Numerical Experiments with ACGSYS package for solving Elastic – Plastic Torsion Problem and Pressure Distribution in a Journal Bearing

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Abstract. In this paper we present the performance of ACGSYS package for solving some applications from MINPACK2 package. The search direction in ACGSYS is selected as a linear combination of $-g_{k+1}$ and s_k, where $g_{k+1} = \nabla f(x_{k+1})$, $s_k = x_{k+1} - x_k$ and the coefficients in this linear combination are selected in such a way that both the descent and the conjugacy condition are satisfied at every iteration. The descent condition is introduced by means of parameter $t > 0$ and the conjugacy condition by parameter $u \geq 0$. It is shown that for general nonlinear functions with bounded Hessian the algorithm with strong Wolfe line search generates directions bounded away from infinity. The algorithm uses an acceleration scheme that modify the steplength α_k in such a manner as to improve the reduction of the function values along the iterations. We consider 6 problems solved for different values of parameter u. The parameter t is fixed to value $t = 7/8$.

1. Elastic – Plastic Torsion Problem

```
    **** CGSYS ****                    Neculai Andrei *
    * Accelerated Conjugate Gradient with Guaranteed *
    * Descent and Conjugacy conditions               *
    ***************************************************

    Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
    CGSYS. Powell restart.             December 12, 2008
-------------------------------------------------------------------------------
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000    241     0    510    27       586 -.4392678188056E+00  .3175755380542E-04
-------------------------------------------------------------------------------
 TOTAL    241     0    510    27      5.86 (seconds)    proc=    .00%

    **** CGSYS ****                    Neculai Andrei *
    * Accelerated Conjugate Gradient with Guaranteed *
    * Descent and Conjugacy conditions               *
    ***************************************************

    Parameters: t=  .8750000000000E+00    u=  .1000000000000E+00
    CGSYS. Powell restart.             December 12, 2008
-------------------------------------------------------------------------------
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000    241     0    510    27       601 -.4392678188056E+00  .3175794941673E-04
-------------------------------------------------------------------------------
 TOTAL    241     0    510    27      6.01 (seconds)    proc=    .00%

    **** CGSYS ****                    Neculai Andrei *
    * Accelerated Conjugate Gradient with Guaranteed *
    * Descent and Conjugacy conditions               *
    ***************************************************

    Parameters: t=  .8750000000000E+00    u=  .2000000000000E+00
    CGSYS. Powell restart.             December 12, 2008
-------------------------------------------------------------------------------
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
```

```
-------------------------------------------------------------------------------
40000    241     0    510    27       583 -.4392678188056E+00  .3175760707814E-04
-------------------------------------------------------------------------------
TOTAL    241     0    510    27      5.83 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .3000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000    241     0    510    27       574 -.4392678188056E+00  .3175767118491E-04
-------------------------------------------------------------------------------
TOTAL    241     0    510    27      5.74 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .4000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000    241     0    510    27       573 -.4392678188056E+00  .3175770336883E-04
-------------------------------------------------------------------------------
TOTAL    241     0    510    27      5.73 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .5000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000    241     0    510    27       575 -.4392678188056E+00  .3175757735335E-04
-------------------------------------------------------------------------------
TOTAL    241     0    510    27      5.75 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .6000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000    241     0    510    27       576 -.4392678188056E+00  .3175769396306E-04
-------------------------------------------------------------------------------
TOTAL    241     0    510    27      5.76 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .7000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000    241     0    510    27       577 -.4392678188056E+00  .3175751098510E-04
-------------------------------------------------------------------------------
TOTAL    241     0    510    27      5.77 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
```

```
   * Descent and Conjugacy conditions                *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .8000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000    241     0    510    27       573 -.4392678188056E+00  .3175769962869E-04
-------------------------------------------------------------------------------
TOTAL    241     0    510    27      5.73 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions                *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .9000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000    241     0    510    27       572 -.4392678188056E+00  .3175756293922E-04
-------------------------------------------------------------------------------
TOTAL    241     0    510    27      5.72 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions                *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E+01
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000    241     0    510    27       573 -.4392678188056E+00  .3175799101114E-04
-------------------------------------------------------------------------------
TOTAL    241     0    510    27      5.73 (seconds)    proc=    .00%
```

