

Parameter fitting in Code_Aster : MACR_RECAL



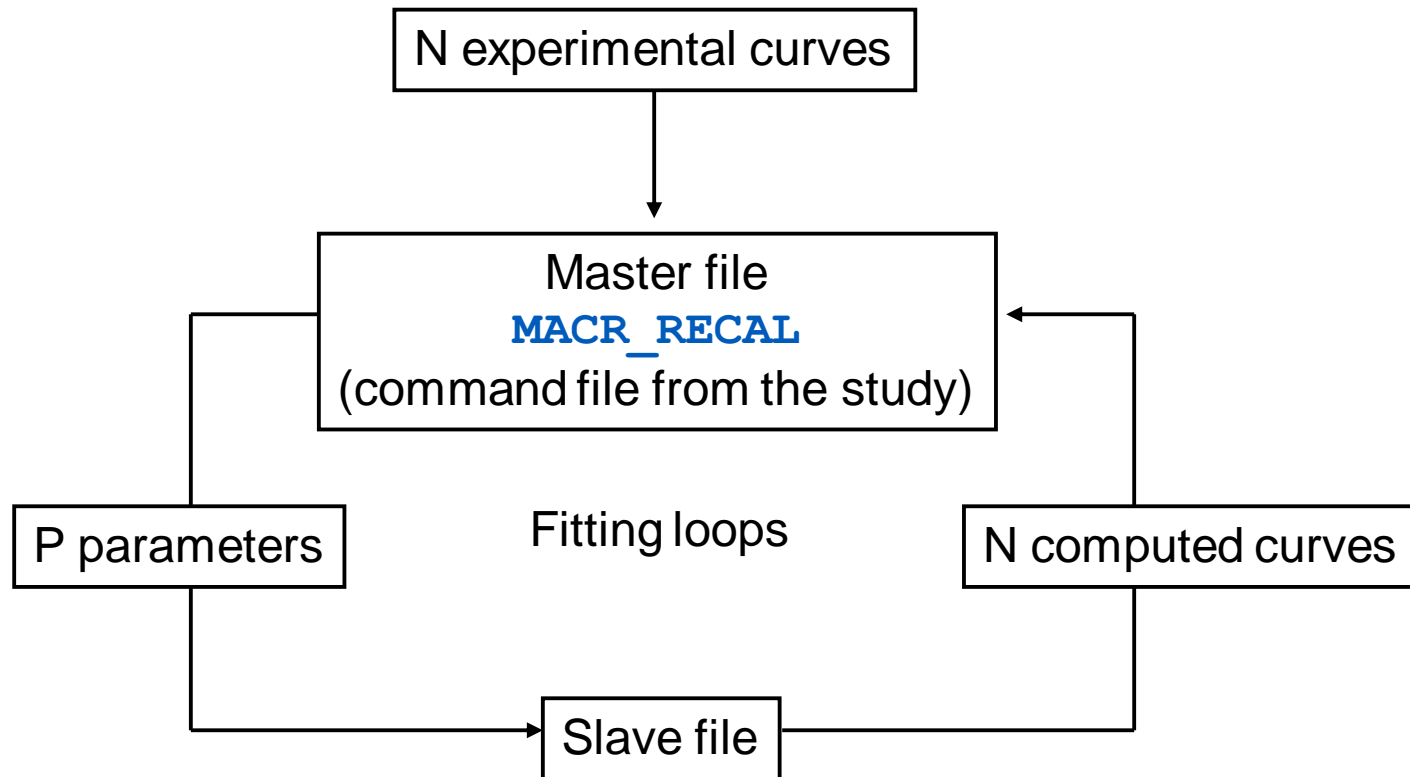
Code_Aster, Salome-Meca course material

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Fitting in Code_Aster

- ▶ A tool for parametric fitting : **MACR_RECAL**
- ▶ The user provides :
 - The command file
 - The parameters and their range of values
 - Experimental or measured data
- ▶ The user obtains :
 - The optimal (fitted) values of the parameters
 - An “indicator” of their releavance

Organization



Technical details

- ▶ Several algorithms, but :
 - Preferably choose the Levenberg-Marquardt algorithm (default)
- ▶ Range of values managed with Lagrange multipliers
- ▶ Requires the evaluation of sensibilities by finite differencies
 - In the case of n parameters, $n+1$ computations of fitting iteration

$$\frac{\partial f}{\partial x} \approx \frac{f(x + \alpha x) - f(x)}{\alpha x}$$

Pros and cons

► Pros :

