Work continued from Page

doesn't look like Abaqus lets you embed do loops in an input deck
→ just make it in excel and then cut and paste it into the inp file

CJW

Oct 15, 2002

began write up of results
- single element tests
  - element description
  - material model
  - loading conditions

CJW

Oct 16, 2002

during write up - got frustrated w/ my single element results for axial tension
- unsure why initial chatter occurred at σ_y on first cycle
- ~~[illegible]~~ 7.2
- modified 7.2 so that it had a ~~smaller~~ time step smaller than initial calc
  - * dynamic, explicitly, fixed time incrementation, scale factor = 0.2
  - saved as 7.2b

⇒ chatter is virtually gone now
charts being updated + incorporated into write up

tried similar thing on 8.1 → at fixed incrementation + 0.2 multiplier ran as 8.1b
(added output too)
→ not changed on this wrt when the ~~[illegible]~~ spot welds failed

CJW

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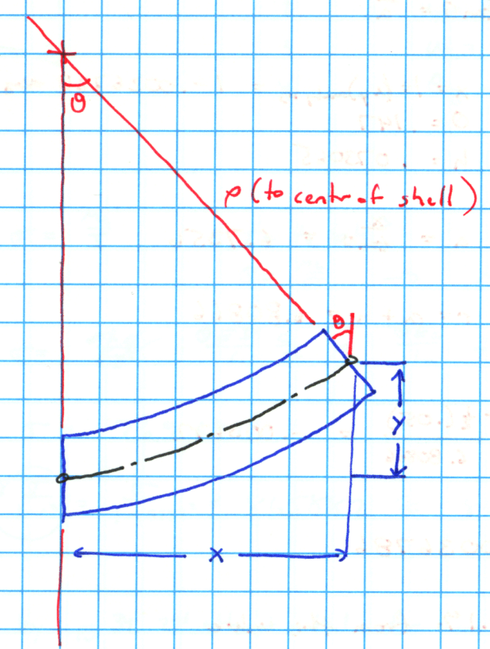
Oct 17, 2002

calc of theoretical bending strain for single shell element



$y = u_y$
$x = 1 + u_x$

from Machinery's Handbook $\rho_1 = \dfrac{(2x)^2 + 4y^2}{8y}$

$$\rho_2 = \frac{57.296\,(2)}{(2\theta)\left(\frac{180}{\pi}\right)} = \frac{\left(\frac{180}{\pi}\right)2}{2\theta\left(\frac{180}{\pi}\right)} = \frac{1}{\theta}$$

case 7.8 @ t = .0033

$u_x \Rightarrow (u_y)_{analysis} = -.002673$
$u_y \Rightarrow (u_z)_{analysis} = .073065$
$\theta \Rightarrow (\varphi_x)_{analysis} = .147$

$\rho_1 = 6.8432$
$\rho_2 = 6.8027$

$\epsilon_x = -\dfrac{\frac{1}{2}h}{\rho} = -.003675$ ~~don't look right~~

Exact agreement w/ Abaqus using ρ_2

Dyna had -.003562

Abaqus is log strain double check

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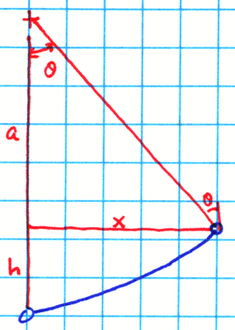
2nd attempt



$\tan\theta = \frac{x}{a}$

$x = 1 + (u_y)_{analysis} = 1 - .0026728$

$\theta = .147$

$h = .073065$

$a = \frac{x}{\tan\theta} = 6.7356$

$r = a + h = 6.80866$

$\epsilon_x = \frac{-\frac{1}{2}(t)}{r} = \frac{-\frac{1}{2}(.05)}{6.80866} = -.003672$

$\ln(1+\epsilon_x) = -.0036786$

Abaqus answer is < 0.1% from this value

Dyna ~ 3.17% lower than this

Erick's elastic analysis

$\theta = \frac{Mc}{EI}$

$\sigma = \frac{Mc}{I}$

elastic case: at $\theta = (.49)(.3)$

$(\sigma)_{normal} = 221{,}000$ psi

$(\sigma)_{Dyna} = 240{,}000$ psi

+8.6%

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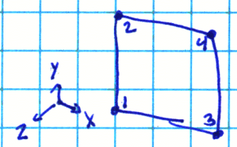

node	BC
1	all DOF = 0
2	$u_x = \theta_z = \theta_y = 0$
3	$u_y = u_z = \theta_x = \theta_y = \theta_z = 0$
4	$\theta_z = \theta_y = 0$

