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For the definition of a macronutrient starting from “measurement”, O

Operator MACR_ELEM_STAT

1 Goal

To create macronutrients for calculations of “static under-structuring” or for calculations of “structural modification”.

In LE case calculations of “static under-structuring”, the macronutrient is calculated by assembly ofelements endis ordinary and condensation of the matrices to the “external” degrees of freedom.

In the case “structural modification”, the macronutrient is calculated by expansion and condensation of the modal model identified (measured) with the “external” degrees of freedom.

Product a structure of data of the type `macr_elem_stat`.

2 Syntax

```
S1 (macr_elem_stat) =  MACR_ELEM_STAT  (

        ◊ reuse = S1,
        ◊  DEFINITION = _F (

          / # static under-structuring :
              ♦ MODEL =                Mo ,                [model]
              ◊  CHAM_MATER =          chmat ,             [cham_mater]
              ◊  CARA_ELEM =           carac ,             [cara_elem]
              ◊  CHAR_MACR_ELEM  =     lchar ,             [l_char_meca]
              ◊  INST  =           /   inst  ,             [R]
                                   /   0.0,                [DEFECT]
              ◊  NMAX_CAS =        /   10,                 [DEFECT]
                                   /   nbcamx ,            [I]
              ◊  NMAX_CHAR =       /   10,                 [DEFECT]
                                    /  nbchmx ,            [I]

          / # structural modification :
              ♦ MODEL =                Mo ,                [model]
              ◊  CHAM_MATER =          chmat ,             [cham_mater]
              ◊  CARA_ELEM =           carac ,             [cara_elem]
               ♦  PROJ_MESU =           repgene          / [tran_gene]
                                                        /  [harm_gene]
                                                        /  [mode_gene]
              ♦  MODE_MESURE =         modemes          /  [mode_meca]
                                                        /  [base_modale]
                        )

       ◊  OUTSIDE = _F  (

           GROUP_NO =       l_gno  ,                     [l_gr_noeud]
                        ),

       ◊  RIGI_MECA = _F   (.),

        ◊ MASS_MECA = _F   ( . ),

        ◊ AMOR_MECA = _F   ( . ),


        # static under-structuring :
       ◊  CAS_CHARGE = (_F (

           ♦  NOM_CAS =        nocas  ,                   [k8]
           ◊  SUIV   =     /   'YES'  ,                   [DEFECT]
                           /   'NOT'
           ◊  LOAD   =     lchar  ,                       [l_char_meca]
           ◊  INST   =     /   tps,                       [R]
                           /   0.0,                       [DEFECT]
                  ),),
                                    )
```

3 General information

This operator is a point of passage **obligatory** for the static under-structuring or a calculation of structural modification by condensation of measurement.

For the static under-structuring, it is useful:

- to define a macronutrient (keywords: DEFINITION and OUTSIDE),
- to ask the condensation of the matrix of rigidity (or mass),
- to define (and condense) the associated loadings; the user can name on this occasion one or more loading case.

These 3 stages can be made in only one call to MACR_ELEM_STAT. But they can be made in several times thanks to the use of the keyword "reuse"(enrichment of macr_elem_stat). The stage of definition is obligatorily to realize in first. The condensation of the mass must be done after the condensation of rigidity.

For the structural modification, it is useful:

- to define a macronutrient (keywords: DEFINITION and OUTSIDE),
- to ask the expansion and the condensation of measurement to lead to matrices of condensed rigidity and mass.

macr_elem_stat is a structure of data which contains:

- its references: model, cara_elem, cham_mater, load,
- its topological description: external nodes,
- its condensed matrices (rigidity, mass,…),
- a list of named condensed loadings (for the static under-structuring).

The use of the whole of the operators of static under-structuring is described in the U2.07.02 note, and the approach of structural modification is described in the U2.07.03 note.

4 Operands

4.1 Keyword DEFINITION

◊ DEFINITION

This keyword factor (not répétable) is used to define the macronutrient.

4.1.1 Operand MODEL

♦ MODEL = Mo

Case “static under-structuring“:

Name of the model which one wants to condense. The matrices (and loadings) which one condenses are always calculated on the model **as a whole**. When one wants to condense several subsets of the same grid, it is thus necessary to create several models on different groups of meshs.

Case “structural modification“:

NRom of the model given in the keyword MODELE_CALCUL order PROJ_MESU_MODAL associated with repgene keyword PROJ_MESU. This model is used as support for the expansion of measurement with the “external” nodes.

4.1.2 Operand CHAM_MATER

◊ CHAM_MATER = chmat

Name of the material field associated with the model. This argument is useless if the model contains only discrete elements and static substructures. It is obligatory if not.

