ZZZZ101 - Validation of the operators AFFE_CARA_ELEM and POST_ELEM

Summary:

Validation of the operators AFFE_CARA_ELEM and POST_ELEM.

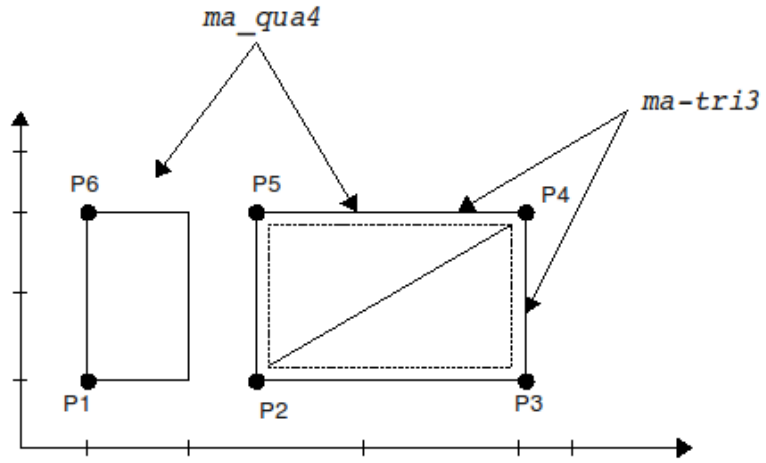
This test relates to the calculation of the mass, the centre of gravity and the tensor of inertia in the centre of gravity for following modelings:

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

1 Problem of reference

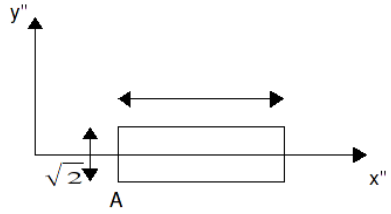
1.1 Geometry

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



Z=7 plan

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



According to z'' : thickness 1.
In the reference mark (x, y, z) the point A has for coordinates $(1, 0, 0)$.
One passes from the reference mark (x, y, z) with reference mark (x'', y'', z'') with the angles of Euler $(45°, 45°, 0°)$.

1.2 Properties of material

$E = 2.10^{11}\ Pa$
$\nu = 0.3$
$\rho = 1.5\ kg/m^3$ (except for the discrete elements: $\rho = 1.5 10^4\ kg/m^3$)

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

Mass and centre of gravity:

$$m = \rho \int_v dv = \rho \int_v dx.dy.dz$$

$$x_G = \frac{\int_v x.dv}{m} \qquad y_G = \frac{\int_v y.dv}{m} \qquad z_G = \frac{\int_v z.dv}{m}$$

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 Sizes and results of reference

Masses and inertias for various modelings.

2.3 Uncertainties on the solution

Note:

For one of the grids modelled in hulls, the solution is digital (not regression).

3 Modeling A

3.1 Characteristics of modeling

Element DISCRETE :

- modeling M_T_D_N — calculation of the mass and the centre of gravity
- modeling M_T_N — calculation of the mass and the centre of gravity
- modeling M_TR_D_N — calculation of the mass, the centre of gravity and the tensor of inertia + offsetting
- modeling M_TR_N — calculation of the mass, the centre of gravity and the tensor of inertia + offsetting
- modeling M_T_L — calculation of the mass and the centre of gravity
- modeling M_TR_L — calculation of the mass and the centre of gravity

Element BAR :

- modeling BAR — calculation of the mass and the general section, centre of gravity, right-angled section and section rings (full and hollow)

Element BEAM :

- modeling POU_D_E — calculation of the mass, general section, right-angled section and section rings (full and hollow)
- modeling POU_D_T — calculation of the mass, general section, right-angled section and section rings (full and hollow)

Element HULL :

- modeling DKT : (triangle and quadrangle) — calculation of the mass, the centre of gravity and the tensor of inertia
- modeling DST : (triangle and quadrangle) — calculation of the mass, the centre of gravity and the tensor of inertia
- modeling Q4G : (triangle and quadrangle) — calculation of the mass, the centre of gravity and the tensor of inertia
- modeling 3D (HEXA8) — calculation of the mass, the centre of gravity and the tensor of inertia

3.2 Characteristics of the grid

Element DISCRETE :

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

Element BAR :

- modeling BAR : 1 mesh SEG2

Element BEAM :

- modeling POU_D_E, POU_D_T : 1 mesh SEG2

Element HULL :

- modeling DKT, DST, Q4G : 5 meshs TRIA3 and QUAD4 2 meshs TRIA3 (irregular grid 2 meshs QUAD4)

Element 3D :

1 mesh HEXA8

3.3 Sizes tested and results

Modeling	Grid	AFFE_CARA_ELEM	Identification	Reference	Variation %
DIS_T	1 POI1	M_T_D_N	MASS	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	MASS	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	MASS	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	MASS	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	MASS	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	MASS	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	MASS	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	MASS	4,24E+000	0
	1 SEG2	section: hollow square	MASS	8.0610E-01	0
	1 SEG2	section: hollow rectangle	MASS	1,09E+000	0
	1 SEG2	section: full circle	MASS	1,33E+001	0
	1 SEG2	section: hollow circle	MASS	7.8772E-01	0
POU_D_E	1 SEG2	section: general	MASS	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	MASS	4,24E+000	0
	1 SEG2	section: hollow square	MASS	8.0610E-01	0
	1 SEG2	section: hollow rectangle	MASS	1,09E+000	0

Modeling	Grid	AFFE_CARA_ELEM	Identification	Reference	Variation %
	1 SEG2	section: full circle	MASS	1,33E+001	0
	1 SEG2	section: hollow circle	MASS	7.8772E-01	0
POU_D_T	1 SEG2	section: general	MASS	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	MASS	4,24E+000	0
	1 SEG2	section: hollow square	MASS	8.0610E-01	0
	1 SEG2	section: hollow rectangle	MASS	1,09E+000	0
	1 SEG2	section: full circle	MASS	1,33E+001	0
	1 SEG2	section: hollow circle	MASS	7.8772E-01	0
DKT	2 TRIA3	thickness	MASS	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	MASS	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	MASS	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	MASS	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	MASS	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
T3G	2 TRIA3	thickness	MASS	2.7000E-01	0
			CDG_X	2.50E+000	0
			CDG_Y	2.00E+000	0
			CDG_Z	7.00E+000	0

Modeling	Grid	AFFE_CARA_ELEM	Identification	Reference	Variation %
			IX_G	9.0020E-02	0
			IY_G	2.0252E-01	0
			IZ_G	2.9250E-01	0
DKT	3 TRIA3 2 QUAD4		MASS	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		MASS	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		MASS	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		MASS	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
			IZ_PRIN_G	3,38E+005	0
			ALPHA	4,50E+001	0

All the values tested are exact.

4 Summary of the results

The results are equal to the reference solutions and make it possible to validate the keyword MASS_INER of POST_ELEM.