$\sigma = \frac{Mc}{I}$ $\quad I = \frac{1}{12} b h^3$

$\theta = \frac{Mc}{EI} \rightarrow M = \frac{\theta EI}{L}$

plane strain type correction

$\sigma = \frac{\theta EI}{L}\frac{c}{I} = \frac{\theta Ec}{L} = \frac{(.49)(1.0472)(30e6)(\frac{1}{2})(0.1)}{1.0}$

fact that we have wide plate rather than normal beam

$\sigma = 769{,}692$

[Rourke, p 184]

$\frac{\sigma}{1-\nu^2} = \frac{\sigma}{1-.3333^2} = 865882 \approx 865880$ from Abaqus

strain calc by pg 34 2nd attempt method for case 7.3 (elastic bending)

$x = 1 + -.032656$

$\theta = .51313$

$h = .25347$

$a = \frac{x}{\tan\theta} = 1.71675$ (A)

$r = a + h = 1.9702$ (B)

$\epsilon_x = \frac{-\frac{1}{2}(.1)}{1.9702} = -.025378$ (C)

$\ln(1+\epsilon_x) = -.025705$

Abaqus LE22 = -.025657 (~.2% diff)

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run case 8.3.2.inp [modified version of 8.3]
remove spot welds
remove contact surface
get disp at 4 corner nodes on 'slave' surface (4 elem)
run out to 0.25 sec

2 issues floating around right now
- failure of Dyna to exactly predict bending of single shell element (vs analytical soln)
- spot weld solution divergence on case 8.3 (biaxial rotation)

case 8.3.4 → t shell = 0.1"
z coord on "single" elem to be 0.41" instead of 0.0"

CJW

Oct 23, 2002
case 8.3.5 → modified 8.3.4
removed rotation bc
added moment of 833 lb-in to top center node
(~ 50 ksi bending stress)

makes it to about .32 seconds befor funcky out and becomes unstable
(Dyna fails ~ .62 sec)

what are we missing here???

8.3.5b → got rid of contact & spot welds
model only ran to ~.18 sec before excessive deformation observed

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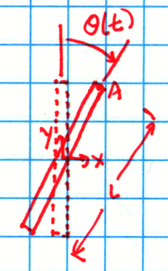
try reducing step size on 8.3.5
- * dynamic, explicit, fixed time incrementation, scale factor = 0.2
- save as 8.3.5c.inp

8.3.5c made it to .55 seconds before numerical instability occured
spot weld failure occured ~.24 seconds (slightly unchanged from 8.3.5)

BUT model was *VERY* distorted beyond ~.38 seconds

reran 8.3.5 w/ RF on "slave" surface nodes
all RFs = 0.0 → didn't give us anything

Issues: Bond Failure Time Under Applied Bending
vs Dyna fails much earlier than Abq for applied rotation
Abq fails much earlier for applied bending moment



location of A in cartesian x-y coord

$x = \frac{L}{2}\sin\theta$

$y = \frac{L}{2}\cos\theta$

} z displacement is very little for small rotations we were applying

take case 8.3.2 and apply bending only about x axis
save as 8.3.2b and re-run
↳ max rotation achieved was 1.57 radians (= 90 degrees)
↳ had time at 0.25 not 1.0
reran and results look good

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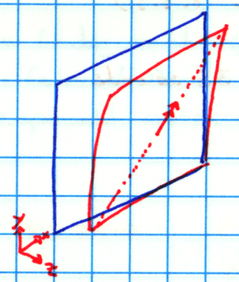
so rotations are getting into model correctly
⇒ why are there still variations between 2 codes?

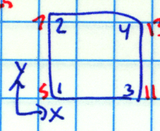


what generates a z displacement after final spot weld goes

CJW

Oct 28, 2002
modified unzipping model case 8.4 .inp
- rather than apply a uniform rotation go with a variation in weld strength

base plate nodes — weld strength (N)
- 1 — ~~10~~ 4.0
- 2 — ~~7.5~~ 2.0
- 3 — ~~5.0~~ .75
- 4 — ~~2.5~~ .25



- all shear strengths are ~~50~~ 10.6 lbs
- elastic material (base model = ~~unzip.inp~~ case 8.0.inp)
- $t = 0.1$
- moved master elem to 0.4" in z coord
- $F_{applied}$ = 8.0 lbs @ 1 sec + hold

