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## Operator CALC\_MATR\_AJOU

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### 1 Drank

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Compute of the mass matrixes [R4.07.03], damping or stiffness added.

The matrixes are induced by a fluid true, incompressible, at rest or out of potential flow, on a structure in 2D, 2D axisymmetric or in 3D.

The terms of these matrixes are calculated on the basis of the structure modal base in the vacuum.

The computation terms of the matrixes is carried out by resolution of the equations of LAPLACE in the frame of a **thermal analogy**. The calculated temperature plays the part of a pressure in the fluid field. Care thus should be taken to define the fluid material by thermal **characteristics**, and to assign a thermal **model** to the part of the mesh which represents the fluid.

Thanks to this operator, one can determine for example, the added matrixes of a tube bundle, considered as only one structure immersed in the same fluid.

In the frame of a computation by dynamic substructuring, it is also possible to evaluate the mass matrix added on one modele generalized.

For systematic uses of this command and to simplify the drafting of the command file, one will use effectively macro-command `MACRO_MATR_AJOU` [U4.66.11].

Product a data structure of the `matr_asse_gene_R` type.

The following benchmarks present examples of use of this operator:

- FDLV100 [V8.01.100],
- FDLV101 [V8.01.101],
- FDLV102 [V8.01.102],
- FDLV103 [V8.01.103],
- FDLV104 [V8.01.104],
- FDLV105 [V8.01.105],
- FDLV106 [V8.01.106],
- FDLV107 [V8.01.107],
- FDLV109 [V8.01.109],

- FDLV110 [V8.01.110].

## 2 Syntax

```
massaj [matr_asse_gene_R] =CALC_MATR_AJOU

(
  ◆MODELE_FLUIDE=fluide [model]
  ◆MODELE_INTERFACE=interf [model]
  ◆CHAM_MATER=matflui [cham_mater]
  ◆CHARGE=charge
[char_ther]
  ◆/MODE_MECA=modes
[mode_meca]
  /CHAM_NO =chamno
[cham_no_DEPL_R]
  /MODELE_GENE =modgen
[modele_gene]
  ◇NUMÉRIQUE_DDL_GENE=numgen
[nume_ddl_gene]
  ◇DIST_REFE=/distance [R]
  /1.E-2 [DEFAULT]
  ◇AVEC_MODE_STAT=/ "OUI" [DEFAULT]
  / "NON"
  ◇NUMERIQUE_MODE_MECA=numeric [1_I]
  ◇INFO=/1 [DEFAULT]
  /2
  ◆OPTION= | ' MASS_AJOU '
  | ' AMOR_AJOU '
  | ' RIGI_AJOU '
  ◇POTENTIEL=phi
[evol_ther]
  to ◇SOLVEUR=voir [U4.50.01]
  ◇NOEUD_DOUBLE=/ "OUI"
  / "NON" [DEFAULT]
);
```

## 3 Operands

### 3.1 Operand `MODELE_FLUIDE`

◆`MODELE_FLUIDE` = fluid

thermal **Model** which one assigns to the part of the mesh which corresponds to the fluid. The elements of edge to the fluid interface/structure must be present in the model fluid. It is on this model that one solves the equation of Laplace with boundary condition of type "fluid flux", to have the field of pressure in all the fluid and *a fortiori* the field of pressure to the fluid interface/structure.

The nodes of the elements of the fluid mesh must all be numbered so that the jacobian of the element is of positive sign on all the fluid mesh.

