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INGRID by Example A Pictorial Tutorial

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Lawrence
Livermore
National
Laboratory

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INGRID BY EXAMPLE A PICTORIAL TUTORIAL*

The following examples of **INGRID** input files and results are from various sources including Doug Stillman. In many cases, they are the same as in the examples section of the **INGRID** manual by Doug Stillman. I have made some modest improvements so that they are all complete input files to be run with the latest version of **INGRID**. These files have been attached to the front end of the **INGRID** source code as comments.

I wish to invite all **INGRID** user's to submit any favorite input files to be included in this tutorial. Such an input file should not be too large, and the object being generated should have a natural appeal to **INGRID** users. Feel free to make suggestions.

This tutorial will soon replace the examples section of the manual. The entire manual will be replaced a section at a time. I chose to do this section first, since it could give the most benefit in the shortest amount of time. As soon as I make **INGRID** interactive, I will then rewrite the section on standard parts.

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INGRID

Golden Gate Bridge Finite Element Model by Robert Rainsberger
Reference: The Golden Gate Bridge Final Report by R. Strauss

imple cube from a standard part with one element

n3d

part

2:1 2:1 2 :

2 1 2 1 2

nd

nd

simple cube from a standard part with sections deleted
dn3d
start 1 6 11 16 21;1 6 11 16 21;1 6 11 16 21;
1 2 4 8 16 1 2 4 8 16 1 2 4 8 16
di 1 2 0 4 5;1 2 0 4 5;1 2 0 4 5;
end end

```
simple example of a solid cylinder
dn3d
start
1 4 ; 1 37 ; 1 10 ;
1 2 0 360 1 14
cyl
end
end
```

telescoping cylinders

dn3d

start

1 2 3 4 5 6;1 37;1 4 7 10 13 16;

1 2 3 4 5 6 0 360 1 2 3 4 5 6

cyl i

d 2 0 5 3 0 6

d 3 0 4 4 0 6

d 4 0 3 5 0 6

d 5 0 2 6 0 6

end

end

```
simple solid sphere section  
dn3d  
start  
1 4:1 37:1 21;  
1.8 2 0 180 -80 80  
sphe  
end  
end
```

stair stepped spheres

11

dn3d

start

1 3 5 7 9 11 ; 1 37 ; 1 4 7 10 13 15 ;

1 1.1 1.2 1.3 1.4 1.5 0 180 0 15 30 45 60 75

sphe

d 2 0 1 3 0 2

d 3 0 1 4 0 3

d 4 0 1 5 0 4

d 5 0 1 6 0 5

lct 1 rxy ;

lrep 0 1 ;

end

end

```
simple circular plate  
dn3d  
start  
1 5 : 1 5 : -1 :  
-1 1 -1 1 0  
a 1 1 0 2 2 0 3 1.0  
end  
end
```

nicely zoned circular plate-solution #1

dn3d

start

1 3 7 9;1 3 7 9;-1;

-.5 -.5 .5 .5 -.5 -.5 .5 .5 0

d 1 1 0 2 2 0

d 1 3 0 2 4 0

d 3 1 0 4 2 0

d 3 3 0 4 4 0

a 1 1 0 4 4 0 3 1

end

end

nicely zoned circular plate-solution #2

dn3d

start

1 3 7 9;1 3 7 9;-1;

-.5 -.5 .5 .5 -.5 -.5 .5 .5 0

di 1 2 0 3 4;1 2 0 3 4;-1;

a 1 1 0 4 4 0 3 1

end

end

nicely zoned circular plate-solution #3

dn3d

start

1 3 7 9;1 3 7 9;-1;

-.5 -.5 .5 .5 -.5 -.5 .5 .5 0

d 1 1 0 2 2 0 + i 2 + j 2 + i -2

a 1 1 0 4 4 0 3 1

end

end

half circular plate - solution # 1

dn3d

start

1 3 5 7 9;1 3 5 7 9;-1;

-.5 -.5 0 .5 .5 -.5 -.5 0 .5 .5 0

d 1 2 0 4 5;1 2 0 4 5;-1;

a 1 1 0 5 5 0 3 1

d 1 0 0 3 0 0

end

end

half circular plate - solution # 2

dn3d

start

1 3 5;1 3 7 9;-1;

0 .5 .5 -.5 -.5 .5 .5 0

d 2 3;1 2 0 3 4;-1;

ac 3 0 0 3 0 0 3 0 0 0 1 0 0 1

ac 0 1 0 0 1 0 3 0 0 0 1 0 0 1

ac 0 4 0 0 4 0 3 0 0 0 1 0 0 1

end

end

quarter circular plate-solution #1

dn3d

start

1 3 5:1 3 5:-1;

0 .5 .5 0 .5 .5 0

d 2 2 0 3 3 0

ac 3 0 0 3 0 0 3 0 0 0 1 0 0 1

ac 0 3 0 0 3 0 3 0 0 0 1 0 0 1

end

end

quarter circular plate-solution #2

dn3d

start

1 3 5 7 9:1 3 5 7 9:-1;

-.5 -.5 0 .5 .5 -.5 -.5 0 .5 .5 0

di 1 2 0 4 5:1 2 0 4 5:-1;

a 1 1 0 5 5 0 3 1

d 1 0 0 3 0 0

d 0 1 0 0 3 0

end

end

circular plate with outer liner

dn3d

mat 1 1 e 1.1 pr 1.2

head

material example # 1

mat 2 10

g 1.3 sigy 1.4 eh 1.5 al 1.6 npts 3

es 3.3 3.4 3.5

eps 4.3 4.4 4.5

p 5.3 5.4 5.5

head

material example # 2

endmat

start

1 3 5 11 13 15 : 1 3 5 11 13 15 : -1 :

-.5 -.5 -.5 .5 .5 .5 -.5 -.5 -.5 .5 .5 .5 0

di 1 3 0 4 6 : 1 3 0 4 6 : -1 :

a 1 1 0 6 6 0 3 1.1

a 2 2 0 5 5 0 3 1

mate 2

mt 2 2 0 5 5 0 1

end

end

circular plate with hole - solution # 1

dn3d

start 1 3 : 1 21 : -1 :

1 1.5 0 360 0

cyl i

end end

circular plate with hole - solution # 2

dn3d

start 1 3 9 11 : 1 3 9 11 : -1 :

-1 -1 1 1 -1 -1 1 1 0

di 1 2 0 3 4 : 1 2 0 3 4 : -1 :

a 1 1 0 4 4 0 3 1.5

d 2 2 0 3 3 0

a 2 2 0 3 3 0 3 1

end end

```

hollow shell cylinder - solution # 1
dn3d
start -1;1 19;1 5;
1.5 0 360 0 2
cyli
end end

```

```

hollow shell cylinder - solution # 2
dn3d
start -1 -5;-1 -5;1 5;
-1 1 -1 1 0 2
a 1 1 0 2 2 0 3 1.5
end end

```

```

hollow shell cylinder - solution # 3
dn3d
start -1 -5;-1 -5;1 5;
-1 1 -1 1 0 2
sf 1 1 0 2 2 0 cy 0 0 0 0 1 1.5
end end

```

cylinder with stiffeners

19

dn3d

start 1 -3;1 19;-1 -5;

1.2 1.5 0 360 0 2

cyli

end end

```

plate with hole in it
dn3d
start 1 5 11 15;1 5 11 15;-1;
-1 -1 1 1 -1 -1 1 1 0
di 1 2 0 3 4;1 2 0 3 4;-1;
a : 1 0 4 4 0 3 3
d 2 2 0 3 3 0
mb 2 2 0 3 3 0 12 .75 .75
a 2 2 0 3 3 0 3 .5
enc end

```

square plate with hole

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dn3d

start 1 5 9 13;1 5 9 13;-1;

0 1 2 3 0 1 2 3 0

d 2 2 0 3 3 0

a 2 2 0 3 3 0 3 .75

end end

```
right triangle
dn3d
start 1 5 9;1 5 9;-1;
0 .3 1 0 .3 1 0
d 2 2 0 3 3 0
pa 2 3 0 12 .5 .5
pa 3 2 0 12 .5 .5
end end
```

square plate with hole

dn3d

start 1 5 9 13;1 5 9 13;-1;

-2 -2 2 2 -2 -2 2 2 0

di 1 2 0 3 4;1 2 0 3 4;-1;

d 2 2 0 3 3 0

a 2 2 0 3 3 0 3 1.1

end end

```

solid sphere
dn3d
start 1 3 5 7 9;1 3 5 7 9;1 3 5 7 9;
-2.5 -2.5 0 2.5 2.5 -2.5 -2.5
0 2.5 2.5 -2.5 -2.5 0 2.5 2.5
d1 1 2 0 4 5;1 2 0 4 5; ;
d1 1 2 0 4 5; ;1 2 0 4 5;
d1 ;1 2 0 4 5;1 2 0 4 5;
sf1 -1 -5;-1 -5;-1 -5;sp 0 0 0 5
d 1 0 0 3 0 0
end end

```

```
spherical shell - radius = 5.0  
dn3d  
start -1 5 -9;-1 5 -9;-1 5 -9;  
-1 0 1 -1 0 1 -1 0 1  
sf1 -1 -3;-1 -3;-1 -3;sp 0 0 0 5  
d 1 0 0 2 0 0  
end end
```

```

high spherical shell - r1 = 3.0, ro = 5.0
ln3d
start 1 3 5 7 9;1 3 5 7 9;1 3 5 7 9;
1 -1 0 1 1 -1 -1 0 1 1 -1 -1 0 1 1
di 1 2 0 4 5;1 2 0 4 5; :
di 1 2 0 4 5; :1 2 0 4 5;
di :1 2 0 4 5;1 2 0 4 5;
sf1 -1 -5;-1 -5;-1 -5;sp 0 0 0 5
sf1 -2 -4;-2 -4;-2 -4;sp 0 0 0 3
j 2 2 2 4 4 4
j 1 0 0 3 0 0
end end

```

solid cylinder with spherical end - radius = 5.0

dn3d

start 1 3 5 7 9;1 3 5 7 9;1 5 7 9;

-2.5 -2.5 0 2.5 2.5 -2.5 -2.5 0 2.5 2.5

-5 0 2.5 2.5

di 1 2 0 4 5;1 2 0 4 5; ;

di 1 2 0 4 5; ;3 4;

di ;1 2 0 4 5;3 4;

sfi -1 -5;-1 -5;1 2;cy 0 0 0 0 0 1 5

sfi -1 -5;-1 -5;2 -4;sp 0 0 0 5

d 1 0 0 3 0 0

end end

```

solid sphere with liner - r1 = 5.0, r2 = 5.5
dn3d
start 1 3 5 7 9 11 13;1 3 5 7 9 11 13;1 3 5 7 9 11 13;
-2.5 -2.5 -2.5 0 2.5 2.5 2.5
-2.5 -2.5 -2.5 0 2.5 2.5 2.5
-2.5 -2.5 -2.5 0 2.5 2.5 2.5
d1 1 3 0 5 7;1 3 0 5 7; ;
d1 1 3 0 5 7; ;1 3 0 5 7;
d1 ;1 3 0 5 7;1 3 0 5 7;
sf1 -2 -6:-2 -6:-2 -6:sp 0 0 0 5
sf1 -1 -7:-1 -7:-1 -7:sp 0 0 0 5.5
d 1 0 0 4 0 0
end end

```

cylinder with spherical cap²⁹ - radius = 5.0

dn3d

start -1 5 -9;-1 5 -9;1 5 -9;

-1 0 1 -1 0 1 -3 0 1

sfi -1 -3;-1 -3;1 2;cy 0 0 0 0 0 1 5

sfi -1 -3;-1 -3;2 -3;sp 0 0 0 5

d 1 0 0 2 0 0

end end

```

solid cylinder with spherical end and liner-r1=5.0,r2=5.5
dn3d
start
1 3 5 7 9 11 13;
1 3 5 7 9 11 13;
1 7 9 11 13;
-2.5 -2.5 -2.5 0 2.5 2.5 2.5
-2.5 -2.5 -2.5 0 2.5 2.5 2.5
-7.5 0 2.5 2.5 2.5
d1 1 3 0 5 7;1 3 0 5 7; ;
d1 1 3 0 5 7; :3 5;
d1 :1 3 0 5 7;3 5;
sf1 -2 -6;-2 -6;2 -4;sp 0 0 0 5
sf1 -1 -7;-1 -7;2 -5;sp 0 0 0 5.5
sf1 -2 -6;-2 -6;1 2;cy 0 0 0 0 0 1 5
sf1 -1 -7;-1 -7;1 2;cy 0 0 0 0 0 1 5.5
d1 0 0 4 0 0
end end

