Modelings *_JOINT, *_ELDI, *_INTERFACE and *_INTERFACE_S

Summary:

This document described, for modelings PLAN_JOINT, AXIS_JOINT, 3D_JOINT, PLAN_ELDI, AXIS_ELDI, PLAN_INTERFACE, AXIS_INTERFACE, 3D_INTERFACE, PLAN_INTERFACE_S, AXIS_INTERFACE_S and 3D_INTERFACE_S, following points:

- degrees of freedom carried by the finite elements which support modeling,
- the related meshs supports,
- nonlinear possibilities,
- CAS-tests implementing modelings.

Modelings of the type JOINT (Phenomenon: MECHANICS) correspond to finite elements of joint. They are based on a formulation by penalization, and make it possible to model the opening of a crack. Their geometrical supports are degenerated finite elements, whose nodes are confused two to two (QUAD4, HEXA8 and PENTA6). These finite elements can support the laws of behavior CZM_EXP_REG and CZM_LIN_REG (cohesive laws: Doc. [R7.02.11]). Moreover, elements PLAN_JOINT, AXIS_JOINT support the law of behavior JOINT_BA (connection steel concrete: Doc. [R7.01.21]).

Modelings PLAN_ELDI and AXIS_ELDI (Phenomenon: MECHANICS) correspond to elements with internal discontinuity. Their geometrical supports are voluminal elements (QUAD4) crossed by a discontinuity. It also make it possible to model the opening of a crack. Such finite elements can support the law of behavior: CZM_EXP (cohesive law: to see Doc. [R7.02.14]).

Modelings PLAN_INTERFACE, AXIS_INTERFACE, 3D_INTERFACE, PLAN_INTERFACE_S, AXIS_INTERFACE_S and 3D_INTERFACE_S (Phenomenon: MECHANICS) correspond to finite elements of interface mixed, based on a formulation of the Lagrangian type increased. Their geometrical supports are degenerated finite elements (QUAD8, HEXA20 and PENTA15). Such elements can support the cohesive laws CZM_OUV_MIX, CZM_EXP_MIX, CZM_TAC_MIX, CZM_FAT_MIX, CZM_TRA_MIX and CZM_LAB_MIX (see Doc. [R7.02.11] and [R3.06.13]).

Thereafter, characters 'XXX'can be replaced by 'PLAN' or 'AXIS'.

1 Discretization

1.1 Degrees of freedom

Modeling	Degrees of freedom on each nodes
XXX_JOINT	DX : following displacement X DY : following displacement Y
3D_JOINT	DX : following displacement X DY : following displacement Y DZ : following displacement Z
XXX_ELDI	DX : following displacement X DY : following displacement Y
XXX_INTERFACE and XXX_INTERFACE_S	DX : following displacement X or SIGN multiplier of Lagrange DY : following displacement Y or SITX : multiplier of Lagrange
3D_INTERFACE and 3D_INTERFACE_S	DX : following displacement X or SIGN multiplier of Lagrange DY : following displacement Y or SITX : multiplier of Lagrange DZ : following displacement Z or SITY : multiplier of Lagrange

For the localization of the ddl of displacement and Lagrange for modelings of the type INTERFACE, to see Doc. R3.06.13.

1.2 Mesh support

The meshs supports of the finite elements are quadrangles, hexahedrons or pentahedrons. The elements are isoparametric for the degrees of freedom of displacement.