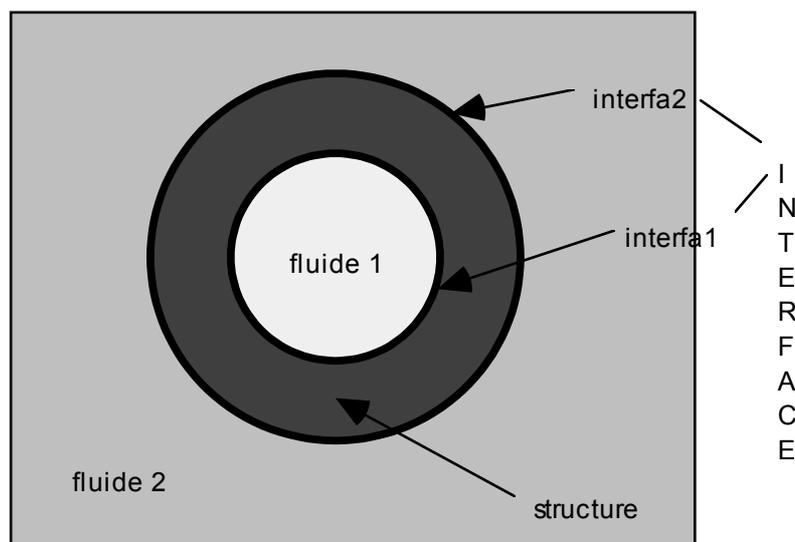
### 3.2 Operand `MODELE_INTERFACE`

◆`MODELE_INTERFACE` = interf

Models **thermal** of interface gathering all the edge elements defining the fluid interface/structure. It is on this model that one calculates the terms of the added matrixes.

The computation depends on **the directional sense** of the norm of these elements of interface. It is necessary to take care that this norm is directed towards **all** these elements, from structure towards the fluid (adopted convention).

If the fluids bathing structure are different densities, it is necessary the model to define interface per as many not geometrically confused mesh groups than there are fluids in contact with structure. For example, a pipework can have its interior surface in contact with a fluid of density 1, and its surface external in contact with a fluid of density 2. The model interface is thus built on two mesh groups not confused geometrically, one in contact with the fluid of density 1 (`interfa1`) and the other in contact with the fluid of density 2 (`interfa2`).



## 3.3 Operands CHAM\_MATER / CHARGE

◆CHAM\_MATER = matflui

Material field defining the fluid immersing structure. This material is defined by equivalent **thermal** characteristics in operator `DEFI_MATERIAU` [U4.43.01]. Thermal conductivity (key word `LAMBDA`) **is always taken equalizes to 1**. Specific heat (key - key `RHO_CP`) check the role of **density of the fluid**.

◆CHARGE = thermal

load Load of type [`char_ther`] necessary to the resolution of the linear system rising from the equation of Laplace in the fluid. One must impose an unspecified **temperature** (which plays in fact the part of a pressure) on an unspecified **node** of the fluid mesh, in order to make the system nonsingular. This operation is carried out with operator `AFFE_CHAR_THER` [U4.44.02].

## 3.4 Operands MODE\_MECA / CHAM\_NO / MODELE\_GENE

◆/MODE\_MECA = dynamic

Modes modes calculated on the model structure. If there are several nonrelated structures immersed in the same fluid, for which one wants to determine the added matrixes including the terms of coupling by the fluid, the model structure which one defines gathers the totality of immersed structures. The modes used by the operator are the modes calculated for total structure.

/CHAM\_NO = chamno

Field at nodes of displacements affected on nodes groups defining the fluid interface/structure. By affecting such a field of displacement on (S) the group (S) of nodes of interface thanks to operator `CREA_CHAMP`, one can for example easily simulate modes of rigid body of structures. This operand is to be used if one wants to estimate the terms of the added matrixes and coupling for a plane geometry **without doing as a preliminary modal computation** of structure in the vacuum, and that one wants to affect these terms in discrete elements (modelization `DIS_T`). Operand `INFO` must imperatively be active to print the calculated terms.

### Caution:

*The use of this operand **excludes** that from operand `NUME_DDL_GENE`. One cannot thus do modal computation, transient or harmonic by means of operand `CHAM_NO`.*

*Indeed, to do calculation of modes out of water, it is necessary to have a generalized mass matrix and a generalized stiffness matrix of structure. This on the structure supposes to have done a modal computation in the vacuum (what one wants precisely to avoid).*

*This operand is used ultimately only **to evaluate the mass matrix, of added stiffness and damping**, and to use to couple structures of type beam by discrete elements of mass, for example.*

```
/MODELE_GENE = modgen
```

Generalized model built by the operator `DEFI_MODELE_GENE` [U4.65.02]. This key word is to be used when one does a calculation by dynamic substructuring, and that one wants to calculate the added mass matrix coupling the group of under - structures. In this case, the substructures can be in different mesh files, these files being able to be themselves distinct from mesh file fluid. The substructures which have a repetitivity within the fluid are to be netted only once, but one will take care on the level it fluid mesh to net all the interfaces fluid/structure. Moreover, it is necessary to take care that the nodes of fluid interface coincide as well as possible with the nodes of structure interface, in order to be able to recopy, on the basis of geometrical criterion of proximity, the values of the fields of displacement of structure on the nodes of fluid interface (see operand `DIST_REFE`).