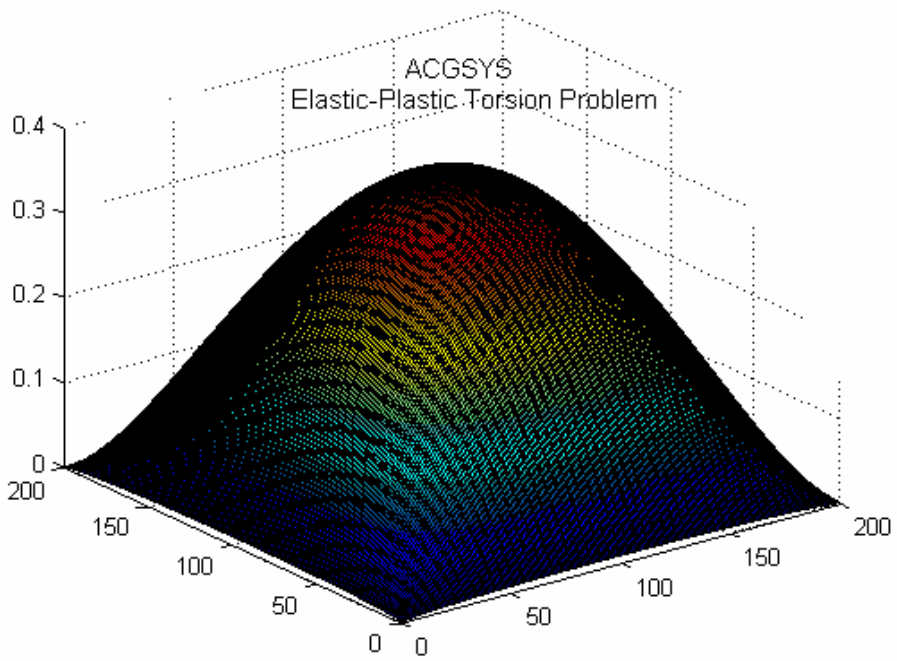

Fig. 1. Elastic – Plastic Torsion Problem. ACGSYS ($n = 40000$ variables)

$$nx = 500, \quad ny = 500$$

```
   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000    591     0   1209    26     10317 -.4392974741315E+00  .5619443178586E-04
-------------------------------------------------------------------------------
TOTAL    591     0   1209    26    103.17 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .2000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000    591     0   1209    26     10251 -.4392974741315E+00  .5619420868896E-04
-------------------------------------------------------------------------------
TOTAL    591     0   1209    26    102.51 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .3000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000    591     0   1209    26     10251 -.4392974741318E+00  .5619246511461E-04
-------------------------------------------------------------------------------
TOTAL    591     0   1209    26    102.51 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .4000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000    591     0   1209    26     10251 -.4392974741322E+00  .5619102848862E-04
-------------------------------------------------------------------------------
TOTAL    591     0   1209    26    102.51 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .5000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000    591     0   1209    26     10249 -.4392974741315E+00  .5619474569202E-04
-------------------------------------------------------------------------------
TOTAL    591     0   1209    26    102.49 (seconds)    proc=    .00%



   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
```

```
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .6000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000    591     0   1209    26     10251 -.4392974741317E+00  .5619326086347E-04
-------------------------------------------------------------------------------
TOTAL    591     0   1209    26    102.51 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .7000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000    591     0   1209    26     10249 -.4392974741321E+00  .5619098806426E-04
-------------------------------------------------------------------------------
TOTAL    591     0   1209    26    102.49 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .8000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000    591     0   1209    26     10257 -.4392974741311E+00  .5619678474627E-04
-------------------------------------------------------------------------------
TOTAL    591     0   1209    26    102.57 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .9000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000    591     0   1209    26     10252 -.4392974741324E+00  .5618974637759E-04
-------------------------------------------------------------------------------
TOTAL    591     0   1209    26    102.52 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E+01
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000    591     0   1209    26     10253 -.4392974741312E+00  .5619578734245E-04
-------------------------------------------------------------------------------
TOTAL    591     0   1209    26    102.53 (seconds)    proc=    .00%
```

```
   **** CGSYS ****                   Neculai Andrei *
```

```
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
1000000   1111     0   2253    30     77964 -.4393016840059E+00  .6698945255028E-04
-------------------------------------------------------------------------------
TOTAL   1111     0   2253    30    779.64 (seconds)    proc=    .00%
```

