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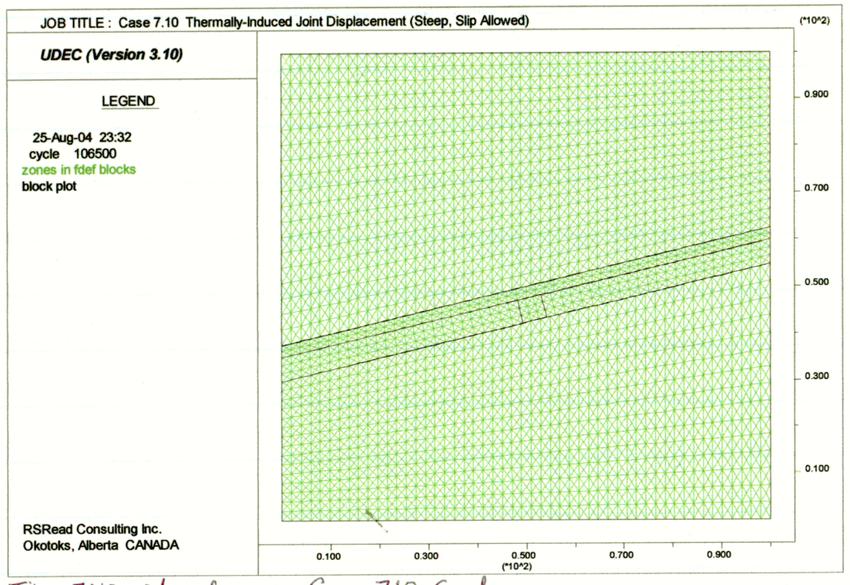
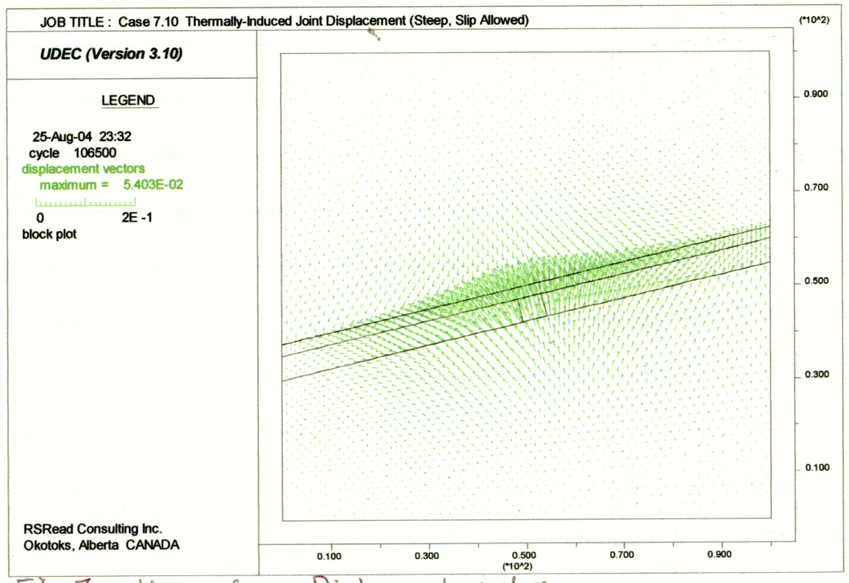


File 7.10grid.emf Case 7.10 Grid.

Aug 25/04



File 7.10dispc.emf Displacement vectors

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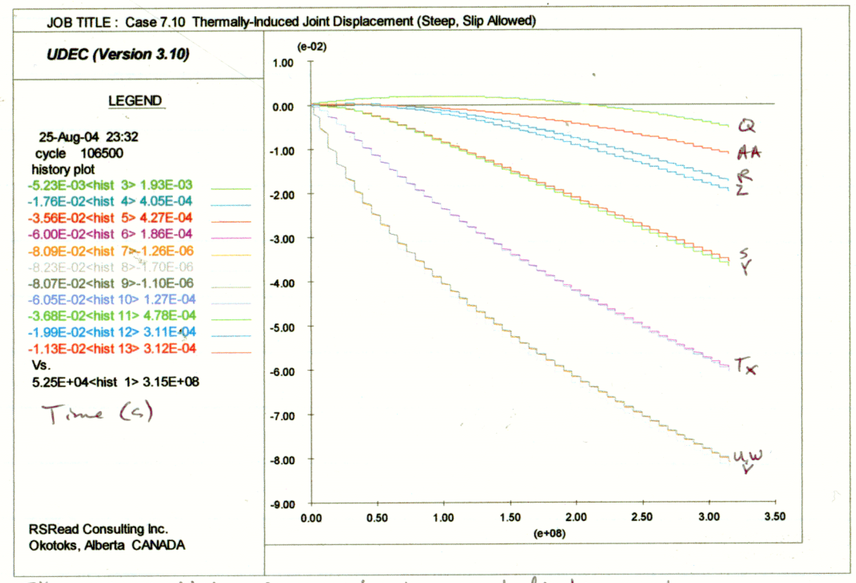
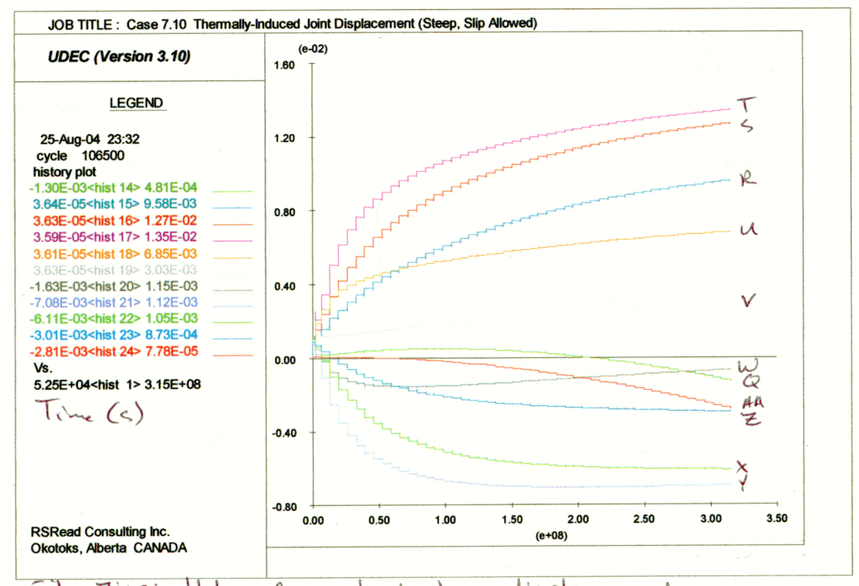


File 7.10jndht.emf Joint normal displacement

Aug 25/04



File 7.10jsdht.emf Joint shear displacement

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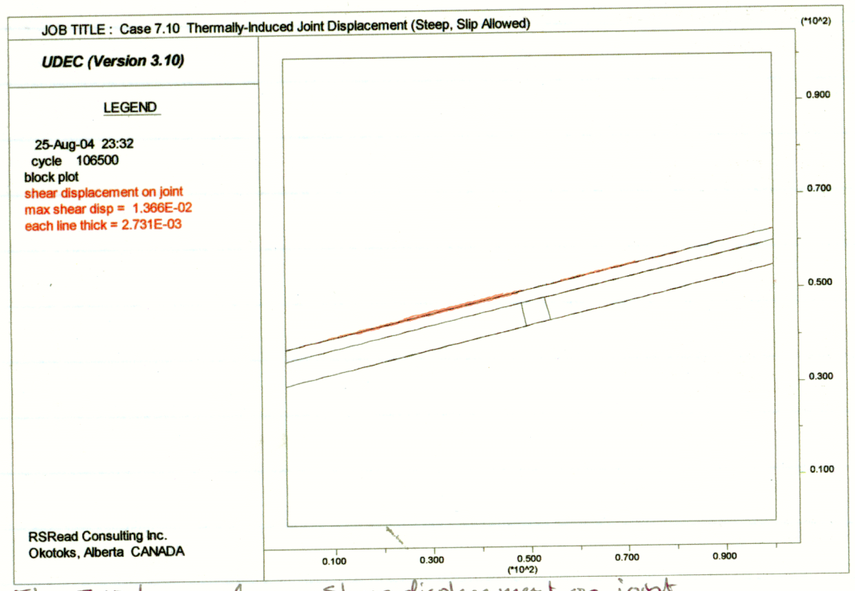
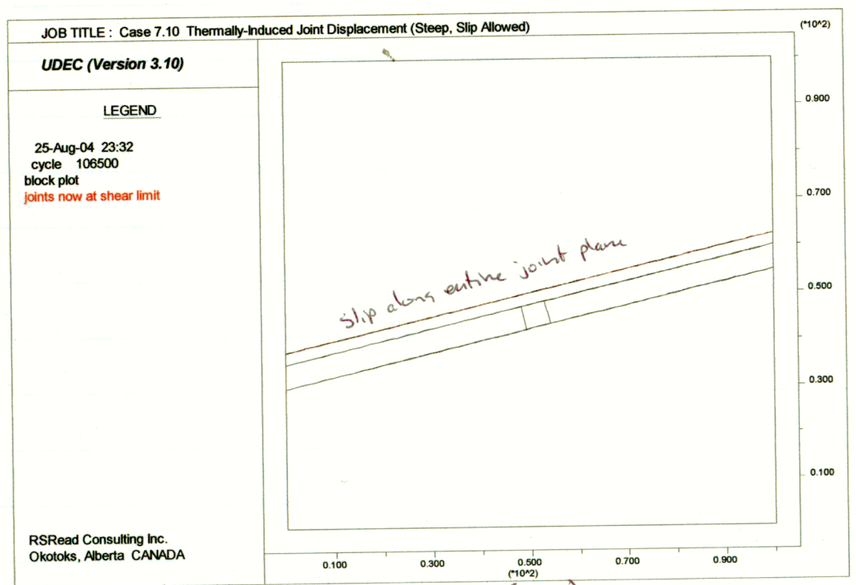


