

FORCES AND STRESSES IN FINITE ELEMENT CELLS OF ADAPT-BUILDER PROGRAMS¹

Details of breakdown of a structure into finite element cells, and the results of the analysis performed by the ADAPT-Builder programs are available in text files to the interested users. This Technical Note describes the principal parameters of interest by way of a simple example.

The following information is covered in this Technical Note.

- ❖ Node numbers used in the analysis
- ❖ Finite element cell numbers and their connectivity
- ❖ Actions (forces and moments) at each node of each finite element cell
- ❖ Average stresses (forces and moments per unit length) at each node of each cell

The slab shown in Fig. 1 is 100 mm thick, fully fixed at one end and subject to a concentrated load of 300 kN at one corner.

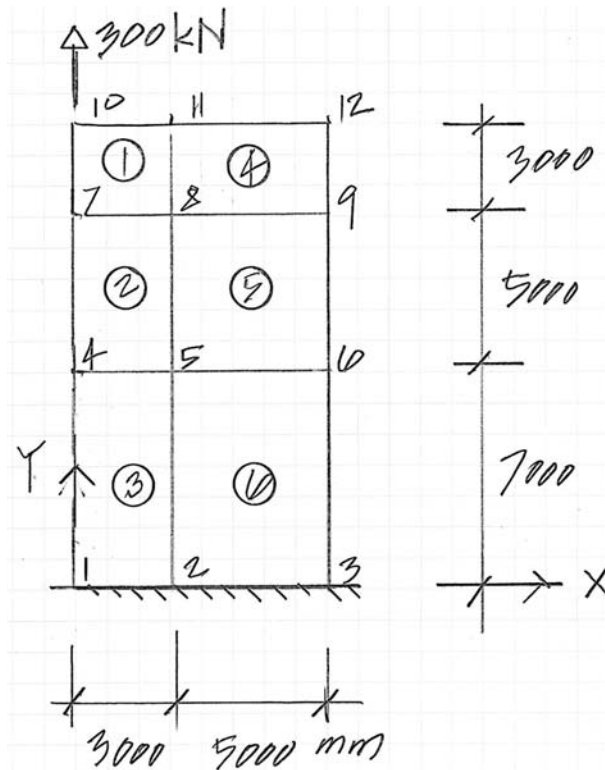


FIGURE 1 PLATE UNDER AN IN-PLANE CONCENTRATED LOAD

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The input and the analysis results are reported by the program in text and binary files. Note that regardless of the system of unit you select for your input data, and the system of units used for the reports of the program, the internal files listed herein will be always in N-mm units.

NODE NUMBER AND COORDINATES

Open the name.inp file in the folder where data was saved, where “name” is the file name you give to the data you run. Look for the data block “NODES,” where you will find the node numbering and their coordinates. The following excerpt from the name.inp file refers to the example of Fig. 1. You will find it easier to follow the data, if before running the program, you change the global coordinate system to a convenient location on the model.

Nodal coordinates in global axes (mm)

```

NODES N=12
;B=1 Node at far end of lower wall/column, B=2 node at far end of of upper
wall/column, B=0, all other nodes
  1 X=0.000000 Y=0.000000 Z=3000.000000 B=0
  2 X=3000.000000 Y=0.000000 Z=3000.000000 B=0
  3 X=8000.000000 Y=0.000000 Z=3000.000000 B=0
  4 X=0.000000 Y=7000.000000 Z=3000.000000 B=0
  5 X=3000.000000 Y=7000.000000 Z=3000.000000 B=0
  6 X=8000.000000 Y=7000.000000 Z=3000.000000 B=0
  7 X=0.000000 Y=12000.000000 Z=3000.000000 B=0
  8 X=3000.000000 Y=12000.000000 Z=3000.000000 B=0
  9 X=8000.000000 Y=12000.000000 Z=3000.000000 B=0
 10 X=0.000000 Y=15000.000000 Z=3000.000000 B=0
 11 X=3000.000000 Y=15000.000000 Z=3000.000000 B=0
 12 X=8000.000000 Y=15000.000000 Z=3000.000000 B=0

```

CELL NUMBERS AND CONNECTIVITY

These are given in the name.inp file in the data block “SHELL ELEMENTS.” The following is the data block associated with the example of Fig. 1. Cell number is followed by the four nodes that define its connectivity in counter clockwise order.

```

SHELL ELEMENTS N=6
  1,11,8,7,10 T=100.000000,100.000000,100.000000,100.000000 D=28 F=1 M=1 V=1.000000,0.000000,0.000000 O=-
0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-50.000000,-
0.000000,-50.000000
  2,8,5,4,7 T=100.000000,100.000000,100.000000,100.000000 D=28 F=1 M=1 V=1.000000,0.000000,0.000000 O=-
0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-50.000000,-
0.000000,-50.000000
  3,5,2,1,4 T=100.000000,100.000000,100.000000,100.000000 D=28 F=1 M=1 V=1.000000,0.000000,0.000000 O=-
0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-50.000000,-
0.000000,-50.000000
  4,12,9,8,11 T=100.000000,100.000000,100.000000,100.000000 D=28 F=1 M=1 V=1.000000,0.000000,0.000000 O=-
0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-50.000000,-
0.000000,-50.000000
  5,9,6,5,8 T=100.000000,100.000000,100.000000,100.000000 D=28 F=1 M=1 V=1.000000,0.000000,0.000000 O=-
0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-50.000000,-
0.000000,-50.000000
  6,6,3,2,5 T=100.000000,100.000000,100.000000,100.000000 D=28 F=1 M=1 V=1.000000,0.000000,0.000000 O=-
0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-0.000000,-50.000000,-0.000000,-0.000000,-50.000000,-
0.000000,-50.000000

