Effects of Solvers on Finite Element Analysis in COMSOL Multiphysics® Software

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Abstract

Introduction: Solver section of FEA plays a very important role; it takes the input from the preprocessor and solves millions of equations using numerical methods. Capability of any analysis tools can be measured based on the solver. Understanding the nature and operation of various structural solid mechanics solvers is the interest of the present study.
Results: Contact pressure is evaluated with the help of various solvers available [Fig. 4]. Percentage error between the simulated and the experimental values are reported for all the solver algorithms available in COMSOL Multiphysics®. The paper also reports the memory consumed by various solvers to solve the same problem. Total number of degrees of freedom solved for in the system is 435853. Direct solver demands 12 to 20 GB of memory to solve the problem, whereas iterative solvers solve the same problem by using less than 5GB memory in some exceptional cases.
Conclusion: High frequency ultrasonic waves were used in the reported experiments. Raw ultrasonic waves reflected will be captured and then transformed into the contact pressure. At the center, there will be full contact. So, it's always better to compare results at the center. Because of the deformation at the edges, the results estimated at the edges cannot be considered for the comparison. Once the body deforms the nature of the reflected wave's changes, the actual capturing of all the reflected data becomes difficult. Effects of various solver settings on the results are estimated in the present study. Direct solver algorithms are always the best, if the problem size allows using this solver. But it always demands a significant amount of memory to solve a problem which involves large number of equations. Method used in iterative solver reduces error through an iterative process and leads solution to convergence. Results estimated in the present study are matching with the theoretical explanations. In the benchmark paper, FEA values were converted to the convolved value to compare with the experimental results. The estimated values are compared with the benchmark FEA values reported in the reference paper. Results have shown good agreement when direct solvers are used.

Figures used in the abstract

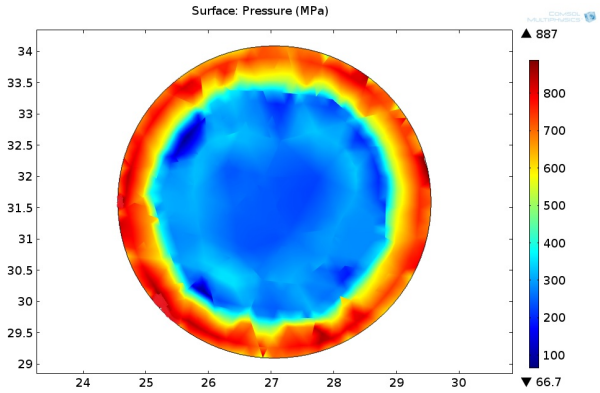

Figure 4: Surface pressure plot.