File 7:10shear.emf Shear displacement on joint

Aug 25/04



File 7:10slip.emf Slip on joint (all)

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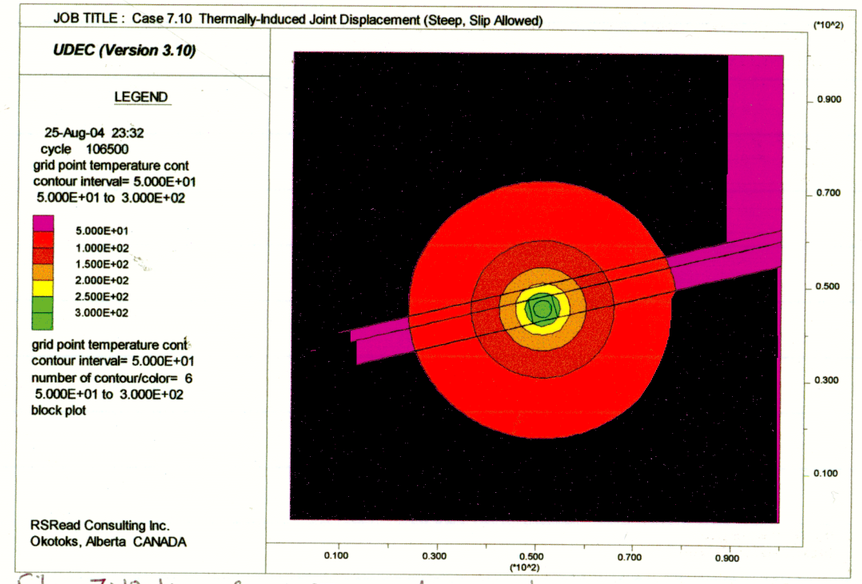
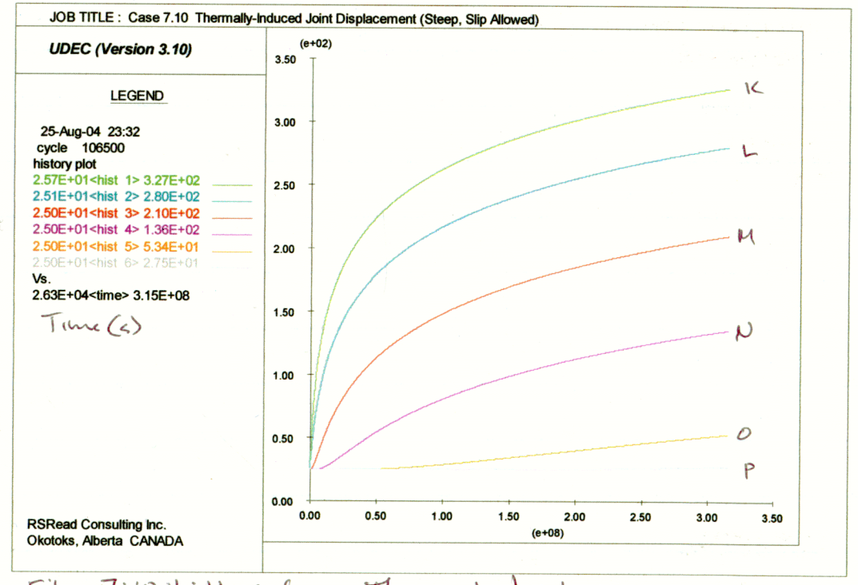
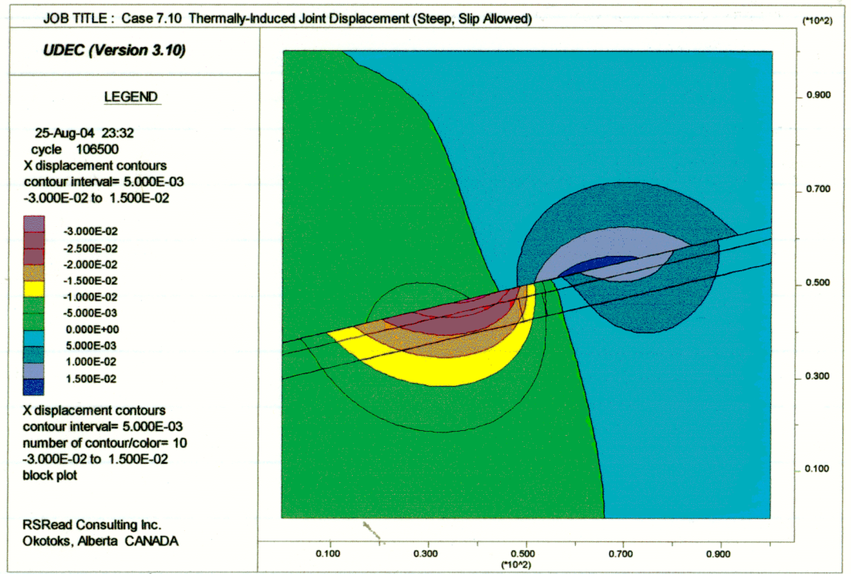


File 7:10slip.emf Temperature contours

Aug 25/04

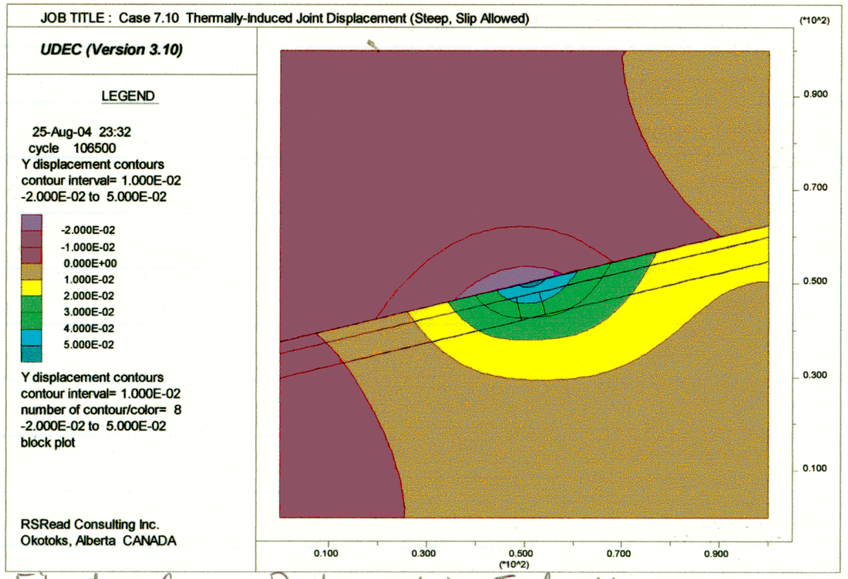


File 7:10thisth.emf Thermal histories

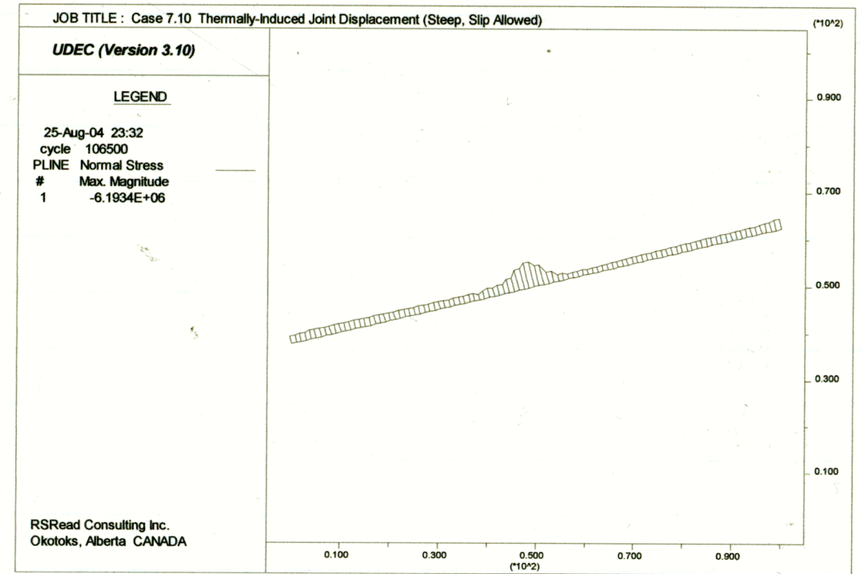


File 7i10xdc.enf Displacement in σ_1 direction.

