

## Structure of data sd\_macr\_elem\_stat

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### Summary:

The structure of data sd\_macr\_elem\_stat represents a macro element in static under-structuring. A macro element is to some extent a finite element whose mesh support has an unspecified number of nodes. "To manufacture it", one starts from a model finite elements and one "condenses it" on some of these nodes (which one calls "external"). This condensation is done by elimination of the ddls carried by the internal nodes. This technique is described for example in the book of J-F. Imbert "Analyzes structures by finite elements" with editions CEPADUES year 1991. At the end of this condensation, the macro element is represented by condensed matrices and loadings. The matrices (rigidity, mass and damping) are full and symmetrical of dimension  $n_{ddle}$  if  $n_{ddle}$  is the external number of ddls macronutrient.

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## 1 The SD in some lines

The structure of data `sd_macr_elem_stat` represent a macro element in static under-structuring.

A macro element is to some extent a finite element whose mesh support has an unspecified number of nodes. "To manufacture it", one starts from a model finite elements and one "condenses it" on some of these nodes (which one calls "external"). This condensation is done by elimination of the ddls carried by the internal nodes. This technique is described for example in the book of J-F. Imbert "Analyzes structures by finite elements" with editions CEPADUES year 1991. At the end of this condensation, the macro element is represented by condensed matrices and loadings. The matrices (rigidity, mass and damping) are full and symmetrical of dimension `nddle` if `nddle` of ddls external macronutrient is the number.

The structure of data contains following information:

- definition of the external nodes of the macronutrient,
- references "upstream" with `sd_maillage` , `sd_modele` , `sd_cham_mater` and `sd_cara_elem`,
- references "upstream" to `sd_char_meca` conditions kinematics,
- a matrix of condensed rigidity,
- a matrix of condensed mass,
- condensed loadings.

It should be noted that these external nodes are not all of the "physical" nodes: owing to the fact that one can impose conditions kinematics (dualized) on one `sd_macr_elem_stat` , certain nodes of the macro element are of type "Lagrange".

A macro element behaves then as a finite element which could calculate only certain options: `RIGI_MECA` , `MASS_MECA` , `AMOR_MECA` and `CHAR_MECA` .

## 2 Tree structure

```
sd_macr_elem_stat (K8):: = record
    % description geometrical and topological:
    ♦ \.DESM'      : OJB S V I          long=10
      \.LINO'      : OJB S V I
      \.REFM'      : OJB S V K8
      \.VARM'      : OJB S V R          long=2
    ◇ \.CONX'      : OJB S V I

    % condensed rigidity:
    ◇ \.RIGIMECA'  : sd_matr_asse
      \.MAEL_RAID_VALE' : OJB S V R
      \.PHI_IE'     : OJB XD V R NAKED long=cste

    % masses condensed and damping:
    ◇ \.MASSMECA'  : sd_matr_asse
      \.MAEL_MASS_VALE' : OJB S V R
    ◇ \.MAEL_AMOR_VALE' : OJB S V R

    % description of the loadings:
    ◇ \.LICA'      : OJB XD V R NO long=cste
      \.LICH'      : OJB XC V K8 NO long=cste

    % if use of DEFINITION/PROJ_MESU:
    ◇ \.PROJM'     : sd_proj_mesu
```

## 3 Contents of the objects

```
\.DESM ` : OJB S V I long=10
  DESM (1) : (vacuum)
  DESM (2) : many external nodes to the grid ( nbnoe )
  DESM (3) : many internal nodes grid ( nbnoi )
                (node physical grid = node or Lagrange node)
  DESM (4) : number of ddls external. total ( nddle )
  DESM (5) : number of ddls internal. total ( nddl )
  DESM (6) : number of sd_char_meca kinematics. ( nbchar )
  DESM (7) : many definite loading cases. ( nbcas )
  DESM (8) : number of external lagranges ( nlage )
  DESM (9) : number of lagranges relations ( nlagl )
  DESM (10) : number of internal lagranges ( nlagi )

\REFM ` : OJB S V K8 LONG=9+nbchar
  REFM (1) : sd_modele
  REFM (2) : sd_maillage
  REFM (3) : sd_cham_mater
  REFM (4) : sd_cara_elem
  REFM (5) : sd_num_dld
  REFM (6) : "OUI_RIGI"/"NON_RIGI"
  REFM (7) : "OUI_MASS"/"NON_MASS"
  REFM (8) : "OUI_AMOR"/"NON_AMOR"
  REFM (9) : name of the structure of data provided by the user behind the keyword
  DEFINITION/PROJ_MESU (type mode_gene , tran_gene , ...)
  REFM (9 +1) : char_cinema_1
  REFM (9 +2) : char_cinema_2
  ...
  REFM (9 +nchar) : char_cinema_N

\LINO' : OJB S V I
  LINO the list of the external physical nodes contains.
  The real number of these nodes ( LONUTI ) is also in DESM (2) .
  The order of the nodes in . LINO is that of appearance in . CONX

\CONX' : OJB S V I
```