4.1.3 Operand CARA_ELEM

◊ CARA_ELEM = carac

Name of the elementary characteristics if the model comprises elements of beam, plate or hull.

4.1.4 Operands CHAR_MACR_ELEM / INST

◊ CHAR_MACR_ELEM = lchar

This argument is used to define:

- the thermal loading which modifies possibly the characteristics of material, when those depend on the temperature; one will specify if necessary the moment of the thermal evolution (keyword INST),
- the conditions kinematics applied to **internal nodes** (cf keyword OUTSIDE) macro element.

◊ INST = inst

During a calculation for which the material characteristics depend on the temperature, one specifies the field of temperature here to be used. The field used is that corresponding to the moment inst thermal evolution referred in the list of the loads lchar (to refer to the order CALC_MATR_ELEM ('RIGI_MECA')) [U4.61.01].

Remarks on the conditions kinematics:

In the operators of static under-structuring, the conditions kinematics of the type "Dirichlet" are always dualisées, ever eliminated.

*In general one will apply the conditions kinematics to **nodes external** at the higher level of under-structuring. Thus they will not appear in the loads of lchar .*

On the other hand, the conditions kinematics which it is necessary to give before condensation (lchar) are those which one will not be able to give any more afterwards:

- *the conditions implying of the internal nodes (linear ddl imposed or relations) because these nodes will be eliminated,*
- *conditions defined from **edges** finite elements (FACE_IMPO) because these finite elements will not exist any more after condensation.*

Notice on the argument lchar :

The loads which appear in the list lchar , which is those make it possible to calculate the matrices of rigidity and mass:

- *possible load of temperature modifying the material characteristics,*
- *conditions kinematics (dualisation).*

on the other hand, these loads intervene of nothing in the definition the loadings (second members).

*For example, dilations due to the field of temperature will be taken into account in a loading case only if the load containing this field of temperature is explicitly given in the definition of this loading case (keywords CAS_CHARGE and LOAD). In the same way them **conditions nonworthless kinematics** must be given again in the definition of the loading cases.*

4.1.5 Operands NMAX_CAS / NMAX_CHAR

◊ NMAX_CAS = nbcamx

One here is given **raising** amongst loading case which the user will define on the macronutrient (cf argument CAS_CHARGE). This number is taken by default with 10.

◊ NMAX_CHAR = nbchmx

One here is given **raising** amongst concepts of the type load that one will affect to **each** loading case (cf argument CAS_CHARGE). This number is taken by default with 10.

4.1.6 Operand PROJ_MESU

♦ PROJ_MESU = repgene

repgene indicate the name of the concept resulting from order PROJ_MESU_MODAL [U4.73.01] who allowed to define measurement and projection bases it.

4.1.7 Operand MODE_MESURE

♦ MODE_MESURE = modemes

One gives here the name of the concept containing in experiments identified clean modes. These clean modes allow to build the modal model of the structure initial which will be then condensed with nodes “external”.

4.2 Keyword OUTSIDE

♦ OUTSIDE =

This keyword factor (not répétable) is used to define the whole of the “external” nodes where the matrices and the loadings will be condensed (the other nodes will be known as “interns”). This keyword must appear in the first call to the order MACR_ELEM_STAT (one defines the outside of a macronutrient in only once).

Each external node carries the same degrees of freedom as the node corresponding of the model Mo. A macro - element (and geometrically) entirely is topologically defined by the whole of its external nodes.

4.2.1 Remarks on the definition of the “outside” of a macro element

- The outside of a macronutrient is the whole of the “external” nodes which define the topology and the geometry of the macronutrient,
- each “external” node carries **all** the degrees of freedom which exist on this node in the unclaimed model under -. Macronutrients produced by *Aster* are usable only by resticking their external nodes and consequently all the degrees of freedom which it carry. Other computer codes operate differently. For certain modelings (slip, articulation,…), one will be led not to restick certain nodes and to use, on the level of under - structuring superior, the linear relations between the degrees of freedom of the external nodes several macronutrients,
- at the time of the definition of the external nodes of a macronutrient, if a node appears several times, one counts it only once,
- for reasons of programming, it is necessary that there exist at the same time external nodes and internal nodes: none the families can be empty.

4.2.2 Operand GROUP_NO

GROUP_NO = l_grno

List of the names of the groups of nodes which one wishes “external”.

4.3 Keywords RIGI_MECA / MASS_MECA

♦ RIGI_MECA

This keyword is used to specify that one wants to condense the matrix of rigidity.

Case “static under-structuring”:
This matrix is calculated on **all** elements of the model like on the elements of LAGRANGE of the conditions kinematics contained in the argument of CHAR_MACR_ELEM.