Aug 25/04

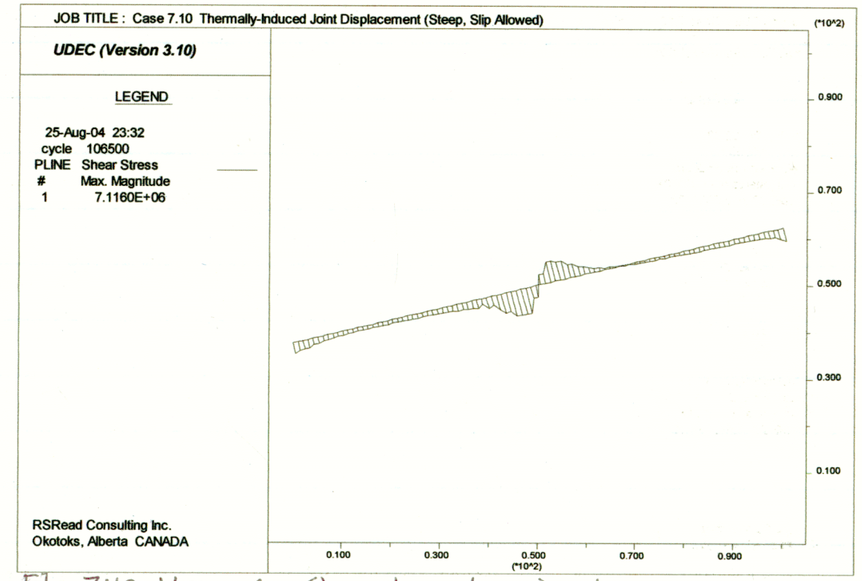


File ydc.enf Displacement in σ_2 direction.

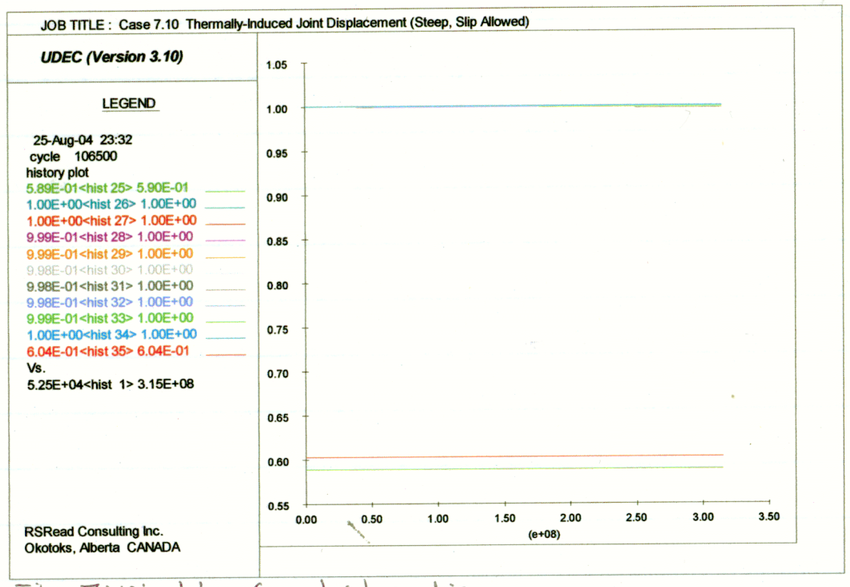


File 7i10pl1ns.enf Normal stress displacement along joint.

Aug 25/04

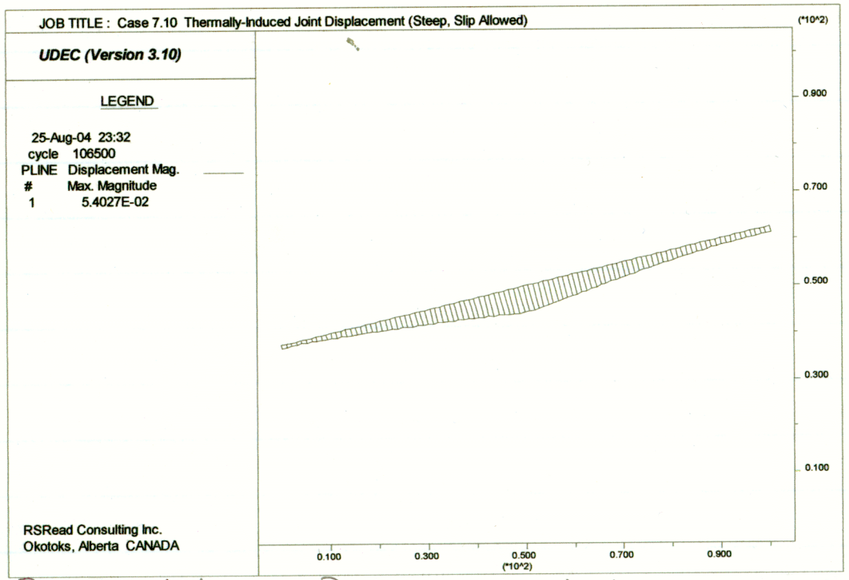


File 7i10pl1ss.enf Shear stress along joint.



File 7:10jsrht.emf Joint sratio

Aug 25/04



File 7:10 pl1d.emf Displacement along joint.

Aug. 26/2004 R.

To complete Case 7, FLAC 4.0 will be used to create models similar to those in several of the preceding cases, and results will be compared. Specifically, histories of key parameters will be compared at points in the model.

Computer Software

FLAC Version 4.00.34 (Fast Lagrangian Analysis of Continua)

Serial number 213-001-0521-11415

Options: Thermal

© Peter Cundall 2000

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Preparation for FLAC modelling

- FLAC commands reviewed. There are differences in how certain values are represented and what history plots are possible. Histories are specific to grid points and therefore the grid must be accumulated to suit the problem. The plots that can be generated to compare to UDEC results are as follows

UDEC	FLAC	
PLO Grid, Bou	Grid, Bou	
PLO Disp	Disp.	
PLO Hist NDIS	Hist ex_n (fish variable)	define fish function to calculate relative displacement.
PLO Hist SDIS	" "	
PLO Hist SRATIO	Hist SRATIO.	
PLOT SHEAR	PLOT IF SD. or SHEAR	
PLOT SLIP	PLOT IF SLIP.	
PLOT TEMP	PLOT TEMP	

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Aug 30/2004 R

Experimentation with FLAC commands - attempt to modify FLAT.TXT from UDEC case 7.1.

Aug 31/2004 R

Further experimentation with FLAC commands - source term produces very high temperature increase - need to assess cause.

Sept 1/2004 R

FLAC treats source differently than UDEC. UDEC requires the operator to multiply the source term by the area of the block. FLAC takes the area into consideration automatically and does not require the operator to multiply source term by area. Source for Case 7.1 is therefore 2000 in FLAC.

Sept 2/2004 R

Modified UDEC input file FLAT.TXT to create UFLAT.TXT for UDEC, and FFLAT.TXT for FLAC. These modified input files are included on the following pages. Comparative plots from FLAC ~~and UDEC~~ R Sept 2/04 follow the input files. These are compared qualitatively to the plots on pages 52-58.

Some plots on pages 52-58 are clipped and therefore not representative of the complete displacement response. Note that FLAC does not contour to the edges of the grid ~~as~~ R Sept 2/04 for ZONE variables. A FISH routine could compensate for this shortcoming, but was not deemed necessary at this time.

