

Modelings POU_D_T, POU_D_E, BAR

Summary:

Four modelings POU_D_T, POU_D_E and BAR correspond to the classical formulations of elements of beams and bars, inspired by the Resistance of Materials.

They are usable for three-dimensional problems in isotropic or not linear linear analysis mechanical.

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1 Discretization

1.1 Degrees of freedom

For three modelings of beam into three-dimensional the degrees of freedom of discretization are, in each node of the mesh support, the six components of displacement (three translations and three rotations). These nodes are supposed to describe a segment of average fibre of the beam.

For the modeling of bar into three-dimensional the degrees of freedom of discretization are, in each node of the mesh support, the three components of displacement in translation.

Finite element	Degrees of freedom (with each node top)					
POU_D_T	DX	DY	DZ	DRX	DRY MARTINI	DRZ
POU_D_E	DX	DY	DZ	DRX	DRY MARTINI	DRZ
BAR	DX	DY	DZ			

1.2 Mesh support of the matrices of rigidity

The meshes support of the finite elements, in displacement formulation, are segments with two nodes SEG2 :

Modeling	Mesh	Finite element	Remarks
POU_D_T	SEG2	MECA_POU_D_T	
POU_D_E	SEG2	MECA_POU_D_E	
BAR	SEG2	MECA_BARRE	

1.3 Mesh support of the loadings

All the loadings applicable to the elements of beam and bar are treated by direct discretization on the mesh support of the element in displacement formulation.

No mesh support of loading is thus necessary for the edge of the elements of beam or bar.

1.4 Main features of modelings

Modeling POU_D_E (Right Beam of Euler) corresponds to the assumption of Euler - Bernouilli, it is - with - to say that the sections remain right and perpendicular to average fibre (assumption of great twinge).

Modeling POU_D_T (Right Beam of Timoshenko) takes into account the effects of transverse shearing.

Modeling BAR treat only the efforts and axial deformations.

The beam with warping is treated in [U3.11.04].

2 Assignment of the characteristics

For these elements of structures 1D, it is necessary to affect geometrical characteristics which are complementary to the data of grid. The definition of these data is carried out with the order `AFFE_CARA_ELEM` associated with the keywords following factors:

- `BEAM`

Allows to lay and affect the characteristics of the cross section and down the direction of the main axes of inertia around neutral fibre.

Supported modelings: `POUT_D_T`, `POU_D_E`

- `BAR`

Allows to define and affect the characteristics of the cross section.

Supported modeling: `BAR`

- `ORIENTATION`

Allows to define and affect the main axes of the cross sections of the elements of type beam.

Supported modelings: `POUT_D_T`, `POU_D_E`

Notice on the discretization:

With regard to the grid of the beams in meshes `SEG2`, it is useless to excessively refine these elements whose integrated formulation makes it possible to obtain exact solutions with the nodes in linear statics [R3.08.01]. In modal analysis and dynamics, one will take care to net sufficiently to represent the expected modes, but without excess: it is necessary that the elements remain a sufficient length, according to dimensions of the section, so that the assumption of beam is valid.

For example, for a beam length 1, and a circular section of external ray 0.05 and thickness 0.01, 10 elements are enough to apprehend the first 10 modes correctly. But if one refines enormously, for example with 1000 elements, then each element of beam is very short: length 0,001 for an external ray of 0.05. The elementary matrices are very badly conditioned, in particular for the element `POU_D_E` (for `POU_D_T` terms of transverse shearing improve a little conditioning). With the resolution, one loses then 8 decimals for `POU_D_E`.

3 Supported loadings

The loadings available are the following ones:

- ``CONTACT'`
Allows to define the zones subjected to conditions of contact.
Supported modelings: POU_D_T, POU_D_E
- ``EPSI_INIT'`
Allows to apply a loading of initial deformation.
Supported modelings: POU_D_T, POU_D_E
- ``FORCE_ELEC'`
Allows to apply the force of LAPLACE acting on a principal driver, due to the presence of a secondary driver right.
Supported modelings: POU_D_T, POU_D_E
- ``FORCE_POUTRE'`
Allows to apply linear forces
Supported modelings: POU_D_T, POU_D_E, BAR
- ``INTE_ELEC'`
Allows to apply the force of LAPLACE acting on a principal driver, due to the presence of a secondary driver not necessarily right compared to this principal driver.
Supported modelings: POU_D_T, POU_D_E
- ``GRAVITY'`
Allows to apply a loading of type gravity.
Supported modelings: POU_D_T, POU_D_E, BAR

Note:

|Possible contact between beam and surface [R5.03.50].

4 Non-linear possibilities

4.1 Law of behaviors

Laws of behaviors specific to these modelings, usable under BEHAVIOR in STAT_NON_LINE, and DYNA_NON_LINE are the following ones (cf [U4.51.11]):

/ 'LEMA_SEUIL'
Supported modelings: POU_D_T, POU_D_E

/ 'PINTO_MENEGOTTO'
Supported modeling: BAR

/ 'VMIS_ASYM_LINE'
Supported modeling: BAR

Note:

It is also possible for these modelings using a monodimensional state of stresses to use the behaviors 3D (thanks to the method of Borst [R5.03.03]).

4.2 Deformations

Only linearized deformations keyword 'SMALL' under deformation are available in the relations of behavior (cf [U4.51.11]):

5 Examples of implementation: CAS-tests

- POU_D_T
 - Linear statics
DEMO004A: Analysis of a lattice 3D without reinforcement, under weight actual and subjected to a specific force.
FORMA01A: Analysis of a piping comprising an elbow subjected to a specific force.
 - Linear dynamics
SDLL01A [V2.02.01]: Research of the Eigen frequencies of a short beam on simple supports.
 - Non-linear dynamics
SDNL103A [V5.02.103]: Calculation of the answer of a post subjected to an unspecified seismic loading.

- POU_D_E
 - Linear statics
SLL102A [V3.01.102]: Analysis of a fixed beam subjected to unit efforts.
 - Linear dynamics
FORMA12A: Modal analysis of a beam (multiple modes).
 - Non-linear dynamics
SDNL105A [V5.02.105]: Shock of 3 beams enter-they - calculation of the transitory response by under structuring in the case of taken into account of nonlinearity of type shock between mobile structures.

- POU_D_T, modeling of elbows
 - Linear dynamics
SDLL11E: Calculation of the Eigen frequencies of a thin circular ring.

- BAR
 - Linear statics
SSLS110A [V3.01.110]: Analysis of a system of 3 bars out of U under actual weight.
 - Non-linear statics
SSLS111B [V6.02.111]: Analysis of three elastoplastic bars perfect Von Mises.