```

```

thick cylindrical shell with31 spherical cap-r1=3.0,ro=5.0
dn3d
start 1 3 5 7 9;1 3 5 7 9;1 5 7 9;
-1 -1 0 1 1 -1 -1 0 1 1 -2 0 1 1
di 1 2 0 4 5;1 2 0 4 5; ;
di 1 2 0 4 5; ;3 4;
di ;1 2 0 4 5;3 4;
sfi -1 -5;-1 -5;2 -4;sp 0 0 0 5
sfi -2 -4;-2 -4;2 -3;sp 0 0 0 3
sfi -1 -5;-1 -5;1 2;cy 0 0 0 0 0 1 5
sfi -2 -4;-2 -4;1 2;cy 0 0 0 0 0 1 3
d 2 2 1 4 4 3
d 1 0 0 3 0 0
end end

```

cylindrical shell with hole

dn3d

start -1 3 7 -9; -1 -9; 1 5 9 13;

-2 -1 1 2 -2 2 -3 -1 1 3

d 2 0 2 3 0 3

sf: -1 -4; -1 -2; :cy 0 0 0 0 0 1 2

sf: -2 -3; :-2 -3; cy 0 0 0 0 1 0 1

cp: 1 0 1 4 0 1 1 + k 3 1

end end

cylindrical shell with hole and transition region

```
dn3d
start -1 -7;-1 -7;1 4 10 13;
-1 1 -1 1 -3 -2 2 3
di ; -1 -2;2 3;
sfi -1 -2;-1 -2; ;cy 0 0 0 0 0 1 2
end
start 1 7 13 19;-1 -2;1 7 13 19;
-1 -1 1 1 -1 1 -2 -2 2 2
di 1 2 0 3 4;-1 -2;1 2 0 3 4;
sfi ; -1 -2; ;cy 0 0 0 0 0 1 2
d 2 0 2 3 0 3
sfi -2 -3; ; -2 -3;cy 0 0 0 0 1 0 .75
end end
```

spherical shell formed from a sheet
dn3d
start 1 4 10 13;1 4 10 13;-1;
-5 -5 5 5 -5 -5 5 5 0
pb 2 2 0 3 3 0 z 5
di 1 2 0 3 4;1 2 0 3 4; ;
sf 0 0 1 0 0 1 sp 0 0 0 5
end end

thick sperical shell formed from a sheet

dn3d

start 1 4 10 13; 1 4 10 13; 1 4;
-10 -10 10 10 -10 -10 10 10 0 0

pb 2 2 0 3 3 0 z 10

di 1 2 0 3 4; 1 2 0 3 4; ;

sf 0 0 1 0 0 1 sp 0 0 0 4

sf 0 0 2 0 0 2 sp 0 0 0 6

end end

cylinder with cylindrical cut out

in3d

start -1 5 -9;-1 5 -9;1 5 9 13;

-2 0 2 -2 0 2 -6 -2 2 6

1 2 0 2 3 0 3

sfi -1 -3;-1 -3; :cy 0 0 0 0 0 1 2

sfi -2 3; :-2 -3;cy 2 0 0 0 1 0 2

end end

solid cylindrical bar with cylindrical cut out

dn3d

start 1 5 7 9 13;1 5 7 9 13;1 5 9 13;

-1 -1 0 1 1 -1 -1 0 1 1 -6 -2 2 6

di 1 2 0 4 5;1 2 0 4 5; ;

d 3 0 2 5 0 3

sfi -1 -5;-1 -5; :cy 0 0 0 0 0 1 2

sfi -3 5; :-2 -3;cy 2 0 0 0 1 0 2

end end

spherical with a hole

dn3d

start -1 3 7 -9;-1 3 7 -9;1 -5;

-2 -1 1 2 -2 -1 1 2 0 2

sf1 -1 -4;-1 -4;1 -2; sp 0 0 0 3

d 2 2 0 3 3 0

sf1 -2 -3;-2 -3; ;cy 0 0 0 0 0 1 1

cpl 0 0 1 0 0 1 1 + s1j j

end end

bracket with hole

dn3d

start 1 4 9 12;1 5 8 13;1 4:

-1.5 -1 1 1.5 0 2 3 3 0 2

d 2 2 0 3 4 0

pb 0 4 0 0 4 0 xy 0 5

sf1 -2 -3;-2 4; :cy 0 3 0 0 0 1 1

sf1 -1 -4;3 4; :cy 0 3 0 0 0 1 1.5

sf 1 1 0 1 3 0 plan -1.5 0 0 1 0 0

sf 4 1 0 4 3 0 plan 1.5 0 0 1 0 0

cpl 1 1 0 1 3 0 j + i 3 j

end end

circular flange with hole

dn3d

start 1 5 9 13;1 3 7 9;1 4;

-1 -1 1 1 10 10 12 12 0 2

d 2 2 0 3 3 0

sf -2 -3;-2 -3; :cy 0 11 0 0 0 1 1

sf 0 1 0 0 1 0 cy 0 0 0 0 0 1 9

sf 0 4 0 0 4 0 cy 0 0 0 0 0 1 13

sf 1 0 0 1 0 0 pl3 rt 0 0 0 cy 1 110 0 rt 0 0 1 0

sf 4 0 0 4 0 0 pl3 rt 0 0 0 cy 1 70 0 rt 0 0 1 0

cpl 1 0 0 1 0 0 j + 3 j

end end

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```

spherical cap with hole and transition region
dn3d
start -1 -7;-1 -7;1 4;
-2 2 -2 2 0 2
sfi -1 -2;-1 -2; :sp 0 0 0 2
end
start 1 7 13 19 ; 1 7 13 19;-1;
-2 -2 2 2 -2 -2 2 2 2
di 1 2 0 3 4;1 2 0 3 4;-1;
sf 0 0 1 0 0 1 sp 0 0 0 2
d 2 2 0 3 3 0
sf 2 2 0 3 3 0 cy 0 0 0 0 0 1 1
end end

```

fel decoy by Gregg Mannell

dn3d lcd 1 3 0 1 1 10 2 0

parameter r2 22 r1 [%r2/sqrt(2)] delta 10;

mat 1 1 shell endmat

start -1 40 -41;-1 -21;-1 -21;

-100 95.4 100 -100 100 -100 100

mate 1 thic .0088 d 2 0 0 3 0 0

sfi -1 -3;-1 -2;-1 -2;sp 0 0 0 100

sf 2 0 0 3 0 0 cy 0 0 0 1 0 0 30 end

start -1;1 4 24 27;1 4 24 27;

95.4 [-%r1] [-%r1] %r1 %r1 [-%r1] [-%r1] %r1 %r1

di;1 2 0 3 4;1 2 0 3 4;

sfi;-1 -4;-1 -4;cy 0 0 0 1 0 0 30

sf 1 2 2 1 2 3 cy 0 %delta 0 1 0 0 [%r2+%delta]

sf 1 3 2 1 3 3 cy 0 [-%delta] 0 1 0 0 [%r2+%delta]

sf 1 2 2 1 3 2 cy 0 0 %delta 1 0 0 [%r2+%delta]

sf 1 2 3 1 3 3 cy 0 0 [-%delta] 1 0 0 [%r2+%delta]

sfi -1;1 4;1 4;sp 0 0 0 100

pr 0 0 0 0 0 0 1 1 0 0 0 0 end

end

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pipe bend with hole

dn3d

start -1 -9:1 15 23 37;-1 -9;

10 15 0 0 0 0 -2.5 2.5

rr 0 2 0 0 2 0 rz 35;

rr 0 3 0 0 3 0 rz 55;

rr 0 4 0 0 4 0 rz 90;

sf: -1 -2: ; -1 -2: ts 0 0 0 0 0 1 12.5 0 2.5

d: 2 2 2 3 2

end

start 1 9 17 25:1 9 17 25:-1;

10 10 15 15 0 0 0 0 2.5

mb 2 2 0 2 3 0 x 1

mb 3 2 0 3 3 0 x -1

rr 0 1 0 0 2 0 rz 35;

rr 0 3 0 0 4 0 rz 55;

di 1 2 0 3 4:1 2 0 3 4: ;

d 2 2 0 3 3 0

sf 0 0 1 0 0 1 ts 0 0 0 0 0 1 12.5 0 2.5

sf 2 2 0 3 3 0 cy 8.8375 8.8375 0 0 0 1 .5

end end

two pipes intersecting at 45 degrees

dn3d

sd 1 cy 0 0 0 0 0 1 2

sd 2 cy 0 0 0 0 1 1 2

start -1 -10;-1 -10;1 7 16 22;

-2 2 -2 2 -6 -2 2 6

d 0 2 2 0 2 3

mb 0 2 2 0 2 3 z 2

sfi -1 -2;-1 -2; :sd 1

sf 0 2 2 0 2 3 sd 2

end

start -1 -10;1 15;-1 -10;

-2 2 2 12 -2 2

rr 0 2 0 0 2 0 rx 45;

mb 0 1 0 0 1 0 z 2

sfi -1 -2; :-1 -2; sd 2

sf 0 1 0 0 1 0 sd 1

end end

three pipes intersecting

dn3d

sd 1 cy 0 0 0 0 0 1 2

sd 2 cy 0 0 0 0 .866 .5 2

sd 3 cy 0 0 0 0 .866 -.5 2

start -1 -11;-1 -11;1 6 11 16 21;

-2 2 -2 2 -6 -2 0 2 6

d 0 2 2 0 2 4

pb 0 2 3 0 2 3 y 0

sf 1 2 2 1 2 3 sd 3 + 1 1 sd 3

sf 1 2 2 2 2 2 sd 3

sf 1 2 3 1 2 4 sd 2 + 1 1 sd 2

sf 1 2 4 2 2 4 sd 2

sf -1 -2;-1 -2; :sd 1

end

start -1 -11;1 21;-1 6 -11;

-2 2 2 10 -2 0 2

rr 0 0 0 0 0 0 rx 30;

pb 0 1 2 0 1 2 y 0

sf 0 1 1 0 1 2 sd 3

sf 0 1 2 0 1 3 sd 1

sf 0 0 0 0 0 0 sd 2

sf 0 1 2 0 1 2 plan 0 0 0 0 0 1

coor 1 rxy;

lrep 0 1;

end end

bend sheet with fading bend⁴⁶

dn3d

ld 1 lp 2 5 0 5 1.5 lap 4.5 2 4.5 1.5

lap 4 2.5 4.5 2.5

lap 4.5 3 4.5 2.5

lap 5 3.5 4.5 3.5

lp 1 5 5

start 1 31:-1:1 16 31;

0 0 5 0 2.5 5

pb 2 0 0 2 0 0 xy 5 0

sf 0 0 1 0 0 1 cy 0 0 0 0 0 1 5

sf 0 0 2 0 0 2 er 0 0 2.5 1 0 0 4 5

sf 0 0 3 0 0 3 cy 0 0 0 0 0 1 5

sf 1 0 0 1 0 0 crz 1

end end

tube within a block

dn3d

start 1 5 11:1 11 21:1 11;

.088 .104 .228 0 45 90 0 .1435

sf 3 1 1 3 2 2 plan .228 0 0 1 0 0

sf 3 2 1 3 3 2 plan 0 .228 0 0 1 0

cyl 1 1 1 ryz:1 rep 0 1: end end

spherical bubble in block with ratio zoning
dn3d

48

parameter p1 10 p2 5 rs 1.4;
term 1 prti 100 plti .01 itss 1.0e-4
lcd 1 2 0 1 100000 1
mat 1 1 e 3.2 pr 17 ro 2.1
mat 2 1 e 3.2 pr 17 ro 2.1
endmat
eos 1 1 c0 0 c1 1 c2 2 c3 3
eos 2 1 c0 0 c1 1 c2 2 c3 3
endeos
sd 1 sp 0 0 0 2
sd 2 sp 0 0 0 1.5
plane 2 0 0 0 0 -1 .01 symm
0 0 0 -1 0 0 .01 symm

start
1 [1+%p1] [1+%p1+%p2];
1 [1+%p1] [1+%p1+%p2];
1 [1+%p1] [1+%p1+%p2];
0 4 4 0 4 4 0 4 4
d 0 2 2 0 3 3
d 2 0 2 3 0 3
d 2 2 0 3 3 0
d 0 0 0 2 2 2
res 2 1 1 3 2 2 i %rs
res 1 2 1 2 3 2 j %rs
res 1 1 2 2 2 3 k %rs
mate 1
pr 1 1 3 2 2 3 1 1 0 0 0
sf 1 1 2 2 2 2 sd 1
sf 1 2 1 2 2 2 sd 1
sf 2 1 1 2 2 2 sd 1
lct 1;ryz;lrep 0 1;
end
end

exploded view of a diaphragm made of shell elements

start

1 3 23 25;

1 3 23 25;

1 2 0 -3 0 4 10;

-.7 -.7 .7 .7

-.7 -.7 .7 .7

0 .05 0 1 0 2 2.3

di 1 2 0 4 5;1 2 0 4 5;1 7;

di 2 3;2 3;1 2 0 6 7;

sfi 2 3;-1 0 -4;1 7;cy 0 0 0 0 0 1 1

sfi -1 0 -4;2 3;1 7;cy 0 0 0 0 0 1 1

sfi 2 3;-2 0 -3;1 7;cy 0 0 0 0 0 1 .9

sfi -2 0 -3;2 3;1 7;cy 0 0 0 0 0 1 .9

end

end

