

Appendix A: Sample ABAQUS Input File

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*HEADING
SEAN MOLLOY
FINITE ELEMENT ANALYSIS OF PRESSURIZED LEANING ARCH SHELLS

TWO ARCHES WITH 4800 ELEMENTS EACH
15 DEGREE TILT ANGLE
SPAN = 25 m, HEIGHT = 17 m, RADIUS = 0.4 m
**
*PREPRINT,MODEL=NO,HISTORY=NO,ECHO=NO
**
**node definition
**
*NODE, NSET=NARCH1
1, -12.875431, 0.035724, 0.133323
2, -12.862639, 0.134507, 0.101985
3, -12.825133, 0.224123, 0.063697
4, -12.765470, 0.298466, 0.021069
...
...
...
4821, 12.687716, -0.316745, 0.156319
4822, 12.765470, -0.247945, 0.167479
4823, 12.825133, -0.162247, 0.167225
4824, 12.862639, -0.065493, 0.155575
*NODE, NSET=NARCH2
4825, -12.875431, 9.564124, 0.133323
4826, -12.862639, 9.465341, 0.101985
4827, -12.825133, 9.375725, 0.063697
...
...
...
9645, 12.687716, 9.916592, 0.156319
9646, 12.765470, 9.847792, 0.167479
9647, 12.825133, 9.762095, 0.167225
9648, 12.862639, 9.665341, 0.155575
**
** nodes for closed ends
**
*NODE, NSET=NBASE1
10101, -12.500000, .000000, .000000
10102, -12.687716, .034506, .059767
10103, -12.681320, .078160, .031849
10104, -12.662567, .116486, .001760
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...
...
...
10123, -12.632734, -.098075, .112972
10124, -12.662567, -.056719, .101760
10125, -12.681320, -.011498, .083613
*NODE,NSET=NBASE2
10201, 12.500000, .000000, .000000
10202, 12.687716, .034506, .059767
10203, 12.681320, .078160, .031849
10204, 12.662567, .116486, .001760
...
...
...
10223, 12.632734, -.098075, .112972
10224, 12.662567, -.056719, .101760
10225, 12.681320, -.011498, .083613
*NODE,NSET=NBASE3
10301, -12.500000, 17.799999, .000000
10302, -12.687716, 17.765493, .059767
10303, -12.681320, 17.721840, .031849
10304, -12.662567, 17.683514, .001760
...
...
...
10323, -12.632734, 17.898075, .112972
10324, -12.662567, 17.856720, .101760
10325, -12.681320, 17.811497, .083613
*NODE,NSET=NBASE4
10401, 12.500000, 17.799999, .000000
10402, 12.687716, 17.765493, .059767
10403, 12.681320, 17.721840, .031849
10404, 12.662567, 17.683514, .001760
...
...
...
10423, 12.632734, 17.898075, .112972
10424, 12.662567, 17.856720, .101760
10425, 12.681320, 17.811497, .083613
**
** element definition
**
**
**ELEMENT, ELSET=ELARCH1, TYPE=S4R
1,1,25,26,2
2,2,26,27,3
3,3,27,28,4

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```

...
...
...
4798,4798,4822,4823,4799
4799,4799,4823,4824,4800
4800,4800,4824,4801,4777
*ELEMENT, ELSET=ELARCH2, TYPE=S4R
4801,4825,4826,4850,4849
4802,4826,4827,4851,4850
4803,4827,4828,4852,4851
...
...
...
9598,9622,9623,9647,9646
9599,9623,9624,9648,9647
9600,9624,9601,9625,9648
**
** elements for closed ends of arches
**
*ELEMENT,TYPE=S4R,ELSET=ELBASE1A
10101,1,2,10103,10102
10102,2,3,10104,10103
10103,3,4,10105,10104
...
...
...
10122,22,23,10124,10123
10123,23,24,10125,10124
10124,24,1,10101,10125
*ELEMENT,TYPE=S3R,ELSET=ELBASE1B
10125,10102,10103,10101
10126,10103,10104,10101
10127,10104,10105,10101
...
...
...
10146,10123,10124,10101
10147,10124,10125,10101
10148,10125,10102,10101
*ELEMENT,TYPE=S4R,ELSET=ELBASE2A
10201,4801,4802,10203,10202
10202,4802,4803,10204,10203
10203,4803,4804,10205,10204
...
...
...

