SSLL119 – Beams subjected to moments distributed

Summary:

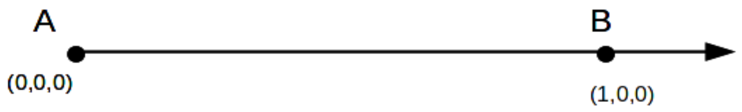
The objective this test is to validate the application of moments distributed on the beams.

Note: The moments distributed on the beams are affected by the orders AFFE_CHAR_MECA and AFFE_CHAR_MECA_F , operand FORCE_POUTRE , keyword MX, MY, MZ, MT, MFY and MFZ. They are applicable to the right beams with constant characteristics.

1 Problem of reference

1.1 Geometry

A beam length is considered $1m$ directed according to X or according to Z according to modelings.



1.2 Loadings

1.2.1 Boundary conditions

In each case, the node A is embedded. Then according to the type of moment tested, the node B can be either left free, or in support according to a given direction.

1.2.2 Moments distributed

The keyword in turn is applied `MX`, `MY`, `MZ`, `MT`, `MFY` and `MFZ`. The load is linear on the beam:

Node	A	B
Value (N.m/m)	1000	2000

These nonconstant loadings are affected by the order `AFFE_CHAR_MECA_F` .
To test moments distributed affected by the order `AFFE_CHAR_MECA` , one supplements this list by constant loadings.

2 Reference solution

2.1 Torque

An analytical solution for the moment of torsion is easily by a calculation of Resistance of Materials.

That is to say the beam AB of length L, embedded in A, if one applies one torque mt in a point C of $[AB]$ then resulting moment in A is mt. The reaction according to the moment is thus $-mt$.

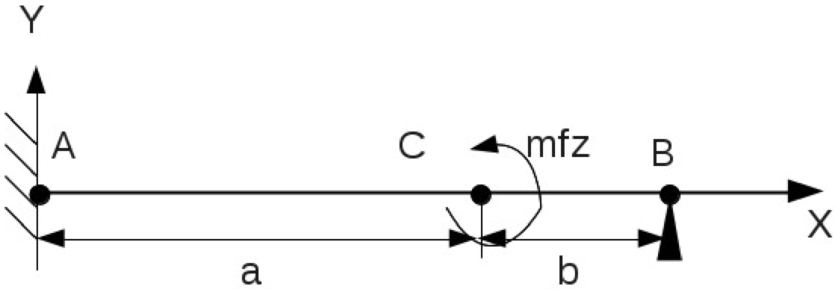
By applying one linear torque, distributed to the beam, equal to mt_A in A and with mt_B in B, one obtains the reaction in moment M_A in A:

$$M_A=-\int_0^L mt_A+\frac{(mt_B-mt_A)}{L}x\,dx$$

$$M_A=-L\frac{(mt_A+mt_B)}{2}$$

2.2 Bending moment

Forms of Resistance of Materials provide results of reference for one moment according to Z applied to the point C of a beam AB of length L embedded in A and in support according to Y in B.



$$R_A=-R_B=\frac{3\,mfz(L^2-b^2)}{2L^3}$$

$$M_A=\frac{mfz(L^2-3b^2)}{2L^2}$$

where R_A is the reaction of support and M_A moment, in A.

By applying one linear bending moment, distributed to the beam, equal to mf_A in A and with mf_B in B, one obtains:

$$R_A=-R_B=\frac{3}{2L^3}\int_0^L\left(mf_A+\frac{(mf_B-mf_A)}{L}x\right)\left(L^2-(L-x)^2\right)dx$$

$$M_A=\frac{1}{2L^2}\int_0^L\left(mf_A+\frac{(mf_B-mf_A)}{L}x\right)\left(L^2-3(L-x)^2\right)dx$$

What gives after integration:

$$R_A = -R_B = \frac{3\,mf_A + 5\,mf_B}{8}$$

$$M_A = L\,\frac{mf_B - mf_A}{8}$$

Note: If one passes in the plan XOZ with the one moment application according to Y, it is necessary to multiply the reactions by -1.

2.3 Uncertainties on the solution

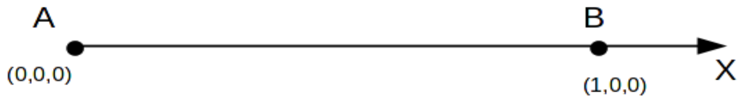
None.

