

## SOLVIA® Performance on Multi-Core Processors

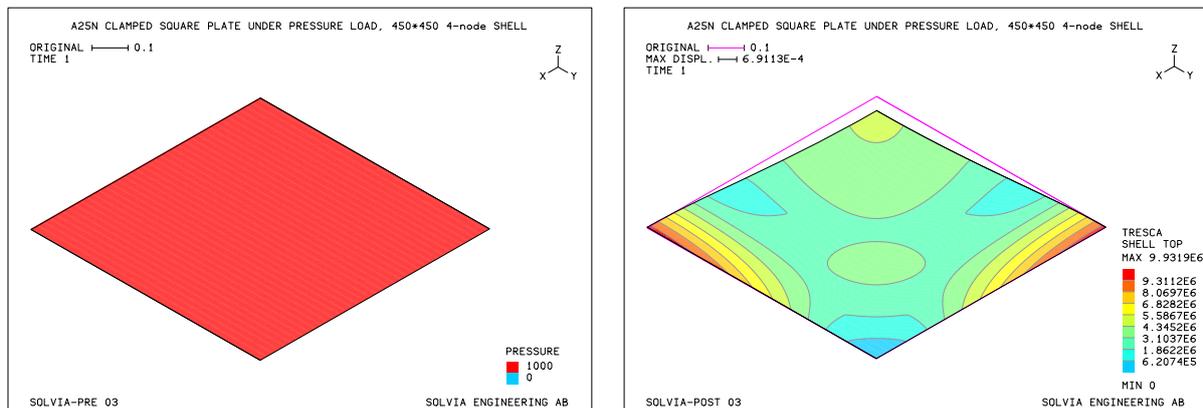
This note presents solution times and peak memory sizes used by the 32-bit or 64-bit SOLVIA 03.0.9 when models of varying size and type are analyzed and the parallel direct sparse solver is employed. The analyses were run either under 32-bit Windows XP or under 64-bit Windows Vista or 64-bit Linux openSUSE 10.3. The PC processor types include Intel Core 2 Duo and AMD Athlon 64 X2 Dual-Core, allowing parallel solutions.

The listed total peak memory is an estimate of what is required for the model data and for the sparse solution when running SOLVIA. It may be noted that solution times may vary depending on a number of computing environment parameters.

With 8 GB RAM available a linear 4-node SHELL element model with about 2.5 million degrees of freedom could be analyzed in-core by SOLVIA with a solution time of about 5 minutes including calculation of element stresses, see case A25Q below. Using the out-of-core option the model could be increased further. For example, a 3.6 M dof model could be solved with a factorization time of about 12 minutes and a total solution time of about 23 minutes including stress calculations, see case A25T below. On both 32-bit and 64-bit systems, linear models of the order a few hundred thousand degrees of freedom have in general a solution time of less than a minute.

### A25 - Clamped Square Plate under Pressure Load, 4-node SHELL Elements

Linear static analysis using 2 threads on an HP xw4600 Workstation with Intel Core 2 Duo and with 8GB RAM under 64-bit Windows Vista.



	Number of elements	Number of equations	Sparse matrix elements	Factorization time (sec.)	Total solution time (sec.)	Total peak memory (MB)
A25N	202500	1010700	23170638	20	56	3075
A25O	250000	1248000	28620138	27	76	3819
A25P	360000	1797600	41244138	41	109	5563
A25Q	490000	2447200	56168138	98	300	7764
A25R	562500	2809500	64492638	291	738	9212 <sup>1)</sup>
A25R	562500	2809500	64492638	291	604	9140 <sup>2)</sup>
A25S	640000	3196800	73392138	337	1091	10432 <sup>3)</sup>
A25T	722500	3609100	82866638	694	1404	6587 <sup>4)</sup>