```

channel
nk3d
mat 1 1
e 1.
pr 1.
shell
endmat
start
1 53:-1 -10:-1 0 -2 -11;
0 2.65 0 .5 0 0 .25 .5
pb 0 1 4 0 1 4 y .1
pb 0 2 4 0 2 4 y .4
pb 0 1 3 0 1 3 y .05
pb 0 2 3 0 2 3 y .45
thic .2
mate 1
end
start
1 53:-1 0 -2:-1 -10;
0 2.65 0 0 .5 0 .25
pb 0 1 2 0 1 2 y .05
pb 0 3 2 0 3 2 y .45
thic .4
mate 1
end
end

```

tiger cask by Gus Aramayo

dn3d87

c delta - offset for interior cylinder surface of part 1

c rad - radius of interior cylinder surface

c th - gap between cylinder container and other parts

c sth - shell thickness of cylinder

c bth - box thickness

parameter delta 2 rad [%delta+6] th .125 sth .25 bth 1;

si 1 sv; c top of box and top of foam

si 2 sv; c bottom of box and bottom of foam

si 3 sv; c left of box and foam

si 4 sv; c right of box and foam

si 5 sv; c front of box and foam

si 6 sv; c back of box and foam

si 7 sv; c between two halves of box

si 8 sv; c between two halves of foam

si 9 sv; c front cap and front foam

si 10 sv; c back cap and back foam

si 11 sv; c between cylinder and foam

si 12 sv; c front cap and contents

si 13 sv; c back cap and contents

si 14 sv; c between cylinder and contents

sd 1 cy 0 0 0 0 1 8

sd 2 sp 0 0 [14+%th] [8-%th]

sd 3 sp 0 0 [86-%th] [8-%th]

sd 4 cy 0 0 0 0 1 [8-%th]

sd 5 sp 0 0 14 8

sd 6 cy 0 0 0 0 1 [8+%th]

mat 1 3 shell c container

mat 2 3 c contents

mat 3 3 c wood

mat 4 3 endmat c foam

velocity 0 0 [sqrt(386.4*360)]

plane 1 0 0 100 0 0 1 .001 ston

start -1 -7;-1 -7;1 45;-8 8 -8 8 6 94 c cylinder

sii- -1 -2;-1 -2;;11 m 0 0 50 sii+ -1 -2;-1 -2;;14 m 0 0 50

thic %sth mate 1 sfi -1 -2;-1 -2;;sd 1 end

start 1 5 11 15;1 5 11 15;-1;-8 -8 8 8 -8 -8 8 8 0 c cylinder cap

sf 2 2 0 3 2 0 cy 0 %delta 0 0 0 1 %rad

sf 2 3 0 3 3 0 cy 0 [-%delta] 0 0 0 1 %rad

sf 2 2 0 2 3 0 cy %delta 0 0 0 0 1 %rad

sf 3 2 0 3 3 0 cy [-%delta] 0 0 0 0 1 %rad

mate 1 thic %sth di 1 2 0 3 4;1 2 0 3 4;;

sf 1 0 0 1 0 0 sd 1 sf 4 0 0 4 0 0 sd 1

sf 0 1 0 0 1 0 sd 1 sf 0 4 0 0 4 0 sd 1 sf 0 0 0 0 0 0 sd 5

si- 0 0 0 0 0 0 10 m 0 0 50 si+ 0 0 0 0 0 0 13 m 0 0 50 end

start 1 5 11 15;1 5 11 15;-1;-8 -8 8 8 -8 -8 8 8 0 c cylinder cap

sf 2 2 0 3 2 0 cy 0 %delta 0 0 0 1 %rad

sf 2 3 0 3 3 0 cy 0 [-%delta] 0 0 0 1 %rad

sf 2 2 0 2 3 0 cy %delta 0 0 0 0 1 %rad

sf 3 2 0 3 3 0 cy [-%delta] 0 0 0 0 1 %rad

mate 1 thic %sth di 1 2 0 3 4;1 2 0 3 4;;

sf 1 0 0 1 0 0 sd 1 sf 4 0 0 4 0 0 sd 1

sf 0 1 0 0 1 0 sd 1 sf 0 4 0 0 4 0 sd 1 sf 0 0 0 0 0 0 sd 5

si- 0 0 0 0 0 0 9 m 0 0 50 si+ 0 0 0 0 0 0 12 m 0 0 50

lct 1;rxz mz 100;lrep 1;end

start 1 3 6 9 11;1 3 6 9 11;1 3 5 15 17 19; c material in cylinder

-8 -8 0 8 8 -8 -8 0 8 8 10.5 10.5 [14+%th] [86-%th] 89.5 89.5

```

di 1 2 0 4 5;1 2 0 4 5;1 3 0 4 6;di 2 4;1 2 0 4 5;1 2 0 5 6; 52
di 1 2 0 4 5;2 4;1 2 0 5 6;mate 2 sli -1 -5;-1 -5;3 4;1 4 s
si 2 2 6 4 4 6 12 s sli -1 -5;-1 -5;4 5;12 s
si 2 2 1 4 4 1 13 s sli -1 -5;-1 -5;2 3;13 s
sfi -1 -5;-1 -5;3 4;sd 4 sfi -1 -5;-1 -5;1 3;sd 2 sfi -1 -5;-1 -5;4 6;sd 3
sf 2 2 1 4 4 1 sd 2 sf 2 2 6 4 4 6 sd 3 pb 2 2 2 4 2 5 y -3
pb 2 4 2 4 4 5 y 3 pb 2 2 2 2 4 5 x -3 pb 4 2 2 4 4 5 x 3 end
start 1 5 6;1 2 13 14;1 2 40 41; c upper half of box
0 9 [9+%bth] [-12-%bth] -12 12 [12+%bth] [-%bth] 0 100 [100+%bth]
mate 3 d 1 2 2 2 3 3 sw 0 0 4 0 0 4 1
si 2 2 2 2 3 3 1 m si 1 2 2 2 2 3 3 m si 1 3 2 2 3 3 4 m
si 1 2 3 2 3 3 5 m si 1 2 2 2 3 2 6 m si 1 0 0 1 0 0 7 m end
start 1 5 6;1 2 13 14;1 2 40 41; c lower half of box
0 9 [9+%bth] [-12-%bth] -12 12 [12+%bth] [-%bth] 0 100 [100+%bth]
si 2 2 2 2 3 3 2 m si 1 2 2 2 2 3 3 m si 1 3 2 2 3 3 4 m
si 1 2 3 2 3 3 5 m si 1 2 2 2 3 2 6 m si 1 0 0 1 0 0 7 s
d 1 2 2 2 3 3 sw 0 0 4 0 0 4 1 mate 3 lct 1;ryz;lrep 1;end
start 1 4 5;1 2 8 9;1 3 13 15;0 9 9 -12 -12 12 12 0 6 9 4 100 c upper foam
di 2 3;1 2 0 3 4;1 3;d 1 2 2 2 3 3 mate 4
pb 2 2 0 2 3 0 x 8 pb 1 2 0 2 2 0 y -8 pb 1 3 0 2 3 0 y 8
sfi 1 2;-2 -3;2 3;sd 6 sf 2 2 2 2 3 3 sd 6 si 3 0 0 3 0 0 1 s
si 0 1 0 0 1 0 3 s si 0 4 0 0 4 0 4 s si 0 0 4 0 0 4 5 s
si 0 0 1 0 0 1 6 s si 1 0 0 1 0 0 8 m si 1 2 3 2 3 3 9 s
si 1 2 2 2 3 2 10 s si 2 2 2 2 3 3 11 s sli 1 2;-2 -3;2 3;11 s end
start 1 4 5;1 2 8 9;1 3 13 15;0 9 9 -12 -12 12 12 0 6 9 4 100 c lower foam
di 2 3;1 2 0 3 4;1 3;d 1 2 2 2 3 3 mate 4
pb 2 2 0 2 3 0 x 8 pb 1 2 0 2 2 0 y -8 pb 1 3 0 2 3 0 y 8
sfi 1 2;-2 -3;2 3;sd 6
sf 2 2 2 2 3 3 sd 6 si 1 0 0 1 0 0 2 s si 0 1 0 0 1 0 3 s
si 0 4 0 0 4 0 4 s si 0 0 4 0 0 4 5 s si 0 0 1 0 0 1 6 s
si 1 0 0 1 0 0 8 s si 1 2 3 2 3 3 9 s si 1 2 2 2 3 2 10 s
si 2 2 2 2 3 3 11 s sli 1 2;-2 -3;2 3;11 s lct 1;ryz;lrep 1;end
bptol 6 8 -1 bptol 1 2 .35 bptol 1 3 .35 end c use stp .001 to merge

```

```
moebius strip  
start 1 11;1 2;1 181;-1 1 -.05 .05 0 0  
edit  
cyli  
y=y+k  
cart  
x=x+4  
ycyli  
x=k*2  
end  
end
```

```
strut
```

```
dn3d
```

```
sd 1 cone 0 0 0 0 0 1 0 35.311
sd 2 cone 0 0 0 0 0 1 5.667 -35.311
sd 3 cone 0 0 0 0 0 1 .75 35.311
sd 4 cone 0 0 0 0 0 1 6.417 -35.311
sd 5 plan 0 0 0 0 0 1
sd 6 plan 0 0 8 0 0 1
```

```
start
```

```
1 2 6 7 8;1 3 5 6 8 10;1 3 4 6 7 9;
```

```
4.25 5 10 10.5 11 0 8 13.5 16.5 22 30 0 2 3 5 6 8
```

```
cyl
```

```
di 2 3;1 3 0 4 6; ;
```

```
di 2 3; ;1 3 0 4 6;
```

```
di 3 4;1 2 0 5 6; ;
```

```
di 3 4;2 5;1 2 0 5 6;
```

```
di 1 2;1 2 0 5 6; ;
```

```
pb 1 2 0 2 2 0 2 0
```

```
pb 1 5 0 2 5 0 2 30
```

```
mb 2 3 0 2 3 0 2 -1.3 + j 1 2 1.3
```

```
sf 1 0 1 1 0 2 sd 2 + k 4 sd 1
```

```
sf 2 0 1 2 0 2 sd 4 + k 4 sd 3
```

```
sf 0 0 1 0 0 1 sd 5
```

```
sf 0 0 6 0 0 6 sd 6
```

```
cpl 1 2 0 1 5 0 j
```

```
end
```

```
end
```

roller

dn3d

sd 1 cone 0 0 0 0 0 1 0 35.311
 sd 2 cone 0 0 0 0 0 1 5.667 -35.311
 sd 3 cone 0 0 0 0 0 1 .75 35.311
 sd 4 cone 0 0 0 0 0 1 6.417 -35.311
 sd 5 plan 0 0 0 0 0 1
 sd 6 plan 0 0 8 0 0 1

gct 1:cscs .3866666666 mz 2;

lev 1 grep 0 1; ;

lev 2 levct 1:rxy mz -20;grep 0; ;

pslv 2

pslv 1

start

1 2 6 7 8;1 3 5 6 8 10;1 3 4 6 7 9;
 4.25 5 10 10.5 11 0 8 13.5 16.5 22 30
 0 2 3 5 6 8

cyl

di 2 3;1 3 0 4 6; ;

di 2 3; ;1 3 0 4 6;

di 3 4;1 2 0 5 6; ;

di 3 4;2 5;1 2 0 5 6;

di 1 2;1 2 0 5 6; ;

pb 1 2 0 2 2 0 2 0

pb 1 5 0 2 5 0 2 30

mb 2 3 0 2 3 0 2 -1.3 + j 1 2 1.3

sf 1 0 1 1 0 2 sd 2 + k 4 sd 1

sf 2 0 1 2 0 2 sd 4 + k 4 sd 3

sf 0 0 1 0 0 1 sd 5

sf 0 0 6 0 0 6 sd 6

cpl 1 2 0 1 5 0 j

lct 11;rz 30;repe 11;

lrep 0 1 2 3 4 5 6 7 8 9 10 11;

end

pplv

pplv

start

1 2;1 61;1 60;

1.4 1.6433333333 0 360 -24 4

cyl

end

end

nk3d

