E+01
EX 2 Values
0.000E+00
2.000E+00
3.000E+00
Boundary plot
0
1E 1
Marked Gridpoints
Plasticity Indicator
Itasca Consulting Group, Inc.
Minneapolis, Minnesota USA
(*10^1)
2.750
2.250
1.750
1.250
0.750
0.250
-0.250
-0.750
-1.750
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
(*10^1)


JOB TITLE : Contrainte Principale Max. - Stage 2.5, Facteur d'Affaiblissement = 30
FLAC (Version 5.00)
LEGEND
10-Sep-06 22:27
step 2676101
Flow Time 9.9245E+11
-2.000E+01 <x< 2.000E+01
-1.000E+01 <y< 3.000E+01
Maximum principal stress
-5.00E+06
-4.00E+06
-3.00E+06
-2.00E+06
-1.00E+06
0.00E+00
Contour interval= 1.00E+06
Boundary plot
0
1E 1
Marked Gridpoints
Itasca Consulting Group, Inc.
Minneapolis, Minnesota USA
(*10^1)
2.750
2.250
1.750
1.250
0.750
0.250
-0.250
-0.750
-1.750
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
(*10^1)


JOB TITLE : Contrainte Principale Min. - Stage 2.5, Facteur d'Affaiblissement = 30
FLAC (Version 5.00)
LEGEND
10-Sep-06 22:27
step 2676101
Flow Time 9.9245E+11
-2.000E+01 <x< 2.000E+01
-1.000E+01 <y< 3.000E+01
Minimum principal stress
-3.00E+06
-2.50E+06
-2.00E+06
-1.50E+06
-1.00E+06
-5.00E+05
0.00E+00
Contour interval= 5.00E+05
Boundary plot
0
1E 1
Marked Gridpoints
Itasca Consulting Group, Inc.
Minneapolis, Minnesota USA
(*10^1)
2.750
2.250
1.750
1.250
0.750
0.250
-0.250
-0.750
-1.750
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
(*10^1)

Géotechnique des ouvrages souterrains

comportements post rupture

PREMIÈRES CONCLUSIONS

- Le concept est encore un objet de recherche
- La définition des modes de rupture n'est pas toujours aisée
- Le phénomène peut aussi être relatif.

géostock

géostock