#### Caution:

| The use of this operand **makes compulsory** that of operand `NUME_DDL_GENE`.

### 3.5 Operand OPTION

This key word specifies the computation of mass, stiffness or damping added that one wants to make, by means of respectively `"MASS_AJOU"`, `"RIGI_AJOU"`, or `"AMOR_AJOU"`. The two last computation options require the presence of a potential (thermal) steady (see operand `POTENTIEL`).

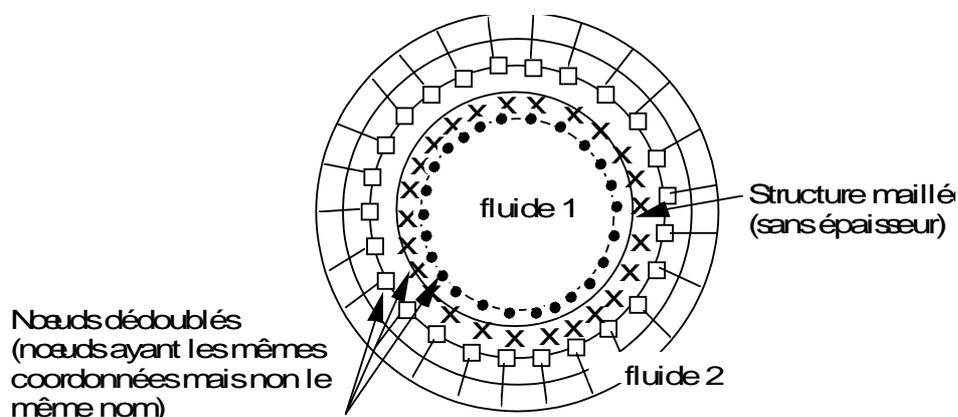
### 3.6 Operand DIST\_REFE

Outdistances reference to informing when one does a calculation of **added mass** on one modele generalized. This distance is a geometrical absolute criterion intended to recopy values of structural displacements in a thermal fluid model, in order to solve there the equation of Laplace of the field of non stationary pressure. By default, it is equal to  $10^{-2} Mr$ .

### 3.7 Opérande NOEUD\_DOUBLE

```
◇NOEUD_DOUBLE = "OUI"
```

This operand is to be used when one does a calculation of **added mass** from one modele generalized which understands substructure with a grid by a mesh telegraphic or surface (*i.e without* thickness like beam or shell) and surrounded by two fluids. One needs in this case for the level it mesh to duplicate the nodes of the fluid interfaces of those of structure, in order to be able to calculate the hydrodynamic jump of pressure on both sides of structure (cf *appears* Ci - below).  
Operand



## 3.8 POTENTIEL ◇

POTENTIEL = Potential phi

(thermal) steady necessary to the computation of damping and the stiffness added of structure subjected to a potential flow. This potential is produced by the operator THER\_LINEAIRE [U4.54.01]. Operand

## 3.9 NUME\_DDL\_GENE ◇

NUME\_DDL\_GENE = numgen generalized

Classification based on the mechanical modes of total structure. The presence of this operand makes it possible to calculate an added mass matrix of type matr\_asse\_gene\_R. It must be necessarily present if one wants to thereafter do modal computation, harmonic or transient. Operand

## 3.10 INFO ◇

INFO = Indicates

the level of printing of the results of the operator on the message file . 1

: no printing, 2

: of the higher triangular part of the added mass matrixes added, damping or stiffness.

pri Presentation

nti

ng

in column. Key word

## 3.11 factor solver See

[U4.50.01]. Operand

## 3.12 AVEC\_MODE\_STAT Makes it possible

to disconnect the computation of the terms of added mass on the static modes contained in the modal base of substructures in the case of a computation with one modele generalized (cf [§ 3.4]). Operand