```

sd 1 cy 0 0 0 0 0 1 10
sd 2 cy 0 0 0 0 0 1 20
sd 3 cn2p 0 0 0 1 0 0 0.0 0.0 2.5 28.28427
sd 4 cy 0 0 0 1 0 0 2.5
sd 5 cy 0 0 0 1 0 0 3.5
sd 6 plan 28.427 0.0 0.0 1 0 0
sd 7 plan 0 0 0 -0.670867 +0.741578 0
sd 8 plan 0 0 0 -0.670867 -0.741578 0
plan 3
0 0 8 0 0 1 0.001 symm
0 0 -8 0 0 1 0.001 symm
28.427 0 0 1 0 0 0.001 symm
start 1 5 9:1 2 4 6 7:1 2 4 6 7:
10 24 28.3 -3.5 -3.5 0 +3.5 +3.5
-3.5 -3.5 0 +3.5 +3.5
d 0 2 2 0 4 4 d 0 1 1 0 2 2 d 0 4 1 0 5 2
d 0 1 4 0 2 5 d 0 4 4 0 5 5
sf 1 0 0 1 0 0 sd 1
sf 2 0 0 2 0 0 sd 2 sf 3 0 0 3 0 0 sd 6
sf 0 1 0 0 1 0 sd 5 sf 0 5 0 0 5 0 sd 5
sf 0 0 1 0 0 1 sd 5 sf 0 0 5 0 0 5 sd 5
sf 0 2 2 0 2 4 sd 3 sf 0 4 2 0 4 4 sd 3
sf 0 2 2 0 4 2 sd 3 sf 0 2 4 0 4 4 sd 3
pr 1 0 0 1 0 0 1 -200 0 0 0 end
start 1 5:1 7 9 11 17:1 5 7 9 13:
10 24 -10 -3.5 0 3.5 10 -8 -3.5 0 3.5 8
d 0 2 2 0 4 4
sf 0 2 2 0 2 4 sd 5 sf 0 4 2 0 4 4 sd 5
sf 0 2 2 0 4 2 sd 5 sf 0 2 4 0 4 4 sd 5
sf 1 0 0 1 0 0 sd 1 sf 2 0 0 2 0 0 sd 2
sf 0 1 0 0 1 0 sd 8 sf 0 5 0 0 5 0 sd 7
pr 1 0 0 1 0 0 1 -200 0 0 0 end
start 1 5 9 12:2 4 0 5 8 23 38 41 0 42 44:
1 5 7 9 13:
10 20 24 25 42.1340 45 0 45 47.86598 180
312.1340 315 0 315 317.86598 -8 -3.5 0 3.5 8
d 2 5 0 4 7 0
si 1 2 0 3 2 0 1 m si 1 4 0 3 4 0 1 s
si 1 8 0 3 8 0 1 s si 1 10 0 3 10 0 1 m
pr 1 2 0 3 2 0 1 200 10 0 0
pr 1 4 0 3 4 0 1 -200 10 0 0
pr 1 8 0 3 8 0 1 -200 10 0 0
pr 1 10 0 3 10 0 1 200 10 0 0
pr 1 0 0 1 0 0 1 -200 0 0 0
b 1 6 0 1 6 0 111111 cyl end end

```

sumore machine model

dn3d

para r1 0.45 r2 1.0 r3 1.25 r4 1.875 ;

para z1 -2 z2 0 z3 1.5 z4 6.25 z5 7.75 z6 10.0 z7 11.0 z8 25.7

para x1 0 x2 -1.326 x3 -2.0625 x4 -4.48125 x5 -6.9 x6 -17.26 ;

para y1 0 y2 1.326 y3 2.6875 y4 6.875 ;

start 2 3:2 10:2 3 5 6;

%r3 %r4 0 360 %z2 %z3 %z4 %z5

mate 1 cyl1 end

start 2 3 4:2 3 -4:-2 -3;

%x1 %x2 %x3 %y1 %y2 %y3 %z3 %z4

ac 2 1 1 2 2 2 3 0 0 0 %r4 0 0 1

ac 1 2 1 2 2 2 3 0 0 0 %r4 0 0 1

d 1 1 1 2 2 2

mate 2 thick 0.25 end

start 2 4 -5 -6:-2 3 4 -5:-2 -3;

%x6 %x5 %x4 %x3 %y1 %y2 %y3 %y4 0.625 7.125

d 2 1 1 3 1 2

b 3 1 1 4 1 2 111111

j 1 0 0 0 2.7 3.7 4.7 5.75

k 3 0 0 0 1.0625 6.6875

k 4 0 0 0 %z3 %z4

mate 2 thick 0.25 end

start 1 -2:2 10:-1 2 3 5 6 -7;

%r1 %r3 0 360 %z1 %z2 %z3 %z4 %z5 %z6

mate 3 thick 0.5 cyl1 end

start 1 -2:2 10:1 2 -6;

%r1 %r2 0 360 %z6 %z7 %z8

pt 2 0 1 1 %r3

mate 4 thick 0.3 cyl1 end

start 2 3:2 3:1 7 15;

-1 1 -1 1 %z1 %z6 %z8

a 1 1 1 2 2 3 3 %r1

mate 1 end end

a simple sprocket

coor 1

rt 20 0 0 rt 21 0 0 rt 20 1 0

start

1 2 3 4 5:1 3 5:1 3:

-1.2 -0.6 .0 .6 1.2 10 11 12 0 .5

d 2 2 0 4 3 0

sf 2 2 0 4 3 0 cy 0 12 0 0 0 1 .8

sf 0 1 0 0 1 0 cy 0 0 0 0 0 1 10

sf 0 3 0 0 3 0 cy 0 0 0 0 0 1 12

sf 1 0 0 1 0 0 pl30 rt 0 0 0 cy 1 95.0 0 rt 0 0 1 0

sf 5 0 0 5 0 0 pl30 rt 0 0 0 cy 1 85.0 0 rt 0 0 1 0

ccor 36:rz 0:rz 10:rz 20:rz 30:rz 40:rz 50

:rz 60:rz 70:rz 80:rz 90:rz 100:rz 110

:rz 120:rz 130:rz 140:rz 150:rz 160:rz 170

:rz 180:rz 190:rz 200:rz 210:rz 220:rz 230

:rz 240:rz 250:rz 260:rz 270:rz 280:rz 290

:rz 300:rz 310:rz 320:rz 330:rz 340:rz 350:

lrep 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36:

end

start

1 2 3 4 5:1 3 5:1 3:

-1.2 -0.5 .0 .5 1.2 4 5 6 0 .5

d 2 2 0 4 3 0

sf 2 2 0 4 3 0 cy 0 6.0 0 0 0 1 .8

sf 0 1 0 0 1 0 cy 0 0 0 0 0 1 4.0

sf 0 3 0 0 3 0 cy 0 0 0 0 0 1 6.0

sf 1 0 0 1 0 0 pl30 rt 0 0 0 cy 1 100.0 0 rt 0 0 1 0

sf 5 0 0 5 0 0 pl30 rt 0 0 0 cy 1 80.0 0 rt 0 0 1 0

ccor 36:rz 0:rz 10:rz 20:rz 30:rz 40:rz 50

:rz 60:rz 70:rz 80:rz 90:rz 100:rz 110

:rz 120:rz 130:rz 140:rz 150:rz 160:rz 170

:rz 180:rz 190:rz 200:rz 210:rz 220:rz 230

:rz 240:rz 250:rz 260:rz 270:rz 280:rz 290

:rz 300:rz 310:rz 320:rz 330:rz 340:rz 350:

lrep 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35:

lrepe 1:end end

threaded bolt

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dn3d

start 1 4:1 5 9 13 17 21 25:1 3:

.25 .45 0 0 0 0 0 0 0 0 .2

rr 0 2 0 0 2 0 rz 60;

rr 0 3 0 0 3 0 rz 120;

rr 0 4 0 0 4 0 rz 180;

rr 0 5 0 0 5 0 rz 240;

rr 0 6 0 0 6 0 rz 300;

rr 0 7 0 0 7 0 rz 360;

sf 1 0 0 1 0 0 cy 0 0 0 0 0 1 .25

end

start 1 7:1 7:1 3 10;

-1 1 -1 1 0 .2 1.5

sf -1 -2:-1 -2::cy 0 0 0 0 0 1 .25

end

start 1 2 3:1 50:1 2 3:

.25 .275 .3 0 9000 .2 .225 .25

d 2 0 2 3 0 3

pa 2 0 1 z .2125

pa 3 0 1 z .225

pa 2 0 2 x .27

pa 2 0 3 xz .275 .2375

pa 3 0 2 xz .275 .2375

ma 0 2 0 z 1.25

cyl

end end

```

wheel - tire, felly, spokes and wheel-nave
parameter
rad1 300
rad2 25
rad3 15
rad4 30
wnl 40
eps 2
rad5 [%rad1-%rad2-%eps] sig [%rad2*3/(4*sqrt(2))];
dn3d term 20.01 pri 100 pli 0.5 lcd 1 2 0 12.5 100 12.5
mat 1 3 shell e 210 pr .33 sigy .2649 etan .3737 beia 1 ro .785e-5
mat 2 7 g 100 ro .785e-5
mat 3 20 e 210 pr .33 ro .785e-3
mat 4 1 beam e 210 pr .33 ro .785e-5 endmat
start -1;1 145;1 9;284 0 360 [-%sig] %sig cyli mate 1
thic 1 sfi -1;;ts 0 0 0 0 : [%rad1-%eps] 0 %rad2 end
start 1 2 6 7;1 37;1 2 6 7;
[%rad1-%sig] [%rad1-%sig] [%rad1+%sig] [%rad1+%sig]
0 360 [-%sig] [-%sig] %sig %sig
cyli mate 2 di 1 2 0 3 4;;1 2 0 3 4;
sfi -1 -4;;-1 -4;ts 0 0 0 0 1 %rad1 0 %rad2 end
start 1 2;1 37;1 2 8 9;
%rad3 %rad4 [acos(%rad4/%rad5)] [360+acos(%rad4/%rad5)]
[-4*%wnl/3] [-%wnl] %wnl [4*%wnl/3] cyli mate 3 end
gct 1;rz 10 rxy;lev 1 grep 0 1;;pslv 1
beam cy 000000 %rad4 0 0
cy 000000 %rad4 [ 20+acos(%rad4/%rad5)] %wnl cy 000000 %rad5 20 0
cy 000000 %rad4 [ -acos(%rad4/%rad5)] %wnl cy 000000 %rad5 0 0
0 2 3 3 4 1 1 4 5 3 4 1 1 0
let 8;rz 40;repe 8;lrep 0 1 2 3 4 5 6 7 8;end pply end

```

c felly

c tire

c wheel nave

c spokes

wood screw by Robert Rainsberger

```
sd 1 sp 0 0 0 2 sd 2 plan 0 0 1 0 0 1
start 1 5 13 21 25;1 5 11 13 15 21 25;1 5 9;
-.7 -.7 0 .7 .7 -.5 -.5 -.3 0 .3 .5 .5 0 .5 .5
dl 1 2 0 4 5;1 7;2 3;dl 1 5;1 2 0 6 7;2 3;
d 2 3 2 4 5 3 dl 1 2 0 4 5;1 2 0 6 7;1 2;
sfi -1 -5;2 6;1 2;sd 1 sfi 2 4;-1 -7;1 2;sd 1
sfi 2 4;2 3 0 5 6;-3;sd 1
sf 0 0 2 0 0 2 sd 2 sf 0 0 1 0 0 1 plan 0 0 0 0 0 1
sfi 2 4;-2 -6;2 3;sd 2 sfi -2 -4;2 3 0 5 6;2 3;sd 2
sf 0 3 0 0 3 0 plan 0 -.3 0 0 1 0
sf 0 5 0 0 5 0 plan 0 .3 0 0 1 0
edit
z=-.75*z-.2
end
start 1 2;1 37;1 3;0 .9 0 360 -.2 0 cyli
edit
fir 1 1 2 2 37 2
z=-.1+.2*(j-1)/36
fir 1 1 3 2 37 3
z=.4*(j-1)/36
end
start 1 2 3;1 1081;1 2 3;0 .9 1.3 0 10800 0 .2 .4
d 2 0 2 3 0 3 cyli
edit
z=z+(j-1)*.4/36
fir 3 1 1 3 1081 1
z=z+.09
fir 3 1 2 3 1081 2
z=z-.09
cyli
fir 1 1 1 3 1081 3
phr 0 -99999 6 6 99999 50
x=x*(1-.15*(z-6))
phr 0 -99999 9 6 99999 50
z=(z-9)*(1-(z-9)/8)+9
end
end
```

connecting rod

sd 1 cy 0 0 115 0 1 0 17.0

sd 2 cy 0 0 5 0 1 0 8.0

sd 3 cy -5 0 19 0 1 0 8.0

sd 4 cy +20 0 16 0 1 0 14.0

sd 5 cy -8 0 90 0 1 0 19.0

start

1 2 5 6:1 2 3 5 6 7:1 2 5 6 8:

-5 -5 5 5 -12 -8 -4 4 8 12 10 10 0 0 -5

d 1 0 1 2 0 2

d 3 0 1 4 0 2

d 1 0 3 2 0 5

d 3 0 3 4 0 5

a 2 0 2 3 0 3 2 5.0

a 1 0 1 4 0 4 2 8.0

d 2 0 2 3 0 3 end

start

1 2 5 6:1 2 3 5 6 7:1 2 5 6 8:

-10 -10 10 10 -12 -8 -4 4 8 12 105 105 125 125 135

d 1 0 1 2 0 2

d 3 0 1 4 0 2

d 1 0 3 2 0 5

d 3 0 3 4 0 5

a 2 0 2 3 0 3 2 15.0

a 1 0 1 4 0 4 2 17.0

d 2 0 2 3 0 3 end

start

1 3 5 7 8 10 12:1 2 4 5:1 6 9 17 20:

0 10 15 17 19 23 25 -8 -4 4 8 122 100 90 18 13

d 1 0 1 4 0 2

d 3 0 3 7 0 5

d 5 2 1 6 3 3

d 1 1 2 2 2 5

d 1 3 2 2 4 5

a 5 2 1 6 3 3 3 3.0

sf 4 0 1 4 0 2 sd 1

sf 1 0 2 4 0 2 sd 1

sf 2 0 4 2 0 5 sd 3

sf 3 0 4 3 0 5 sd 4

sf 0 0 5 0 0 5 sd 2

sf 2 0 2 2 0 3 sd 5

sf 0 0 1 0 0 1 plan 0 0 122 0 0 1

mb 4 0 2 7 0 3 3 7.0

ac 5 1 1 7 1 3 3 19 0 0 8.0 0 0 1

ac 5 4 1 7 4 3 3 19 0 0 8.0 0 0 1

ac 7 0 1 7 0 3 3 19 0 0 8.0 0 0 1

coord 1 rt 0 0 0 rt -1 0 0 rt 0 -1 0 lrep 0 1:end end

piston by Robert Rainsberger

dn3d

