PETSC01 - Validation of the PETSc solver in linear elasticity 3D

Summarized:

This benchmark makes it possible to validate solver PETSC in linear elasticity 3D under various configurations:

- Total splitted commands or operators
- Dualisation and elimination of boundary conditions (AFFE_CHAR_CINE/MECA)
- Use of PETSC with method NEWTON_KRYLOV in the nonlinear operator of dynamics

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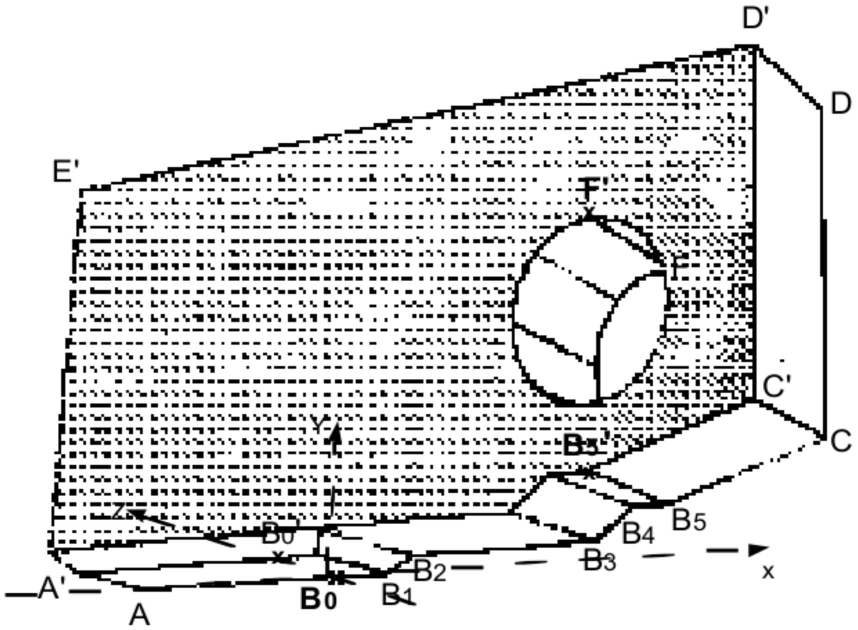
1 Problem of reference

1.1 Geometry



the geometry represents only one quarter of test-tube CTJ25:
symmetry planes: $(x\,B_0\,y)$ and $(x\,B_0\,z)$

Thickness: $DD\,'=12.5\,mm$

Face1: $(A\,,B0\,,B1\,,B2\,,B3\,,B4\,,B5\,,C\,,D\,,E)$
Face2: $(A\,,B0\,,B0'\,,A')$

Coordinates of the points (mm):

	min	max	$B0$	F “	$B5$ ’
x	-20.	42.5	0.	30.	30.
y	0.	30.	0.	20.25	3.5
z	0.	12.5	0.	12.5	12.5

1.2 Materials properties

the elastic properties of the material are the following ones:

- Young modulus: $E=2.027027\,10^{11}\,Pa$
- Poisson's ratio: $\nu=0.3$

1.3 Boundary conditions and loadings

All nodes of $face1$: $DZ=0$
All nodes of $face2$: $DY=0$

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All nodes of line FF' : $DX=0$ $DY=0.01$

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2 Reference solution

2.1 Method of calculating used for the reference solution

the reference solution is that obtained on the same mesh with the code PERMAS, computations carried out in 1997.

2.2 Results of reference and quantities tested

Localization		Reference (mm)	*Accuracy*
Point F'	DY	1. 10-2	1.5E-4
	DZ	1.0296 10-4	1.5E-4
Point $B5'$	DX	4.3006 10-3	1.5E-4
	DY	9.2890 10-3	1.5E-4
	DZ	-2.9173 10-5	1.5E-4