```

FORCES AT EACH NODE OF EACH FINITE ELEMENT CELL

Open the name.ado file. The data block starting with "SHELL FORCES," lists the forces and moments at each node of each finite element cell along or about the global axes. The units for the force is N, and for the moments is Nmm. The following reflects the forces for the example shown in Fig. 1.

```

11102  "SHELL_FORCES"

// Forces given in global coordinates
// Internal stress resultants (moments and forces) at the corners of shell
elements
//--ELEM---NODE---<---FX-----FY-----FZ---><-----MXX-----MY-----
--MZZ--->
      1      11 -8.3623E+004  6.8722E+004 -2.9716E-014  3.4361E+006
4.1812E+006  0.0000E+000
      1      8  3.7477E+004 -1.5235E+005 -3.1507E-012 -7.6173E+006 -
1.8738E+006  0.0000E+000
      1      7  4.6147E+004 -2.1638E+005  3.1804E-012 -1.0819E+007 -
2.3073E+006  0.0000E+000
      1     10  5.8208E-011  3.0000E+005 -3.4735E-026  1.5000E+007 -1.8020E-
009  0.0000E+000
      2      8  2.0232E+004  1.1421E+005 -3.8632E-013  5.7104E+006 -
1.0116E+006  0.0000E+000
      2      5  3.0457E+004 -1.5740E+005  2.4675E-012 -7.8700E+006 -
1.5228E+006  0.0000E+000
      2      4 -4.5423E+003 -1.7319E+005  1.0993E-012 -8.6593E+006
2.2711E+005  0.0000E+000
      2      7 -4.6147E+004  2.1638E+005 -3.1804E-012  1.0819E+007
2.3073E+006  0.0000E+000
      3      5  1.8933E+003  1.4898E+005  2.7619E-012  7.4490E+006 -
9.4667E+004  0.0000E+000
      3      2 -6.4356E+003 -1.3396E+005  5.1145E-012 -6.6981E+006
3.2178E+005  0.0000E+000
      3      1  2.3283E-010 -1.8820E+005 -6.7772E-012 -9.4101E+006 -6.0624E-
009  0.0000E+000
      3      4  4.5423E+003  1.7319E+005 -1.0993E-012  8.6593E+006 -
2.2711E+005  0.0000E+000
      4     12  6.5484E-011  0.0000E+000  1.3732E-026  3.5453E-009 -1.0048E-
009  0.0000E+000
      4      9 -4.8034E+004  5.0174E+004 -1.5008E-012  2.5087E+006
2.4017E+006  0.0000E+000
      4      8 -3.5589E+004  1.8548E+004  1.4711E-012  9.2740E+005
1.7795E+006  0.0000E+000
      4     11  8.3623E+004 -6.8722E+004  2.9716E-014 -3.4361E+006 -
4.1812E+006  0.0000E+000
      5      9  4.8034E+004 -5.0174E+004  1.5008E-012 -2.5087E+006 -
2.4017E+006  0.0000E+000

```

AVERAGE STRESSES IN FINITE ELEMENT CELLS

From name.ADO file, average stresses at each node of each finite element cell can be read off. The stresses are listed in data block "Shell Stresses." The values are along or about the global axes. The forces are in N/mm and the moments in units of Nmm/mm. The following gives the stresses for the example shown in Fig. 1.

```
~DATA SHELL_STRESSES
```

```

11104  "SHELL_STRESSES"

// Stress resultants given in global coordinates at the nodes.
//--NODE-----NX-----NY-----NZ-----MXX-----MYY-----MXY---->
1.2611E-013  1  6.6772E+000  1.4808E+002 -2.1452E+000  4.4005E-012  1.9733E-012  -
6.3819E-013  2  1.9670E+000  6.8689E+001 -4.2904E-001  1.9305E-012  1.9664E-013  -
6.6728E-013  3 -1.6651E+001 -8.0238E+001  1.2871E+000 -1.7277E-012 -1.6257E-012  -
3.9660E-013  4  1.0493E+001  1.5904E+002  3.2465E+000 -2.7915E-012 -1.1551E-012  -
2.5299E-013  5  1.7140E+000  5.9086E+001  6.4930E-001 -1.8795E-013 -2.6771E-013  -
5.0434E-013  6 -1.3692E+001 -7.4004E+001 -1.9479E+000  2.4427E-012 -2.8826E-012  -
5.0086E-013  7  4.3324E+001  2.2906E+002  1.8256E+001  1.2995E-012  5.3347E-014  -
3.2472E-013  8  1.3200E+001  1.6400E+001  3.6513E+000  2.6620E-013 -2.8831E-013
2.0067E-013  9  1.6482E+001 -2.9221E+001 -1.0954E+001 -6.0994E-013  1.1125E-012
1.0469E-012 10 -2.3659E+001  2.6891E+002  2.7874E+001 -6.5233E-013  1.9183E-012
5.8756E-013 11 -7.0292E+001 -3.5729E+001  5.5749E+000  2.2506E-012 -1.9545E-013
4.9822E-013 12 -5.0765E+001 -9.5664E+000 -1.6725E+001  1.7127E-012 -2.5766E-013  -
~END_DATA SHELL_STRESSES

```

INPUT DATA

The name of input data shown in Fig. 1 is TN316_cell_data_1.adm. It is available with this Technical Note.