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Oct 30
spot weld case 8.4 (variable weld strength)

going to 8 lbs at 1 sec, so at $t = .25$, an applied load of 2 lbs was exerted (2 welds would have failed)
both Dyna + Abaq show this to be the case
but weld at nodes 2 + 7 fail at diff times
~.28 sec for Abaqus
~.36 sec for Dyna
all other nodes fail at about same time

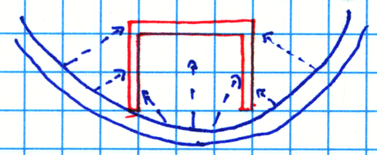
CJW

Nov 1, 2002
DIV 20
need to generate the input deck for case 2.4 given TrueGrid / Excel data
- input deck
- tracer pts

loading protocol will be forth coming - Erick in process of running a couple trial runs to see that we get "good" amount of def + most of spot welds fail

how to handle contact surface between channel + cylinder

--- possible deformed shape



define post neg channel surfaces:
* surface, name = bsurf, type = element
shell_el,

⇑ should solve the problem

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SIGNATURE DATE CJW (11/1/02)

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Nov 3, 2002

appears to be something wrong w/ spot weld definition in case 2.4.inp

get package.exe failure when running

- remove spot weld if it runs
- go through adding single spot welds sequentially (starting at 7937)

7937 ✓
8097 ✓
8737 ✓
8877 ✓
9036 ✓
9817 → FAILED } Failure in package.exe (omitted in future runs)
9196 → FAILED
9957 → FAILED

had to break out node set into 2 groups
7937-9036
9196-9957
⇒ worked like a charm

CJW

Nov 4, 2002

modify case 2.4.inp to have 5 integration pts
save as case 2.4b.inp & rerun to .0015 (just past weld failure in 2.4)

overall load history goes with spot welds is comparable
- Abaqus welds break earlier
- duration to failure is very comparable

CJW

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Nov 5, 2002

Abaqus EOS

- need to determine what Dyna means by the following EOS definition

$$p = C(\epsilon_v) + \gamma T(\epsilon_v) E$$

- similar to for U_s-U_p Hugoniot form

$$p = \frac{\rho_0 C_0^2 \eta}{(1-s\eta)^2}\left(1 - \frac{\Gamma_0 \eta}{2}\right) + \Gamma_0 \rho_0 E_m$$

nominal $\epsilon_{vol} \Rightarrow \eta = 1 - \frac{\rho_0}{\rho}$

if $s = \Gamma_0 = 0.0$, you get simple hydrostatic bulk response

received call from Abaqus that the spot weld issue discovered on Nov 3 is in fact a bug in the code
- Flower Mound office was able to reproduce my error on 6.2
  - 6.3 cleared the error and on to completion
- Abaqus has issued a bug on the feature and will address it

[redacted]

CJW

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Nov 13, 2002

case 4.2 → gravity load on can w/ 4 support pts

* dload
elset, grav, 386.4, -1.0, 0.0, 0.0

total applied load during gravity
- $\bar{D} = 10.0''$
- $h = 20''$

$A = 2\pi\left(\frac{\bar{D}}{2}\right)^2 + \pi \bar{D} h$

$A = \cancel{471.239\ in^2}$ 785.398 in^2

$\gamma = .284\ \frac{lb}{in^3}$

$W = \gamma A t = (.284)(\cancel{471.239}\ 785.398)(.1) = \cancel{13.38\ lbs}$ 22.73 lbs

needed to increase time to get quasi-static solution

CJW

Nov 14, 2002

case 4.2 → gravity loading using smooth amplitude out to .004 sec
not quasi static but reasonable

case	t_{max}	t_1 (end grav)	amp curve through t_1 (post t_1 = const)
4.2b	.003	.002	smooth
4.2c	.003	.002	ramp
4.2d	.005	.004	smooth
4.2e	.005	.004	ramp

CJW

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nf 6718 n 7598

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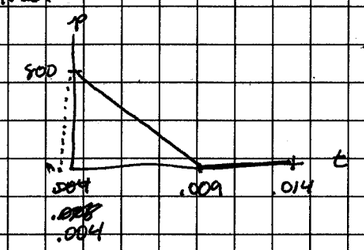
Nov 15, 2002

case 4.3
rigid wall + can
gravity load:
smooth curve 0 - ~~.008~~ .004 seconds
pressure load



pt A is at 0.00399 seconds

neg y side of neutral axis

elset	position	face	node	el
	0h	back (to wall)	2889	3305
	¼h		3428	3324
	½h		3868	3344
	¾h		7158	7064
	h		7598	7084
	0h	front	1284	1721
	¼h	(neg z dir	1844	1740
	½h		2284	1760
	¾h		6278	6184
	h		6718	6204