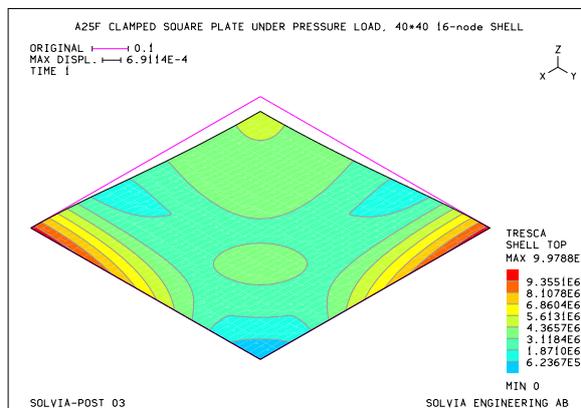
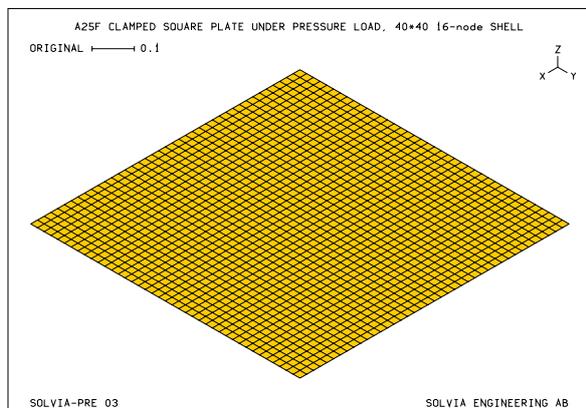
<sup>1)</sup> In-core but with paging to disk.      <sup>2)</sup> Out-of-core, 1 thread, memory SOLVIA=2000, MKL=10000

<sup>3)</sup> Out-of-core, 1 thread, memory SOLVIA=3000, MKL=12000

<sup>4)</sup> Out-of-core, 1 thread, memory SOLVIA=3000, MKL=8000

### A25 - Clamped Square Plate under Pressure Load, 16-node SHELL Elements

Linear static analysis using 2 threads on an HP xw4600 Workstation with Intel Core 2 Duo processor under 32-bit Windows XP using 2 GB RAM.



	Number of elements	Number of equations	Sparse matrix elements	Factorization time (sec.)	Total solution time (sec)	Total peak memory (MB)
A25E	400	17760	1067050	0.2	1.9	59
A25F	1600	71520	4401130	0.6	5.3	241
A25G	3600	161280	10003210	1.7	12.	547
A25H	6400	287040	17873290	3.6	22.	977
A25I <sup>1)</sup>	10000	448800	28011370	31.	61.	1488
A25JA <sup>2)</sup>	12100	543180	33930910	40.	78.	1802

<sup>1)</sup> Out-of-core, Memory MKL=1200, 1 thread.

<sup>2)</sup> Out-of-core, Memory MKL=1500, 1 thread.

### A25 - Clamped Square Plate under Pressure Load, 16-node SHELL Elements

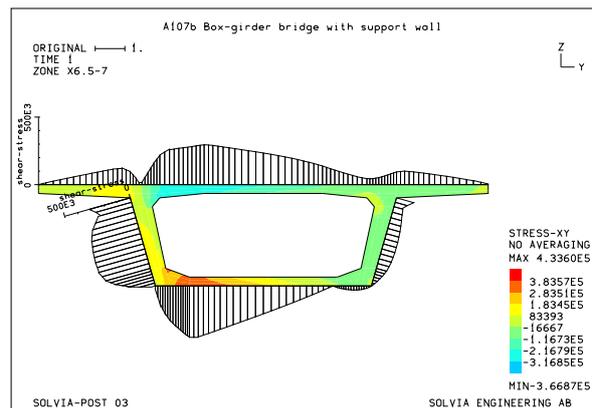
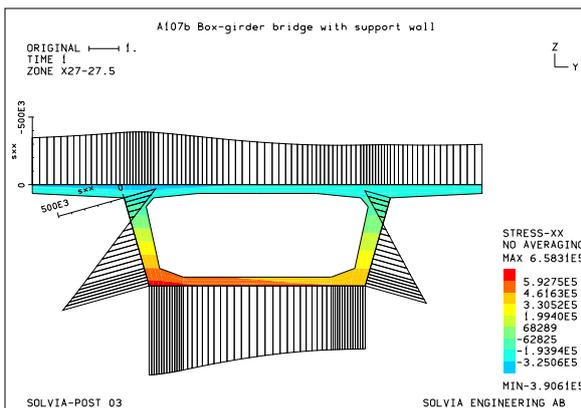
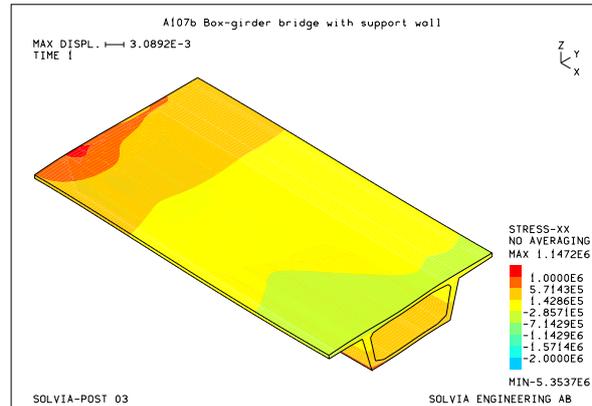
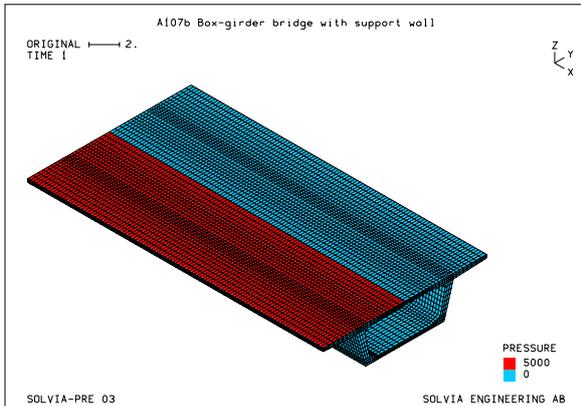
Linear static analysis using 2 threads on an HP xw4600 Workstation with Intel Core 2 Duo processor and with 8 GB RAM under 64-bit Windows Vista.