SN654 Vol 1

```
; Flat transgressing joint in a heated
infinite rock mass
;
config thermal
;
; Geometry
;
grid 50 51
model elastic th_isotropic
mod null j=26
gen 0,0 0,50 100,50 100,0 i=1,51 j=1,26
gen 0,50 0,100 100,100 100,50 i=1,51 j=27,52
int 1 aside from 1,26 to 51,26 bside from 1,27
to 51,27
ini x=47.5 i=25
ini x=52.5 i=27
ini y=42.5 j=22
ini y=45 j=23
ini y=47 j=24
ini y=47.5 j=25
ini y=75 j=39
gen line 47.5,42.5 47.5,47.5 mark
gen line 47.5,47.5 52.5,47.5 mark
gen line 52.5,47.5 52.5,42.5 mark
gen line 47.5,42.5 52.5,42.5 mark
;
; Material properties
;
prop de=2210.0 b=19.0e9 s=13.0e9
prop thexp=15.0e-6 cond=20.0 spec=1000.0
int 1 kn=19.0e11 ks=13.0e11
int 1 c=1.0e20 f=0.0 t=1.0e20 di=0
;
; Initial conditions
;
ini tem 34.0
;
; Boundary conditions
;
apply yvel 0.0 j=1
apply yvel 0.0 j=52
apply xvel 0.0 i=1 j=1,26
apply xvel 0.0 i=1 j=27,52
apply xvel 0.0 i=101 j=1,26
apply xvel 0.0 i=101 j=27,102
;
; Apply heat source
;
interior source 2000 i=25,26 j=22,24
;
set mech on therm off
step 2000
ini xd 0
ini yd 0
ini xv 0
ini yv 0
;
; Thermal histories
;
hist temp i=26 j=23 ;1
hist temp i=26 j=24 ;2
hist temp i=26 j=27 ;3
hist temp i=26 j=31 ;4
hist temp i=26 j=39 ;5
hist temp i=26 j=52 ;6
;
; Mechanical histories
;
hist ydisp i=26 j=23 ;1
hist ydisp i=26 j=24 ;2
hist ydisp i=26 j=27 ;3
hist ydisp i=26 j=31 ;4
hist ydisp i=26 j=39 ;5
hist ydisp i=26 j=52 ;6
hist unbalanced ;7
hist thtime ; 8
;hist ndis 51 52 ;8
;hist sdis 51 52 ;9
;
; Thermal mechanical analysis
;
;
set mech off therm on
set thdt 1e2
solve age 100000
set mech on therm off
step 2000
set mech off therm on
solve age 200000
set mech on therm off
step 2000
set mech off therm on
solve age 300000
set mech on therm off
step 2000
set mech off therm on
solve age 400000
set mech on therm off
step 2000
set mech off therm on
solve age 500000
set mech on therm off
step 2000
set mech off therm on
solve age 600000
set mech on therm off
step 2000
set mech off therm on
solve age 700000
set mech on therm off
step 2000
set mech off therm on
solve age 800000
set mech on therm off
step 2000
set mech off therm on
solve age 900000
set mech on therm off
step 2000
set mech off therm on
solve age 1000000
set mech on therm off
step 2000
save f7ffinal.sav
;
set plot emf color
title
Case 7.1 Horizontal Transgressing Joint (FLAC,
No Slip Allowed)
;
set out f7fgrid.emf
set fore 15
plot gri green bou iw
copy
;
; Joint condition plots
;
set out f7fjnd.emf
set fore 15
plot if 1 ndisp
copy
;
set out f7fjsd.emf
set fore 15
plot if 1 sdisp
copy
```

R Sep 2/04

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FLAC Input file FFLAT.TXT for Case 7.1

```
;
set out f7fjss.emf
set fore 15
plot if 1 ss
copy
;
set out f7fjns.emf
set fore 15
plot if 1 ns
copy
;
; Contour plots
;
set out f7ftemp.emf
set fore 15
plot temp fill temp iw bou iw
copy
;
set out f7fdisp.emf
set fore 15
plot disp bou iw
copy
;
set out f7fxd.emf
set fore 15
plot xd fill xd iw bou iw
copy
;
set out f7fyd.emf
set fore 15
plot yd fill yd iw bou iw
copy
;
set out f7fsig1.emf
set fore 15
plot sig1 fill sig1 iw bou iw
copy
;
set out f7fsig2.emf
set fore 15
plot sig2 fill sig2 iw bou iw
copy
;
set out f7fsdif.emf
set fore 15
plot sdiff fill sdiff iw bou iw
copy
;
set out f7fthist.emf
set fore 15
plo hist 1 2 3 4 5 6 vs 14
copy
;
set out f7fydhist.emf
set fore 15
plo hist 7 8 9 10 11 12 vs 14
copy
;
set out f7funbal.emf
set fore 15
plo hist 13
copy
;
;set out 7jns.emf
;plo hist 8 9
;copy
;
ret
```

Sep 2/04.

Pg 2 of 2

Input file FFLAT.TXT
for FLAC Case 7.1


```
; Flat transgressing joint in a heated infinite rock mass
;
config thermal
set mech on
;
; Geometry
;
rou 0.001
bl 0,0 0,100 100,100 100,0
crack 0 50 100 50
crack 0 47.5 100 47.5
crack 47.5 42.5 47.5 47.5
crack 52.5 42.5 52.5 47.5
crack 0 42.5 100 42.5
gen quad 2.0
;
; Material properties
;
prop m=1 de=2210.0 k=19.0e9 g=13.0e9
prop jm=1 jkn=19.0e11 jks=13.0e11
prop jm=1 jcoh=1.0e20 jfric=0.0 jten=1.0e20 jd=0
prop m=1 thexp=15.0e-6 cond=20.0 spec=1000.0
;
; Initial conditions
;
initem 34.0 0 100 0 100
;
; Boundary conditions
;
bound yvel 0.0 range (0,100) (-0.1, 0.1)
bound yvel 0.0 range (0,100) (99.1, 100.1)
bound xvel 0.0 range (-0.1, 0.1) (0,100)
bound xvel 0.0 range (99.1, 100.1) (0,100)
;
; Apply heat source
;
thapp source 50000 0 range 47.5 52.5 42.5 47.5
;
set ovtol 0.5
step 4000
ini xd 0
ini yd 0
ini nd 0
ini sd 0
ini xv 0
ini yv 0
ini bxv 0
ini byv 0
ini brv 0
;
; Thermal histories
;
thist temp 50,45 ;1
thist temp 50,47 ;2
thist temp 50,50 ;3
thist temp 50,60 ;4
thist temp 50,75 ;5
thist temp 50,100 ;6
;
; Mechanical histories
;
hist ydisp 50,45 ;1
hist ydisp 50,47 ;2
hist ydisp 50,50 ;3
hist ydisp 50,60 ;4
hist ydisp 50,75 ;5
hist ydisp 50,100 ;6
hist unbalanced ;7
hist ndis 50 50 ;8
hist sdis 50 50 ;9
hist thtime ; 10
; Plot lines
;
set pline 0.000 50 100.000 50 100 ; 1
;
; Thermal mechanical analysis
;
;
damp auto
set nther 2500
set nmech 2000
run age 1000000 ;temp 50
;
save u7ffinal.sav
;
set plot emf color
title
Case 7.1 Horizontal Transgressing Joint (UDEC, No Slip
Allowed)
;
set out u7fgrid.emf
set color iw
plo zone green blo iw
copy
; Joint condition plots
;
set out u7fjnd.emf
set color iw
plot joint 0 50 100 50 ndisp 0.1
copy
;
set out u7fjsd.emf
set color iw
plot joint 0 50 100 50 sdisp 0.1
copy
;
set out u7fjss.emf
set color iw
plot joint 0 50 100 50 sstr 0.1
copy
;
set out u7fjns.emf
set color iw
plot joint 0 50 100 50 nstr 0.1
copy
;
; Contour plots
;
set out u7ftemp.emf
set color iw
plot temp fill temp iw blo iw
copy
;
set out u7fdisp.emf
set color iw
plot disp blo iw
copy
;
set out u7fxd.emf
set color iw
plot xd fill xd iw blo iw
copy
;
set out u7fyd.emf
set color iw
plot yd fill yd iw blo iw
copy
;
set out u7fsig1.emf
set color iw
plot sig1 fill sig1 iw blo iw
copy
;
set out u7fsig2.emf
set color iw
plot sig2 fill sig2 iw blo iw
copy
;
set out u7fsdif.emf
set color iw
plot sdiff fill sdiff iw blo iw
copy
;
set out u7fthist.emf
set color iw
plo thist 1 2 3 4 5 6
copy
;
set out u7fydhist.emf
set color iw
plo hist 1 2 3 4 5 6
copy
;
set out u7funbal.emf
set color iw
plo hist 7
copy
;
set out 7jns.emf
set color iw
plo hist 8 9
copy
;
; Plot lines
;
set out u7fpllss.emf
set color iw
plo pline 1 ss
copy
;
set out u7fpllns.emf
set color iw
plo pline 1 nstr
copy
;
set out u7fplld.emf
set color iw
plo pline 1 disp
copy

ret
```