Modeling	Mesh	Interpolation	Remarks
XXX_JOINT	QUAD4	linear	
3D_JOINT	HEXA8	linear	
	PENTA6	linear	
XXX_ELDI	QUAD4	linear	
XXX_INTERFACE and XXX_INTERFACE_S	QUAD8	quadratic in displacement linear in lagrange	mixed formulation
3D_INTERFACE and 3D_INTERFACE_S	HEXA20	quadratic in displacement linear in lagrange	mixed formulation
	PENTA15	quadratic in displacement linear in lagrange	mixed formulation

2 Non-linear possibilities

2.1 Law of behaviors

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

/ 'CZM_EXP_REG'

Supported modelings: XXX_JOINT, 3D_JOINT

/ **'CZM_LIN_REG'**

Supported modelings: XXX_JOINT, 3D_JOINT

/ **'JOINT_BA'**

Supported modelings: XXX_JOINT

/ **'CZM_EXP'**

Supported modelings: XXX_ELDI (only with STAT_NON_LINE)

/ **'CZM_OUV_MIX'**

Supported modelings: all modelings of the type INTERFACE

/ **'CZM_EXP_MIX'**

Supported modelings: all modelings of the type INTERFACE

/ **'CZM_TAC_MIX'**

Supported modelings : all modelings of the type INTERFACE

/ **'CZM_FAT_MIX'**

Supported modelings : all modelings of the type INTERFACE

/ **'CZM_TRA_MIX'**

Supported modelings : all modelings of the type INTERFACE

/ **'CZM_LAB_MIX'**

Supported modelings : all modelings of the type INTERFACE

2.2 Deformations

Only the small deformations (keyword 'SMALL' under DEFORMATION) are available for these modelings (cf [U4.51.11]).

3 Examples of implementation: CAS-tests

- **PLAN_JOINT**
  - Non-linear statics:

    SSNP118 [V6.03.118]: CAS-test of validation of the element of joint 2D plan (and 3D)
    SSNP133 [V6.03.118]: Rupture of a plate perforated with elements of joint 2D plan
    SSNP126 [V6.03.126]: CAS-test of validation of the law of behavior JOINT_BA (steel-concrete connection) with an element of joint 2D plan.
  - Non-linear dynamics:

    SDNS105 [V5.06.105]: Dynamic propagation of a crack.

- **AXIS_JOINT**
  - Non-linear statics:

    SSNA112 [V6.01.112]: Test of wrenching carried out by Borderie & Pijaudier - Pooch for the study of the steel-concrete connection with the law of behavior JOINT_BA.

- **3D_JOINT**
  - Non-linear statics:

    SSNP118 [V6.03.118]: CAS-test of validation of the element of joint 3D (and 2D).
    SSNV199 [V6.04.199]: Propagation of a crack planes in a beam DCB.

- **PLAN_ELDI**
  - Non-linear statics:

    SSNP128 [V6.03.128]: Validation of the element with internal discontinuity and the law CZM_EXP on a plane plate.
    SSNP133 [V6.03.118]: Rupture of a plate perforated with elements with internal discontinuity and the cohesive law of behavior: CZM_EXP.

- **AXIS_ELDI**
  - Non-linear statics:

    SSNA115 [V6.01.115]: Wrenching of a rigid reinforcement with elements with discontinuity and the cohesive law of behavior: CZM_EXP.

- **PLAN_INTERFACE**
  - Non-linear statics:

    SSNP139 [V6.03.139] Propagation of crack in a DCB 2D.
    SSNP151 [V6.03.151] Propagation of a crack planes in a beam CT 2D.

- **PLAN_INTERFACE_S**
  - Non-linear statics:

    SSNP118 [V6.03.118] CAS-test of validation of the element of interface in 2D.

- **AXIS_INTERFACE**
  - Non-linear statics:

    SSNA120 [V6.01.120] Propagation of a crack in a beam AE.

- **AXIS_INTERFACE_S**
  - Non-linear statics:

    SSNA115 [V6.01.115] Wrenching of a rigid reinforcement.

- **3D_INTERFACE**
  - Non-linear statics:

    SSNP151 [V6.03.151] Propagation of a crack planes in a beam CT 3D.
    SSNV199 [V6.04.199] Propagation of a crack planes in a beam DCB 3D.
    SSNS110 [V6.05.110] Extraction of a tablecloth of reinforcement represented by a membrane.

- **3D_INTERFACE_S**
  - Non-linear statics:

    SSNP118 [V6.03.118] CAS-test of validation of the element of interface in 3D.