Operator DEFI_MODELE_GENE

1 Drank

To create total structure starting from substructures in dynamic substructuring (cf [R4.06.02]).

In the frame of a computation using the methods of dynamic substructuring (modal analysis or harmonic), operator DEFI_MODELE_GENE allows to describe total structure starting from the macro-elements resulting from MACR_ELEM_DYNA [U4.65.01] and various connections which bind substructures the ones to the others. A macro-element can be used for the definition of several under - structures, whatever their directional sense in the physical reference if the coupling is carried out by static modes (option "CLASSIQUE"). This possibility makes it possible to take account of the repetition of a component in total structure.

Product a data structure of the modele_gene type.

Contents

2 Syntax

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mo_gene [modele_gene] = DEFI_MODELE_GENE (

   ♦ SOUS_STRUC = _F (♦ NOM = nom_sstruc,                  [KN]
                      ♦ MACR_ELEM_DYNA = macro_dy,
                                              [macr_elem_dyna]
                      ◊ ANGL_NAUT = angl_naut,             [l_R]
                      ◊ TRANS = trans,                     [l_R]
                     ),
   ♦ LIAISON =   _F (♦ SOUS_STRUC_1 =” nom_sstruc1',       [kN]
                   ♦ INTERFACE_1 = “nom_int1”,             [kN]
                   ♦ SOUS_STRUC_2 = “nom_sstruc2”,         [kN]
                   ♦ INTERFACE_2 = “nom_int2”,             [kN]
                   ◊ GROUP_MA_MAIT_1 = lgma1,      [l_gr_maille]
                   ◊ MAILLE_MAIT_1 = lma1,            [l_maille]
                   ◊ GROUP_MA_MAIT_2 = lgma2,      [l_gr_maille]
                   ◊ MAILLE_MAIT_2 = lma2,            [l_maille]
                   ◊ OPTION =/“CLASSIQUE”,             [DEFAULT]
                             /“REDUIT”,
                  ),