3 Modeling A

3.1 Characteristics of modeling

Modelings POU_D_E, POU_D_T, POU_D_TG, POU_D_EM and POU_D_TGM are affected in turn on the grid.

3.2 Characteristics of the grid



The grid consists of a mesh SEG2.
The local reference mark is identical to the total reference mark.

3.3 Sizes tested and results

The values tested are the same ones some is the modeling of beam.

3.3.1 Torque distributed

The load applied in this case obtained by AFFE_CHAR_MECA_F/FORCE_POUTRE/MX or MT.

Node	Field	Component	**Value of reference**	**Tolerance (%)**
With	REAC_NODA	DRX	-1500.0	0.1

3.3.2 Bending moment distributed according to Y

The load applied in this case obtained by AFFE_CHAR_MECA_F/FORCE_POUTRE/MY or MFY.
It is specified that the node B is in support according to Z.

Node	Field	Component	**Value of reference**	**Tolerance (%)**
With	REAC_NODA	DZ	-1625.0	0.1
With	REAC_NODA	DRY MARTINI	125.0	0.1
B	REAC_NODA	DZ	1625.0	0.1

3.3.3 Bending moment distributed according to Z

The load applied in this case obtained by AFFE_CHAR_MECA_F/FORCE_POUTRE/MZ or MFZ.
It is specified that the node B is in support according to Y.

Node	Field	Component	**Value of reference**	**Tolerance (%)**
With	REAC_NODA	DY	1625.0	0.1
With	REAC_NODA	DRZ	125.0	0.1
B	REAC_NODA	DY	-1625.0	0.1

3.3.4 Constant bending moment according to Y and Z

The load applied in this case obtained by AFFE_CHAR_MECA/FORCE_POUTRE/MFZ, MZ. MFY, MY, MX, MT.
Next moment Z, node B is in support according to Y.

Node	Field	Component	**Value of reference**	**Tolerance (%)**
With	REAC_NODA	DY	1000.0	0.1
With	REAC_NODA	DRZ	0.0	0.1
B	REAC_NODA	DY	-1000.0	0.1

Next moment Y , node B is in support according to Z .

Node	Field	Component	**Value of reference**	**Tolerance (%)**
With	REAC_NODA	DZ	-1000.0	0.1
With	REAC_NODA	DRY MARTINI	0.0	0.1
B	REAC_NODA	DZ	1000.0	0.1

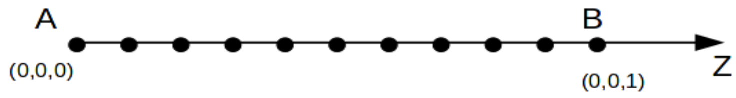
4 Modeling B

4.1 Characteristics of modeling

Modelings POU_D_E, POU_D_T, POU_D_TG, POU_D_EM and POU_D_TGM are affected in turn on the grid.

4.2 Characteristics of the grid

The grid consists of 10 meshs SEG2.



One specifies the correspondence between the local reference mark and the total reference mark:

Local reference mark	Total reference mark
X	Z
there	Y
Z	- X

4.3 Sizes tested and results

The values tested are the same ones some is the modeling of beam.

4.3.1 Torque distributed

The load applied in this case obtained by AFFE_CHAR_MECA_F/FORCE_POUTRE/MZ or MT.

Node	Field	Component	**Value of reference**	**Tolerance (%)**
With	REAC_NODA	DRZ	-1500.0	0.1

4.3.2 Bending moment distributed according to Y

The load applied in this case obtained by AFFE_CHAR_MECA_F/FORCE_POUTRE/MY or MFY.
It is specified that the node B is in support according to X.

Node	Field	Component	**Value of reference**	**Tolerance (%)**
With	REAC_NODA	DX	1625.0	0.1
With	REAC_NODA	DRY MARTINI	125.0	0.1
B	REAC_NODA	DX	-1625.0	0.1

4.3.3 Bending moment distributed according to X

The load applied in this case obtained by AFFE_CHAR_MECA_F/FORCE_POUTRE/MX or MFZ.
It is specified that the node B is in support according to Y.

Node	Field	Component	**Value of reference**	**Tolerance (%)**
With	REAC_NODA	DY	1625.0	0.1
With	REAC_NODA	DRX	-125.0	0.1
B	REAC_NODA	DY	-1625.0	0.1

5 Summary of the results

For each treated modeling, the results are very close to the analytical solution.
This validates the use of moments distributed in *Code_Aster*.