```

parameter m 2 n 1 t 1; c course mesh
c parameter m 3 n 2 t 2; c medium mesh
c parameter m 5 n 4 t 3; c fine mesh
sd 1 cy 0 0 1 0 0 20 sd 2 cy 0 0 1 0 0 18
sd 3 cy 21 0 0 0 1 8 sd 4 cy 2 0 0 0 1 19
sd 5 cy 2 0 0 0 -1 19 sd 6 cy 21 0 0 0 0 1 5
sd 7 cy 0 0 0 1 0 0 16
start 1 [1+%m] [1+2*%m] [1+5*%m] [1+6*%m] [1+6*%m] [1+6*%m+4*%n]
[1+6*%m+2*%n] [1+6*%m+3*%n] [1+6*%m+4*%n]
[1+6*%m+5*%n] [1+6*%m+6*%n] [1+7.5*%m+6*%n];
1 [1+%t] [1+2*%t] [1+3*%t+4*%m] [1+3*%t+4*%m]
[1+4*%t+5*%m] [1+5*%t+5*%m] [1+6*%t+5*%m];
1 [1+%t] [1+2*%t] [1+3*%t+4*%m] [1+3*%t+4*%m]
[1+4*%t+5*%m] [1+5*%t+5*%m] [1+6*%t+5*%m];
2 11 15 27 31 32 33 34 35 36 37 43
-20 -20 -20 -6.5 6.5 20 20 -20 -20 -20 -6.5 6.5 20 20 20
d 1 2 0 2 7 0 d 5 2 0 6 3 0 +j 4
d 5 3 3 10 6 6 d 3 4 0 4 5 0 d 1 2 2 5 7 7
di; 1 3 0 6 8; 1 3 0 6 8; di 5 7 0 8 9 0 10 11; 1 2 0 7 8;
di 1 2;; 1 4 0 5 8; di 5 7 0 8 9 0 10 11; 1 2 0 7 8;;
a 0 3 3 0 6 6 1 14 a 12 2 2 12 7 7 1 16
pb 3 4 0 3 4 0 x 13 pb 3 5 0 3 5 0 x 13
pb 4 4 0 4 4 0 x 29 pb 4 5 0 4 5 0 x 29
pb 3 4 0 4 4 0 2 -8 pb 3 5 0 4 5 0 2 8
mb 12 3 3 12 6 6 12 sf 3 4 0 4 5 0 sd 3
sfi 1 12;-1 -8;-1 -8;sd 1 sfi 1 11;-2 -7;-2 -7;sd 2
sfi 1 -2;7 8;-5 6;sd 4 sfi 1 -2;-5 6;7 8;sd 4
sfi 1 -2;7 8;-3 -4;sd 5 sfi 1 -2;3 -4;7 8;sd 5
sfi 1 -2;1 2;-5 6;sd 5 sfi 1 -2;-5 6;1 2;sd 5
sfi 1 -2;1 2;3 -4;sd 4 sfi 1 -2;3 -4;1 2;sd 4 end
start 1 [1+%m] [1+4*%m] [1+5*%m] [1+5*%m]; 1 [1+%m] [1+4*%m] [1+5*%m];
|| [1+%t] [1+2*%t] 0 [1+4*%t] [1+5*%t] [1+6*%t];
13 13 29 29 -8 -8 8 -20 -20 -14 0 14 20 20
d 2 2 0 3 3 0 di 1 2 0 3 4; 1 2 0 3 4;;
sf 2 2 0 3 3 0 sd 6 sfi -1 -4; -1 -4;; sd 3
sfi -1 -7;sd 1 sfi -2 -6;sd 2 end
start 1 [1+3*%m]; 1 [1+3*%m]; 1 [1+7*%m]; 20 22 -1 1 -19 19
a 0 0 0 0 0 3 5 end
end

```

chain link

```

coor 10 mx 0:mx 2.4:mx 4.8:mx 7.2:mx 9.6:

```

```

mx 12.0:mx 14.4:mx 16.8:mx 19.2:mx 21.6:

```

```

start 1 2 4 6 7:1 2 5 6:1 2 5 6:

```

```

-1.2 -1.2 0 1.2 1.2

```

```

-1.2 -1.2 1.2 1.2 -.75 -.5 .5 .75

```

```

d 1 0 2 2 0 3 d 4 0 2 5 0 3 d 0 1 2 0 2 3

```

```

d 0 3 2 0 4 3 d 1 1 0 2 2 0 d 1 3 0 2 4 0

```

```

d 4 1 0 5 2 0 d 4 3 0 5 4 0

```

```

a 2 2 0 4 3 0 3 0.8

```

```

ac 1 2 0 1 3 0 3 0 0 0 1.2 0 0 1

```

```

ac 2 1 0 3 1 0 3 0 0 0 1.2 0 0 1

```

```

ac 2 4 0 3 4 0 3 0 0 0 1.2 0 0 1

```

```

repe 1 3 5 7 9:end

```

```

start 1 2 4 6 7:1 2 5 6:1 2 5 6:

```

```

1.2 1.2 0 -1.2 -1.2

```

```

-1.2 -1.2 1.2 1.2 -.75 -.5 .5 .75

```

```

d 1 0 2 2 0 3 d 4 0 2 5 0 3 d 0 1 2 0 2 3

```

```

d 0 3 2 0 4 3 d 1 1 0 2 2 0 d 1 3 0 2 4 0

```

```

d 4 1 0 5 2 0 d 4 3 0 5 4 0

```

```

a 2 2 0 4 3 0 3 0.8

```

```

ac 1 2 0 1 3 0 3 0 0 0 1.2 0 0 1

```

```

ac 2 1 0 3 1 0 3 0 0 0 1.2 0 0 1

```

```

ac 2 4 0 3 4 0 3 0 0 0 1.2 0 0 1

```

```

coor 1 rt 2.4 0 0 rt 2.5 0 0 rt 2.4 1 0

```

```

lrep 1:repe 1 3 5 7 9:end

```

```

start 1 2 4 6 7:1 2 5 6:1 2 5 6:

```

```

-1.2 -1.2 0 1.2 1.2

```

```

-1.2 -1.2 1.2 1.2 -.5 -.25 .25 .5

```

```

d 1 0 2 2 0 3 d 4 0 2 5 0 3 d 0 1 2 0 2 3

```

```

d 0 3 2 0 4 3 d 1 1 0 2 2 0 d 1 3 0 2 4 0

```

```

d 4 1 0 5 2 0 d 4 3 0 5 4 0

```

```

a 2 2 0 4 3 0 3 .8 d 2 2 0 4 3 0

```

```

ac 1 2 0 1 3 0 3 0 0 0 1.2 0 0 1

```

```

ac 2 1 0 3 1 0 3 0 0 0 1.2 0 0 1

```

```

ac 2 4 0 3 4 0 3 0 0 0 1.2 0 0 1

```

```

repe 2 4 6 8 10:end

```

```

start 1 2 4 6 7:1 2 5 6:1 2 5 6:

```

```

1.2 1.2 0 -1.2 -1.2

```

```

-1.2 -1.2 1.2 1.2 -.5 -.25 .25 .5

```

```

d 1 0 2 2 0 3 d 4 0 2 5 0 3 d 0 1 2 0 2 3

```

```

d 0 3 2 0 4 3 d 1 1 0 2 2 0 d 1 3 0 2 4 0

```

```

d 4 1 0 5 2 0 d 4 3 0 5 4 0

```

```

a 2 2 0 4 3 0 3 .8 d 2 2 0 4 3 0

```

```

ac 1 2 0 1 3 0 3 0 0 0 1.2 0 0 1

```

```

ac 2 1 0 3 1 0 3 0 0 0 1.2 0 0 1

```

```

ac 2 4 0 3 4 0 3 0 0 0 1.2 0 0 1

```

```

coor 1 rt 2.4 0 0 rt 2.5 0 0 rt 2.4 1 0

```

```

lrep 1:repe 2 4 6 8 10:end end

```

```

axisymmetric mirror problem 67
tole .01 exch 3 1 2
start 2 6 7 8 9 10 11 12 13 14;
2 6 7 9 10 11 13 14 16 17;1 21;
-4.872 -2.947 -2.637 -2.48 -2.32 -2.2
-2.0 -1.8 -.183 0 9.125 10.625 10.935
11.535 11.875 12.514 13.285 13.5
14.55 14.75 0 360
d 1 2 1 3 10 2 d 3 4 1 5 7 2
d 6 9 1 7 10 2 d 9 9 1 10 10 2
d 7 7 1 8 8 2 d 8 1 1 10 8 2
j 4 0 0 1 -2.48 -2.48 -2.48 -2.48
0 0 -2.137 -2.137 -1.975 -1.975
j 3 0 0 1 -2.637 -2.637 -2.637 -2.637
0 0 -2.32 -2.32 -2.32 -2.32
ac 2 2 0 3 2 0 3 -2.947 10.935 0 .31 0 0 1
ac 3 2 0 3 3 0 3 -2.947 10.935 0 .31 0 0 1
j 8 0 0 1 -1.8 -1.425 -1.368 -1.197
-1.112 -.952 -.755 -.7 -.7 -.7
j 7 0 0 1 -1.983 -1.608 -1.55 -1.38
-1.295 -1.135 -.938 -.938 -1.03 -1.03
j 6 0 0 1 -2.2 -2.073 -2.047 -1.96
-1.916 -1.664 -1.565 -1.565 -1.285 -1.285
j 5 0 0 1 -2.32 -2.32 -2.32 -2.32
-2.32 -1.975 -1.975 -1.975 -1.63 -1.63
ac 4 7 1 5 7 2 3 -2.395 12.785 0 .5 0 0 1
ac 5 6 1 5 7 2 3 -2.395 12.785 0 .5 0 0 1
pt 6 9 0 12 -1.285 14.650
pt 7 9 0 12 -1.030 14.650 cyl end
start 2 8 9 10;2 3;1 21;
-5.832 -2.637 -2.48 -2.32 11.535 11.6 0 360
b 1 1 1 1 2 1 100000 cyl end end

```

```

helix
dn3d
start
1 5 ;
1 226 ;
1 5 ;
1.5 2.5 0 900 -.5 .5
cyl
sf -1 -2 : 1 2 : -1 -2 : ts 0 0 0 0 0 1 2 0 1
ecut
for 1 1 1 5 226 5
z = z + 0.050 * j
end
end

```

```

spring
start
  1 5 ;
  1 331 ;
  1 5 ;
  1.8 2.2 0 1320 -.2 .2
cyl
sfil -1 -2 ; 1 2 ; -1 -2 ; ts 0 0 0 0 0 1 2 0 .2
edit
fir 1 1 1 5 79 5
  z = z + 4.05
fir 1 80 1 5 80 5
  z = z + 4.0625
fir 1 81 1 5 81 5
  z = z + 4.075
fir 1 82 1 5 249 5
  z = z + 0.05*j
fir 1 250 1 5 250 5
  z = z + 12.475
fir 1 251 1 5 251 5
  z = z + 12.4875
fir 1 252 1 5 331 5
  z = z + 12.5
end
end

```