initial master node = (-.05, 0, -7.5) ← 10391

create new node = (-1.05, 0, -7.5) ← ~~10392~~ 13092

CJW

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Nov 18, 2002

remaining case 4 tasks

1) add concrete cylinder to driver
   A) verify material model
   B) added node/elem sets
2) soil wall
   A) verify semi-infinite elements
   B) add to model ← will be different from Dyna model

issues remaining

1) concrete modeling w/ EOS
2) semi-infinite elements

semi-infinite elements in Abaqus - Explicit

- In v6.2 documentation, EX problem 2.1.3 might be significant
  2.1.3 simulates a projectile impacting a plate
  - CIN3D8 elements are used around the perimeter
  - does not appear that boundary of ∞ nodes are "24" away from pole
  - need to try out simple example to see if I can get this to work

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA Work continued to Page

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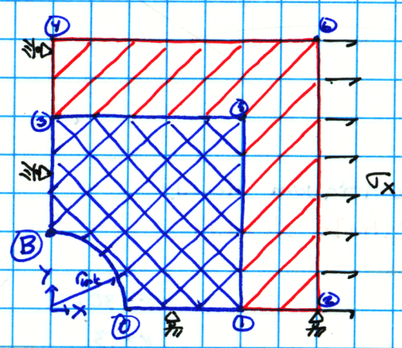
plate_w_hole_~~infinite~~_el_ex.inp ← rerun



solid continuum element

infinite elements

material $E = 30e6$

$\nu = .3$

$\rho = .000734$

σ_x = ~~30e6~~ psi 30 000 psi

plate: r_{hole} = 1.0 in t = 1.0"

plate_w_hole_inf_el_1.inp

pt	x	x
1	2	0
2 *	3	0
3	0	2
4 *	0	3
5	2	2
6 *	3	3

* these pts will be moved to determine if 2nd node affects solution at pt B

hole discretization → ~~40~~ elem along edge (center = ¼ × end)

~~40~~ elem along B-3, C-1 w/ ¼-1 bias

8 elements through thickness

1 element for ∞

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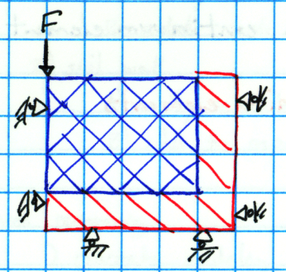
model is invalid – can't apply pressure/stress to infinite elements

⇒ adjust accordingly



continuum elements
infinite elements

$E = 30e6$
$\nu = .3$
$\rho = .00074$

continuum: 10" × 10" × 10"
infinite el: very thickness from 1" to 10"
pt_load.1.inp 1"
pt_load.5.inp 5"
pt_load.10.inp 10"

F = ~~20~~ 5,000 lbs (full load = ~~40~~ 20 000 #)

vertical stress $P_v = \frac{3Q}{2\pi z^2}$ [vertical stress according to Boussinesq eq directly beneath pt load]

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* get, per, Node, pta_node, S, eqv

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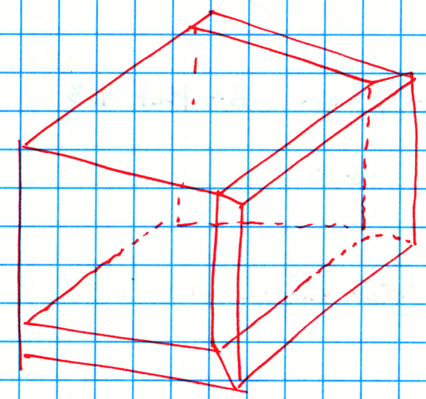
modify model so it looks like



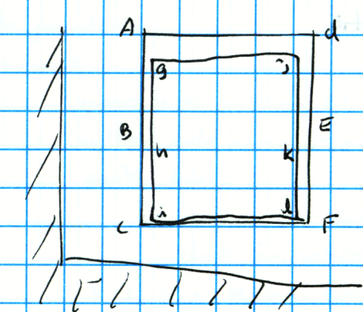
didn't work either

CJW

Nov 20, 2002

case ~~4.3~~ 4.4b

[redacted]



pt	node	el →	changed to
a	1918	1781	15221
b	988	846	14110
c	744	827	14091
d	1699	1581	15401
e	593	450	14466
f	343	431	14447
g	19659	12440	
h	12329	5620	
i	11229	5601	
j	7308	1201	
k	8628	1220	
l	16134	8040	

concrete
$E = 3.6e6$
$\nu = .3$
$\rho = 2.2e-4$

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loading applied to case 4.4B.inp
- gravity ~~yes~~
- lateral pressure

repeat 4.3 loading w/ lateral pressure 3x that 4.3

run was sent off and should finish ~3:30

very large oscillations observed
- high peak stresses on order of 0.5e6 psi observed
- need to rethink loading

