

ZZZZ101 - Validation of operators AFFE_CARA_ELEM and POST_ELEM

Summarized:

Validation of operators AFFE_CARA_ELEM and POST_ELEM.

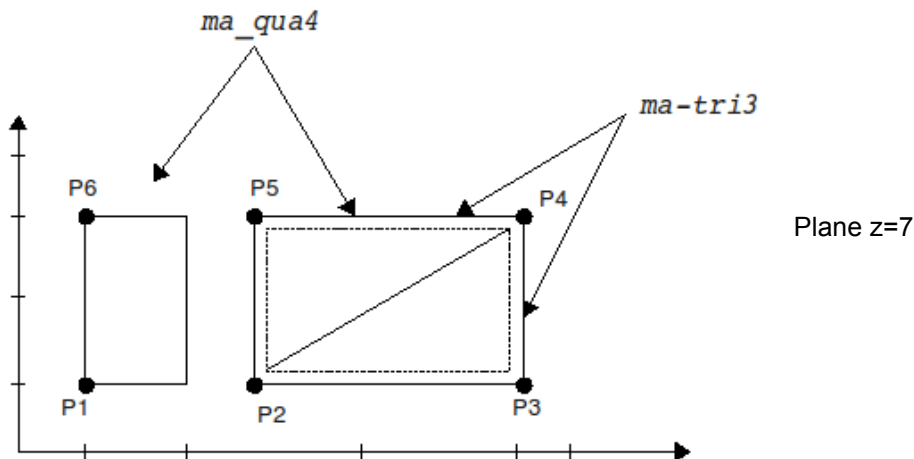
This test relates to the computation of the mass, the center of gravity and the tensor of inertia at the center of gravity for the following modelizations:

- discrete elements: DIS_TR and DIS_T,
- elements of bar: BAR,
- beam elements: POU_D_E, POU_D_T, POU_C_T,
- shell elements: DKT, DST, Q4G,
- voluminal elements: 3D.

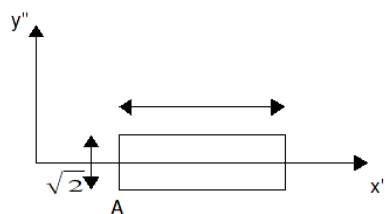
1 Problem of reference

1.1 Geometry

Mesh in space 3D not modelling any defined structure, formed by meshes specific, linear, of plates, and a hexahedral volume.



Parallépipède on side $1, \sqrt{2}, 7$.



According to z'' : thickness 1.

In the reference (x, y, z) the point A has as coordinates $(1, 0, 0)$.

One passes from the reference (x, y, z) to the reference (x'', y'', z'') with the Eulerian angles $(45^\circ, 45^\circ, 0^\circ)$.

1.2 Properties of the material

$$E = 2.10^{11} \text{ Pa}$$

$$\nu = 0.3$$

$$\rho = 1.5 \text{ kg/m}^3 \text{ (except for the discrete elements: } \rho = 1.5 \cdot 10^4 \text{ kg/m}^3 \text{)}$$

1.3 Boundary conditions and loadings

Without object (not of resolution).

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Method of calculating

Masses and center of gravity:

$$m = \rho \int_v dv = \rho \int_v dx.dy.dz$$
$$x_G = \frac{\int_v x.dv}{m} \quad y_G = \frac{\int_v y.dv}{m} \quad z_G = \frac{\int_v z.dv}{m}$$

Tensor of inertia:

$$I_{xx} = \rho \int_v (y^2 + z^2).dv \quad I_{xy} = \rho \int_v x.y.dv$$
$$I_{yy} = \rho \int_v (x^2 + z^2).dv \quad I_{xz} = \rho \int_v x.z.dv$$
$$I_{zz} = \rho \int_v (x^2 + y^2).dv \quad I_{yz} = \rho \int_v y.z.dv$$

2.2 Quantities and results of reference

Masses and inertias for the various modelizations.

2.3 Uncertainties on the solution

Note:

| For one of the meshes modelled in shells, the solution is numerical (non regression).