	Number of elements	Number of equations	Sparse matrix elements	Factorization time (sec.)	Total solution time (sec.)	Total peak memory (MB)
A25E	400	17760	1067050	0.1	1.5	67
A25F	1600	71520	4401130	0.5	5.9	276
A25G	3600	161280	10003210	1.5	13.	627
A25H	6400	287040	17873290	3.2	23.	1119
A25I	10000	448800	28011370	5.7	36.	1755
A25J	14400	646560	40417450	9.5	55.	2533
A25K	22500	1010700	63279070	18.	86.	3967
A25M	40000	1797600	112721770	44.	174.	7072

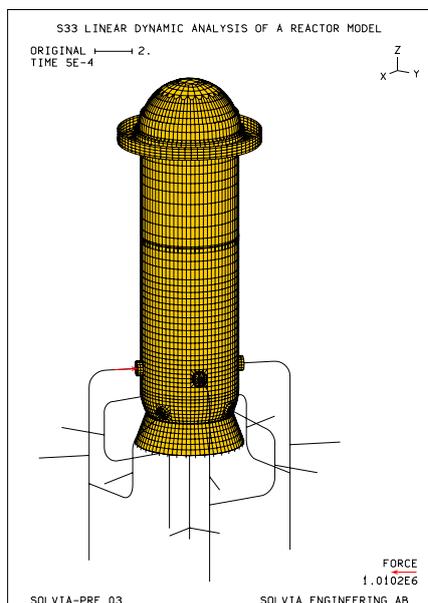
### A107B - Box-Girder Bridge with Support Wall

Total number of parabolic SOLID elements = 29212  
 Number of SOLID element pressure loads = 2530  
 Number of equations = 435127  
 Number of sparse matrix elements = 32671176

This is a linear static analysis using 2 threads on an AMD Athlon 64 X2 Dual-Core 5600+ processor with 4 GB RAM available under 64-bit openSUSE Linux 10.3. Estimated total peak memory in SOLVIA is 4074 MB using the sparse direct solver. Assembling the linear stiffness matrix took 8 sec. and the factorization time was 165 sec. including some paging to disk. The total solution time was 221 sec.



### S33 - Linear Dynamic Analysis of a Reactor Model with Fluid-Structure Interaction



Total number of elements = 27204  
 Number of SHELL pressure loads = 8452  
 Number of rigid links = 2427  
 Number of constraint equations = 6042  
 Number of FLUID potential equations = 11160  
 Total number of equations = 108706  
 Number of sparse matrix elements = 3290688

The Newmark implicit time integration method is employed in the fluid-structure dynamic analysis using 2 threads on an HP xw4600 Workstation with Intel Core 2 Duo under 32-bit Windows XP with 2 GB RAM available.

Estimated total peak memory in SOLVIA is 753 MB using the sparse direct solver.

Assembling stiffness matrix, consistent mass matrix and consistent (Rayleigh) damping matrix took 7 sec.

Factorization time is 2.5 sec. and the solution time per step (excluding stress calculations) is 0.33 sec.