CJW

Nov 21, 2002 [redacted]

loading options
1) reduce the magnitude of impulse but increase its duration
- induce "enough" rigid body motion to hit boundary
- other
2) keep current load + make materials inelastic
- harder to interpret results
3) how about just doing a drop test
- remove pressure loading all together

case 4.4d

remove gravity

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loads going into 4.4d are still way above yield (peak @ about 1e6 psi) can

case 4.4e.inp
- elastic perfectly plastic for the steel can
  - $(\sigma_y)_{true}$ = 45000 psi
  - ν = .3333
  - E = 30e6 psi
- maintain gravity (smoothly applied over 0.004 sec)
- apply following impulse type load

CJW

Nov 26, 2002

update presentation
- Case 4
  - appears to be problem w/ Dyna model
  - multiple nodes appear to get caught behind rigid wall after initial impact
  - possible fixes
    - smaller time steps
    - check for contact changes more often
  - don't have to use semi-infinite elements
    - on picture
    - not on table w/ features

CJW

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Dec 3, 2002

case 8.4

re-run case 8.4 with the following modifications

- base plate is moved by 1e-5 inches so there is initially a gap between the two plates [new z position = .39999]
- model saved as 8.49.inp

CJW

Dec 10, 2002

review meeting

case 2 - looks good

case 3 - clean

case 4 - 8 mm days

Jan 15

Goodlock - soil model

all elastic - single stiffness

$\delta = \ln\left(\frac{y_1}{y_2}\right)$

$\delta = 2\pi \xi / \sqrt{1-\xi^2}$ $\delta = 2\pi \xi$

idea of ξ of ~~dist~~ damping

$\delta = .012 \rightarrow \sim 1.2\%$ critical

double check value

case 5 - 2 mm days

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additional runs

1) see if I am in fact close to critically damped in 5.1m

- 5.1m.2 → 90% of 5.1m's α_R (= 282.6)
- 5.1m.3 → 110% of 5.1m's α_R (= 345.4)

CJW

Dec 30, 2002

case 4.4e comparison

- pt A hits wall at same time
- pt A releases from wall at same time
- pt C hits wall at diff time
- pt C slides up wall in Abaqus while Dyna just bounced off

→ same material inputs

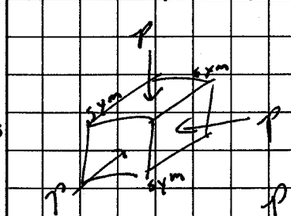
looks like

CJW

Jan 6, 2003

Holmquist/Johnson/Cook EOS (as per DA Cox's data - 7000 psi hi storm concrete)

HJC EOS - load + unload curve



P (dyne/cm²) →

0
1.6e8
0
1.6e8
8e9
0
8e9
6.47e10
0
1.11e11
0
1.47e11
0
2.28e11
0

incorrect

PA will check w/ his data + get back with us

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SIGNATURE DATE CJW (1/6/03)

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Jan 20, 2003

final report

- finish up case 8 rewards
- go through case 2 final

CJW

Jan 30 (CJW 1-30-03), 2003

meeting w/ PA, Erick, Assad, + myself

technical reviewers

- probably either doug or goodluck

Assad will check w/ Doug

got w/ Assad on available.

Div 20 still looking for street eng

run w/ EOS → concrete

mass damping issues

Dyna isn't critically damped @ 314 $\frac{lb}{sec}$

need to go to much high damping

- double check mass going into
- try single mass on spring

$\alpha = \frac{2\pi}{T}$ to see what is going on

see if closed form solutions can be matched here

stiffness damping

- drop it

flex to rigid conversion

validate against closed form solution

gravity load would be sufficient

add'l mat models

go w/ single test cate for

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Strain Rate Dependency in Abaqus