3 Modelization A

3.1 Characteristic of the modelization

DISCRET element :

- • modelization M_T_D_N computation of the mass and the center of gravity
- • modelization M_T_N computation of the mass and the center of gravity
- • modelization M_TR_D_N computation of the mass, the center of gravity and the tensor of inertia + eccentring
- • modelization M_TR_N computation of the mass, the center of gravity and the tensor of inertia + eccentring
- • modelization M_T_L computation of the mass and the center of gravity
- • modelization M_TR_L computation of the mass and the center of gravity

Element BARS :

- • modelization BARS computation of the mass and of the center of gravity, general section, right-angled section and section (full and hollow) Element

rings BEAM:

- • modelization POU_D_E computation of the mass, general section, right-angled section and section rings (full and hollow)
- • modelization POU_D_T computation of the mass, general section, right-angled section and section rings (full and hollow)
- • modelization POU_C_T computation of the mass, general section, right-angled section and section rings (full and hollow)

Element COQUE :

- • modelization DKT : computation of the mass, the center of gravity and the tensor of inertia (triangle and quadrangle)
- • modelization DST : computation of the mass, the center of gravity and the tensor of inertia (triangle and quadrangle)
- • modelization Q4G : computation of the mass, the center of gravity and the tensor of inertia (triangle and quadrangle)
- • modelization 3D (HEXA8) computation of the mass, the center of gravity and the tensor of inertia

3.2 Characteristics of the mesh

DISCRET element :

- modelization M_T_D_N, M_T_N, M_TR_D_N, M_TR_N : 1 mesh POI1
- modelization M_T_L, M_TR_L : 1 mesh SEG2

Element BARS :

- modelization BARS : 1 mesh SEG2

Element BEAM:

- modelization POU_D_E, POU_D_T : 1 mesh SEG2
- modelization POU_C_T : 7 meshes SEG2

Element COQUE :

- modelization DKT, DST, Q4G :

5 meshes TRIA3 and
QUAD4
2 meshes TRIA3 (irregular
mesh 2 meshes QUAD4)

Element 3D :

1 mesh HEXA8

3.3 Quantities tested and results

| Modelization | Mesh | AFFE_CARA_ELEM | Identification | Reference | Variation % |
|--------------|--------|----------------------|----------------|-------------|-------------|
| DIS_T | 1 POI1 | M_T_D_N | MASSE | 5.16E+001 | 0 |
| | | | CDG_X | 1.00E+000 | 0 |
| | | | CDG_Y | 1.00E+000 | 0 |
| | | | CDG_Z | 7.00E+000 | 0 |
| DIS_T | 1 POI1 | M_T_N | MASSE | 5.16E+001 | 0 |
| | | | CDG_X | 1.00E+000 | 0 |
| | | | CDG_Y | 1.00E+000 | 0 |
| | | | CDG_Z | 7.00E+000 | 0 |
| DIS_TR | 1 POI1 | M_TR_D_N | MASSE | 5.16E+001 | 0 |
| | | | CDG_X | 1.00E+000 | 0 |
| | | | CDG_Y | 1.00E+000 | 0 |
| | | | CDG_Z | 7.00E+000 | 0 |
| | | | IX_G | 6.9815E-04 | 0 |
| | | | IY_G | 5.2962E-04 | 0 |
| | | | IZ_G | 2.7170E-04 | 0 |
| | | | IXY_G | -1.0317E-04 | 0 |
| | | | IXZ_G | -1.5476E-04 | 0 |
| | | | IYZ_G | -3.0951E-04 | 0 |
| DIS_TR | 1 POI1 | M_TR_N | MASSE | 5.16E+001 | -0.01 |
| | | | CDG_X | 1.00E+000 | 0 |
| | | | CDG_Y | 1.00E+000 | 0 |
| | | | CDG_Z | 7.00E+000 | 0 |
| | | | IX_G | 6.9815E-04 | -0.006 |
| | | | IY_G | 5.2962E-04 | -0.004 |
| | | | IZ_G | 2.7170E-04 | 0 |
| | | | IXY_G | -1.0317E-04 | 0.03 |
| | | | IXZ_G | -1.5476E-04 | 0.03 |
| | | | IYZ_G | -3.0951E-04 | -0.003 |
| DIS_T | 1 SEG2 | M_T_L | MASSE | 2.00E+000 | 0 |
| | | | CDG_X | 1.50E+000 | 0 |
| | | | CDG_Y | 1.00E+000 | 0 |
| | | | CDG_Z | 7.00E+000 | 0 |
| DIS_TR | 1 SEG2 | M_TR_L | MASSE | 5.16E+001 | 0 |
| | | | CDG_X | 1.50E+000 | 0 |
| | | | CDG_Y | 1.00E+000 | 0 |
| | | | CDG_Z | 7.00E+000 | 0 |
| BAR | 1 SEG2 | section: general | MASSE | 6.66E+000 | 0 |
| | | section: full square | MASSE | 4.24E+000 | 0 |