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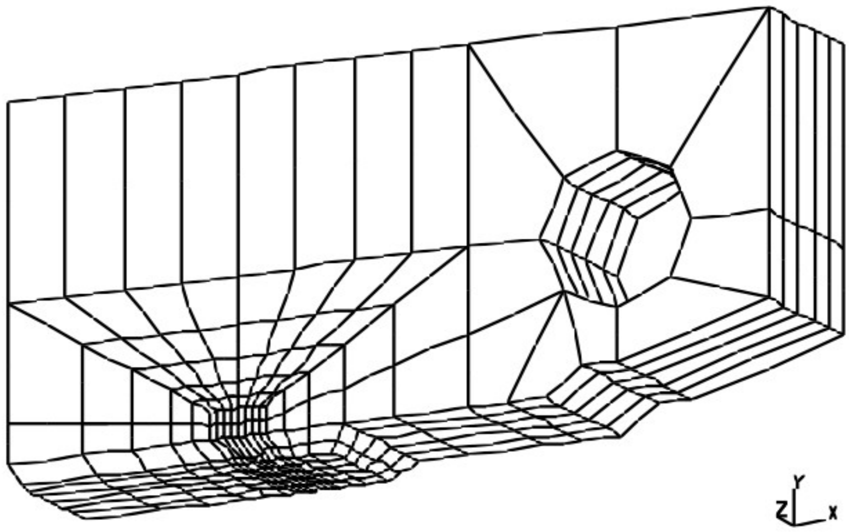
3 Modelization of reference

3.1 Modelization common to all the tests



Mesh: Many nodes: 3323 Number of meshes: 630 `HEXA20`

Cutting:	Face1 $(A, B1, \ldots, B5, C, D, E)$	428 Face2
	nodes $(A, B0, B0', A')$	198 nodes
	Segment FF'	11 nodes
Name of the nodes:	Not $F'=NO2958$	Not $B5'=NO2974$

Boundary conditions:

in all the nodes of $Face1$	`(GROUP_NO=' Grno1", DZ=0)`
in all the nodes of $Face2$	`(GROUP_NO=' Grno8', DY=0)`
in all the nodes of segment FF'	`(GROUP_NO=' Grno7', DX=0, DY=0.01)`

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4 Modelization A

Operator of resolution MECA_STATIQUE.
Dualisation and elimination of the kinematical boundary conditions (AFFE_CHAR_MECA and AFFE_CHAR_CINE).
Solver PETSC, algorithms CR and CG (with incomplete prepacking LDLT with level of filling 0 and renumbering RCMK).

5 Modelization B

Operator of resolution STAT_NON_LINE.
Dualisation and elimination of the kinematical boundary conditions (AFFE_CHAR_MECA and AFFE_CHAR_CINE).
Solver PETSC, algorithm CR (with incomplete prepacking LDLT with level of filling 0 and renumbering RCMK).

6 Modelization C

Splitted commands CALC_MATR_ELEM , TO FACTORIZE and SOLVE .
Dualisation and elimination of the kinematical boundary conditions (AFFE_CHAR_MECA and CALC_CHAR_CINE).
Solver PETSC, algorithm CR (with incomplete prepacking LDLT with level of filling 0 and renumbering RCMK).

7 Modelization D

Operator of resolution MECA_STATIQUE.
Dualisation and elimination of the kinematical boundary conditions (AFFE_CHAR_MECA and AFFE_CHAR_CINE).
Solver PETSC, algorithm CR (prepacking LDLT_SP of factorization single precision and without renumbering).

8 Modelization E

Operator of resolution STAT_NON_LINE.
Dualisation and elimination of the kinematical boundary conditions (AFFE_CHAR_MECA and AFFE_CHAR_CINE).
Solver PETSC, algorithm CR (prepacking LDLT_SP of factorization single precision and without renumbering).

9 Modelization F

Splitted commands CALC_MATR_ELEM , TO FACTORIZE and SOLVE .
Dualisation and elimination of the kinematical boundary conditions (AFFE_CHAR_MECA and CALC_CHAR_CINE).
Solver PETSC, algorithm CR (prepacking LDLT_SP of factorization single precision and without renumbering).

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10 Modelization G

Operator of resolution MECA_STATIQUE.
Elimination of the kinematical boundary conditions (AFFE_CHAR_CINE).
Solver PETSC, algorithms CR and GCR (5 resolutions without renumbering with respectively prepacking JACOBI, prepacking SOR, SANS prepacking, preconditionning ml and prepacking BOOMER).

11 Modelization H

Operator of resolution DYNA_NON_LINE.
Dualisation and elimination of the kinematical boundary conditions (AFFE_CHAR_MECA and AFFE_CHAR_CINE).
Solver PETSC, algorithm GMRES (prepacking LDLT_SP by factorization single precision).

12 Modelization I

Operator of resolution DYNA_NON_LINE.
Dualisation and elimination of the kinematical boundary conditions (AFFE_CHAR_MECA and AFFE_CHAR_CINE).
Solver PETSC, algorithm GMRES (prepacking LDLT_SP by factorization single precision).
Use of method NEWTON_KRYLOV instead of method NEWTON.

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13 Summary of the results

This benchmark shows the correct operation of solver PETSC in the various studied cases.

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