2. Pressure Distribution in a Journal Bearing

```
   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    631     0   1297    34      1536 -.2828929485422E+00  .2454640595422E-04
-------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.36 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    631     0   1297    34      1542 -.2828929485442E+00  .2449514420940E-04
-------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.42 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .2000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    631     0   1297    34      1514 -.2828929485437E+00  .2450340679455E-04
-------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.14 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .3000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    631     0   1297    34      1516 -.2828929485503E+00  .2445463377893E-04
-------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.16 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
```

```
   ************************************************

   Parameters: t=  .8750000000000E+00    u=  .4000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    631     0   1297    34      1514 -.2828929485440E+00  .2450070711614E-04
-------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.14 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ************************************************

   Parameters: t=  .8750000000000E+00    u=  .5000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    631     0   1297    34      1512 -.2828929485448E+00  .2448137849973E-04
-------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.12 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ************************************************

   Parameters: t=  .8750000000000E+00    u=  .6000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    631     0   1297    34      1514 -.2828929485451E+00  .2448294317394E-04
-------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.14 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ************************************************

   Parameters: t=  .8750000000000E+00    u=  .7000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    634     0   1303    34      1519 -.2828929487198E+00  .2266574895699E-04
-------------------------------------------------------------------------------
TOTAL    634     0   1303    34     15.19 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ************************************************

   Parameters: t=  .8750000000000E+00    u=  .8000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    631     0   1297    34      1514 -.2828929485423E+00  .2454647065825E-04
-------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.14 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ************************************************

   Parameters: t=  .8750000000000E+00    u=  .9000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
```

```
  40000    631     0   1297    34      1512 -.2828929485441E+00  .2449489958048E-04
-------------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.12 (seconds)    proc=    .00%

   **** CGSYS ****                    Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E+01
   CGSYS. Powell restart.             December 12, 2008
-------------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------
  40000    631     0   1297    34      1515 -.2828929485421E+00  .2454895834299E-04
-------------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.15 (seconds)    proc=    .00%
```