### Notice :

*This object is actually obligatory. But it appears in the structure of data only at the time of condensation of rigidity and like sd\_macr\_elem\_stat is a réentrant object which one can build in several stages, it can happen that the object . CONX that is to say absent from the SD.*

```
nbnoe = lonuti (LINO)
nbnoet = nbnoe + nlage + nlagl : it is the full number of external nodes.
CONX is dimensioned with 3*nbnoet
```

The external nodes are numbered in the order of appearance in initial classification (condensed matrix).

```
CONX (1, inoe) : ili = number of ligrel of .LILI (nume_dld)
                  containing the external node inoe
CONX (2, inoe) : ino = number of inoe in ligrel ili
CONX (3, inoe) : = 0 if physical node
                  = -1 if this node of Lagrange is a node "before"
                  = -2 if this node of Lagrange is a node "after"
```

\.VARM ` : OJB S V R LONG=2

VARM (1) size of the blocks of the matrix of factorized rigidity ( LDLT ) and cuts blocks of the matrix PHI\_IE . This size is given in kilo r8.

VARM (2) moment of calculation ( DEFINITION/INST )

\.PHI\_IE ` : OJB XD V R long=cste NAKED ( )

PHI\_IE is the matrix:  $PHI\_IE = K\_II ** (-1) * K\_IE$

or  $K\_II$  : submatrix of the internal ddls.

or  $K\_IE$  : submatrix of the internal/external couplings.

PHI\_IE is a matrix of dimensions  $n\_ddle \times n\_ddli$  . It is stored as a dispersed collection because this object can be very bulky. In each object of the collection (of size maximum VARM (1) ), one stores a certain number ( nlblph ) lines of the matrix PHI\_IE . Each line is length nddle .

Lines of PHI\_IE are of course stored consecutively in the objects of the collection. The 1<sup>er</sup> object contains the lines 1 with nlblph , 2<sup>eme</sup> object contains the lines nlblph+1 with 2\*nlblph , ...

\.MAEL\_RAID\_VALE' : OJB S V R

Matrix of condensed rigidity (which one calls KP\_EE ).

KP\_EE is the matrix:  $KP\_EE = K\_EE - K\_EI * PHI\_IE$

This matrix is stored "symmetrical" by columns:

$KP\_EE (I, J) = KP\_EE (j * (j-1)/2 + i)$  for  $j \geq i$

KP\_EE is a vector length  $n\_ddle * (n\_ddle+1)/2$

\.MAEL\_MASS\_VALE' : OJB S V R

Matrix of condensed mass (which one calls MP\_EE ).

MP\_EE is the matrix:

$\Rightarrow MP\_EE = M\_EE + PHI\_EI * M\_II * PHI\_IE - M\_EI * PHI\_IE - PHI\_EI * M\_EI$

This matrix is stored "symmetrical" like KP\_EE

\.MAEL\_AMOR\_VALE' : OJB S V R

Matrix of damping condensed (which one calls AP\_EE ).

This matrix is stored "symmetrical" like KP\_EE

#### Note:

The order MACR\_ELEM\_STAT does not allow (for the moment) to calculate .MAEL\_AMOR\_VALE . But there exists one (or several?) orders dynamic in which one makes pass one sd\_macr\_elem\_dyna for one sd\_macr\_elem\_stat . The object .MAEL\_AMOR\_VALE , if it is present, is then assembled in the total matrix of damping .

\.LICH' : OJB XC V K8 LONG (cste) NO ( )

This collection is oversize compared to the number of the loading cases.

It is named by the names of loading case `nomcas` .  
`LICH (nomcas)` is of dimension `n_char_max+1`  
`LICH (nomcas) (1) = / 'NON_SUIV ' nonfollowing loading ' OUI_SUIV ' following loading`  
`LICH (nomcas) (1<i≤n_char_max+1) = name of the load i-1`

``.LICA' : OJB XD V R LONG (cste) NO ()`

This collection is oversize compared to the number of the loading cases.  
 It is named by the names of loading case `nomcas` .