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10222,4822,4823,10224,10223
10223,4823,4824,10225,10224
10224,4824,4801,10201,10225
*ELEMENT,TYPE=S3R,ELSET=ELBASE2B
10225,10202,10203,10201
10226,10203,10204,10201
10227,10204,10205,10201
...
...
...
10246,10223,10224,10201
10247,10224,10225,10201
10248,10225,10202,10201
*ELEMENT,TYPE=S4R,ELSET=ELBASE3A
10301,4825,4826,10303,10302
10302,4826,4827,10304,10303
10303,4827,4828,10305,10304
...
...
...
10322,4846,4847,10324,10323
10323,4847,4848,10325,10324
10324,4848,4825,10301,10325
*ELEMENT,TYPE=S3R,ELSET=ELBASE3B
10325,10302,10303,10301
10326,10303,10304,10301
10327,10304,10305,10301
...
...
...
10346,10323,10324,10301
10347,10324,10325,10301
10348,10325,10302,10301
*ELEMENT,TYPE=S4R,ELSET=ELBASE4A
10401,9625,9626,10403,10402
10402,9626,9627,10404,10403
10403,9627,9628,10405,10404
...
...
...
10422,9646,9647,10424,10423
10423,9647,9648,10425,10424
10424,9648,9625,10401,10425
*ELEMENT,TYPE=S3R,ELSET=ELBASE4B
10425,10402,10403,10401
10426,10403,10404,10401

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10427,10404,10405,10401
...
...
...
10446,10423,10424,10401
10447,10424,10425,10401
10448,10425,10402,10401
**
** node set and element set definitions
**
*NSET,NSET=LEFTEND1,GENERATE
1,24
*NSET,NSET=RGHTEND1,GENERATE
4801,4824
*NSET,NSET=LEFTEND2,GENERATE
4825,4848
*NSET,NSET=RGHTEND2,GENERATE
9625,9648
*ELSET,ELSET=BASES
LEFTEND1,RGHTEND1,LEFTEND2,RGHTEND2
*ELSET,ELSET=ELALL
ELARCH1,ELARCH2
*NSET,NSET=NALL
NARCH1,NARCH2,ENDS
*NSET,NSET=APEX
2424
7248
*NSET,NSET=NCROSS,GENERATE
2401,2424
7225,7248
*ELSET,ELSET=ELCROSS,GENERATE
2401,2424
7201,7224
*NSET,NSET=NOUT
49,61,1225,1237,2424,2412
*ELSET,ELSET=ELOUT
49,61,1225,1237,2424,2412
**
**contact surface definitions
**
*SURFACE DEFINITION,NAME=SURFACE1
ELARCH1,SPOS
*SURFACE DEFINITION,NAME=SURFACE2
ELARCH2,SPOS
*CONTACT PAIR,INTERACTION=SCONT,SMALL SLIDING
SURFACE2,SURFACE1

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*SURFACE INTERACTION,NAME=SCONT
**
**material definitions
**
*MATERIAL,NAME=ARCH
*DENSITY
1440.0
*ELASTIC
7.0E9, 0.3
*SHELL SECTION,ELSET=ELALL,MATERIAL=ARCH
0.0025
*SHELL SECTION,ELSET=BASES,MATERIAL=ARCH
0.0025
**
**boundary conditions
**
*BOUNDARY
10101,PINNED
10201,PINNED
10301,PINNED
10401,PINNED
*EQUATION
2
2406,1,1,7230,1,-1
2
2406,2,1,7230,2,-1
2
2406,3,1,7230,3,-1
2
2406,4,1,7230,4,-1
2
2406,5,1,7230,5,-1
2
2406,6,1,7230,6,-1
**
**internal pressure and self weight
**
*STEP,NLGEOM,INC=100
*STATIC
0.0001,1.0,0.0000001,1
*DLOAD
ELALL,GRAV,9.8066,0,0,-1.0
ELALL,P,500000
BASES,P,500000
*NODE PRINT,NSET=NOUT,FREQUENCY=100,SUMMARY=NO
U

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```
*NODE FILE,FREQUENCY=0
*EL PRINT,ELSET=ELOUT,FREQUENCY=100,SUMMARY=NO
S
SP
*END STEP
**
**full snow load
**
*STEP,NLGEOM,INC=100
*STATIC,RIKS
0.1,1.0,0.0001,0.1,1.0
*CLOAD
STOP,3,-360.4
*NODE PRINT,NSET=NOUT,FREQUENCY=100,SUMMARY=NO
U
RF
*NODE FILE,FREQUENCY=0
*EL PRINT,ELSET=ELOUT,POSITION=AVERAGED AT
NODES,FREQUENCY=100,SUMMARY=NO
S
SP
*END STEP
**
**natural frequency calculation
**
*STEP
*FREQUENCY
10
*NODE PRINT,FREQUENCY=0,SUMMARY=NO
*NODE FILE,FREQUENCY=0
*EL PRINT,FREQUENCY=0,SUMMARY=NO
*END STEP
```