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| | | | | | | |
|---------|---|-------|---------------------------|-------|------------|--------|
| | 1 | SEG2 | section: hollow square | MASSE | 8.0610E-01 | 0 |
| | 1 | SEG2 | section: hollow rectangle | MASSE | 1.09E+000 | 0 |
| | 1 | SEG2 | section: full circle | MASSE | 1.33E+001 | 0 |
| | 1 | SEG2 | section: ring hollow | MASSE | 7.8772E-01 | 0 |
| POU_D_E | 1 | SEG2 | section: general | MASSE | 6.66E+000 | 0 |
| | | | | CDG_X | 3.00E+000 | 0 |
| | | | | CDG_Y | 2.00E+000 | 0 |
| | | | | CDG_Z | 7.00E+000 | 0 |
| | 1 | SEG2 | section: full square | MASSE | 4.24E+000 | 0 |
| | 1 | SEG2 | section: hollow square | MASSE | 8.0610E-01 | 0 |
| | 1 | SEG2 | section: hollow rectangle | MASSE | 1.09E+000 | 0 |
| | 1 | SEG2 | section: full circle | MASSE | 1.33E+001 | 0 |
| | 1 | SEG2 | section: ring hollow | MASSE | 7.8772E-01 | 0 |
| POU_D_T | 1 | SEG2 | section: general | MASSE | 6.66E+000 | 0 |
| | | | | CDG_X | 3.00E+000 | 0 |
| | | | | CDG_Y | 2.00E+000 | 0 |
| | | | | CDG_Z | 7.00E+000 | 0 |
| | 1 | SEG2 | section: full square | MASSE | 4.24E+000 | 0 |
| | 1 | SEG2 | section: hollow square | MASSE | 8.0610E-01 | 0 |
| | 1 | SEG2 | section: hollow rectangle | MASSE | 1.09E+000 | 0 |
| | 1 | SEG2 | section: full circle | MASSE | 1.33E+001 | 0 |
| | 1 | SEG2 | section: ring hollow | MASSE | 7.8772E-01 | 0 |
| DKT | 2 | TRIA3 | thickness | MASSE | 1.8000E-01 | 0 |
| | | | | CDG_X | 3.00E+000 | 0 |
| | | | | CDG_Y | 2.00E+000 | 0 |
| | | | | CDG_Z | 7.00E+000 | 0 |
| | | | | IX_G | 6.0020E-02 | -0.011 |
| | | | | IY_G | 6.0020E-02 | -0.011 |
| | | | | IZ_G | 1.2000E-01 | 0 |
| DKT | 2 | QUAD4 | thickness | MASSE | 2.7000E-01 | 0 |
| | | | | CDG_X | 2.50E+000 | 0 |
| | | | | CDG_Y | 2.00E+000 | 0 |
| | | | | CDG_Z | 7.00E+000 | 0 |
| | | | | IX_G | 9.0020E-02 | 0 |
| | | | | IY_G | 2.0252E-01 | 0 |
| | | | | IZ_G | 2.9250E-01 | 0 |
| DST | 2 | TRIA3 | thickness | MASSE | 1.8000E-01 | 0 |
| | | | | CDG_X | 3.00E+000 | 0 |
| | | | | CDG_Y | 2.00E+000 | 0 |
| | | | | CDG_Z | 7.00E+000 | 0 |
| | | | | IX_G | 6.0020E-02 | -0.011 |
| | | | | IY_G | 6.0020E-02 | -0.011 |
| | | | | IZ_G | 1.2000E-01 | 0 |
| DSQ | 2 | QUAD4 | thickness | MASSE | 2.7000E-01 | 0 |
| | | | | CDG_X | 2.50E+000 | 0 |
| | | | | CDG_Y | 2.00E+000 | 0 |
| | | | | CDG_Z | 7.00E+000 | 0 |
| | | | | IX_G | 9.0020E-02 | 0 |
| | | | | IY_G | 2.0252E-01 | 0 |
| | | | | IZ_G | 2.9250E-01 | 0 |
| | | | | IX_P | 7.11E+000 | 0 |
| | | | | IY_P | 7.56E+000 | 0 |
| | | | | IZ_P | 1.17E+000 | 0 |
| Q4G | 2 | QUAD4 | thickness | MASSE | 2.7000E-01 | 0 |
| | | | | CDG_X | 2.50E+000 | 0 |