**B74 - Analysis of a Rubber Bushing**

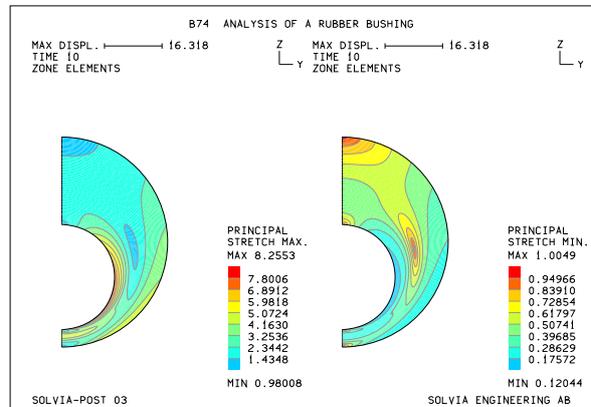
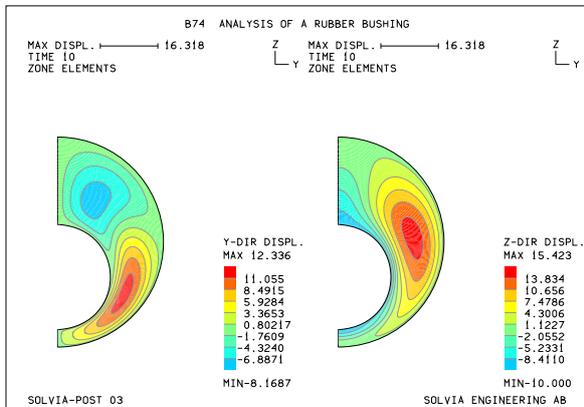
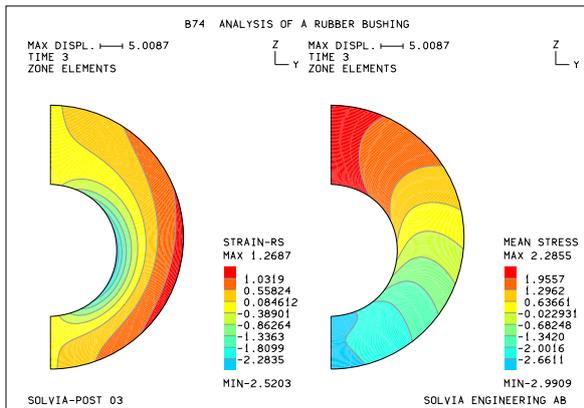
Total number of quadratic PLANE elements = 8192  
 Number of equations = 65025  
 Number of sparse matrix elements = 1059154

The nonlinear large displacement analysis is carried out using 2 threads on an HP xw4600 Workstation with Intel Core 2 Duo and with 2 GB RAM available under 32-bit Windows XP.

Estimated total peak memory in SOLVIA is 85 MB using the sparse direct solver.

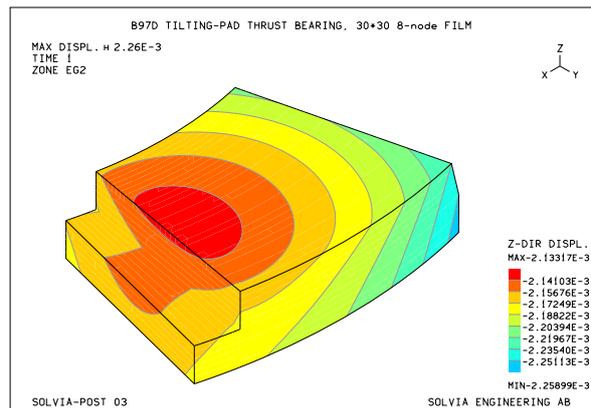
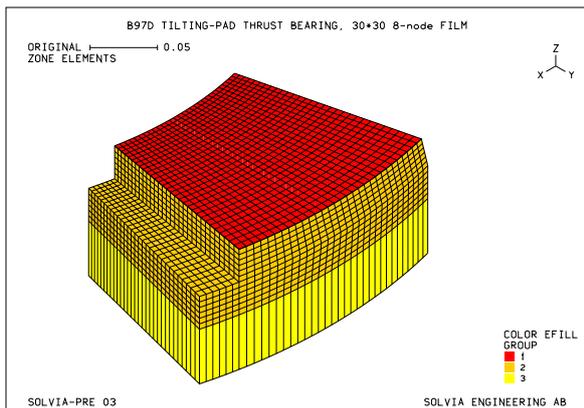
Ten incremental solution steps, each step using 3 or 4 full Newton iterations.

Total solution time in SOLVIA is 26 sec.



**B97 - Tilting-Pad Thrust Bearing (Spring-Supported)**

Nonlinear coupled analysis of oil film pressure, temperature and deformations using 2 threads on an HP xw4600 Workstation with Intel Core 2 Duo and with 8 GB RAM under 64-bit Windows Vista.