```

wine glass
dn3d
start 1 9 15 35 41 49;1 9 15 35 41 49;-1;
-1 -1 -1 1 1 1 -1 -1 -1 1 1 0
di 1 3 0 4 6;1 3 0 4 6;;
sfi -1 -6;-1 -6;;cy 0 0 0 0 1 1.3
sfi -2 -5;-2 -5;;cy 0 0 0 0 1 1.03
sfi -3 -4;-3 -4;;cy 0 0 0 0 1 1.7
edit
cyli
phr 1.00001 -600 -1 1.300001 600 1000
z=2-sqrt(4-16*(x-1)**2)
end
start -1;1 81;1 40;1.3 0 360 .4 4 cyli
edit
cyli
x=x+(.2*(k-1)/39+.15)*sin(((k-1)/39)*405)+.1*(k-1)/39
end
start 1 4;1 4;1 30;-.1 .1 -.1 .1 0 -2
sfi -1 -2;-1 -2;1 2;cy 0 0 0 0 1 1.1
edit
cyli
fir 1 1 1 4 4 5
x=x*(1+.2*(6-k))
fir 1 1 26 4 4 30
x=x*(1+.2*(k-25))
end
start 1 6 16 21;1 6 16 21;-1;
-.6 -.6 .6 .6 -.6 -.6 .6 .6 -2
di 1 2 0 3 4;1 2 0 3 4;;
sfi -1 -4;-1 -4;;cy 0 0 0 0 1 1.2
sfi -2 -3;-2 -3;;cy 0 0 0 0 1 1.6
end end

```

```

kline bottle
dn3d
start -1 6 10 13 16 20 -25:-1 12 -23:-1 10 12 14 -23:
-7 -3.5 -1.3 0 1.3 3.5 7 -7 0 7 -7 -1 0 1 7
pb 2 3 2 3 2 xz -5.3 -7.2
pb 2 3 3 2 3 3 x -5.3
pb 2 3 4 2 3 4 xz -5.3 7.2
pb 6 3 2 6 3 2 xz 5.3 -7.2
pb 6 3 3 6 3 3 x 5.3
pb 6 3 4 6 3 4 xz 5.3 7.2
pb 3 3 2 3 3 2 xz -1 -.78
pb 3 3 3 3 3 3 x -1
pb 3 3 4 3 3 4 xz -1 .78
pb 5 3 2 5 3 2 xz 1 -.78
pb 5 3 3 5 3 3 x 1
pb 5 3 4 5 3 4 xz 1 .78
pb 6 1 2 6 1 2 xz 5.3 -7.2
pb 6 1 3 6 1 3 x 5.3
pb 6 1 4 6 1 4 xz 5.3 7.2
pb 5 1 2 5 1 2 xz 1 -.78
pb 5 1 3 5 1 3 x 1
pb 5 1 4 5 1 4 xz 1 .78
sfil -5 -6:-1 -3:-2 -4:cy 3 0 0 0 1 0 2
sfil -2 -3:-3:-2 -4:cy -3 0 0 0 1 0 2
sfil -1 -7:-1 -3:-1 -5:sp 0 0 0 12
dl 5 6:-1 -3:2 4:
dl 2 3:-3:2 4:
edit
ycyli
phr -720 -100 0 720 100 7
flr 1 1 1 25 1 23
y=-9.746794344809
flr 1 1 1 25 23 23
phr -720 -100 0 720 100 100
y=(y+9.746794344809)*1.5
end
start -1 -5:1 23 32:-1 3 -5:2 4 0 16.746794344809 26 -1 0 1
pb 1 2 1 1 2 1 xz 1 -.78
pb 1 2 2 1 2 2 x 1
pb 1 2 3 1 2 3 xz 1 .78
pb 2 2 1 2 2 1 xz 5.3 -7.2
pb 2 2 2 2 2 2 x 5.3
pb 2 2 3 2 2 3 xz 5.3 7.2
pb 2 2 4 2 2 4 xz 5.3 7.2
sfil -1 -2:-1 -3:cy 3 0 0 0 1 0 2
sfil -1 -2:-2:-1 -3:sp 0 9.746794344809 0 12
edit
ycyli
y=y*1.5
end
start -1 -5:1 10:-1 3 -5:-4 -2 16.746794344809 26 -1 0 1
pb 1 1 1 1 1 1 xz -5.3 -7.2
pb 1 1 2 1 1 2 x -5.3
pb 1 1 3 1 1 3 xz -5.3 7.2
pb 2 1 1 2 1 1 xz -1 -.78
pb 2 1 2 2 1 2 x -1
pb 2 1 3 2 1 3 xz -1 .78
sfil -1 -2:-1 -3:cy -3 0 0 0 1 0 2
sfil -1 -2:-2:-1 -3:sp 0 9.746794344809 0 12
edit
y=y*1.5
end
start -1 3 -5:1 20:-1 3 -5:2 3 4 0 180 -1 0 1
sfil -1 -3:-1 -3:ts 0 0 0 0 1 3 0 2
cyli
edit
y=y+39
end
c uso stp .02 to merge parts

```

model of rear hub

dn3d

plan 1 0 0 0 1 0 0 0.001 symm

sd 2 cy 0 0 0 0 0 1 3.23

sd 5 cy 0 3.5 0 0 0 1 0.6349

sd 6 cy -1.15 3.6 0 0 0 1 0.562

sd 8 cy 0 0 0 0 0 1 2.375

sd 9 ts 0 0 5.81 0 0 1 1.59 0 2.0

sd 10 ts 0 0 5.81 0 0 1 1.2 0 3.14

sd 11 ts 0 0 5.81 0 0 1 2.15 0 1.44

coor 1 ryz ; lev 1 repe 0 1 ; ; pslv 1

start

1 2 3 4 7 8 11 12 ; 1 3 9 ; 1 2 3 4 5 7 ;

2.59 3.096 3.257 3.8873 4.34 5.053 6.067 6.625

90.0 94.5 108.0 5.81 6.44 7.25 7.94 8.9 10.0

pb 6 2 2 7 2 4 y 96.0

d 5 0 1 8 0 2 d 1 0 1 4 0 3 d 1 0 4 2 0 6

d 2 0 5 3 0 6 d 4 0 4 8 0 6 d 6 1 2 7 2 4

sf 1 -6 -7 ; 1 -2 ; 2 4 ; cy 0 5.56 0 0 0 1 .507

sf 1 -4 ; ; 1 -3 ; sd 11

pa 4 0 6 x 3.5383 pa 4 0 3 x 3.4

ve 6 1 2 6 2 2 + i 1 + k 2 + i -1

ve 6 2 2 7 2 2 + k 2

ve 1 0 3 1 0 3 + k 1 + i 1 + i 2 + i 4 + k -2 + i -3

ve 2 0 5 2 0 5 + i 1 + i 1 + k 1 + i -1

coor 10 rz 0 ; rz 36 ; rz 72 ; rz 108 ; rz 144 ;

ryz rz 36 ; ryz rz 72 ; ryz rz 108 ; ryz rz 144 ; ryz rz 180 ;

lrep 1 2 3 4 5 6 7 8 9 10 ;

cyl end

start

1 2 3 5 6 ; 1 4 7 11 ; 1 4 5 6 9 ;

2.375 2.865 3.2265 3.7734 4.1349

90.0 96.75 103.5 112.5 0. 2.75 3.444 3.949 5.81

d 1 0 1 2 0 3 d 1 0 4 3 0 5 d 3 1 1 4 2 2

ma 5 2 4 y +2.5 ma 5 3 4 y +1.0

sf 5 1 1 5 2 4 sd 5 sf 5 2 1 5 3 3 sd 6 sf 5 3 1 5 4 3 sd 2

sf 1 -3 -4 ; 1 -2 ; 1 2 ; cy 0.0 3.5 0.0 0 0 1 0.2735

sf 1 0 3 1 0 4 sd 8

sf 1 -3 ; ; -4 5 ; sd 9

sf 5 3 3 5 4 5 sd 10

sf 5 0 5 5 0 5 sd 10

cpl 3 0 4 5 0 5 1 cpl 2 0 3 5 0 3 1 cpl 2 3 1 5 4 2 1

cyl coor 8 rz 0 ; rz 45 ; rz 90 ; rz 135 ;

ryz rz 45 ; ryz rz 90 ; ryz rz 135 ; ryz rz 180 ;

lrep 1 2 3 4 5 6 7 8 ;

ve 3 1 1 3 2 1 + k 1 + i 1 + k -1

ve 3 2 1 4 2 1 + k 1

ve 5 0 1 5 0 1 + i -3 + k 1 + i -1 + k 1

end pplv end

partially excavated tunnel and neighboring fault
 nk3d anal stat bwmo off nbsr 1 nbel 1 nbsr 10 msrf 15
 dctrl .001 ectol .01 lprt 1000 lplt 1 nstep 100 term .001
 c s1 = minimum z coordinate : slice 1
 c s2 = z coordinate for beginning of tunnel plug : slice 2
 c s3 = z coordinate for beginning of tunnel : slice 3
 c s4 = z coordinate for tunnel opening : slice 4
 c k2 = maximum node number of region behind tunnel
 c k3 = node number at slice 3
 c k4 = node number at slice 4
 c k5 = node number at slice 4 for outer region
 c rk1 = ratio zoning in k direction in unexcavated region
 c rk2 = ratio zoning in k direction in excavated region
 c para k2 2 k3 2 k4 3 k5 3 s2 1 s3 2 s4 3 rk1 .8 rk2 1.25;
 para k2 11 k3 15 k4 25 k5 14 s2 50 s3 60 s4 65 rk1 .8 rk2 1.25;
 mat 1 5 mat 2 5 endmat
 sd 1 cy 0 1.5 0 0 0 1 1.5 sd 2 cy 0 0 0 0 0 1 6.5 sd 3 plan 3 0 0 1 0 0
 sd 4 plan 1.06 2.56 0 1 0 0 sl 1 tied;sl 2 sv;
 start 1 9;1 7 15 30;1 %k3 %k4 ;1.5 3 0 1.5 2.56 6 %s2 %s3 %s4
 res 0 0 0 0 0 0 1 1.3 res 1 3 0 2 4 0 j 1.2
 res 0 0 1 0 0 2 k %rk1 res 0 0 2 0 0 3 k %rk2
 sf 1 2 0 1 3 0 sd 1 sf 1 4 0 2 4 0 sd 2 sf 2 0 0 2 0 0 sd 3
 sf 1 3 0 1 4 0 sd 4 sf 1 1 0 1 2 0 plan 1.5 0 0 1 0 0
 mate 1 b 1 0 0 1 0 0 111000
 sl 0 0 1 0 0 1 1 s sl 2 0 0 2 0 0 2 s sl 1 4 0 2 4 0 1 s end
 start 1 16;1 20;1 %k3 %k4 ;3 6.5 45 152.3 %s2 %s3 %s4
 mate 1 cyll
 res 0 0 0 0 0 0 1 1.2 res 0 0 1 0 0 2 k %rk1 res 0 0 2 0 0 3 k %rk2
 sf 1 2 0 2 2 0 plan -1.5 1.5 0 0 1 0 sf 1 1 0 2 1 0 sd 4
 sf 1 1 0 1 2 0 sd 1 sf 2 1 0 2 2 0 sd 2
 sl 2 1 0 2 2 0 1 s sl 0 0 1 0 0 1 1 s end
 start 1 16;1 7;1 %k3 %k4 ;-6.5 -1.5 0 1.5 %s2 %s3 %s4
 res 0 0 0 0 0 0 1 .8333333333 res 0 0 1 0 0 2 k %rk1 res 0 0 2 0 0 3 k %rk2
 sf 1 2 0 2 2 0 plan -1.5 1.5 0 0 1 0 sf 2 1 0 2 2 0 plan -1.5 1.5 0 1 0 0
 sf 1 1 0 2 1 0 plan 0 0 0 0 1 0 sf 1 1 0 1 2 0 sd 2
 mate 1 b 1 0 0 1 0 0 111000
 sl 1 1 0 1 2 0 1 s sl 0 0 1 0 0 1 1 s end
 start 1 5 8;1 7 12 19 22;1 %k3 %k4 ;3 4.7 4.7 0 1.5 2.56 4.5 4.5 %s2 %s3 %s4
 d 2 4 0 3 5 0 res 0 0 1 0 0 2 k %rk1 res 0 0 2 0 0 3 k %rk2
 pb 2 3 0 2 3 0 y 2.7 pb 3 4 0 3 4 0 y 5.8
 pb 2 5 0 2 5 0 y 5.8 pb 2 4 0 2 4 0 xy 3.8 4.1
 sf 1 5 0 2 5 0 sd 2 sf 3 1 0 3 4 0 sd 2 sf 1 0 0 1 0 0 sd 3
 sf 0 1 0 0 1 0 plan 0 0 0 0 1 0 mate 1 b 1 0 0 1 0 0 111000
 sl 0 0 1 0 0 1 1 s sl 1 0 0 1 0 0 2 m sl 1 5 0 2 5 0 1 s sl 3 1 0 3 4 0 1 s end
 start 1 5 16 20;1 7 15 19;1 %k3 ;
 -1.5 -1.1 1.1 1.5 0 1.5 2.15625 3 %s2 %s3
 mate 1 dl 1 2 0 3 4;3 4;; b 0 1 0 0 1 0 111000 res 0 0 1 0 0 2 k %rk1
 pb 1 3 0 1 3 0 xy -.820865 2.75546 pb 2 4 0 2 4 0 xy -.820865 2.75546
 pb 2 3 0 2 3 0 xy -.77 2.44 pb 3 3 0 3 3 0 xy .89 2.29625
 res 1 1 0 2 3 0 1 1.25 res 3 1 0 4 3 0 1 .8 res 2 3 0 3 4 0 j .8
 sf 2 3 0 3 3 0 cy 0 1.5 0 0 0 1 1.1
 sf 3 4 0 3 4 0 sd 4 sf 4 3 0 4 3 0 sd 4
 sfl -1 -4;2 3;;sd 1 sf 2 4 0 3 4 0 sd 1
 sl 0 0 1 0 0 1 1 s end
 start 1 6 11;1 6 11;1 %k2 %k5 ;-50 -6.5 0 50 6.5 0 0 %s2 %s4
 mate 2 d 2 2 2 3 3 3 b 0 3 0 0 3 0 111000
 pb 2 1 0 2 1 0 x -20 pb 1 2 0 1 2 0 y 20
 sf 2 2 2 2 3 3 sd 2 sf 2 2 2 3 2 3 sd 2 sf 3 0 0 3 0 0 sd 3
 sl 3 1 2 3 2 3 2 s sl 3 1 1 3 3 2 2 s
 sl 2 2 2 3 3 2 1 m sl 2 2 2 3 2 3 1 m sl 2 2 2 2 3 3 1 m end
 start 1 9 11;1 6 11;1 %k2 %k5 ;50 6.5 3 50 6.5 0 0 %s2 %s4
 mate 2 d 2 2 2 3 3 3 b 0 3 0 0 3 0 111000
 pb 2 1 0 2 1 0 x 13 pb 1 2 0 1 2 0 y 20
 sf 2 2 2 2 3 3 sd 2 sf 2 2 2 3 2 3 sd 2 sf 3 0 0 3 0 0 sd 3
 sl 3 1 2 3 2 3 2 m sl 3 1 1 3 3 2 2 m
 sl 2 2 2 3 3 2 1 m sl 2 2 2 3 2 3 1 m sl 2 2 2 2 3 3 1 m end
 end c use stp .001 to merge parts

MAZE example in INGRID-see MAZE manual

dn3d

plane 3

