ME 7120: Project 2

Finite Element Method Applications

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Single Element Test

* Eigenvalue test

Calculate the eigenvalues of the stiffness matrix of a single brick 8 element, 24 eigenvalues are obtained. Different numbers of gauss points are chosen to calculate the eigenvalues listed in the following table. There are 6 values corresponding to the rigid body motion, which are imaginary numbers close to zero with very small imaginary part. The rest of eigenvalues are all positive. For the case with 4 gauss points, all eigenvalues are real.

Table 1. 24 Eigenvalues with 4 Gauss points for integration

|  |  |  |  |
| --- | --- | --- | --- |
| -6.03E-05 | 6.57E+10 | 1.97E+11 | 3.94E+11 |
| -4.71E-05 | 6.57E+10 | 1.97E+11 | 3.94E+11 |
| 3.80E-06 | 1.18E+11 | 2.63E+11 | 3.94E+11 |
| 3.88E-05 | 1.18E+11 | 3.79E+11 | 3.94E+11 |
| 8.99E-05 | 1.18E+11 | 3.79E+11 | 3.94E+11 |
| 1.30E-04 | 1.97E+11 | 3.79E+11 | 1.21E+12 |

Table 2. 24 Eigenvalues with 5 Gauss points for integration

|  |  |  |  |
| --- | --- | --- | --- |
| 2.66E-05 | 6.57E+10 | 1.97E+11 | 3.94E+11 |
| 7.27E-05 -3.44E-05i | 6.57E+10 | 1.97E+11 | 3.94E+11 |
| 7.27E-05 +3.44E-05i | 1.18E+11 | 2.63E+11 | 3.94E+11 |
| -7.66E-05 -2.64E-05i | 1.18E+11 | 3.79E+11 | 3.94E+11 |
| -7.66E-05 +2.64E-05i | 1.18E+11 | 3.79E+11 | 3.94E+11 |
| 1.01E-04 | 1.97E+11 | 3.79E+11 | 1.21E+12 |

* Uniform stress test

Apply uniform load at one direction with appropriate boundary conditions and loading conditions. Check the displacement to make sure the stress is uniform distribution. Fig. 1 and 2 show the uniform displacement field applying uniform load at x and z direction using WFEM, respectively. The same case for loading at x direction has been applied using ANSYS for comparison. The deformed shape is shown in Fig. 3. The comparison of WFEM and ANSYS for x deflection is listed in Table 1. There is a 0.003% difference for the results getting from WFEM and ANSYS.



Fig. 1. Uniform displacement field at x direction (WFEM)

Fig.2. Uniform displacement field at z direction (WFEM)

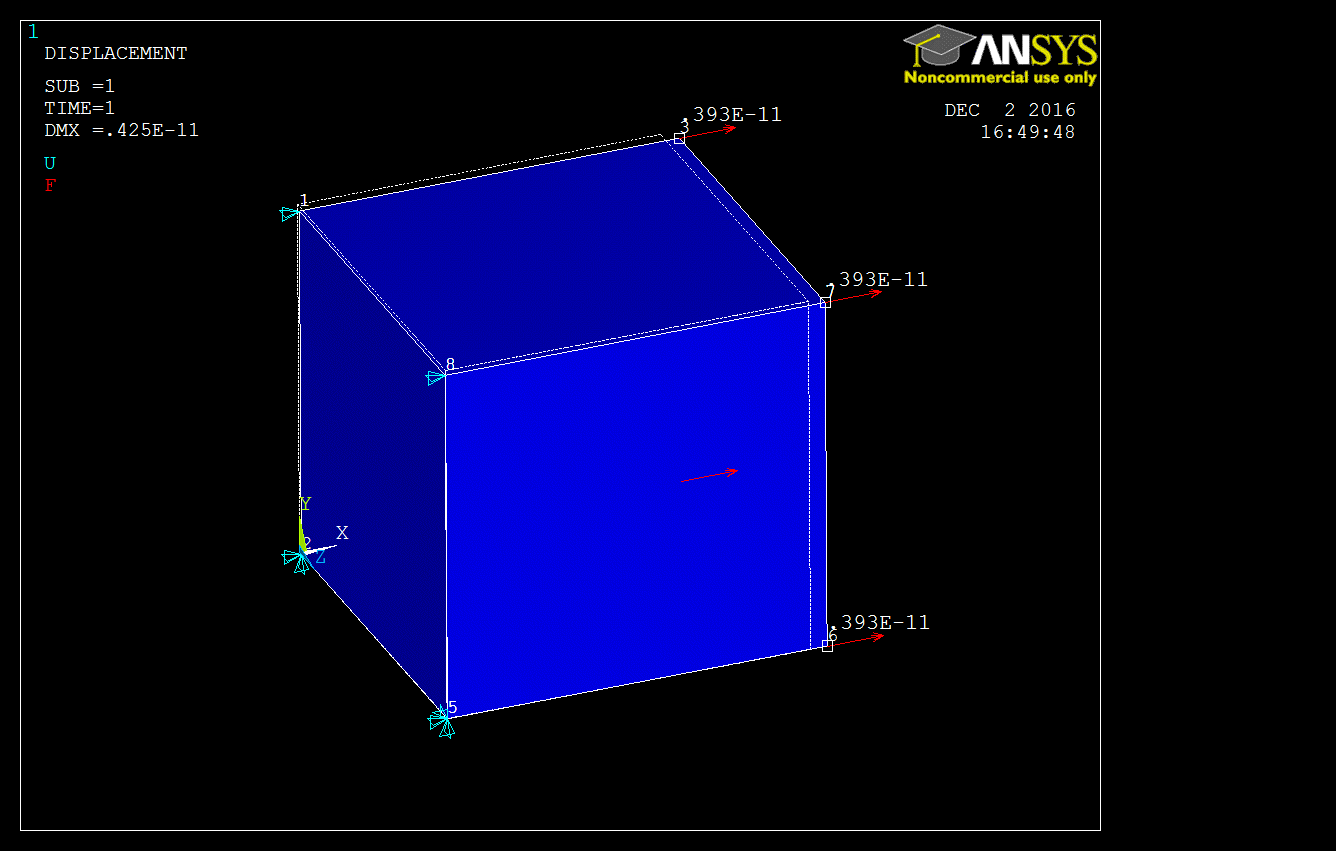


Fig. 3. Deformed shape (ANSYS)

Table 1. Deflection Comparison for x deflection

|  |  |  |  |
| --- | --- | --- | --- |
|  | ANSYS | WFEM | Difference |
| x deflection | 3.93310E-12 | 3.93323E-12 | 0.003% |

Brick Element Comparison

* Pyramid

Table 2. Deflection Comparison for x deflection at tip

|  |  |  |  |
| --- | --- | --- | --- |
|  | ANSYS | WFEM | Difference |
| x deflection | 0.346E-9 | 0.246E-9 | 29% |