`LICA (nomcas)` is of dimension `2*nddlt= 2* (nddli+ nddle)`

Each object `LICA (nomcas)` is made of 2 of the same segments length ( `nddli+ nddle` ) stored end to end.

In the 1<sup>er</sup> segment, one finds the second member corresponding to the loading case `nomcas` :

`LICA (nomcas) (1 ≤ I ≤ nddli) = F_I`  
`LICA (nomcas) (nddli+1 ≤ I ≤ nddli+nddle) = F_E`

In the second segment, one finds the second member condensed correspondent with `nomcas` :

`LICA (nomcas) (nddlt+1 ≤ I ≤ nddlt+nddli) = (K_II ** - 1) *F_I`  
`LICA (nomcas) (nddlt+nddli+1 ≤ I ≤ nddlt+nddle) = FP_E`  
 with `FP_E = F_E - K_EI* (K_II ** - 1) *F_I`

## 4 Example: sd\_macr\_elem\_stat S\_1 test SSLP100B

### Structure of Data: S\_1

```

-----
SEGMENT IMPRESSION OF VALUES >S_1 .CONX <
    1 -          1          1          0          1          3
    6 -          0          1          4          0          1
   11 -          7          0          1          9          0
   16 -          1          6          0          1         10
   21 -          0          1         12          0
-----
SEGMENT IMPRESSION OF VALUES >S_1 .DESM <
    1 -          0          8          4         16         12
    6 -          1          2          0          0          4
-----
IMPRESSION OF THE COLLECTION: S_1 .LICA
SEGMENT IMPRESSION OF VALUES >S_1 .LICA $$NOM <
>>>>> REPERTOIRE OF NAMES OF THE COLLECTION: S_1 .LICA
    1 - >CHF1 <>CHF2 <
OBJECT IMPRESSION OF COLLECTION >S_1 .LICA < OC: 1
    1 - 3.53553D+00 1.46447D+00 0.00000D+00 0.00000D+00 0.00000D+00
    6 - 0.00000D+00 0.00000D+00 0.00000D+00 0.00000D+00 0.00000D+00
   11 - 0.00000D+00 0.00000D+00 1.91342D+00 3.80604D-01 1.62212D+00
   16 - 1.08386D+00 0.00000D+00 0.00000D+00 0.00000D+00 0.00000D+00
   21 - 0.00000D+00 0.00000D+00 0.00000D+00 0.00000D+00 0.00000D+00
   26 - 0.00000D+00 0.00000D+00 0.00000D+00 2.39508D-01 9.92075D-02
    
```

Warning : The translation process used on this website is a "Machine Translation". It may be imprecise and inaccurate in whole or in part and is provided as a convenience.

31 -	2.98282D-02	1.23552D-02	-1.97778D-19	-7.02300D-20	2.95966D-03
36 -	7.14525D-03	-3.06170D-19	-5.50571D-21	2.95966D-03	7.14525D-03
41 -	2.64693D+00	1.18501D+00	2.70958D+00	1.03373D+00	8.48546D-01
46 -	-3.31522D-01	1.30381D-01	-6.22318D-02	4.81890D-02	1.36198D-01
51 -	3.65592D-01	8.34435D-01	-1.16015D-18	8.41068D-19	4.58200D-20
56 -	2.87916D-20				

OBJECT IMPRESSION OF COLLECTION >S\_1 .LICA < OC: 2

1 -	0.00000D+00	0.00000D+00	0.00000D+00	0.00000D+00	0.00000D+00
6 -	-2.00000D+01	0.00000D+00	0.00000D+00	0.00000D+00	0.00000D+00
11 -	0.00000D+00	0.00000D+00	0.00000D+00	0.00000D+00	0.00000D+00
16 -	0.00000D+00	0.00000D+00	0.00000D+00	0.00000D+00	0.00000D+00
21 -	0.00000D+00	0.00000D+00	0.00000D+00	0.00000D+00	0.00000D+00
26 -	0.00000D+00	0.00000D+00	0.00000D+00	-1.61431D-18	-7.81792D-19
31 -	-6.45718D-18	-2.26429D-18	3.01596D-01	-1.61168D+00	-8.43526D-02
36 -	-1.00331D-01	-1.59744D-17	-1.28342D-17	-8.43526D-02	-1.00331D-01
41 -	-2.64622D-17	-4.13600D-17	-5.05295D-17	1.06224D-17	-9.17765D-17
46 -	-1.39652D-16	-4.67445D+00	-7.31983D+00	3.49452D+00	-1.72624D+00
51 -	-1.21457D-16	2.45518D-17	2.19705D+00	-4.60236D+00	3.50220D+00
56 -	-2.55199D+00				