   ◊ VERIF = _F ( ◊ STOP_ERREUR =/“OUI',                [DEFAULT]
                                /“NON”,
                ◊  accuracy =/prec,                         [R]
                             /1.E-3,                   [DEFAULT]
                ◊ CRITERE =/“RELATIF”,                [DEFAULT]
                          /“ABSOLU”,
               ),
   ◊ INFO=/1,                                         [DEFAULT]
         /2,
                                )
```

3 Operands

3.1 Key word SOUS_STRUC

♦SOUS_STRUC

Key word factor allowing to define all the substructures which compose total structure. The definition of one substructure is done by the data of its name, the macro-element which is associated to him and its directional sense in the physical reference.

3.1.1 Operand NOM

♦NOM = "nom_sstruc"

Name of 8 characters maximum which will make it possible thereafter to indicate substructure in:

- operator: DEFI_MODELE_GENE [U4.65.02], operands: LIAISON and SOUS_STRUC_1,
- operator: DEFI_SQUELETTE [U4.24.01], operand: SOUS_STRUC,
- operator: ASSE_VECT_GENE [U4.65.05], operand: SOUS_STRUC,
- operator: REST_SOUS_STRUC [U4.63.32], operand: SOUS_STRUC.

3.1.2 Operand MACR_ELEM_DYNA

♦ MACR_ELEM_DYNA = macro_dyna

Name of the concept macr_elem_dyna resulting from the operator MACR_ELEM_DYNA [U4.65.01] who indicates the model condensed of the substructure. It is pointed out that a macro-element can be used for the definition of several substructures.

3.1.3 Operand ANGL_NAUT

◊ANGL_NAUT = angl_naut

List of the 3 nautical angles, in degrees, which make it possible to pass from the directional sense of the model which has given rise to the macro-element that of the substructure.

One will refer to operator AFFE_CARA_ELEM [U4.42.01]: Operand ORIENTATION for the definition and the use of the nautical angles.

3.1.4 Operand TRANS

◊TRANS = trans

List of 3 components of translation which make it possible to build a news under - structure starting from the model which has given rise to the macro-element, by applying an overall translation.

3.2 Key word LIAISON

♦LIAISON

Key word factor allowing to define all the interfaces of connection between under - structures. A connection is defined by the names of two substructures in opposite, and for each one of them, the name of the corresponding interface.

In the case of an incompatibility of mesh between two substructures in opposite, it is necessary to indicate that of both whose interface will be considered as Master (keywords GROUP_MA_MAIT* and/or MAILLE_MAIT*). The nodes slaves which are projected on the interface Master are definite first by DEFI_INTERF_DYNA [U4.64.01]. The “resticking” of the 2 interfaces will be done by writing of linear relations between the degrees of freedom of the 2 sides.

Note:

It is recommended that, in the case of incompatible interfaces, the main interface is the interface whose discretization is coarsest. In the case of the use of classical static modes (as much as degrees of freedom), it is thus advisable to use the interface with more the small number of degrees of freedom like main interface. In the case of the use of modes of couplings, this choice can be more delicate. The choice of the main interface can impact the quality of result clearly if the two models present very different discretizations. See the discussion on this subject in section 5.2.

Displacements of the nodes of slave face will be connected to displacements of their projections on the face Master. For each node of slave face, one will write 2 (in 2D) or 3 (in 3D) linear relations.
An application of this functionality is for example the resticking of a mesh formed by linear elements (P1) on another quadratic mesh (P2). In this case it is rather advised to choose like face “slave” the quadratic face.

It is possible to define a connection by reduced modes (or modes of interface) by key word OPTION.

3.2.1 Operand SOUS_STRUC_1

♦SOUS_STRUC_1 = “nom_sstruc1”

Name of the first of substructures concerned on both sides of connection. It must have been as a preliminary defined by the key word: SOUS_STRUC.

3.2.2 Operand INTERFACE_1

♦INTERFACE_1 = “nom_int1”

Name of the interface of the first substructure intervening in the connection. It must have been as a preliminary defined by the operator DEFI_INTERF_DYNA [U4.64.01] for the macro-element support of the substructure.

Note:

In the case of the use of modes of couplings (operator MODE_STATIQUE) with the key word MODE_INTERF, it is essential that the dynamic interface is of type CRAIGB.

3.2.3 Operand GROUP_MA_MAIT_1, MAILLE_MAIT_1

◊GROUP_MA_MAIT_1= lgma1
◊MAILLE_MAIT_1 = lma1

This key word makes it possible to indicate under structure Master, independently of the mesh or of the group of mesh specified in entry. Operator DEFI_MODELE_GENE deals with the search of meshes in opposite in all the cases, by leaning on the definition of the interfaces in glance (operator DEFI_INTERF_DYNA – U4.64.01). If the interface is incompatible, and that the key word is not indicated, it is under structure 1 which is defined like mistress.

3.2.4 Operand SOUS_STRUC_2

♦SOUS_STRUC_2 = “nom_sstruc2”

Name of the second of substructures concerned on both sides of connection. It must have been as a preliminary defined by the key word SOUS_STRUC.

3.2.5 Operand INTERFACE_2

♦INTERFACE_2 = “nom_int2”

Name of the interface of the second substructure intervening in the connection. It must have been as a preliminary defined by the operator DEFI_INTERF_DYNA [U4.64.01] for the macro - element support of the substructure.

Note:

In the case of the use of modes of couplings (operator MODE_STATIQUE) with the key word MODE_INTERF, it is essential that the dynamic interface is of type CRAIGB.

3.2.6 Operand GROUP_MA_MAIT_2, MAILLE_MAIT_2

◊GROUP_MA_MAIT_2=lgma2
◊MAILLE_MAIT_2 =lma2