Code Aster

Version
default

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Responsable : Jean-Luc FLÉJOU

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| | | | | | |
|------------------------|--------------------|------------------------------|-----------|------------|------|
| | | | CDG_Y | 2.00E+000 | 0 |
| | | | CDG_Z | 7.00E+000 | 0 |
| | | | IX_G | 9.0020E-02 | 0 |
| | | | IY_G | 2.0252E-01 | 0 |
| | | | IZ_G | 2.9250E-01 | 0 |
| T3G | 2 TRIA3 | thickness | MASSE | 2.7000E-01 | 0 |
| | | | CDG_X | 2.50E+000 | 0 |
| | | | CDG_Y | 2.00E+000 | 0 |
| | | | CDG_Z | 7.00E+000 | 0 |
| | | | IX_G | 9.0020E-02 | 0 |
| | | | IY_G | 2.0252E-01 | 0 |
| | | | IZ_G | 2.9250E-01 | 0 |
| POU_C_T and POU_D_T | 7 SEG2 | DEFI_ARC centers | MASSE | 5.55E+000 | 0 |
| POU_C_T and POU_D_T | 7 SEG2 | DEFI_ARC different center | MASSE | 3.67E+001 | 0 |
| DKT3 | TRIA3 2 QUAD4 | | MASSE | 3.90E+002 | 0 |
| | | | CDG_X | 8,5000E-01 | 0 |
| | | | CDG_Y | 1.47E+000 | 0 |
| | | | CDG_Z | 1.90E+000 | 0 |
| | | | IX_PRIN_G | 3.25E+001 | 0.01 |
| | | | IY_PRIN_G | 8.13E+002 | 0 |
| | | | IZ_PRIN_G | 8.45E+002 | 0 |
| | | | ALPHA | 6.00E+001 | 0 |
| | | | GAMMA | 9.00E+001 | 0 |
| DST | 3 TRIA3 2 QUAD4 | | MASSE | 3.90E+002 | 0 |
| | | | CDG_X | 8,5000E-01 | 0 |
| | | | CDG_Y | 1.47E+000 | 0 |
| | | | CDG_Z | 1.90E+000 | 0 |
| | | | IX_PRIN_G | 3.25E+001 | 0.01 |
| | | | IY_PRIN_G | 8.13E+002 | 0 |
| | | | IZ_PRIN_G | 8.45E+002 | 0 |
| | | | ALPHA | 6.00E+001 | 0 |
| | | | GAMMA | 9.00E+001 | 0 |
| Q4G | 3 TRIA3 2 QUAD4 | | MASSE | 3.90E+002 | 0 |
| | | | CDG_X | 8,5000E-01 | 0 |
| | | | CDG_Y | 1.47E+000 | 0 |
| | | | CDG_Z | 1.90E+000 | 0 |
| | | | IX_PRIN_G | 3.25E+001 | 0.01 |
| | | | IY_PRIN_G | 8.13E+002 | 0 |
| | | | IZ_PRIN_G | 8.45E+002 | 0 |
| | | | ALPHA | 6.00E+001 | 0 |
| | | | GAMMA | 9.00E+001 | 0 |
| 3D | 1 HEXA8 | | MASSE | 7.80E+004 | 0 |
| | | | CDG_X | 2.49E+000 | 0 |
| | | | CDG_Y | 2.49E+000 | 0 |
| | | | CDG_Z | 2.20E+000 | 0 |
| | | | IX_PRIN_G | 1.95E+004 | 0 |
| | | | IY_PRIN_G | 3.32E+005 | 0 |

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| | | |
|-----------|-----------|---|
| IZ_PRIN_G | 3.38E+005 | 0 |
| ALPHA | 4.50E+001 | 0 |

All values tested are exact.

4 Summary of the results

the results are equal to the reference solutions and make it possible to validate key word `MASS_INER` of `POST_ELEM`.