SSNL504 - Beam of multifibre beams

Summary:

This test makes it possible to validate the element multi-beam describes using multifibre beams.

The first calculation is carried out using a grid of ten beams, where boundary conditions equivalent to a kinematics of beams are applied to the beams. This solution is regarded as that of reference. Then, the second calculation is carried out where the element multi-beam describing ten bolsters is employed on only one nets.

1 Problem of reference

1.1 Geometry

A beam of multifibre beams of Euler length 1 m in direction X is described using ten multifibre beams of Euler positioned in plan YZ. The following table presents the position of these ten beams:

Number Beam	YP	ZP
1	0	0
2	0	-2
3	0	3
4	4	0
5	-1	0
6	-3	-1
7	-3	3
8	-2	-3
9	5	-3
10	1	-3

All the beams are discretized using 4 fibres of surface of 0,02m^2. Those are positioned, compared to the beam (in m):

Number Fibre	Position Y	Position Z
1	0.1	0
2	0	0.1
3	-0.1	0
4	0	-0.1

1.2 Properties of material

$E=2.0\,E11\,Pa$ Young modulus
$Gx=1\,Pa$ Module of inflection
$\nu=0,3$ Poisson's ratio

1.3 Boundary conditions and loadings

Boundary conditions specific are forced on the beam beams in order to bind them enters they using a kinematics of beam centered in (0.0) for displacement and of common rotations. By imposing boundary conditions with the beam of beam such as:

Ux	Uy	Uz	θX	θy	θZ
1	1	1	0.1	0.1	0.1

One obtains for each beam the boundary conditions following:

Number Beam	Ux	Uy	Uz	θx	θy	θz
1	1	1	1	0.1	0.1	0.1
2	-1	1	3	0.1	0.1	0.1
3	4	1	-2	0.1	0.1	0.1
4	-3	5	1	0.1	0.1	0.1
5	2	0	1	0.1	0.1	0.1
6	3	-2	2	0.1	0.1	0.1
7	7	-2	-2	0.1	0.1	0.1
8	0	-1	4	0.1	0.1	0.1
9	-7	6	4	0.1	0.1	0.1
10	-3	2	4	0.1	0.1	0.1

2 Reference solution

2.1 Method of calculating used for the reference solution

The reference solution is given using a calculation by finite elements where the ten beams are modelled using ten elements beam of multifibre Euler. The efforts in each beam are homogenized thereafter in the manner of the element multi-beam. For the efforts, one thus has:

$$\mathbf{F}_x=\sum_{p=1}^{N_p} F_x^p;\ \mathbf{V}_y=\sum_{p=1}^{N_p} V_y^p;\ \mathbf{V}_z=\sum_{p=1}^{N_p} V_z^p$$

For the moment:

$$\mathbf{M}_x=\sum_{p=1}^{N_p} M_x^p+\sum_{p=1}^{N_p} V_z^p Y^p-\sum_{p=1}^{N_p} V_y^p Z^p;\ \mathbf{M}_y=\sum_{p=1}^{N_p} M_y^p+\sum_{p=1}^{N_p} F_x^p Z^p;\ \mathbf{M}_z=\sum_{p=1}^{N_p} M_z^p-\sum_{p=1}^{N_p} F_x^p Y^p$$

where Fx is the normal effort, Vy and Vz respectively the efforts cutting-edges, MX torque and My and Mz respectively bending moments. Np = 10 because modeling is carried out using ten beams.

2.2 Results of reference

Calculation by finite elements results in:

For homogenized Node 1:

Fx	Vy	Vz	MX	MX	Mz
-2337344934	-153812376	-168892021	-329490238	-117872556	-1912852934

For homogenized Node 2:

Fx	Vy	Vz	MX	MX	Mz
2337344934	153812376	168892021	329490238	286764577	1759040558

3 Modeling A

3.1 Characteristics of modeling

Calculation is this time carried out with one only element beam, to which one affects ten multifibre bolsters of Euler of Euler using the element multi-beam. A reference is employed, because the coupling between the calculation of the term of torsion is different between the multifibre beams and the multi-beams.

Tests of the efforts to the two nodes of the multi-beam:

Node 1	**Value of reference**	**Tolerance (in %)**	**Reference**
Fx	-2337344934.27	0.1	AUTRE_ASTER
Vy	-153812376.32	0.1	AUTRE_ASTER
Vz	-168892021.057	0.1	AUTRE_ASTER
MX	-77252567160.6	100	AUTRE_ASTER
My	-117872556.363	0.1	AUTRE_ASTER
Mz	-1912852934.92	0.1	AUTRE_ASTER
Node 2	**Value of reference**	**Precision (in %)**	**Reference**
Fx	2337344934.27	0.1	AUTRE_ASTER
Vy	153812376.32	0.1	AUTRE_ASTER
Vz	168892021.057	0.1	AUTRE_ASTER
MX	77252567160.6	100	AUTRE_ASTER
My	286764577.42	0.1	AUTRE_ASTER
Mz	1759040558.6	0.1	AUTRE_ASTER

4 Summary of the results

The got results are excellent. The values obtained using several multifibre beams of Euler are identical to the values obtained using the element multi-beam.

On the other hand the results are not in agreement for the term of torsion, the coupling of the various efforts being different.