Sept 2/04

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UDEC Input file ~~for~~ RC Cut Off UFLAT.TXT for Case 7.1

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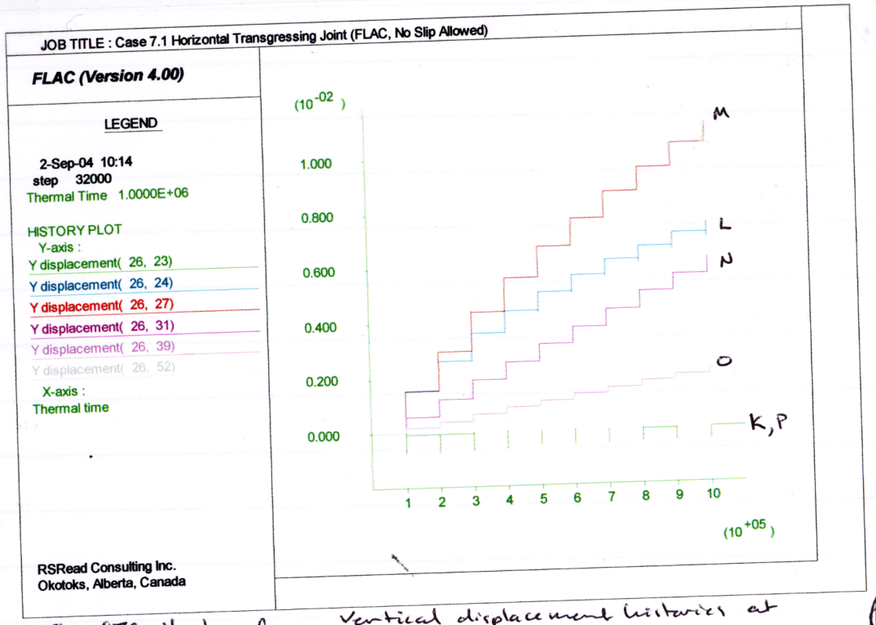
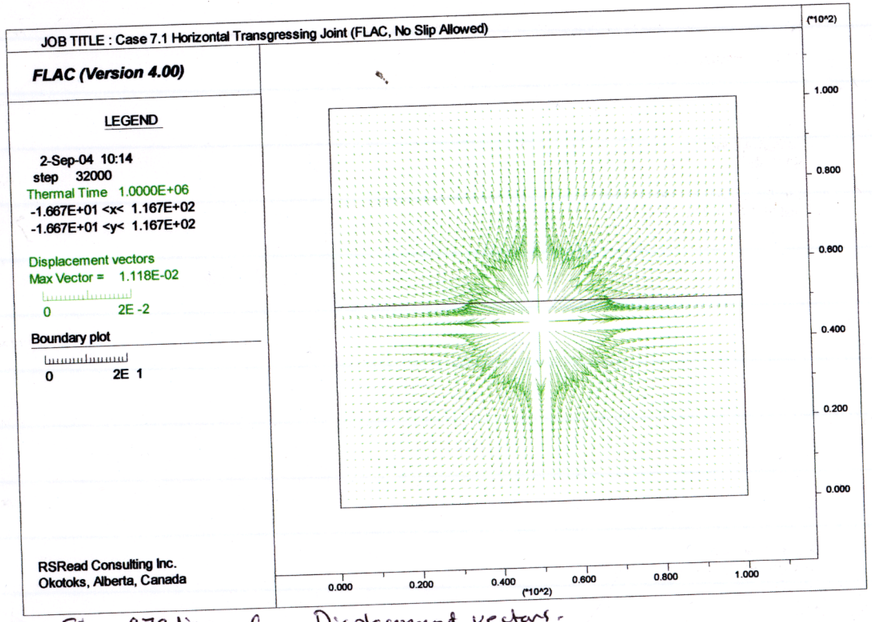


File f7fydhist.emf Vertical displacement histories at

SEP 2/04



File f7fdisp.emf Displacement vectors.

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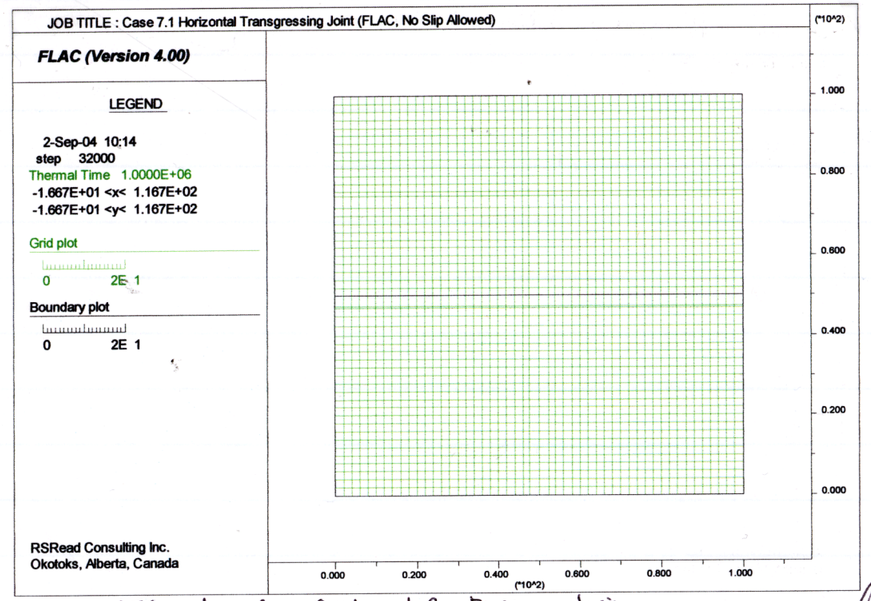
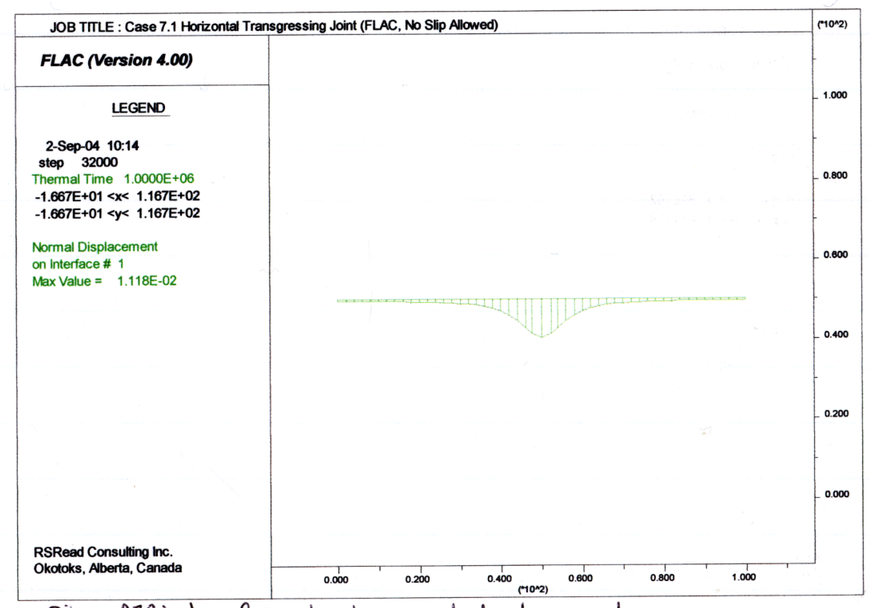


File f7fgrid.emf Grid used for FLAC analysis.

SEP 2/04



File f7fjnd.emf Joint normal displacement.

