

Operator INCLUDE_MATERIAU

1 Drank

To recover the characteristics of a preset material in the Catalog Materials of *Code_Aster*.

The files of the Catalog Materials are located in the sub-directory `material` of the directory of installation, for example `/aster/STA10/materiau` on the centralized machine.

Note : for an external use at EDF (free software), a single file is provided in the directory `material` as demonstration.

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2 Syntax

```
mat = INCLUDE_MATERIAU (
    ◆NOM_AFNOR=nomafnor                ,                [kN]
    ◆TYPE_MODELE=/                      "REF",
                                          / "PAR",
    ◆VARIANTE=/                          "A",
                                          / "B",
                                          / "It
                                          / .
                                          / "Z",
    ◆TYPE_VALE=/                          "NOMI",
                                          / "MAXI",
                                          / "MINI",
    ◇EXTRACTION=_F                      (                [1_K16]
        ◆COMPOR=1_compor                ,                [R]
        ◆TEMP_EVAL=temp                  ,
    ) ,
    ◇UNITE_LONGUEUR=/                    "Me ,
[DEFAULT]                               / "MM" ,
    ◇INFO=/1                              ,
[DEFAULT]                               /2 ,
)

mat are of type [to subdue].
```

3 Catalogue Materials Aster

`Code_Aster` has a Catalog Materials whose purposes are:

- to provide the users, the data materials necessary to the realization of numerical studies,
- to ensure the perennality of information,
- to guarantee the reliability and the coherence of the available data,
- and to facilitate and automate the access to the data.

In `Code_Aster`, the material is defined by a set of characteristics necessary to the implementation of a constitutive law, which are introduced by the command general `DEFI_MATERIAU`.

In the Catalog Materials, the material is indexed by its designation in norm AFNOR.

The Catalog Materials distinguishes two types of materials according to the type of study:

- the “**material of reference**” for generic studies. It corresponds to a set of products manufactured according to the same well defined specification. It is characterized by values median, minimal and maximum typical of the population concerned. It is this material which it is advised to use if one does not have a perfect description of the material with modelling,
- the “**particular material**” for specific studies. It corresponds to a well identified product or a concept of material given. This material is characterized by specific values of its properties, together with extreme values related on the heterogeneity of the material and/or uncertainty on the values. This material is finely documented in order to avoid its systematic use without precaution.

In addition, one can index various materials (of reference or individual) corresponding to the same designation AFNOR. The RCC-M distinguishes, for the same designation AFNOR, the characteristics material following the technical specification of reference, the type of product (forged, rolled, tube, sheet,...) and the dimensions of the component. In order to take account of this additional dimension, in the Catalog Materials, one associates with each material a letter of the alphabet.

To summarize, in the Catalog Materials the materials are indexed by a character string which is composed of the concatenation:

- designation in norm AFNOR,
- of key REF (if material of reference) or PAR (if particular material),
- of a letter of the alphabet.

For example: 18MND5_REF_A

the Catalog Materials is presented in two distinct forms:

- a form “files” usable by `Code_Aster` by the command `INCLUDE_MATERIAU`. They is a set of files having for name the character string previously described (for example 18MND5_REF_A) and for extension one of the following character strings: `NOMI` (for the median values), `MINI` (for the minimal values) and `MAXI` (for the maximum values),
- a form “files”, where the user can consult the characteristic materials in the form of tables and obtain the origin of the characteristics. This shape of the catalog is accessible on the site from `Code_Aster` : www.code-aster.org (only in Intranet EDF, in the section Documentation M). Each file material is the object of an independent validation by department MMC.

4 Operands

NOM_AFNOR / TYPE_MODELE / VARIANTE / TYPE_VALE

These operands make it possible to choose the material to be used and thus to define its name according to the rule presented to the preceding paragraph.

◆ NOM_AFNOR = `nomafnor` , [kN]

Makes it possible to specify the designation of the material in norm AFNOR (for example: 18MND5).

◆ TYPE_MODELE = / "REF",
/ "PAR",

Allows to specify if they are the characteristics of those or reference material used of the particular material which one wishes to use.

◆ VARIANTE = / "A",
.....
/ "Z",

Allows to specify the alternative of the material which one wishes to use (the characteristics are in general different according to the thickness or the diameter and this for the same designation in norm AFNOR). The paragraph of description of the material of the file material makes it possible to know the alternative interesting the user.

◆ TYPE_VALE = / "NOMI",
/ "MAXI",
/ "MINI",

Allows to specify if one wants to use the median values, minimal or maximum.

5 Key word EXTRACTION

the values of characteristics material contained in the Catalog Materials are generally tables of values depending on the temperature. So one informed in the Catalog Materials only certain keywords factors of the command `DEFI_MATERIAU`: those for which the operands are defined by functions (for example: `ELAS_FO`, `THER_NL`,...). On the other hand, the key words factors for which the operands are defined by realities (for example: `ELAS`,...) in the various files composing the form "files" of the Catalog Materials are not indicated.