LS Dyna

$R_{LSD} = 1 + \left(\frac{\dot{\epsilon}}{C}\right)^{1/p}$

$\bar{\sigma} = R_{LSD}\,\sigma_0$

define material via following command

* Elastic
* Plastic

σ_y, ϵ_{pl}

⋮

* Rate Dependent

R_i, $\dot{\epsilon}^{pl}$

⋮

where $R_i = \frac{\bar{\sigma}_i}{\sigma_0}$

$\dot{\epsilon}^{pl}$ = equiv plastic strain rate

⇑

prefered option

Element Failure

two options look promising

* Shear Failure → remove elements when they exceed a certain ϵ level
  removal done as each integration pt exceeds level
  based on equiv plastic strain at failure
* Tensile Failure → failure based on hydrostatic pressure

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model definition for strain rate effect

excel file: strain_rate_def.xls

use mat def in case 6.3a as baseline

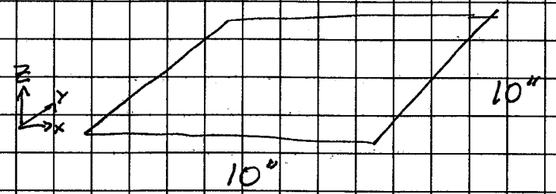
~~make it so R > 1 if $\dot{\epsilon}^{pl}$ > ~~ (CJW 1-30-03)

standard steel mechanical testing ~ .1 in/in/min

let $\dot{\epsilon}^{pl} \approx \dot{\epsilon} = \frac{\epsilon}{dt}$ $\qquad \epsilon_{ln} = \ln(1+\epsilon_{nom}) = \ln(1+\frac{\Delta L}{L})$

$dt = \frac{\epsilon}{\dot{\epsilon}^{pl}}$

shear failure



positive normal on elements going

CJW

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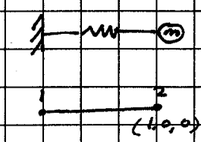
Jan 31, 2003

simple model to verify frequency



m = 1.0
K = 10
.1 initial extension on spring

spring defined by nodes 1+2
mass defined at node 2

T = 1.987
$\left(T = \frac{1}{\frac{1}{2\pi}\sqrt{\frac{K}{m}}}\right)$

* element, type = mass, elset = ____
....
* mass, elset =
#,

need to use Direct Time Incremental
step size of 10^{-6}

solution matched hand calc
sent it on to Erick for his review/confirmation

strain rate effect modeling
case 9.2 – base geometry 7.1

CJW

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(CW 3-4-03 (should have been Feb 4 2003)

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(CW 3-4-03 (should have been Feb 4, 2003 - CW)

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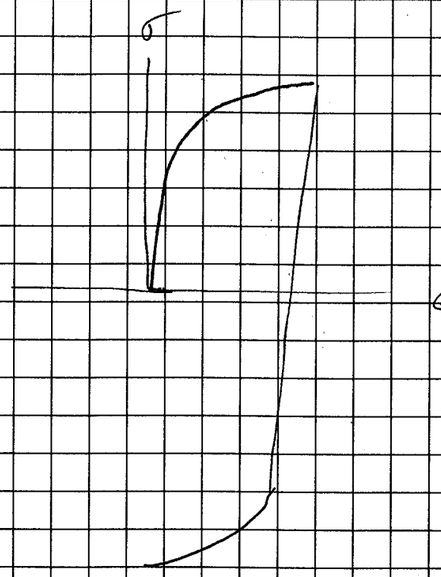
Feb 4, 2003

strain rate modeling
- matrix laid out in /case_9_strain_rate_material/strain_rate_mat_detmt.xls

case 9.2 - ~~strain rate~~ of
nominal strain rate $1 \frac{in}{in}$
~~log strain rate~~
~~$\ln\left(1+\frac{.25''}{1.00''}\right) =$~~ (CJW 2-4-03)



tabular strain rate effect *only* valid for isotropic hardening
- not a good approximation for what we are trying to do

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case 10 - strain failure model
using multilinear plasticity mat model, $t = .1''$, + all clamped bc

apply pressure load of $\frac{14}{20}$ (1300 psi) to model over .005 seconds
$\Rightarrow \sim 900$ psi

→ modifications to pressure loading

$t_{max} = .005$ sec

linear ramp to 750 psi

resulting model is case 10.1.inp

CJW

Feb 5, 2003
modified case 10.1 to have 9 integration pts through thickness - should help show strain failure better + offer better answer quality as well

strain rate effect issues
- want evenly spaced (or as much as possible) tabular data
  - if it is too irregular, Abaqus has problems
- Abaqus isotropic hardening does not include multilinear hardening *IF* perfectly plasticity has occurred
- case 9.3 ($100 \frac{in}{in}$/sec. strain rate) had spike at initial onset of plasticity probably need to resolve this but right now I'll leave it