Case “structural modification”:
The matrix of condensed rigidity is calculated by expansion of the spectral matrix measured with the “external” nodes.

◊ MASS_MECA

This keyword is used to specify that one wants to condense the matrix of mass.

Case “static under-structuring”:
This matrix is calculated on **all** elements of the model (condensation of GUYAN).

Case “structural modification”:
Lmatrix of condensed mass has is obtained by expansion of the matrix of generalized masses measured with the “external” nodes.

◊ AMOR_MECA

This keyword is used to specify that one wants to condense the matrix of damping.

This functionality is not available in “static under-structuring”:

Case “structural modification”:
Lmatrix D has' damping condensed is obtained by expansion of the matrix of the generalized depreciation measured with the “external” nodes.

4.4 Keyword CAS_CHARGE.

◊ CAS_CHARGE

This keyword factor makes it possible to define a set of loading cases **named** (keyword NOM_CAS). These loading cases could be applied to the model of higher level (CALC_VECT_ELEM [U4.61.02]).

In general, one will seek to apply the nodal loadings (FORCE_NODALE) at the higher level of under-structuring.

On the other hand all the loadings defined on the finite elements must be applied before any condensation: (GRAVITY, ROTATION, FORCE_FACE, FORCE_CONTOUR, FORCE_INTERNE, FORCE_COQUE, FORCE_POUTRE, PRES_REP,…) since these finite elements “will have disappeared” after condensation.

Let us note that for a macronutrient, there is no concept of contour, orientation, of face,…

4.4.1 Operand NOM_CAS

♦ NOM_CAS = nocas

The loading condensed under the name nocas (between “quotes”) corresponds to the loading defined by the arguments of LOAD and INST which one adds **systematically** loadings of name nocas possibly present on under structures of lower level contained in the model Mo.

4.4.2 Operand SUIV

◊ SUIV = 'YES'/'NOT'

This keyword says if the loading case "follows" the macronutrient in its geometrical transformations: translation, rotation, (cf operator DEFI_MAILLAGE [U4.23.01]). For example, the loading due to a rotation (centrifugal force), a pressure (or an opposed dilation) is "following" because its direction is related to the position of under - structure. On the other hand, gravity is a loading "not follower" (its direction is absolute).

Caution:

The loadings kinematics are always "following" because their taking into account is made in the matrix of rigidity (dualisation) and this matrix is "following" by nature.

4.4.3 Operands LOAD / INST

◊ LOAD = lchar,
◊ INST = tps,

Keywords LOAD and INST have the same meaning as in the operator CALC_VECT_ELEM [U4.61.02].

5 Examples of definition of a macro element

5.1 To define the outside of a macronutrient

```
sup1 =    MACR_ELEM_STAT   (

          DEFINITION = _F  (  MODEL = Mo,          CHAM_MATER = chmat),
          OUTSIDE = _F  (   GROUP_NO = EXT.),
                           )

sup3 =    MACR_ELEM_STAT   (

           DEFINITION =_F  (  MODEL = Mo,          CHAM_MATER = chmat,),
          OUTSIDE = _F  (   GROUP_NO = ('L1', 'L3'),)
```

5.2 To condense matrices of rigidity and mass

```
sup1 =    MACR_ELEM_STAT   (reuse = sup1,

          RIGI_MECA = _F (),  MASSE_MECA = _F (),
                           )
```

5.3 To define a loading on the macronutrient

```
sup1 =    MACR_ELEM_STAT   (reuse = sup1,

          CAS_CHARGE = (   NOM_CAS = 'ch1'  ,   LOAD = ch1,),
                           )
```

5.4 To define the macronutrient, its loadings, and to ask the condensation of the matrices

```
sup2 =    MACR_ELEM_STAT   (

          DEFINITION    = _F   (  MODEL = Mo    ,  CHAM_MATER = chmat),
          OUTSIDE       = _F   (  GROUP_NO = EXT.),
          RIGI_MECA     = _F   (),
          MASSE_MECA    = _F   (),
          CAS_CHARGE    = _F   (  NOM_CAS = 'ch1' ,  LOAD = ch1),
                                 )
```

5.5 To define a macronutrient for a calculation of structural modification and to ask the condensation of the matrices

```
Sup4 =    MACR_ELEM_STAT   (

          DEFINITION    = _F   (  MODEL = Mo    ,  CHAM_MATER = chmat
                                  PROJ_MESU=repgene, MODE_MESURE=modemes),
          OUTSIDE       = _F   (  GROUP_NO = EXT.),
          RIGI_MECA = _F   (),MASSE_MECA = _F (),
                                 )
```