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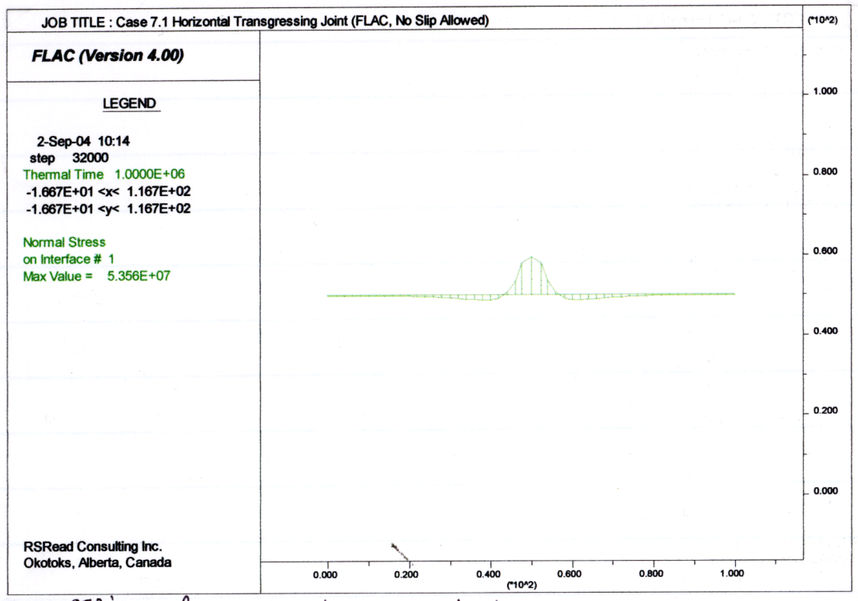
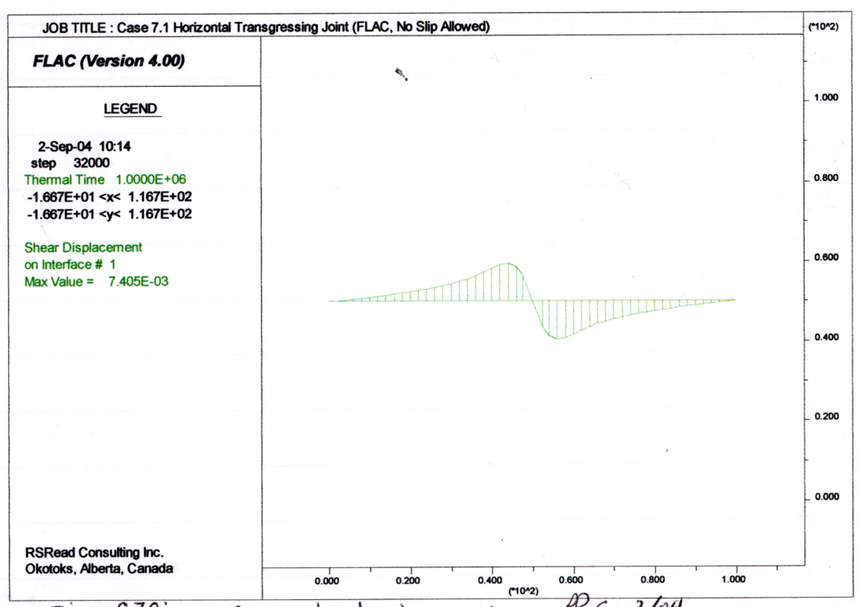


File f7fjns.emf Joint normal stress

RR Sep 2/04



File ~~f7fjss.emf~~ RR Sept 2/04 ~~Joint shear stress~~ RR Sep 2/04
f7fjsd.emf Joint shear displacement

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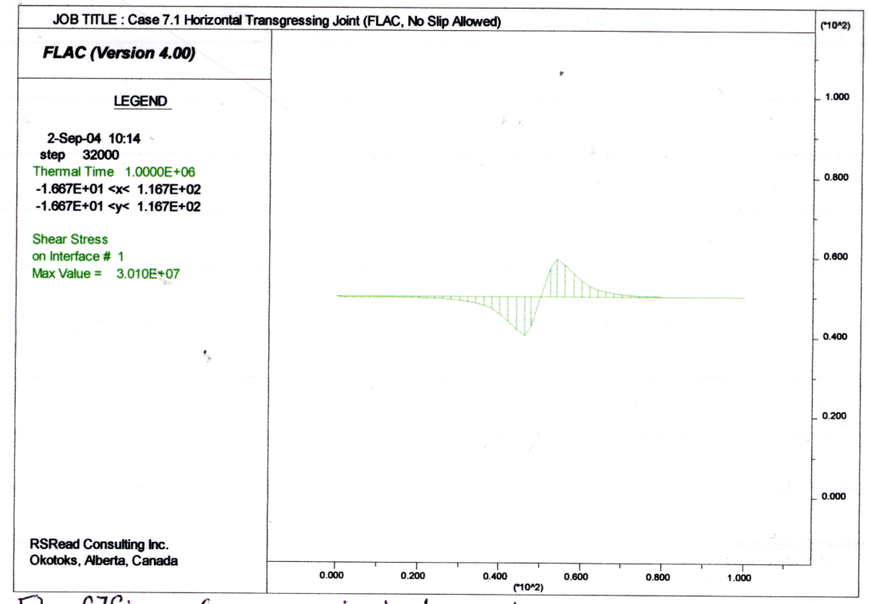
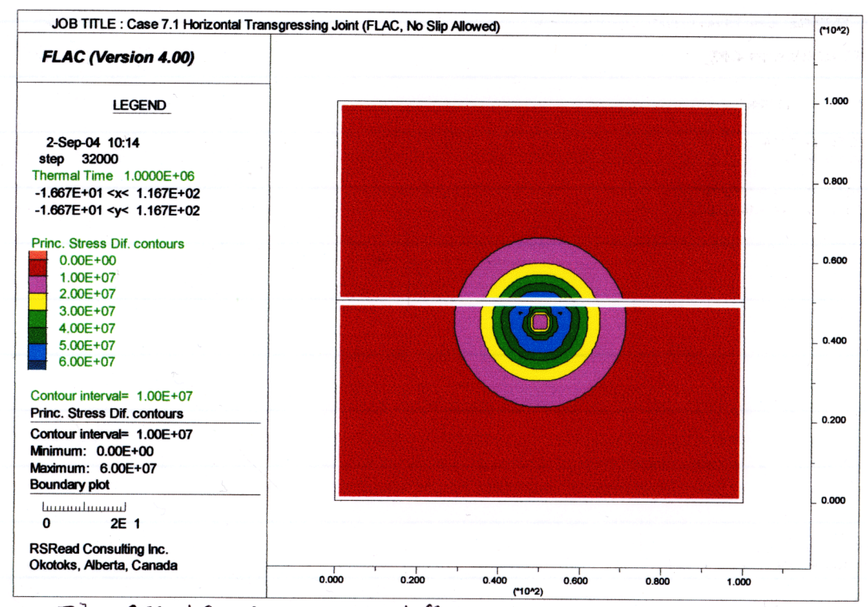


File f7fjss.emf Joint shear stress.

RR Sep 2/04



File f7fsdif.emf Stress difference contours.

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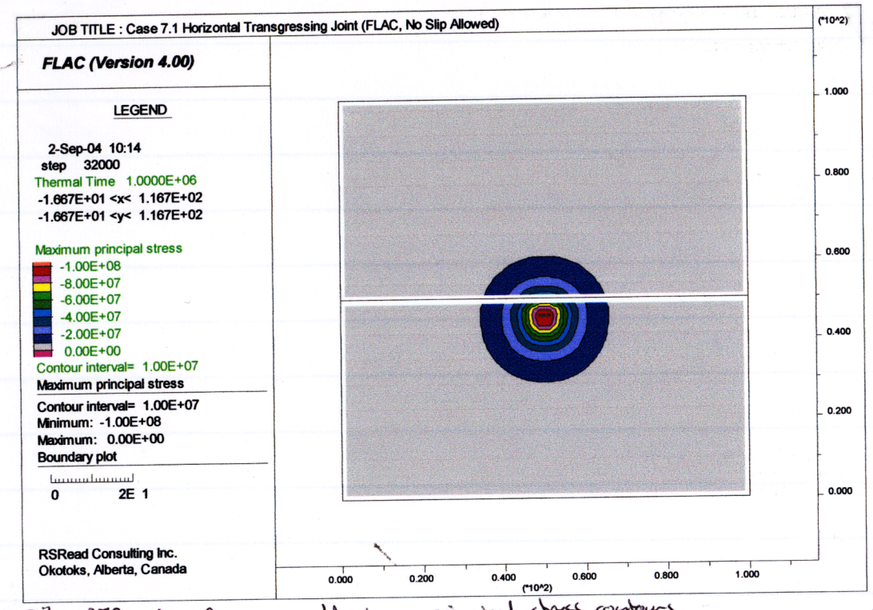
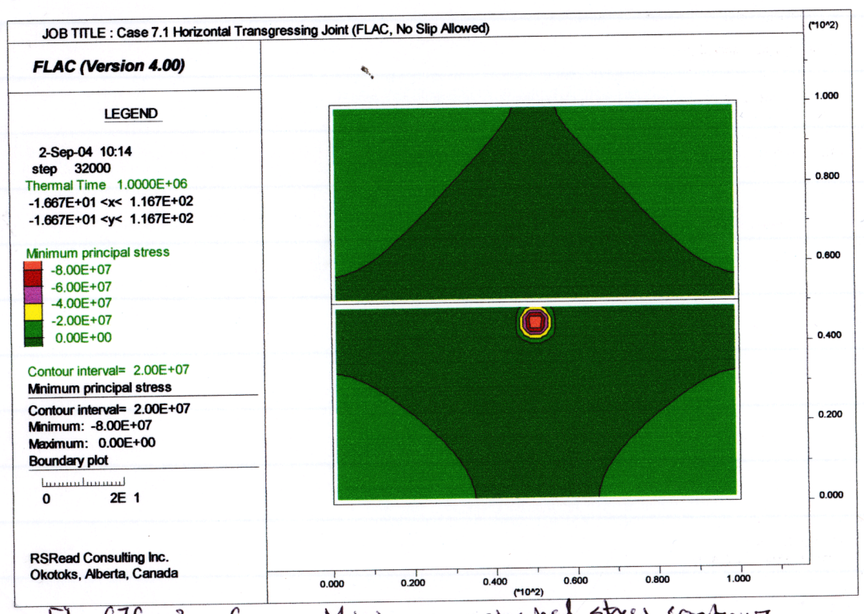