CJW

Feb 12, ~~2002~~ 2003 (CJW 2-12-03)
spoke w/ Erick regarding to completion
- he needs to reduce Case 9 + 10 results
- add new case 5 results w/ damping
- he'll write up Case 4 to describe contact interaction search
- he'll double check w/ Doug about review process

should be on pg 61

CJW

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case 9 axial stress-strain curves

CJW

Feb 7, ~~2002~~ 2003 (CJW 2-7-03)

modify case 10.1 to add following element output

~~centrnod =~~
centrnod = 1301
centr_el = 1226
end_el = 1201
mid_el = 1214
~~end_el~~
endmidel = 601

back to case 9 → ~~what are the theoretical~~
need add'l data pts for each curve - insufficient to get E + actual onset of plasticity
add'l data pts highlighted the elastic modulus AND timestep issues for large strain rates during initial plasticity
run 9.3b which reduced base time step by factor of 0.2
most of noise eliminated by this action

case 3 effort summary
- initial model had 2 beams inside 2 cylinders
- Abaqus doesn't have beam - beam contact } only did cylinder w/ not beam
- Cyl - Cyl contact addressed in Case 2

- single beam example
- beam in cylinder

CJW

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Feb 12, ~~2002~~ 2003 (CJW 2-12-03)

notes added at bottom of pg 59
hopefully when I return next week, those tasks will be resolved
meet w/ Erick Wed morning to sort through this stuff

CJW

Feb 19, 2003

case 9 - double check yield pts
looks like I have too many slopes appearing
- should have elastic (E)
E_2 (45-53) } ish #s on yield stress
E_3 (53-66)
E_4 (66 → ∞)

case 10 - looks like Dyna is going an all or nothing on the failure (not progressive like Abaqus)

CJW

Feb 20, 2003

need to estimate strain rate for case 9.1

$$\dot{\epsilon}^{(x_0)} = \frac{1}{12h}\left[f(x_0-2h) - 8f(x_0-h) + 8f(x_0+h) - f(x_0+2h)\right]$$

don't go there yet

Abaqus provide an example where they ~~and~~ only had $\dot{\epsilon} = 0 + 1.0$
- this should 4 slopes as it should
- try re-running case 9.1 with only 2 sets + then 3 sets of strain rates
- reducing to only 2 strain rate plasticity models resulted in better agreement but nothing significantly better (still 5 slopes)

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re-run last model sent by Abaqus as 9.5 and see if it compares well to the solution in LS Dyna

CJW

March 7, 2003

meeting w/ Erick regarding remaining tasks
- he'll set w/ LSTC on strain failure stuff
- case 9, while not very explainable, will be submitted as 'done'
  - don't know if it is possible to determine why additional slope appears w/o ton of work including interpolation scheme implementation
  - agreement is not poor by any stretch
- next step will be to begin write up

CJW

April 1, 2003

look @ case 3 and start working thru chapter was complete

remaining write up on
- case 4 - need updated LS Dyna data
- case 5 - incorporate Erick's work
- case 9 - strain rate models
- case 10 - failure criterion

CJW

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April 20, 2003

continue write up

Case 3 - need to perform addl'd run on Case 3.0c → beam OD = .25

ID = ~~.10~~ .05 (CJW 4-20-03)

$r_o = \frac{.25}{2} = .125$

$t = \frac{1}{2}(.25 - .05) = .10$

CJW

June 11 2003 x2307

review meeting w/ RA, Erick, me, Dan + Asad

- goal - verify Dyna against Abaqus
  Abaqus has QA program so it is valid + correct
  Dyna doesn't have the
  impetus Dyna to Abaqus
- very, though "theme" that the baseline is Abaqus
  we're comparing Dyna to Abaqus not other way around
- code validation not model validation
- correct version: plan references Ansys 5.7 not Dyna 960
  justify why we did what we did
- need to add Abaqus run to deform to rigid model
- EOS model description - what is going on w/ Abaqus inputs
  are options there + could we correlate to Dyna

report is due on June 23rd

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document comments

sect 2:

2.3.12 - was *shell section or *shell general section used?
why one over the other?

*shell general section - defines linear moment-bending and force membrane-strain
stresses + strains are not available for output

*shell section - cross-sectional behavior calculated based on num integration

usage: *sgs → linear elastic
*ss → nonlinear material behavior

→ How does Dyna compare to these options?

