

Check before Installing *Super Matrix Solver*

1. Purpose of this Document

This material provides a list of items that need to be checked by those who are considering evaluation and/or purchase of the *Super Matrix Solver* (SMS) products.

2. Checking Points

[Type of your application]

(1) Your application must be that of an implicit method. In other words, your application must be a solver program that carries out calculation of simultaneous linear equation systems. SMS cannot be implemented to your application if it is an application of explicit method, or if it does not perform calculation of simultaneous linear equation systems.

(2) The best way of ensuring your application's compatibility with SMS is to **check if your application uses any kind of matrix solver or not.** Your matrix solver may be of a direct method or of an iterative method. Please make sure that your application generates the coefficient matrix A and right-hand side constant vector b of $Ax=b$, passes the data (A and b) to a function or a sub-routine to solve simultaneous equation system, and then obtains a solution vector x .

(3) Further considerations must be given for cases in which **calculation of simultaneous equation systems is not performed by an independent (self-contained) module in your application** and the calculation is performed without explicitly generating array data representing the coefficient matrix A and constant vector b . In such cases, please check if your program can be changed to generate and pass A and b to SMS, to be used as arguments.

(4) Is the coefficient matrix A sparse or dense?

SMS-AMG solves simultaneous equation systems that have a sparse matrix as its coefficient. It can not solve dense matrices. Although it may be difficult to differentiate sparse from dense in a quantitative manner, matrices generated by difference methods, finite volume methods and finite element methods are sparse matrices. Those generated by boundary element methods are dense matrices. Boundary element methods (BEM) are used in such fields as acoustic field analyses, electromagnetic analyses, and so on. VINAS has developed solvers dedicated for direct method and BEM, for solving dense matrices. Please contact us for further information if you would consider using our solvers for dense matrices.

[How effective would SMS be for your application?]

(5) Verify the ratio of the time spent for matrix calculation to those spent for non-matrix calculation. An implementation of SMS-AMG to your current solver can only speed up the process of matrix (simultaneous equation system) calculation. Thus, if the percentage of the application (solver) calculation time spent on matrix calculation is relatively small, it would be difficult to benefit from the calculation speed reduction effects for an entire application. Figure 1 shows how SMS effects change depending on the ratio of matrix calculation to an entire calculation time for solving a simultaneous equation system.

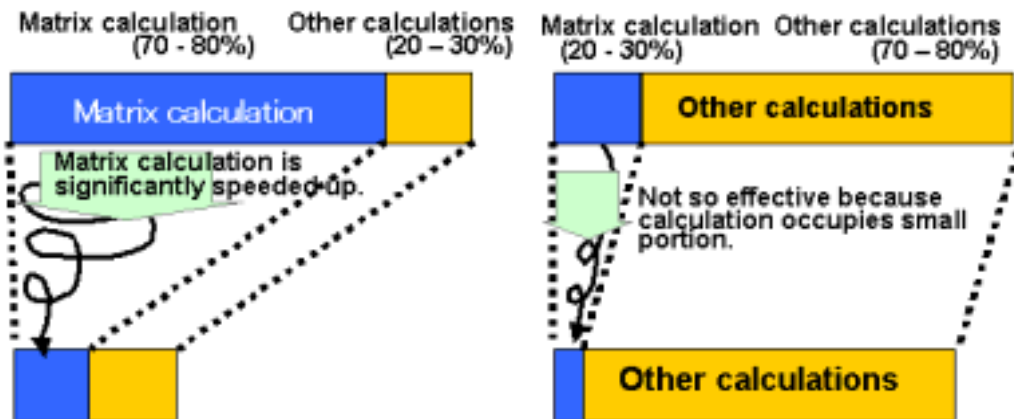


Figure 1. SMS' calculation speed-up effect depending on the ratio of matrix calculation to an entire calculation time in solving a simultaneous coefficient matrix

(6) If your application uses approximated linear equations for a non-linear equation system, find out the level of convergence (accuracy) required for your solution. If your calculation does not require high level of convergence, for example, if you only need the secondary norm of residual to be about 10^{-2} , SMS may not be very effective. In order for SMS-AMG to have significant effect, problems being solved must be of a large size (in terms of the number of unknowns) and require high level of convergence.

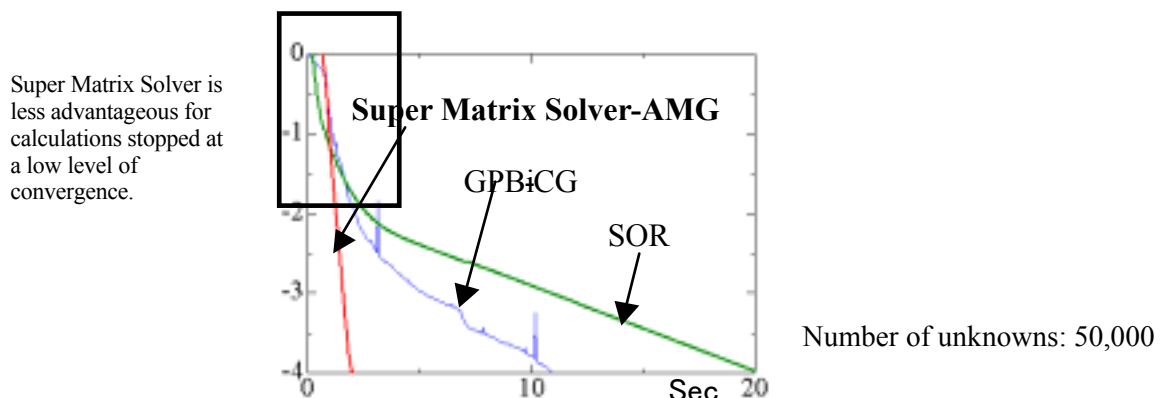


Figure 2. Calculation speed at low level of convergence (where conventional method may be faster than SMS-AMG)

(7) For a type of simultaneous linear equation systems(*1) that includes multiple unknowns (displacement, x, y and z, etc...) such as structural analysis problem, the current version of SMS-AMG V2 is capable of calculating problems with solid elements. The shell element capability is planned for SMS-AMG V3.

*1 This is different from dimension of simultaneous equation system. This means that multiple unknowns such as displacement(x, y, z), rotation(ϕ , θ , ψ) and velocity(u, v, w) are included in one matrix.

[Parallel processing environment]

(8) Super Matrix Solver-AMG itself is not compatible with parallel processing. However, SMS-AMG may be used to solve your problem if your application divides the matrix with a function such as domain decomposition method (DDM), independently calculate each of the divided components, and makes adjustment with outer iteration loop.

SMS-AMG may not be used, however, if communication and information exchange between matrix solvers are required when calculating the divided matrix. Thus, please check if any kind of communication between matrix solvers is required or not.

[Types of calculation for which SMS-AMG is not applicable]

9: Following types of calculation can not be performed by SMS-AMG.

- 1) Calculation involving handling of complex number
- 2) Calculation of inverse matrix
- 3) Eigenvalue calculation
- 4) Problems including diagonal element of which value is zero.

For more detailed information, please refer to a separate document titled: “*Super Matrix Solver FAQ*”.

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