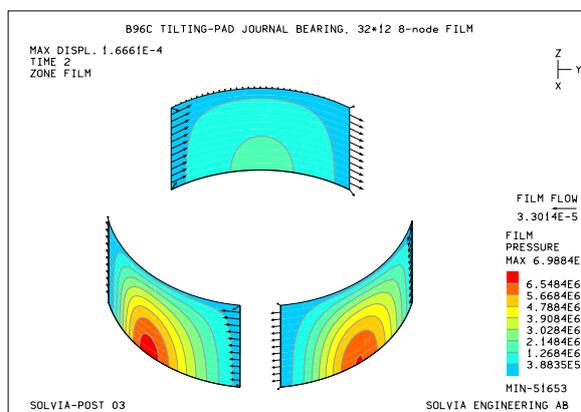
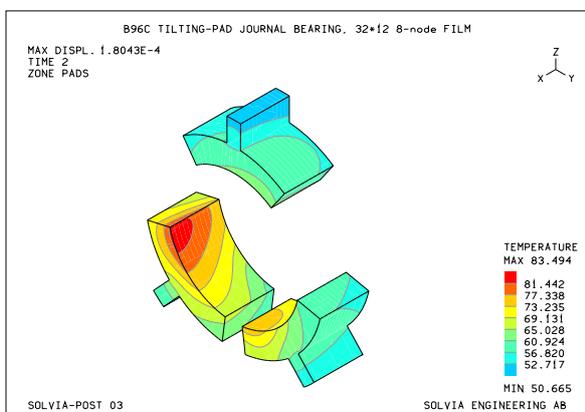
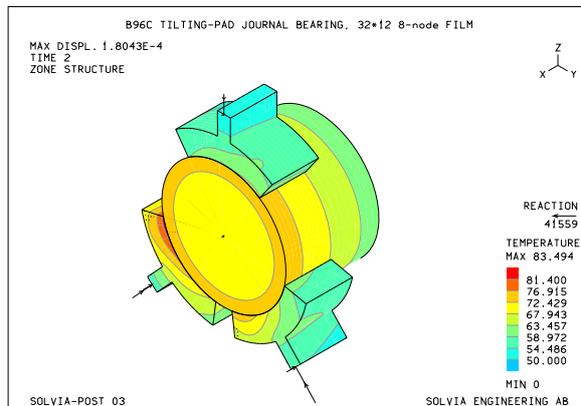
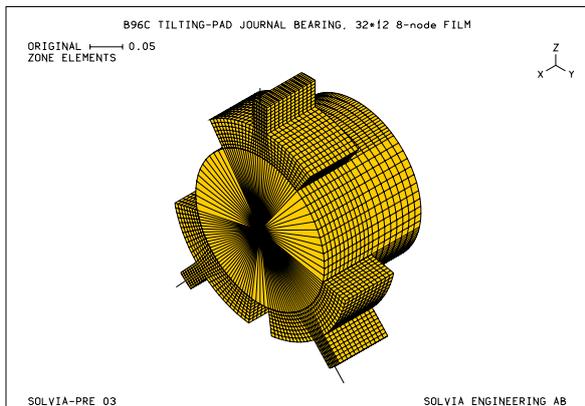
One solution step in a coupled analysis using full Newton iterations.

	Number of elements	Number of temperature equations	Number of displacement equations	Number of oil pressure equations	Total solution time (min.)	Total peak memory (MB)
B97D	13860 <sup>1)</sup>	16834	41383	841	0.9	335
B97E	48600 <sup>1)</sup>	56050	143665	2401	6.5	1589
B97F	2640 <sup>2)</sup>	13657	28816	1121	0.8	288
B97G	17600 <sup>2)</sup>	82077	198892	4641	18.	3236

<sup>1)</sup> 8-node FILM and SOLID elements. <sup>2)</sup> 16-node FILM and 20-node SOLID elements.

### B96 - Tilting-Pad Journal Bearing

Nonlinear coupled analysis of oil film pressure, temperature and deformations using 2 threads on an HP xw4600 Workstation with Intel Core 2 Duo and with 8 GB RAM under 64-bit Windows Vista.



Two incremental solution steps with full Newton iterations were used.

	Number of elements	Number of temperature equations	Number of displacement equations	Number of oil pressure equations	Total solution time (min.)	Total peak memory (MB)
B96A	2351 <sup>1)</sup>	10380	30836	828	1.2	230
B96B	15155 <sup>1)</sup>	63802	190880	3384	15.	2214
B96C	15155 <sup>2)</sup>	16666	49768	1116	1.1	287
B96D	106691 <sup>2)</sup>	112110	335976	4536	23.	3271

<sup>1)</sup> 16-node FILM and 20-node SOLID elements.

<sup>2)</sup> 8-node FILM and SOLID elements.