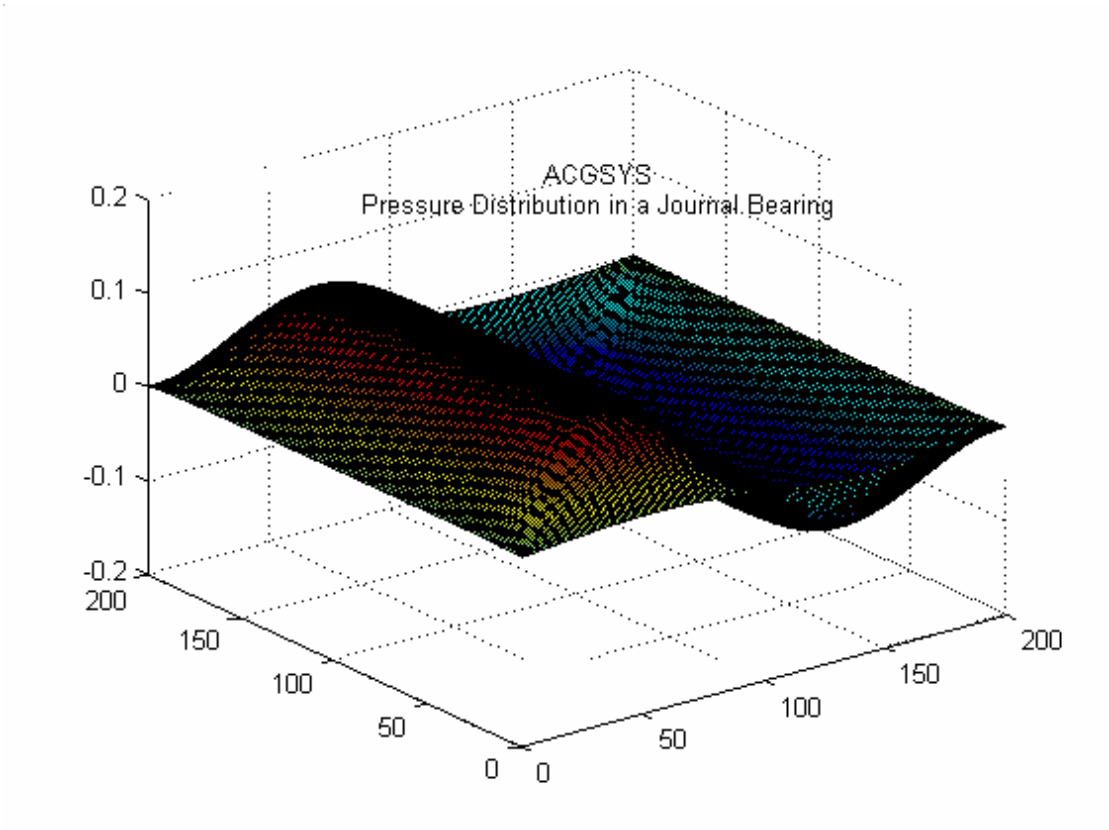

Fig.2. Pressure Distribution in a Journal Bearing. ($n = 40000$ variables)

```
   **** CGSYS ****                    Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E+00
   CGSYS. Powell restart.             December 12, 2008
-------------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------
 250000   1495     0   3021    30     27658 -.2829080180437E+00  .5006393159178E-04
-------------------------------------------------------------------------------------
TOTAL   1495     0   3021    30    276.58 (seconds)    proc=    .00%


   **** CGSYS ****                    Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
```

```
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .2000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000   1496     0   3023    30     27582 -.2829080183171E+00  .4949205011630E-04
-------------------------------------------------------------------------------
TOTAL   1496     0   3023    30    275.82 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .3000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000   1495     0   3021    30     27559 -.2829080180469E+00  .5005822628043E-04
-------------------------------------------------------------------------------
TOTAL   1495     0   3021    30    275.59 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .4000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000   1496     0   3023    30     27571 -.2829080183154E+00  .4949108223546E-04
-------------------------------------------------------------------------------
TOTAL   1496     0   3023    30    275.71 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .5000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000   1495     0   3021    30     27554 -.2829080180434E+00  .5005863437913E-04
-------------------------------------------------------------------------------
TOTAL   1495     0   3021    30    275.54 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .6000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000   1496     0   3023    30     27571 -.2829080183178E+00  .4949399310197E-04
-------------------------------------------------------------------------------
TOTAL   1496     0   3023    30    275.71 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   **************************************************

   Parameters: t=  .8750000000000E+00    u=  .7000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
```

```
-------------------------------------------------------------------------------
 250000   1495     0   3021    30     27551 -.2829080180461E+00  .5005811048468E-04
-------------------------------------------------------------------------------
TOTAL   1495     0   3021    30    275.51 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .8000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000   1496     0   3023    30     27675 -.2829080183180E+00  .4949128238262E-04
-------------------------------------------------------------------------------
TOTAL   1496     0   3023    30    276.75 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .9000000000000E+00
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000   1495     0   3021    30     27553 -.2829080180452E+00  .5005912018986E-04
-------------------------------------------------------------------------------
TOTAL   1495     0   3021    30    275.53 (seconds)    proc=    .00%

   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E+01
   CGSYS. Powell restart.            December 12, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 250000   1496     0   3023    30     27568 -.2829080183176E+00  .4948979782673E-04
-------------------------------------------------------------------------------
TOTAL   1496     0   3023    30    275.68 (seconds)    proc=    .00%


   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
   CGSYS. Powell restart.            December 15, 2008
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
1000000   2837     0   5702    27    217509 -.2829101145836E+00  .8050152356213E-04
-------------------------------------------------------------------------------
TOTAL   2837     0   5702    27   2175.09 (seconds)    proc=    .00%
```

January 5, 2009