```
0 0 0 0 0 1 .0002 symm
0 0 0 0 1 0 .0002 symm
0 0 0 1 0 0 .0002 symm
```

si 1 sl;

si 2 sl;

ld 1 lp 2 0 0 20 0

ld 2 lp 2 14 0 14 14

lat 0 28 -1 28 14

ld 3 lp 2 0 0 0 40

ld 4 lp 2 0 14 20 14

ld 5 lp 2 18 0 18 14

lep 18 22 0 14 0 90 0

part 4 2 3 3 1 10 10

spin 18 90

si 1 1 1 2 2 1 1 m

si 1 1 2 2 2 2 2 s

end

part 1 2 4 3 2 20 20

spin 18 90

si 1 1 2 2 2 2 1 s

si 2 1 1 2 2 2 2 s

end

t13 part 1 5 4 2 3 3 20

spin 18 90

si 1 1 1 1 2 2 2 m

end

part 4 5 3 2 3 9 40

spin 18 90

si 1 1 1 1 2 2 2 m

end

mat 1 1 heading

elastic material 6061-t6 aluminum

ro 2.71 e .689 pr .33 hgqt 2 hgq .15

endmat

mat 2 3 heading

elastic-plastic material 1020 steel

ro 7.83 e 2.07 pr .29 sigy .004

beta 1.0 etan .010 endmat

mat 3 3 heading

elastic material 110 copper

ro 8.94 e 1.17 pr .33 hgq .05

endmat

end

c use stp 0.002 in the interactive

c stage to merge parts 3 and 4

```

MAZE example in INGRID - see MAZE manual
dn3d si 1 sl;si 2 sl;plane 3 0 0 0 0 1 .0002 symm
0 0 0 0 1 0 .0002 symm 0 0 0 1 0 0 .0002 symm
ld 1 lp 2 0 0 20 0 ld 2 lp 2 14 0 14 14
lat 0 28 -1 28 14 ld 3 lp 2 0 0 0 40
ld 4 lp 2 0 14 20 14 ld 5 lp 2 18 0 18 14
lep 18 22 0 14 0 90 0 ld 6 lp 2 5 0 5 40
part 4 2 6 6 1 10 10 spin 18 90
si 1 1 1 2 2 1 1 m si 1 1 2 2 2 2 2 s end
part 1 2 4 6 2 20 20 spin 18 90
si 1 1 2 2 2 2 1 s si 2 1 1 2 2 2 2 s end
tl3 part 1 5 4 2 3 3 20 spin 18 90
si 1 1 1 1 2 2 2 m end
part 4 5 6 2 3 9 40 spin 18 90
si 1 1 1 1 2 2 2 m end
start 1 10 16;1 10 16;1 21;0 3 2 3 2 0 3 2 3 2 0 14
mate 2 d 2 2 1 3 3 2 pb 2 2 1 2 2 2 xy 2.4 2.4
sf 1 3 1 2 3 2 crz 6 sf 3 1 1 3 2 2 crz 6
si 1 1 2 2 3 2 1 s si 2 1 2 3 2 2 1 s end
start 1 10 16;1 10 16;1 21;0 3 2 3 2 0 3 2 3 2 14 28
mate 1 d 2 2 1 3 3 2 pb 2 2 1 2 2 2 xy 2.4 2.4
sf 1 3 1 2 3 2 crz 6 sf 3 1 1 3 2 2 crz 6
sf 1 1 2 2 3 2 crz 2 sf 2 1 2 3 2 2 crz 2
si 1 1 1 2 3 1 1 m si 2 1 1 3 2 1 1 m
si 1 1 2 2 3 2 2 s si 2 1 2 3 2 2 2 s end
start 1 10 16;1 10 16;1 10;0 3 2 3 2 0 3 2 3 2 28 36
mate 3 d 2 2 1 3 3 2 pb 2 2 1 2 2 2 xy 2.4 2.4
sf 1 3 1 2 3 2 crz 6 sf 3 1 1 3 2 2 crz 6
sf 1 1 2 2 3 2 crz 5 sf 2 1 2 3 2 2 crz 5
sf 1 1 1 2 3 1 crz 2 sf 2 1 1 3 2 1 crz 2
si 1 1 1 2 3 1 2 m si 2 1 1 3 2 1 2 m end
mat 1 1 ro 2.71 e .689 pr .33 hgqt 2 hgq .15 heading
elastic material 6061-t6 aluminum
mat 2 3 ro 7.83 e 2.07 pr .29 sigy .004 beta 1.0 etan .010 heading
elatic-pastic material 1020 steel
mat 3 3 ro 8.94 e 1.17 pr .33 hgq .05 heading
elastic material 110 copper
endmat end
c use stp 1.0e-50 to merge the plugs and parts 3 and 4

```

INGRID/DYNA3D/TAURUS ROTATING PIPE EXAMPLE

This simple test problem contains 1 part. It has a constant pressure load on the inside of the pipe pointing outwards. It is rotating. The following is the input to INGRID. The ingrido file from INGRID is used as the input to DYNA3D.

```
rotating pipe
dn3d term 2.5e-03 plti 1.25e-05 prti 2.5e-03
mat 1 3 e 7.1e+10 pr .333 sigy 2.86e+08
etan 3.56e+09 beta 0 ro 2680 endmat
lcd 1 2 0 6.69e+07 1000 6.69e+07
start 1 2;1 73;1 11;
.02413 .02667 0 360 0 .02413
cyli mate 1
rotation 0 0 0 0 4000
epb 1 1 1 1 1 1;
pr 1 0 0 1 0 0 1 1 100 180 .013
end end c use stp .00000001
```

The following is the interactive input to TAURUS after this program has initialized. The period is the prompt from TAURUS.

```
.angle 1  
.rx 30  
.state 1 v  
.phs2  
.elements 1 1  
.gather  
.etime 8 1 1  
.etime 1 1 1  
.etime 2 1 1  
.end
```

rotating pipe
time = 0.

tating pipe

rotating pipe

rotating pipe

INGRID/DYNA3D/TAURUS IMPACTING BAR EXAMPLE

The problem is calculated with 1/4 of the model using 2 planes of symmetry. A third plane of symmetry is used to simulate the bar impacting its reflection.

Note that the quarter bar is generated where 2 logically distinct faces of the mesh are placed in the same location. When INGRID is in the interactive mode, use the command

`stp .001 continue`

to connect these two faces and write the input file for DYNA3D.

```

bar impact problem
dn3d
velocity 0 0 -.0227
mate 1
mat 1 3 e 1.17 pr .35 sigy .004 etan .0010
beta 1 ro 8.93 endmat
term 80.0
plti 1. prti 81.
plane 3 0 0 0 0 -1 0 .001 symm
      0 0 0 -1 0 0 .001 symm
      0 0 0 0 0 1 .001 symm
start 1 4 7 10 13:1 4 7 10 13:1 37:
-.16 -.16 0 .16 .16 -.16 -.16 0 .16 .16 0 3.24
d 0 1 0 0 3 0 d 1 0 0 3 0 0
d 1 2 0 4 5:1 2 0 4 5::
sf 1 -1 -5:-1 -5::cy 0 0 0 0 0 1 .32
end end

```

The following is the interactive input to TAURUS after TAURUS was initialized with the plot files from the DYNA3D run. The period is the prompt from TAURUS for more input.