-----  
IMPRESSION OF THE COLLECTION: S\_1 .LICH

SEGMENT IMPRESSION OF VALUES >S\_1 .LICH \$\$NOM <

>>>> REPERTOIRE OF NAMES OF THE COLLECTION: S\_1 .LICH

1 - >CHF1 <>CHF2 <

OBJECT IMPRESSION OF COLLECTION CONTIGUE>S\_1 .LICH < OC: 1

1 -	>OUI_SUIV<>CHBL_1	<>CHF1_1	<>	<>	<>	<
8 -	>	<>	<>	<		

OBJECT IMPRESSION OF COLLECTION CONTIGUE>S\_1 .LICH < OC: 2

1 -	>NON_SUIV<>CHF2_1	<>	<>	<>	<>	<
8 -	>	<>	<>	<		

-----  
SEGMENT IMPRESSION OF VALUES >S\_1 .LINO <

1 -	1	3	4	7	9
6 -	6	10	12		

-----  
SEGMENT IMPRESSION OF VALUES >S\_1 .MAEL\_RAID\_VALE <

1 -	6.41345D+00	1.76677D+00	9.20402D+00	-1.81735D+00	1.25037D+00
6 -	9.57550D+00	1.00328D+00	-4.07100D+00	-1.39527D+00	6.04196D+00
11 -	-2.86996D+00	-2.86915D-01	-2.19245D+00	1.87984D+00	1.43014D+01
...					
131 -	2.36288D-18	-3.29156D-18	-5.30569D-01	-4.81304D-01	2.71008D+00
136 -	1.03411D+01				

-----  
IMPRESSION OF THE COLLECTION: S\_1 .PHI\_IE

OBJECT IMPRESSION OF COLLECTION >S\_1 .PHI\_IE < OC: 1

1 -	-2.11984D-01	1.09032D-02	-9.57179D-02	-1.05534D-01	-1.51204D-18
6 -	-6.17392D-19	-8.67300D-03	-2.98079D-02	-2.08419D-18	-7.70800D-19
...					
186 -	-1.27599D-01	-1.52778D-01	4.83504D-03	4.08788D-19	-1.44063D-17

191 - -1.52778D-01 4.83504D-03

---

SEGMENT IMPRESSION OF VALUES >S\_1 .REFM <

1 - >MO\_1 <>MA <>CHMAT <> <>S\_1 <>OUI\_RIGI<>NON\_MASS<  
8 - >NON\_AMOR<> <>CHBL\_1 <

---

SEGMENT IMPRESSION OF VALUES >S\_1 .RIGIMECA .REFA <

1 - >MA <>S\_1 <  
3 - > <>RIGI\_MECA <  
5 - > <> <  
7 - > <>DECP <  
9 - >MS <>NOEU <

---

IMPRESSION OF THE COLLECTION: S\_1 .RIGIMECA .UALF

OBJECT IMPRESSION OF COLLECTION >S\_1 .RIGIMECA .UALF< OC: 1

1 - 1.77687D+01 -3.40898D-01 2.78185D+01 -1.18521D-01 -1.90123D-01  
6 - 3.20885D+01 -2.57251D-01 1.96913D-01 -7.70137D-02 3.68408D+01  
11 - ...  
341 - 0.00000D+00 0.00000D+00 2.77973D+00 1.12895D+01

---

IMPRESSION OF THE COLLECTION: S\_1 .RIGIMECA .VALM

OBJECT IMPRESSION OF COLLECTION >S\_1 .RIGIMECA .VALM< OC: 1

1 - 1.77687D+01 -6.05732D+00 2.98834D+01 -2.10596D+00 -4.57102D+00  
6 - 3.33437D+01 -4.57102D+00 7.03607D+00 -2.97096D+00 3.92857D+01  
11 - ...  
166 - 1.12895D+01

---

SEGMENT IMPRESSION OF VALUES >S\_1 .VARM <

1 - 8.00000D+02 0.00000D+00

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