3.4.1.7 - spot welds in Dyna
- appears as if rotations are coupled in Dyna
- not true in Abaqus

→ How does rotational restraint affect load going into spot weld?
- could this explain differences in failure time when shear is introduced?
- is bead size specified in Dyna?

4.3.1.5 - sensitivity of Abaqus runs to time step size
could just try sending it off again

5.3.2.1 - rigid analytical surface could be used in Abaqus but might probably sufficient to just state this option

general - how do we want to address issues of effort at defining mesh convergence and time scale?

6.5.2 - "solution drift"
effect of time scale
exist

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"Solution Drift" Investigation

rerun beam solutions in v6.3-1

3.2a → baseline model

3.2d → baseline + *Dynamic, Explicit, Fixed Time Incrementation, Scale Factor = 0.2

need to gather exicerd for v6.3 to get results post-processed

CJW

June 12, 2003

repeat time step investigation on inverted pendulum

use case 5.1m as baseline

5.1m4 → fixed time integration, sf = .2

5.1m time step: .25 sec in 220875 steps (~4 hrs)

5.1m4 time step:

CJW

June 24, 2003

case 1 convergence study results

- ~~post~~ 1 (CJW 6-24-03)
nodes at free
planar surface

- ~~post~~ 2 (CJW 6-24-03)
node at top center

- part
all nodes

- SS1M1
all elements

Analysis run	Analysis run	Top element model	Top element el	(ny x nz)
✓	✓	80x96	el.20	4157
✓	✓	40x48	el.21	1039
✓	✓	20x24	el.22	260
✓		160x192	el.23	16633

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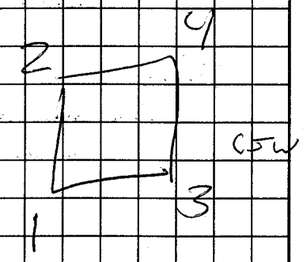
case 1 convergence study

displacement at $t = .005$ sec

model		Abaqus	Dyna
HZ0	1.22	-7.2025	-7.3185
HZ1	1.21	-8.4785	-8.6659
HZ2	1.20	-8.7857	-9.0719
HZ3	1.27	-8.8727	-9.3145



CFW

July 28, 2003

review comments on report by Duy

need to collect following input decks

- ✓ ✓ · 1.20
- ✓ ✓ · 3.0c
- ✓ · 3.2b – no equivalent analysis performed here – just Dyna deck on elem type
- ✓ ✓ · 4.4kb – corresponding Abaqus file is 4.4a (don't have 4.4kb)
- 5.1 series w/ 5.ϕ files sent to me ✓ · 5.ϕ } ✓ · 5.ϕ_{pd} } → 5.ϕ files in report are: 5.1m.2 (90%), 5.1m (100%), 5.1m.3 (110%)
- ✓ ✓ · 6.2
- ✓ ✓ · 7.#2
- ✓ ✓ · 7.4

3.2 → .4, .2 ← need to update Sect 4.1 model description for this geometry
↑ ↑ ↳ diff from complete model
OD ID

6.2 as well

same w/ Dyna · double check input decks on 7.2 – look closer to make sure they are correct

- case 3.0c inp → input deck says 600 psi
  doc says 800 psi ← typo in document

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- put all input decks w/ labels as per report
  - make something easy to read
- add standard acknowledgement page
  - check w/ PA
  - scratch notebooks, codes are under QA control procedure

CFW

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GEOSCIENCES AND ENGINEERING DIVISION

SCIENTIFIC NOTEBOOK REVIEW CHECKLIST RECORD

Scientific Notebook No. 601 Project Numbers: 20.06002.01.336

Accomplished

- [x] 1. Initial entries per QAP-001
- [x] 2. Dating of entries
- [x] 3. Corrections (crossed out, one line through w/initials/date)
- [x] 4. No White out used
- [x] 5. Page number visible on copy or original notebook
- [x] 6. In process entries per QAP-001
- [x] 7. Figure information present
- [x] 8. Text readable
- [x] 9. Copyrighted material is identified
- [x] 10. Permanent ink or type only
- [x] 11. Signing of entries (not required on each page)
- [x] 12. Electronic media in the scientific notebook properly labeled
- [x] 13. NRC Supplementary Scientific Notebook Questions are addressed.
- [x] 14. The independent, two person verification required by AP-019, Section 5.2.1.2(b) is complete

Any discrepancies must be resolved before notebook closeout.

==========

I have reviewed this scientific notebook and find it in agreement with QAP-001.

Manager's Signature 9-27-07 Date

Attach this completed form to the last page of the notebook.