- Easy to use
- Results are often pleasing

► Cons

- Costly computation
- Requires expertise of results

Example (1)

- ▶ Elastoplastic constitutive law with linear isotropic hardening
 - Corresponds to the test case zzzz159a

Example (1) : Master file

```
DEBUT ( ) ;

experiment=DEFI_FONCTION( NOM_PARA= 'INST' ,
                          NOM_RESU= 'SIYY' ,
                          VALE=     (0.00000E+00 , 0.00000E+00 ,
                                      .....
                                      9.50000E-01 , 2.07500E+02 ,
                                      1.00000E+00 , 2.08000E+02 ) ,)

RESU2=MACR_RECAL (
  UNITE_ESCL = 3,
  % parameters
  PARA_OPTI=( _F( NOM_PARA='YOUN__' ,
                  VALE_INI=100000.0,VALE_MIN=50000.0,VALE_MAX=500000.0) ,
              _F( NOM_PARA='DSDE__' ,
                  VALE_INI=1000. ,    VALE_MIN=500. ,    VALE_MAX=10000. ) ,
              _F( NOM_PARA='SIGY__' ,
                  VALE_INI=30. ,      VALE_MIN=5. ,      VALE_MAX=500. ) ) ,
  % experiment data and computed
  COURBE=(    _F( FONC_EXP= experiment ,
                  NOM_FONC_CALC='REPONSE1' , PARA_X='INST' , PARA_Y='SIYY' ) ,
  )

FIN ( ) ;
```

Example (1) : Slave file

```
DEBUT ( ) ;

DSDE__ = 200. ;
YOUN__ = 8.E4 ;
SIGY__ = 1. ;

.....
STEEL=DEFI_MATERIAU (ECRO_LINE=_F (D_SIGM_EPSI=DSDE__,
                                   SY=SIGY__, ) ,
                    ELAS=_F (NU=0.3 ,
                              E=YOUN__, ) , ) ;

.....
REPONSE1=POST_RELEVE_T (ACTION=_F (OPERATION='EXTRACTION' ,
                                   INTITULE='SIGYY' ,
                                   RESULTAT =EVOL ,
                                   NOM_CHAM = 'SIEF_ELNO' ,
                                   NOM_CMP  = 'SIYY' ,
                                   GROUP_NO  = 'A' , ) , ) ;

FIN ( ) ;
```


Example (1) : data setting

The screenshot shows the Aster configuration interface. At the top, there are menu items: "Eichier", "Configuration", "Outils", "Options", and "Aide". Below the menu is a row of tabs: "ETUDE" (selected), "TESTS", "SURCHARGE", "AGLA", and "REX".

The main area is titled "FICHIERS" and contains a "Chemin de base" field with the value "/aster/v10/NEW10/astest". Below this is a table with columns: "Type", "Serveur", "Nom", "UL", "D", "R", "C", and a column of icons.

Type	Serveur	Nom	UL	D	R	C	Icon
comm	Local	/159a.comm	1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	File icon
libr	Local	/159a.3	3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Folder icon
mail	Local	/159a.mail	20	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Red X icon
mess	Local	/159a.mess	6	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Eraser icon
resu	Local	/159a.resu	8	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Up arrow icon
libr	Local	/159a.91	91	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Down arrow icon

At the bottom of the main area is an "Arguments" field.

On the right side, there are configuration options:

- Mémoire totale (Mo): 300
- dont Aster (Mo): 30.0
- Temps (h:m:s): 600
- Machine exéc: aster2
- Version: NEW10
- batch:
- interactif: suivi interactif
- nodebug:
- debug:

At the bottom right, there are buttons: "Lancer" (with a "run" dropdown), and "Suivi des jobs".

Example (1) : results

```
=====  
Iteration 0 :
```

```
=> Function      = 1.0  
=> Résidu       = 1.0  
=> Parameters    =  
    YOUN__      = 100000.0  
    DSDE__      = 1000.0  
    SIGY__      = 30.0  
=====
```

```
.....  
=====
```

```
Iteration 5 :
```

```
=> Function      = 2.18082165482e-12  
=> Residual      = 1.75721591654e-06  
=> Parameters    =  
    YOUN__      = 199999.887792  
    DSDE__      = 1999.95570634  
    SIGY__      = 200.000278867  
=====
```

◆ The following combinations of parameters are primordial for the calculation

- $+9.8E-01 * YOUN_ -1.9E-01 * DSDE_$
- Associated to the eigenvalue 7.2E+00

◆ The following combinations of parameters are insensitive for the calculation

- $-1.9E-01 * YOUN_ -9.8E-01 * DSDE_$
- Associated to the eigenvalue 6.3E-04

Example (2)