One can however generate these key keys in command `DEFI_MATERIAU` by key word `EXTRACTION` by specifying the behavior or the behaviors which one wishes to generate and by specifying the value of the temperature to which one wishes to extract the values from the function.

5.1 Operand COMPOR

◆ COMPOR = `l_compor` [l_K16]

Indicates the name of the key words factors of `DEFI_MATERIAU` which will be extracted. For example, "ELAS" or "THER".

5.2 Operand TEMP_EVAL

◆ TEMP_EVAL = `temp` [R]

Temperature to which, one wishes to extract the values from the characteristic materials. For example, one E creates in command `DEFI_MATERIAU` the operand = `E0` under the key

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word factor `ELAS` by interpolating the value with `T0` of the operand `E = E (T)` defined in the catalog. The interpolation type is determined by the corresponding function of the catalog. In general, the interpolation is linear, prohibited extrapolations.

6 Operand UNITE_LONGUEUR

```
◇UNITE_LONGUEUR= / "Me" , [DEFAULT]
/ "MM" ,
```

Allows to use the data of the catalog material with the millimetre like unit of length.

The values indicated in the catalog material are and remain in meters. If the user specifies `UNITE_LONGUEUR = "MM"` in command `INCLUDE_MATERIAU`, that means that the user wishes to handle units of length in millimetres, and `INCLUDE_MATERIAU` orders it carries out the transformation of the units.

7 Operand INFO

```
◇INFO = 1, [DEFAULT]
/2,1
2 steps of printing of the contents of the file included,
printing of the contents of the file included, in the file "MESSAGE".
```

8 Example of debut

```
use ()  
  
.....  
  
MAT3 = INCLUDE_MATERIAU (          NOM_AFNOR= "18MND5",  
                                TYPE_MODELE=  "REF",  
                                VARIANTE=     "A"      ,  
                                TYPE_VALE=    "NOMI",  
                                INFO=         2)  
  
chmat3 = AFFE_MATERIAU ( MAILLAGE = my,  
                        AFPE=_F (  GROUP_MA= ("STRIA1". , "SQUA"),  
                                MATER=MAT3) )  
  
FIN ()
```

9 To define its own material

This paragraph is halfway between the use and the development. One uses a not qualified overload which is responsibility for the user/developer.

One approaches here the definition of a catalog for a material given by an user.

The catalog thus developed will be able to integrate the catalog managed in configuration after the required qualification, but in the meantime it can be used in overload.

For that, it is enough to define a particular directory where the new catalog will be stored, and to use the argument - rep_mat [name of the directory] in the launching of the study (cf [u1.04.00]).

9.1 Management of the unit of length of the mesh

to manage the change of unit, one has the function `coef_unit`.

`coef_unit (N)` is worth 1. if `UNITE_LONGUEUR` is worth "Me, and is worth 10" if `UNITE_LONGUEUR` is worth "MM".

For example, for a quantity in MPa, one will write:

```
E = 2.1e11 * coef_unit (- 6)
```

9.2 Extraction and evaluating according to the temperature

In the writing of the catalog, it is necessary to determine which are the key words turned over in the presence of `EXTRACTION` and those which are not it.

Example: If one does not request the extraction from a given temperature, one wishes to obtain the elastic properties depending on the temperature, key word `ELAS_FO`. Whereas if one requests these properties from 20°C, one wishes to obtain factor key word the `ELAS`.

One will write `extraction=True` to indicate (in the catalog) that factor key word must be preserved if `EXTRACTION` is present (in the command set), `extraction=False` to indicate that it should be preserved if `EXTRACTION` is absent. If `extraction` is not indicated, the key word is preserved in both cases.

One indicates which function must be evaluated according to the temperature (only currently supported command variable) by means of the function `temp_eval`:

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`E = temp_eval (_A2)` where `_A2` is a function defined before.

9.2.1 Syntax, words reserved

the catalog does not call `DEFI_MATERIAU` itself, it defines only the list of the key words. For that, it is necessary to use the function `defi_motscles` and to name `keywords` result this function:

```
keywords = defi_motscles (...)
```

a catalog material is not a macro-command. However, he obeys the same rules concerning the naming of the intermediate concepts (functions of the properties depending on the temperature in particular). In order not to cause conflicts with the concepts of the command set of the user, it is necessary to take care to prefix the intermediate concepts of the catalog with a `"_"` (cf [d5.01.02]) and to destroy the concepts which can the being.

Lastly, a restricted number of commands are usable in a catalog: those which handle the functions primarily (to consult the file `Macro bibpyt//include_materiau_ops.py` to have the exhaustive list).