This key word makes it possible to indicate under structure Master, independently of the mesh or of the group of mesh specified in entry. Operator DEFI_MODELE_GENE deals with the search of meshes in opposite in all the cases, by leaning on the definition of the interfaces in glance (operator DEFI_INTERF_DYNA – U4.64.01). If the interface is incompatible, and that the key word is not indicated, it is under structure 1 which is defined like mistress.

3.2.7 Operand OPTION

◊OPTION=/ "CLASSIQUE",
/"REDUIT",

Allows to choose between a classical substructuring by static modes (method Mac - Neal, harmonic Craig-Bampton or not) or by modes of interface.

3.3 Key word VERIF

◊VERIF

Key word factor allowing to check the coherence of modele generalized: it is checked that connection is compatible with the directional senses and the translations affected to under - structures. The nodes of the two interfaces do not have *a priori* to be ordered so that they are two to two confused. If the nodes of the interfaces are not in opposite two to two, the code detects this state and reorders the nodes in order to give them in opposite.

3.3.1 Operand STOP_ERREUR

Makes it possible to carry out or not the checking of coherence of modele generalized.

3.3.2 Operands accuracy/CRITERE

Indicates the threshold of accuracy to beyond which connections are incompatible. It is the distance (relative or absolute following CRITERE) beyond which the nodes of connection are regarded as too distant being actually connected.

3.4 Key word INFO

Key word allowing to specify level of printing.

4 Stage of execution

the operator carries out a certain number of checks on the coherence of connections if connection does not present an incompatibility of mesh:

- identical number of nodes on both sides of connection,
- coherence, in each node, after directional sense of the active degrees of freedom on both sides of connection.

5 Matrixes and conditions of connections calculated by DEFI_MODELE_GENE

5.1 In the case of option "CLASSIQUE"

the operator calculates the matrixes of directed connection intervening in the model generalized:

$$L^k_{j\ orientee} = B^k_j R^k \Phi^k$$

where: the exhibitor k characterizes substructure,

the index j characterizes the interface of connection,

B^k_j is the matrix of extraction of the degrees of freedom of connection j,

R^k is the matrix of rotation which makes it possible to pass from the directional sense of the model which has given rise to the macro-element that of the substructure,

Φ^k is the matrix column of the eigenvectors of the substructure k.

Conditions of connection between substructures 1 and 2 being written:

$$q^1_{j orientee} = q^2_{j orientee} \text{ , with } q^k_{j orientee} = L^k_{j orientee} \eta^k$$

where: q^k_j is the vector column of the physical coordinates of the connection j of under - structure k,

η^k is the vector column of the generalized coordinates of the substructure k.

5.2 In the case of option "REDUIT"

the operator calculates the matrixes of directed connection intervening in the model generalized:

$$L^k_{j\ orientee} = B^k_j R^k \Phi^k$$

where: the exhibitor k characterizes substructure,

the index j characterizes the interface of connection,

B^k_j is the matrix of extraction of the degrees of freedom of connection j,

R^k is the matrix of rotation which makes it possible to pass from the directional sense of the model which has given rise to the macro-element that of the substructure,

Φ^k is the matrix column of the eigenvectors of the substructure k.

In the case of option "REDUIT", one resticks generalized motions of the two interfaces. One ensures:

$$[\Phi_{esclave}]^T q^1_{j orientee} = [\Phi_{esclave}]^T q^2_{j orientee} \text{ , with } q^k_{j orientee} = L^k_{j orientee} \eta^k$$

Indeed, in the case of option "CLASSIQUE", the main choice of the degrees of freedom and slave amount writing the equation of connection in the form

$$y_{esclave} - C\, y_{maître} = 0 \text{ ,}$$

where y corresponds to the degrees of freedom. However, the use of a space of size reduced for the writing of the relation amounts imposing the following stresses:

$$\Phi_{esclave} q_{esclave} - C \Phi_{maître} q_{maître} = 0 \ .$$

One has, so more equations than unknowns, the number of generalized degrees of freedom $q_{esclave}$ being definitely lower than the number of physical degrees of freedom of the interface $y_{esclave}$. To ensure the good conditioning of the conditions of connection, one thus projects this relation on the restriction on the interface of the modes of under structure slaves, and the relation to be checked becomes then:

$$\Phi_{esclave}^{T} \Phi_{esclave} q_{esclave} - \Phi_{esclave}^{T} C \Phi_{maître} q_{maître} = 0$$

The choice of under structure Master thus conditions the quality of the resticking in the case of strongly incompatible interfaces.

Note:

It is appropriate, in the case of the use of the option particularly to pay attention to the choices of the main interfaces and slave, insofar as the kinematic relation between the interfaces is written on the physical degrees of freedom, but that the relation is then projected on the modes of the interface slave. If the two modelizations are identical (3D – 3D, or 2D-2D), and the discretization equivalent, then the main interface will be the interface presenting more a large number of modes. In the case of different modelizations, it will have to be made sure that one has an equivalent number of modes of interface for each one of under structures, ideally a little less for under structure slave, and to choose like interface Master that presenting the coarsest discretization. In all the cases, while waiting for the development of tools making it possible to evaluate the quality of the resticking, it will be necessary to carry out a visual checking of the results.