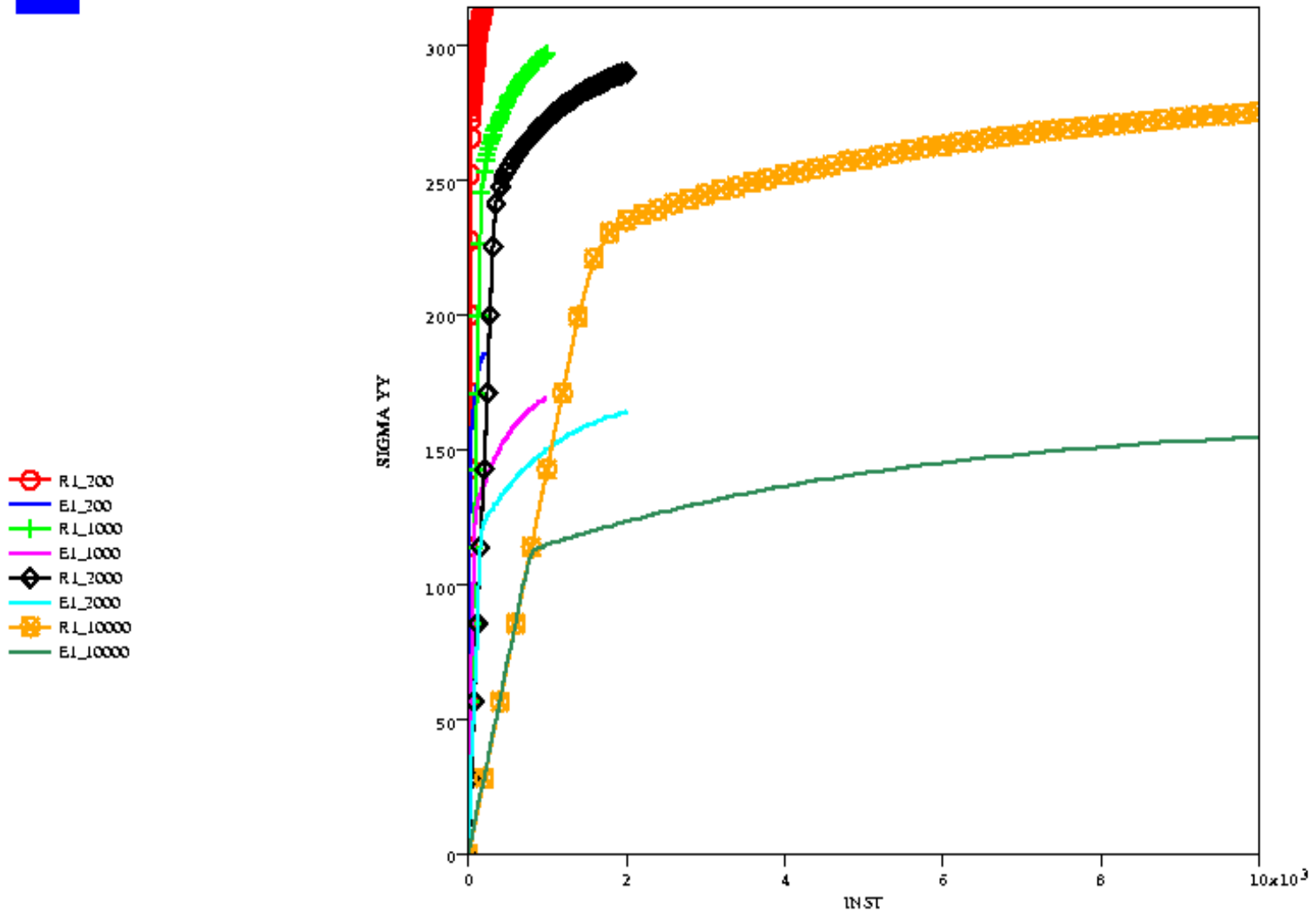
▶ Chaboche constitutive law

- 12 parameters !
- Corresponds to the test case ssna110a
- 4 tensile curves with different speeds of sollicitation

Example (2)