## 3.13 NUME\_MODE\_MECA Makes it possible

to specify a list of numbers of modes retained for computation. Stage of execution

## 4 One

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checks that the models fluid and interface are quite thermal. It

is checked that the storage of the added matrixes is done on a full profile . It

is checked that the coefficients of added auto--mass (diagonal terms of the matrix) are well all positive. In the contrary case, an alarm message is transmitted so that the user checks the directional sense of the norms. It

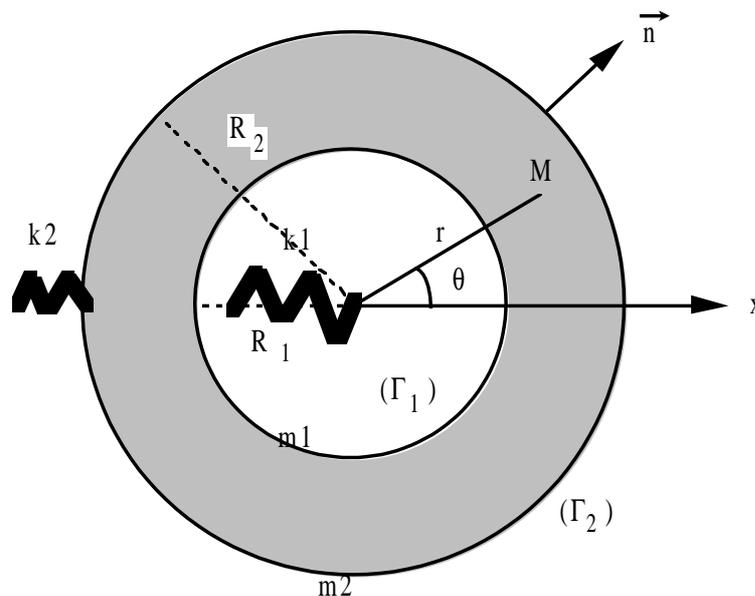
is checked that, for a computation of added damping or stiffness, key word POTENTIEL is quite indicated. In the case of

a computation of added mass on one modele generalized, one informs the user on the recopies of fields of structural displacements in the fluid (many recopied values) and one indicates how to change the distance from reference (DIST\_REFE) . Example:

*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.*

## 5 Computation of the added mass matrix of a structure made up of two concentric cylinders separated by an incompressible fluid

the cylinders are supported each one by springs. The added mass matrix is calculated for the first two modes of structure, namely the modes of rigid body of each cylinder in direction OX (cf *diagram* ). One will present here only the stages of the command file, because this example is inspired by benchmark FDLV101 [V8.01.101]. For the detail of the syntax of the other operators, the user will be able to thus refer to the command file of this benchmark. 1)



Definition of the fluid material by equivalent thermal characteristics: 2)

Assignment of this fluid material on the fluid mesh including the group of mesh defining the fluid interface/structure. 3)

Assignment of the fluid thermal model (also including the interface) 4)

Assignment of the thermal model of interface 5)

Assignment of model structure total (including the two cylinders and their springs of self-supporting quality) 6)

Assignment of a temperature imposed in the fluid mesh 7)

Computation of the eigen modes of structure in the vacuum 8)

Generalized classification based on the calculated mechanical modes 9)

Computation of the added mass matrix of type `matr_asse_gene_r` (operand `NUME_DDL_GENE` present ). So one can then calculate the eigen modes of "wet" structure `matraj`

```
= CALC _MATR_AJOU (MODELE_FLUIDE = fluid , MODELE_INTERFACE
= interf , CHAM_MATER
= chammat1, CHARGE
= load, OPTION
= "MASS_AJOU", MODE_MECA
= modes, NUME_DDL_GENE
= numgen, INFO
=1) 10
```

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- ) Computation of the mass matrixes and stiffness generalized on the generalized classification based on the calculated mechanical modes numgen . These matrixes are of type [matr\_asse\_gene\_r] 11
- ) Computation of the total mass matrix of the structure (more generalized mass matrix added mass matrix) 12
- ) Computation of the modes of immersed structure. 13
- ) Restitution of the modes "wet" on physical base.