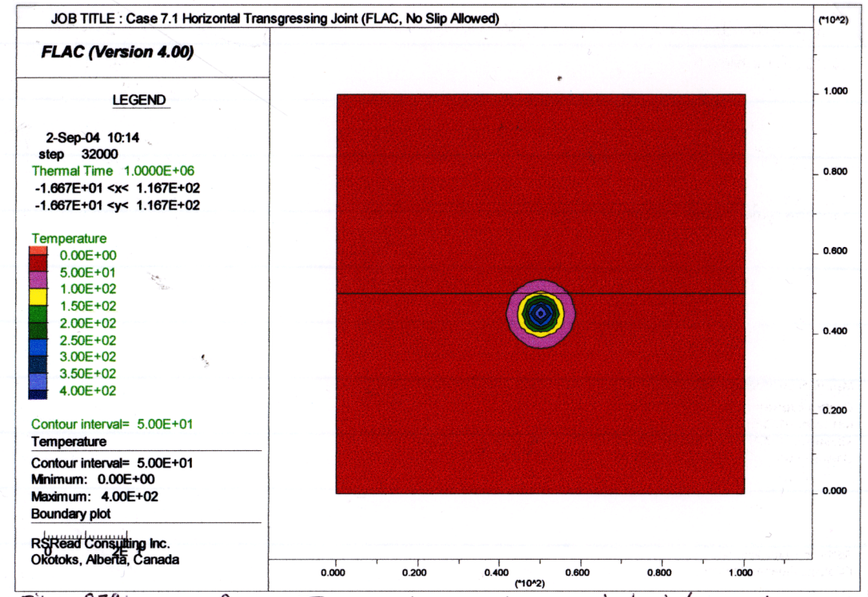
File f7fsig1.emf Maximum principal stress contours

Sept 02/04



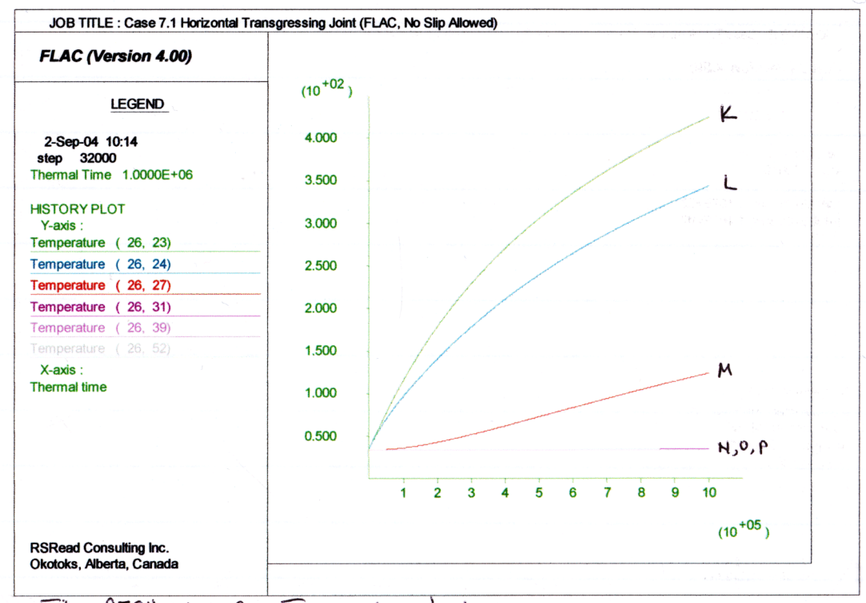
File f7fsig2.emf Minimum principal stress contours

SN 654 Vol 1

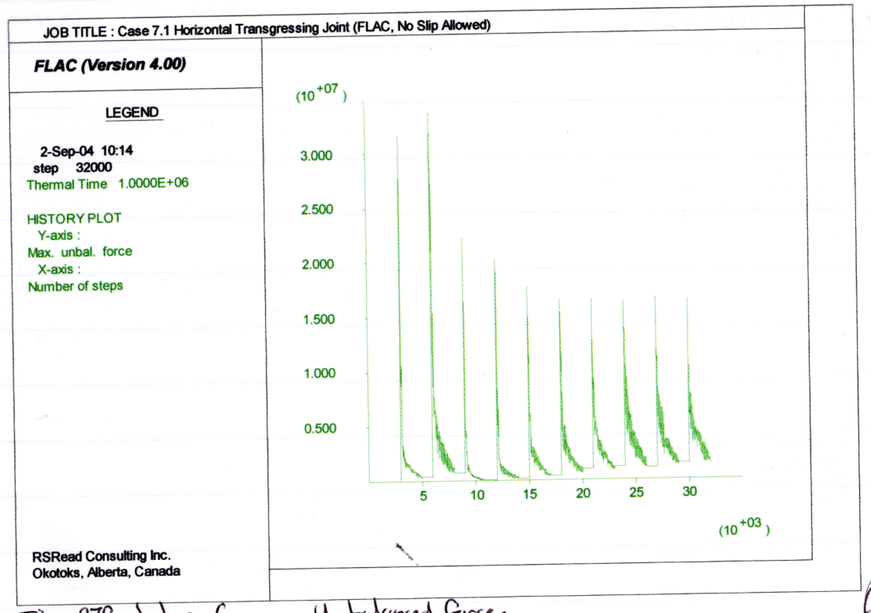


File f7ftemp.emf Temperature contours at t=1e6 seconds.

Sep 2/04

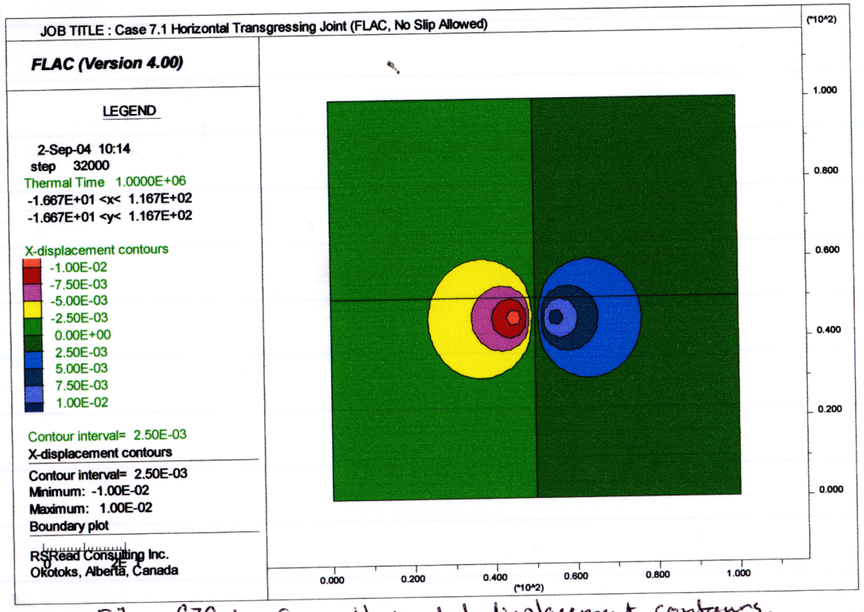


File f7fthist.emf Temperature histories.