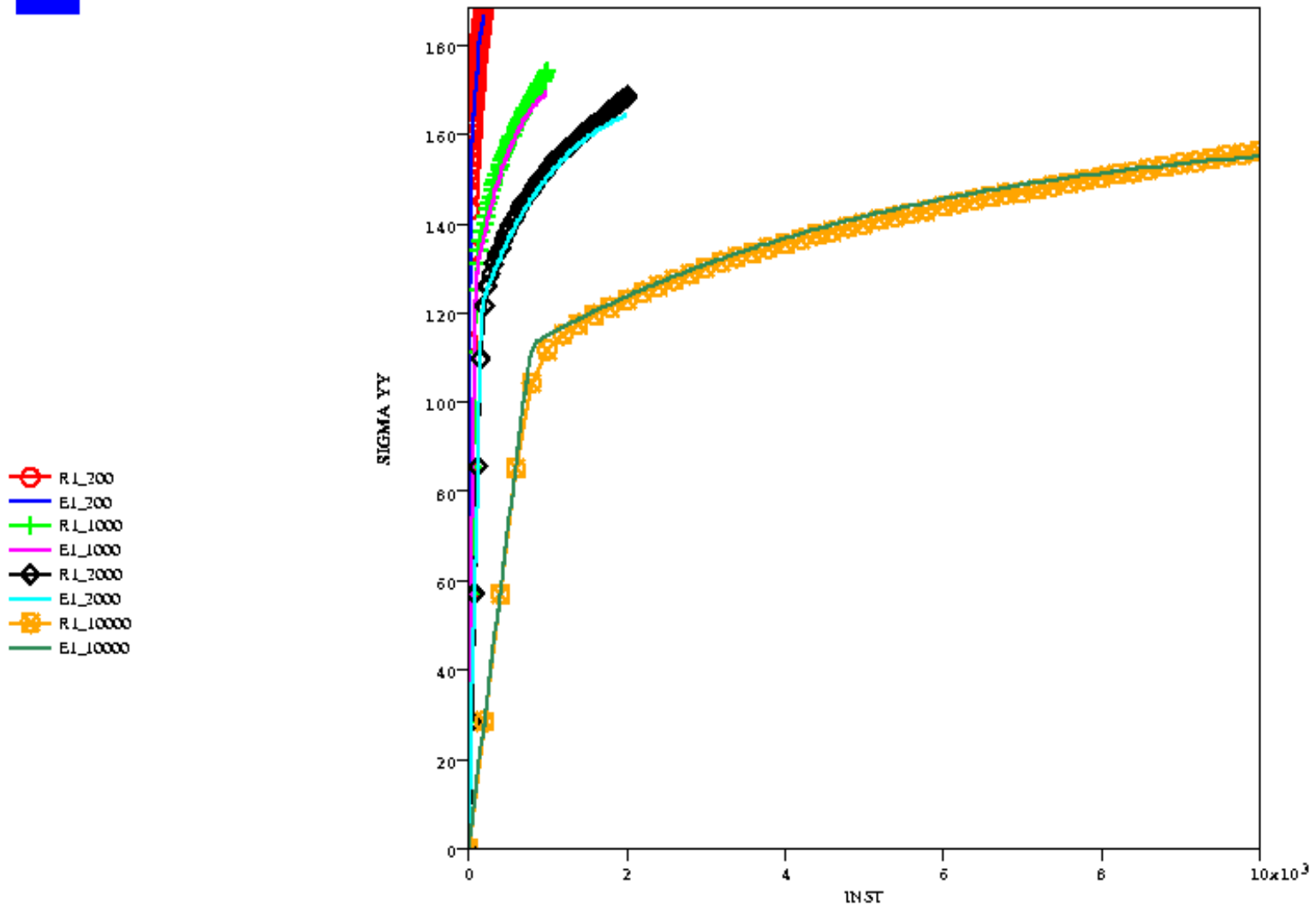
Recalage modèle viscoplastique de Chaboche (12 paramètres) sur 4 courbes de traction à différentes vitesses
Itération 0 : R0=100.0 RI=120.0 N=15.0



Example (2)



Recalage modèle viscoplastique de Chaboche (12 paramètres) sur 4 courbes de traction à différentes vitesses
Itération 3 : $R0=5.39556628611$ $RI=124.516713235$ $N=14.5181576689$



Conclusion

- ▶ Parameter fitting : **MACR_RECAL**
 - ZZZZ159 test case
 - Documentation [U4.73.02]

- ▶ Finds the set of parameters giving the best reproduction of the experimental data

- ▶ One must be critical towards results
 - Needs an expert overview
 - The sensitivity of the functional with respect to various parameters recalibrated must be checked

End of presentation

Is something missing or unclear in this document?
Or feeling happy to have read such a clear tutorial?

Please, we welcome any feedbacks about Code_Aster training materials.
Do not hesitate to share with us your comments on the Code_Aster forum
[dedicated thread](#).