```
.angle 1  
.rx -45  
.ry -45  
.movie 0 80 16 0 v  
.restore  
.ry 90  
.xscale 3 yscale 3 zscale 3  
.xtrans 1  
.ytrans -.3  
.movie 0 80 16 0 contour 7  
.end
```

bar impact problem
time = 5.00000e+00

bar impact problem
time = 1.00000e+01

bar impact problem
time = 1.50000e+01

bar impact problem
time = 2.00000e+01

bar impact problem
time = 2.50000e+01

bar impact problem
time = 3.00000e+01

bar impact problem
time = 3.50000e+01

bar impact problem
time = 4.00000e+01

bar impact problem
time = 5.50000e+01

bar impact problem
time = 5.00000e+01

bar impact problem
time = 5.50000e+01

bar impact problem
time = 6.00000e+01

bar impact problem
time = 6.50000e+01

bar impact problem
time = 7.00000e+01

bar impact problem
time = 7.50000e+01

bar impact problem
time = 8.00000e+01

bar impact problem
time = 5.00000e-01
contours of eff. plastic strain
min: 0. in element 972
max: 1.833e-01 in element 327

contour values
A: 4.95e-02
B: 1.11e-01
C: 1.72e-01
D: 2.33e-01
E: 2.95e-01
F: 3.56e-01
G: 4.17e-01
H: 4.79e-01
I: 5.40e-01

bar impact problem
time = 1.00000e-01
contours of eff. plastic strain
min: 0. in element 972
max: 9.908e-01 in element 3

contour values
A: 0.39e-01
B: 1.60e-01
C: 3.92e-01
D: 7.95e-01
E: 4.99e-01
F: 6.03e-01
G: 7.07e-01
H: 8.11e-01
I: 9.15e-01

bar impact problem
time = 1.50000e-01
contours of eff. plastic strain
min: 0. in element 972
max: 1.461e-00 in element 1

contour values
A: 1.23e-01
B: 2.75e-01
C: 4.27e-01
D: 5.70e-01
E: 7.30e-01
F: 8.82e-01
G: 1.03e-00
H: 1.19e-00
I: 1.34e-00

bar impact problem
time = 2.00000e-01
contours of eff. plastic strain
min: 0. in element 972
max: 1.868e-00 in element 1

contour values
A: 1.57e-01
B: 3.51e-01
C: 5.45e-01
D: 7.40e-01
E: 9.34e-01
F: 1.13e-00
G: 1.32e-00
H: 1.52e-00
I: 1.71e-00

bar impact problem
time = 2.50000e+01
contours of eff. plastic strain
min: 0. in element 972
max: 2.201e+00 in element 1

contour values
A: 1.05e-01
B: 4.44e-01
C: 6.43e-01
D: 8.72e-01
E: 1.0e+00
F: 1.21e+00
G: 1.56e+00
H: 1.79e+00
I: 2.02e+00

bar impact problem
time = 3.00000e+01
contours of eff. plastic strain
min: 0. in element 972
max: 2.455e+00 in element 1

contour values
A: 2.86e-01
B: 4.61e-01
C: 7.17e-01
D: 9.72e-01
E: 1.23e+00
F: 1.46e+00
G: 1.74e+00
H: 1.99e+00
I: 2.25e+00

bar impact problem
time = 3.50000e+01
contours of eff. plastic strain
min: 0. in element 972
max: 2.632e+00 in element 1

contour values
A: 2.21e-01
B: 4.95e-01
C: 7.60e-01
D: 1.04e+00
E: 1.32e+00
F: 1.59e+00
G: 1.86e+00
H: 2.14e+00
I: 2.41e+00

bar impact problem
time = 4.00000e+01
contours of eff. plastic strain
min: 0. in element 972
max: 2.742e+00 in element 1

contour values
A: 2.30e-01
B: 5.15e-01
C: 8.01e-01
D: 1.09e+00
E: 1.37e+00
F: 1.66e+00
G: 1.94e+00
H: 2.23e+00
I: 2.51e+00

bar impact problem
 time = 4.50000e+01
 contours of eff. plastic strain
 min: 0. in element 972
 max: 2.795e+00 in element 1

contour values
 A: 2.35e-01
 B: 5.29e-01
 C: 0.16e-01
 D: 1.11e+00
 E: 1.40e+00
 F: 1.69e+00
 G: 1.99e+00
 H: 2.27e+00
 I: 2.56e+00

bar impact problem
 time = 5.00000e+01
 contours of eff. plastic strain
 min: 0. in element 972
 max: 2.804e+00 in element 1

contour values
 A: 2.36e-01
 B: 5.27e-01
 C: 0.19e-01
 D: 1.11e+00
 E: 1.40e+00
 F: 1.69e+00
 G: 1.99e+00
 H: 2.28e+00
 I: 2.57e+00

bar impact problem
 time = 5.50000e+01
 contours of eff. plastic strain
 min: 0. in element 972
 max: 2.804e+00 in element 1

contour values
 A: 2.36e-01
 B: 5.27e-01
 C: 0.19e-01
 D: 1.11e+00
 E: 1.40e+00
 F: 1.69e+00
 G: 1.99e+00
 H: 2.28e+00
 I: 2.57e+00

bar impact problem
 time = 6.00000e+01
 contours of eff. plastic strain
 min: 0. in element 972
 max: 2.804e+00 in element 1

contour values
 A: 2.36e-01
 B: 5.27e-01
 C: 0.19e-01
 D: 1.11e+00
 E: 1.40e+00
 F: 1.69e+00
 G: 1.99e+00
 H: 2.28e+00
 I: 2.57e+00

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bar impact problem
time = 6.50000e-01
contours of eff. plastic strain
min: 0. in element 972
max: 2.804e+00 in element 1

contour values
A: 2.36e-01
B: 5.27e-01
C: 0.19e-01
D: 1.11e+00
E: 1.40e+00
F: 1.69e+00
G: 1.99e+00
H: 2.28e+00
I: 2.57e+00

bar impact problem
time = 7.00000e-01
contours of eff. plastic strain
min: 0. in element 972
max: 2.804e+00 in element 1

contour values
A: 2.36e-01
B: 5.27e-01
C: 0.19e-01
D: 1.11e+00
E: 1.40e+00
F: 1.69e+00
G: 1.99e+00
H: 2.28e+00
I: 2.57e+00

bar impact problem
time = 7.50000e-01
contours of eff. plastic strain
min: 0. in element 972
max: 2.804e+00 in element 1

contour values
A: 2.36e-01
B: 5.27e-01
C: 0.19e-01
D: 1.11e+00
E: 1.40e+00
F: 1.69e+00
G: 1.99e+00
H: 2.28e+00
I: 2.57e+00

bar impact problem
time = 8.00000e-01
contours of eff. plastic strain
min: 0. in element 972
max: 2.804e+00 in element 1

contour values
A: 2.36e-01
B: 5.27e-01
C: 0.19e-01
D: 1.11e+00
E: 1.40e+00
F: 1.69e+00
G: 1.99e+00
H: 2.28e+00
I: 2.57e+00

INGRID/DYNA3D/TAURUS EARTH PENETRATOR EXAMPLE

This problem is calculated with 1/4 of the model using 2 planes of symmetry. The hollow projectile consists of 4 parts of steel for the casing and 1 part for the fuze and accessories. The target consists of 2 parts of concrete. All parts are generated by dragging or rotating MAZE parts from a 2 dimensional model.

Three slide surfaces are used. The first slide surface ties the fuze and accessories part to the steel casing. The third slide surface ties the 2 concrete parts together. This was needed due to the change in zoning. The second slide surface allows for the projectile to penetrate the concrete at the center of the target. The projectile is given an initial velocity of 20784 units towards the target along the axis of symmetry.

The input to INGRID is shown in the following. A picture of the resulting mesh is also included. This was done on the CRAY with the execute line

```
ingrid i=erthpntr
```

where erthpntr was the command file for INGRID. When prompted by

```
>>
```

the commands

```
stp .002 cont
```

were typed to complete the input to INGRID. For the VAX, the execute line was

```
run ingrid
```

and when prompted, then

```
i=erthpntr
```

was typed. The rest was the same.

The INGRID output file Ingrido was then used as the input file to DYNA3D. When DYNA3D was completed, it produced a d3plot file. This was used by TAURUS. On the CRAY, the execute line was

```
taurus g=d3plot
```

and after the initialization was complete, TAURUS prompted with a period for interactive graphics commands. This complete session is included in the following.

3d duplicate of axisymmetric model

3d duplicate of axisymmetric model
 in3d

ld 1 lp 2 .2 0 .2 56.8
 ld 2 lp 2 0 0 .705425 0
 ld 3 lp 4 2.725 56.8 2.725 46.6622 2.475 32.8622 2.475 14.9425
 lar .717546 7.31183 -17.4445
 lar 0 7.118885 -1.4307199
 ld 4 lp 2 0 14.9425 3.475 14.9425
 ld 5 lp 2 3.475 56.8 3.475 14.9425
 lap .705425 0 -38.225 14.9425
 ld 7 lpil 1 3 lvc -30 5
 ld 9 lvc 0 3.00 -30 4.
 ld 12 lp 2 0 49.53 3.475 49.53
 ld 14 lp 2 0 56.8 3.475 56.8
 ld 25 lp 2 .705 0 198 0
 ld 27 lp 2 .705 -72 198 -72
 ld 22 lp 2 .705 0 .705 -336.75
 ld 24 lp 2 11 0 11 -336.75
 ld 28 lp 2 90 0 90 -336.75
 sr 1 tied: sr 2 sv: sr 3 tied:
 plane 2 0 0 0 0 1 0 .001 symm 0 0 0 1 0 0 .001 symm
 term 1.51e-3 prti .1 plti 100.e-6
 mat 1 3 head
 steel case - 6dac
 ro 7.202e-4
 e 3.e7
 pr .3
 sigy 194.e3
 etan 1.0e5
 mat 2 3 head
 fuze and accesories
 ro 2.065e-4
 e 3.e7 pr .3 sigy 174.e3 etan 0
 mat 3 5 head
 concrete
 ro 2.1692e-4
 g .788e6
 ku .600e7
 a0 .352e7
 a1 8570
 a2 0
 pc 0
 npts 6
 vs 0 .020 .0377 .0418 .0513 .1
 p 0 21000 34800 45000 58000 125000
 endmat

```

part 2 5 9 1 1 2 2
drag rota 5 0 0 0 0 0 1 90;
si 2 1 1 2 2 2 2 m
velo 0 0 -20784.
end
part 9 5 7 1 1 2 3
drag rota 5 0 0 0 0 0 1 90;
si 2 1 1 2 2 2 2 m
velo 0 0 -20784.
end
part 7 5 4 3 1 2 5
drag rota 5 0 0 0 0 0 1 90;
si 2 1 1 2 2 2 2 m
velo 0 0 -20784.
end
part 4 5 14 3 1 2 20
drag rota 5 0 0 0 0 0 1 90;
si 2 1 1 2 2 2 2 m
si 1 1 1 1 2 2 1 s
velo 0 0 -20784.
end
part 12 3 14 1 2 2 3
drag rota 5 0 0 0 0 0 1 90;
si 2 1 1 2 2 2 1 m
velo 0 0 -20784.
end
part 22 27 24 25 3 102 4
drag rota 5 0 0 0 0 0 1 90;
si 1 1 1 2 2 1 2 s
si 1 1 2 2 2 2 3 s
end
part 28 25 24 27 3 34 -12 2.0
drag rota 5 0 0 0 0 0 1 90;
si 1 1 2 2 2 2 3 m
end
end
c use the command stp .001

```

The following is the interactive input to TAURUS after this program has initialized. The period is the prompt from TAURUS.

```
.angle 1  
.state 16  
.ry 75 rx 30  
.movie 0 .0015 15 0 v  
.m 3  
.ry -15  
.center  
.ytrans -10  
.xscale 3 yscale 3 zscale 3 v  
.contour 8  
.contour 19  
.phs2  
.matls 1 1  
.gather  
.mtime 6 1 1  
.end
```

3d duplicate of axisymmetric model
time = 0.

3d duplicate of axisymmetric model
time = 1.00000e-04

3d duplicate of axisymmetric model
time = 2.00000e-04

3d duplicate of axisymmetric model
time = 3.00000e-04

3d duplicate of axisymmetric model
time : 4.00000e-04

3d duplicate of axisymmetric model
time : 5.00000e-04

3d duplicate of axisymmetric model
time : 6.00000e-04

3d duplicate of axisymmetric model
time : 7.00000e-04

3d duplicate of axisymmetric model
time = $8.00000e-04$

3d duplicate of axisymmetric model
time = $9.00000e-04$

3d duplicate of axisymmetric model
time = $1.00000e-03$

3d duplicate of axisymmetric model
time = $1.10000e-03$

3d duplicate of axisymmetric model
time = 1.20000e-03

3d duplicate of axisymmetric model
time = 1.30000e-03

3d duplicate of axisymmetric model
time = 1.40000e-03

3d duplicate of axisymmetric model
time = 1.50000e-03

3d duplicate of axisymmetric model

INGRID/NIKE3D/TAURUS PIPE WHIP EXAMPLE

The problem is calculated with 1/2 of the model using 1 plane of symmetry. Half of a pipe is modeled to impact a second pipe. Both pipes are modeled in INGRID with thin shells which are four node shell elements in NIKE3D. Both pipes are deformed. NIKE3D is stopped before the pipes spring back and come to rest.

When INGRID is in the interactive mode, use the command

```
stp .0001 continue
```

to connect the two edges of the second pipe and write the input for NIKE3D.

```

pipe whip by r. ferencz
nk3d anal dyn
bwm0 off
nbsr 1 nbei 1 nbsr 10 msrf 15
dctol .001 ectol .01
iprt 99 iplt 1 nstep 200 term 10e-3
mat 1 3 shell ro 7.298e-4 e 3.0e+7
pr .3 sigy 1.0e+5 etan 1.0e+5
mat 2 3 shell ro 7.298e-4
e 3.0e+7 pr .3 sigy 1.0e+5
etan 1.0e+5 endmat
plan 1 0 0 0 1 0 0 .001 symm
coor 2 rt 0 0 0 rt 1 0 0 sp 1 90 -16
      rt 0 0 25 rt 0 0 26 rt 0 1 25
start -1:1 8 15:1 10 24 33;
3.3125 90 180 270 0 18 32 50
cyl1 thic .432
b 1 1 1 1 1 4 100011
b 1 3 1 1 3 4 100011
b 1 2 1 1 2 1 111000
si- 1 2 2 1 3 3 1 1 0 0 0
rota 1 0 0 75 0 0
repe 1:end
start -1:1 29:1 7 15;
3.3125 0 360 0 7 25
cyl1 thic .432
n- 1 1 1 1 2 2 20 0 12.5
b 0 0 3 0 0 3 111111
b 0 0 1 0 0 1 100011
si- 1 1 1 1 2 2 1 0 0 0 25
mate 2 repe 2:end end
c use stp in interactive phase

```

The following is the interactive input to TAURUS after TAURUS was initialized with the plot files from the NIKE3D run. The period is the prompt from TAURUS for more input.

```
.angle 20  
.ry -50  
.rx 20  
.xscale 4 yscale 4 zscale 4  
.ytrans 7  
.xtrans -2  
.movie 0 .01 15 0 v  
.end
```

pipe vp by rm, fercz 23 gust 16

time = 0s

pipe vp by rm, fercz 23 gust 16

time = 6.66667e-04

pipe vp by rm, fercz 23 gust 16

time = 1.33333e-03

pipe vp by rm, fercz 23 gust 16

time = 2.00000e-03

pipe vp by rm. fercz 23 gust 16
time = 2.66667e-03

pipe vp by rm. fercz 23 gust 16
time = 3.33333e-03

pipe vp by rm. fercz 23 gust 16
time = 4.00000e-03

pipe vp by rm. fercz 23 gust 16
time = 4.66667e-03

pipe up by rm, fercz 23 gust 16
time = 5.3333e-03

pipe up by rm, fercz 23 gust 16
time = 6.0000e-03

pipe up by rm, fercz 23 gust 16
time = 6.6667e-03

pipe up by rm, fercz 23 gust 16
time = 7.3333e-03

pipe up by rw, fercz 23 gust 16
time = 8.8800e-03

pipe up by rw, fercz 23 gust 16
time = 8.6567e-03

pipe up by rw, fercz 23 gust 16
time = 9.3333e-03

pipe up by rw, fercz 23 gust 16
time = 7.8800e-02

- END -

DATE FILMED

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