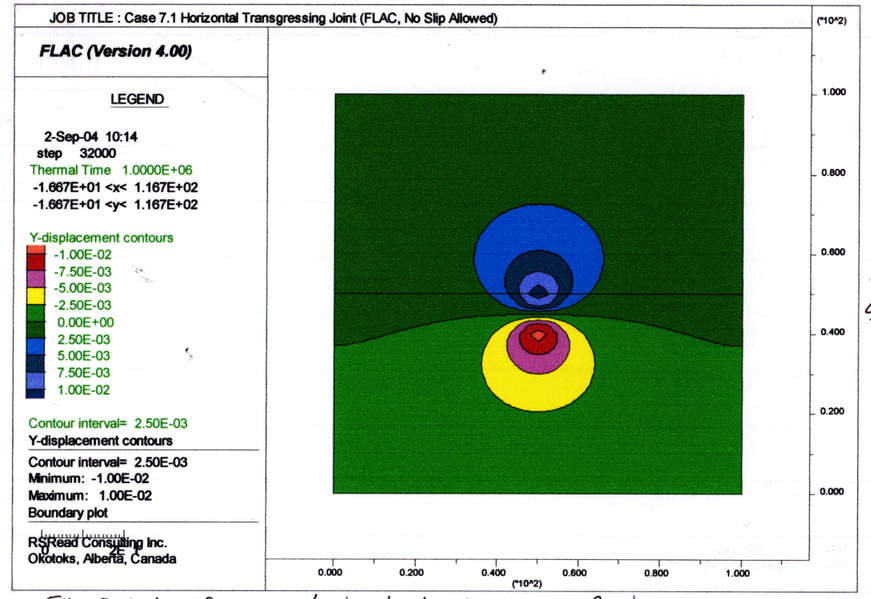


File f7funbal.emf Unbalanced force.

R Sep 2/04



File f7fxd.emf Horizontal displacement contours.



File f7fyd.emf Vertical displacement Contours.

R Sep 2/04

Sep 4/04. UDEC input file UFLAT.TXT was run to create the comparable plots in UDEC for Case 7.1. These are essentially the same plots as those on pages 52-58. Select plots of displacement and temperature are shown on the next pages.

The contour intervals and color schemes used for UDEC differ from those for FLAC. However, it is obvious that the same general trends develop in both codes in terms of temperature and displacement. The displacement contour plots suggest that the interface has very little effect in Case 7.1 in either FLAC or UDEC results.

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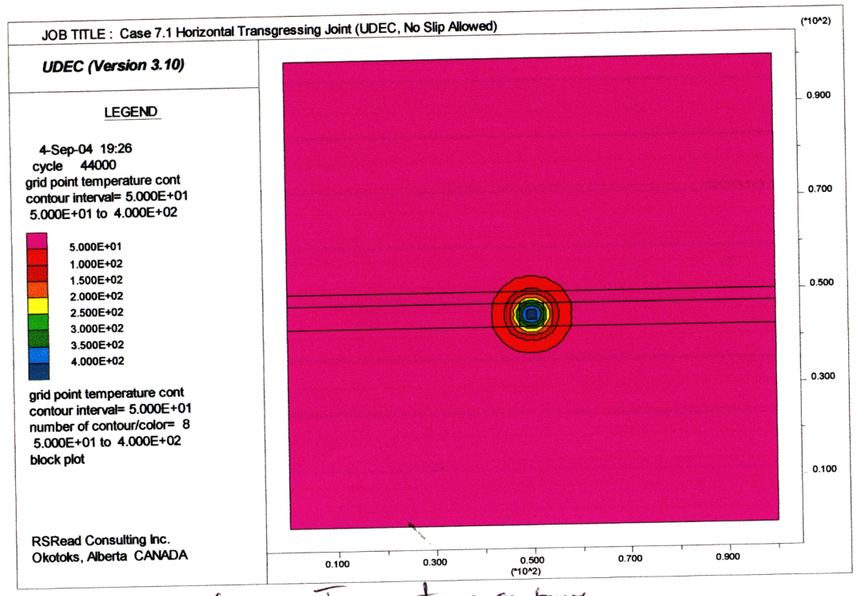

File u7ftemp.emf Temperature contours

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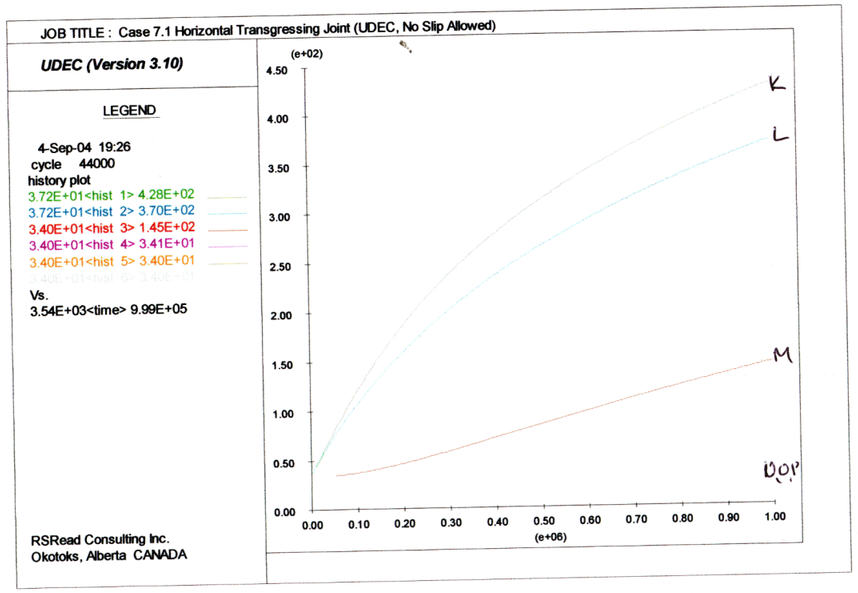

File u7fhist.emf Temperature histories

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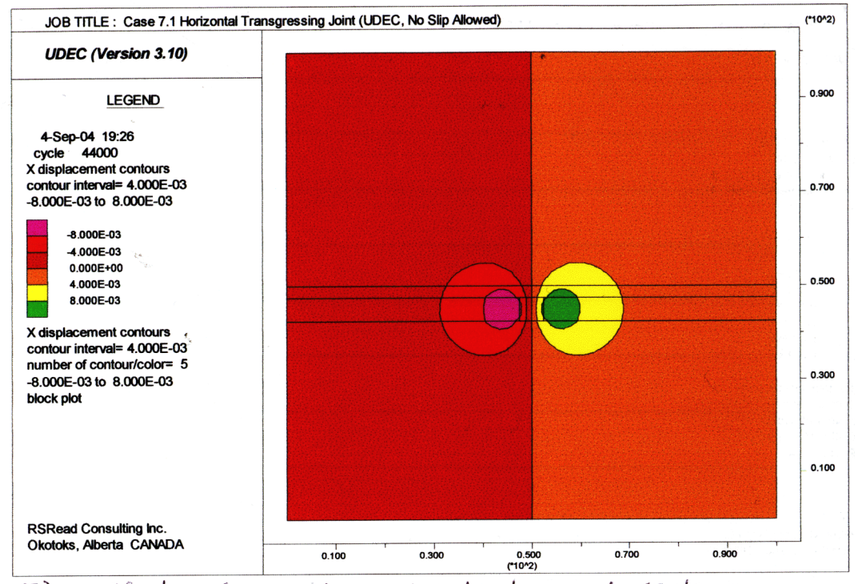
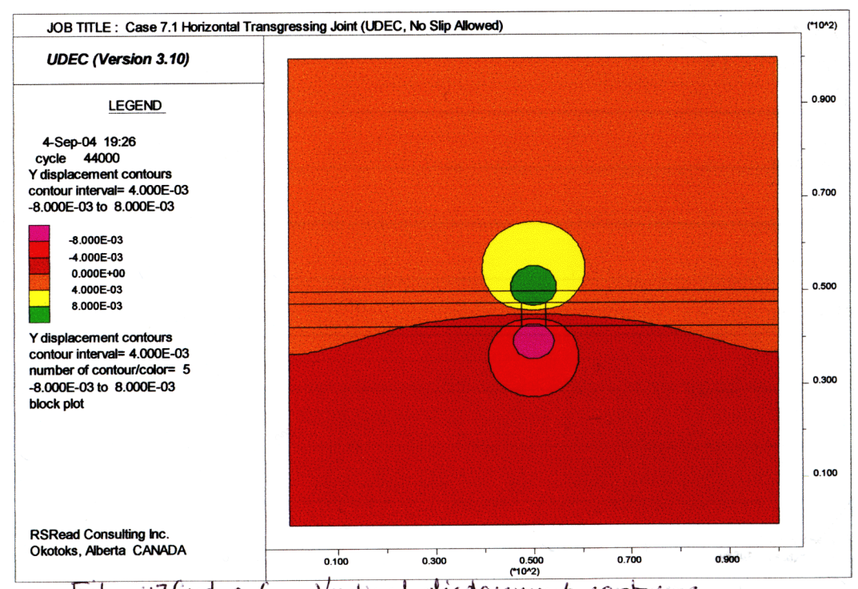


File u7fxd.emf Horizontal displacement contours

Sept 4/04



File u7fyd.emf Vertical displacement contours