

PERF016 – Performances of INFO_MODE and of CALC_MODES+OPTION=' BANDE' parallèles

Summary:

The objective of this CAS-test is to measure the performances of the office plurality of two strategies of parallelization in INFO_MODE and CALC_MODES +OPTION=' BANDE' with cutting in sub-bands. The savings of time and memory are interesting and these accelerations (up to 2 times in peak report, 30/40 times in time on about sixty processors) can really facilitate many dynamic studies on modal basis.

1 Problem of reference

The cas-test perf013c is used as problem of reference.

Large modal calculations, in the face of problem and/or of many searched modes, are carried out *via* the operator `CALC_MODES +OPTION=' BANDE'` with cutting in sub-bands. This operator cuts out the frequential band of research in several contiguous sub-bands so as to reduce consumption in time and memory of calculation. This research by sub-bands also makes it possible to improve the robustness and the precision of the results.

To limit the déséquilibrages of load in modal calculation, they pre-are gauged *via* a call to `INFO_MODE`. This last operator activates same the two levels of parallelism as those of `CALC_MODES +OPTION=' BANDE'` with cutting in sub-bands.

The decomposition in sub-bands gets finally a last advantage, it arranges level of an explicit and very effective parallelism, by allowing the distribution of each sub-band on 1 or several processors. Thus, the modal calculations operated within each sub-band proceed jointly. If several processors are available for each sub-band, one can even call a second level of parallelism *via* linear solvor direct MUMPS. These two combined levels of parallelism make it possible to gain much in time and a little in peak report RAM (keyword `NIVEAU_PARALLELISME=' COMPLET'`, value by default).

To center the profits mainly on the peak report or because the number of processors available is insufficient compared to the number of sub-bands, one can also limit parallelism to the only second level, that of MUMPS (`NIVEAU_PARALLELISME=' PARTIEL'`).

The objective of this CAS-test is to measure the performances of these two strategies of parallelization in `INFO_MODE` and `CALC_MODES +OPTION=' BANDE'` with cutting in sub-bands. The savings of time and memory are interesting and these accelerations (up to 2 times in peak report, 30/40 times in time on about sixty processors) can really facilitate many dynamic studies on modal basis.

Modal calculation used takes again modeling C of the CAS-test *perf013*: square plate with a grid in elements of hulls ($N = 4M$ degrees of freedom), linear finite elements, search for 50 clean modes in 4 sub-bands with the modal solvor by default and linear solvor MUMPS. One tests the sequential configuration (modeling A), as well as the two parallel strategies out of 4 and 16 processors (modelings B/C and D/E).

For calculations `CALC_MODES +OPTION=' BANDE'` with cutting in sub-bands, one checks various values of frequency and different component from the unit effective modal masses ¹.

For calculations `INFO_MODE`, one tests the minimal, maximum values and the sum of the components 'NB_MODE' generated table.

2 Reference solution

See the CAS-test perf013c.

1 At the boundaries of the sub-bands to detect possible problems in communications MPI.

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3 Modeling A

3.1 Characteristics of modeling A

Number of processor: 1

One uses modeling C of the CAS-test perf0013: square plate with a grid in elements of hulls, linear finite elements, search for 50 clean modes *via* the operator `CALC_MODES +OPTION=' BANDE '` with cutting in sub-bands. One uses the modal solver and the value of the test of Sturm by default.

One pre-gauges modal calculation by a call to `INFO_MODE` on the sub-bands of frequencies: $[0.1\text{GHz}, 1.1\text{GHz}]$, $[1.1\text{GHz}, 2.0\text{Hz}]$, $[2.0\text{GHz}, 3.0\text{GHz}]$ and $[3.0\text{GHz}, 4.0\text{GHz}]$.

One parameter the linear brick solver with the best currently available tool in *Code_Aster* for this kind of calculation: solver MUMPS (`METHODE=' MUMPS '`) coupled with renumberator QAMD (`RENUM=' QAMD '`) and invited in memory (to accelerate the many descent-increase, `GESTION_MEMOIRE=' IN_CORE '`).

Characteristics of the grid: 667,489 `NODE`, 3,264 `SEG2` and 665,856 `QUAD4`.
Many degrees of freedom : 4,024,530.

3.2 Results

Size	Reference
<code>FREQ</code> n°1	47,605
<code>MASS_EFFE_UN_DZ</code> n°1	0.420180
<code>FREQ</code> n°10	1546.457
<code>MASS_EFFE_UN_DZ</code> n°10	$3,423 \cdot 10^{-3}$
<code>FREQ</code> n°21	3978.453
<code>MASS_EFFE_UN_DZ</code> n°21	$1,467 \cdot 10^{-3}$

4 Modeling B

4.1 Characteristics of modeling B

Many processors: 4.

Identical to modeling A but calculation on 4 processors by privileging the first level of parallelism (that by default is carried out here *via* `NIVEAU_PARALLELISME=' COMPLET '`).

Each sub-band is entrusted to a processor. Occurrences MUMPS, called jointly by each sub-band, thus work only on 1 processor.

4.2 Results

Identical to modeling A.

5 Modeling C

5.1 Characteristics of modeling C

Many processors: 16.

Identical to modeling A but calculation is carried out here on 16 processors by using two levels of parallelism (operation by default via NIVEAU_PARALLELISME=' COMPLET').
Each sub-band is entrusted to four processors. Occurrences MUMPS, called jointly by each sub-band, thus work each one on 4 processors.

5.2 Results

Identical to modeling A.

6 Modeling D

6.1 Characteristics of modeling D

Number of processor: 4.

Identical to modeling A but calculation is carried out here on 4 processors by privileging the second level of parallelism (NIVEAU_PARALLELISME=' PARTIEL'). All the sub-bands are treated the ones after the others.

Only occurrences MUMPS, called for digital factorizations and the descent-increase required by the modal solver, work in parallel on 4 processors.

6.2 Results

Identical to modeling A.

7 Modeling E

7.1 Characteristics of modeling E

Identical to modeling D but calculation is carried out here on 16 processors.

7.2 Results

Identical to modeling A.

8 Summary of the results

These results were got in version 11.3.9 on machine IVANOE with 1 process MPI by node. For recall, the performances in version 11.2 (parameters by default) were: 9296 s and 23.5 Go (for CALC_MODES +OPTION=' BANDE' with cutting in sub-bands) and 2016 s and 17.0 Go (for INFO_MODE).

V11.3.9 INFO_MODE/ CALC_MODES	With	B	C	D	E
Type of parallelism	1×1	4×1	4×4	1×4	1×16
Elapsed time	1008 s 3544 s	387 s 1123 s	170 s 636 s	422 s 1853 s	253 s 1432 s
Vmpeak	7.8 Go 17.2 Go	7.8 Go 19.5 Go	7.8 Go 13.8 Go	7.8 Go 10.6 Go	7.8 Go 9.5 Go