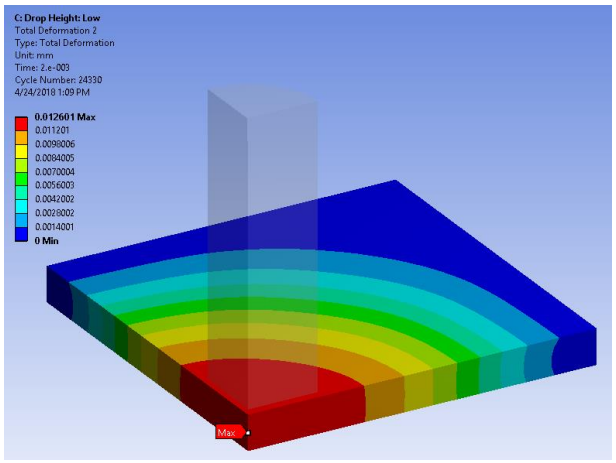
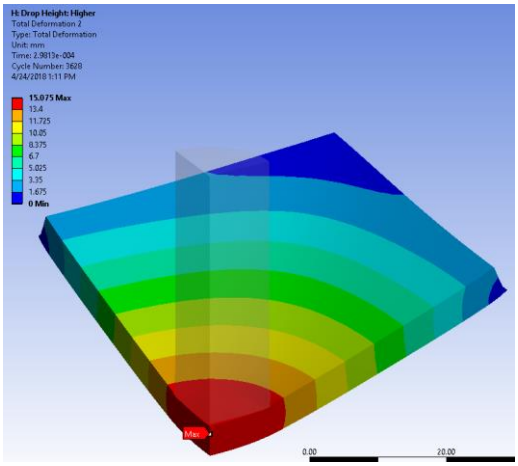
Which analysis system should I use, Transient Dynamics or Explicit Dynamics if I want to reduce the running time?





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SOFTWARE VERSION

R19.0 ANSYS Mechanical

DESCRIPTION

In ANSYS Mechanical, structural analysis in both space and time domains can be conducted either in Transient Structural or Explicit Dynamics Analysis system. There are a lot of factors that could influence the decision on which analysis system to use. This knowledge material doesn't address these factors. This knowledge material discusses the comparison of running time if a model can be solved successfully in both Transient Structural and Explicit Dynamics Analysis system without any technical or numerical difficulties.

The drop test simulation of a circular cylinder on a square plate is used in this knowledge material as the example. Discussion is conducted on which analysis system runs faster under the specified loading conditions, based upon the magnitude of the resulted maximum deformation and the peak stress.

INSTRUCTIONS

Model Descriptions

Drop test simulation of a circular cylinder on a square plate is used. The cylinder is made of steel while the plate is made of aluminum. Fixed Support boundary condition is applied to the edges of the bottom surface of the plate.

There are three drop heights used in the simulations: low, high, and higher. Thus, the initial drop impact velocity is different. They are 0.5 m/s (low), 20 m/s (high), 100 m/s (higher), respectively.

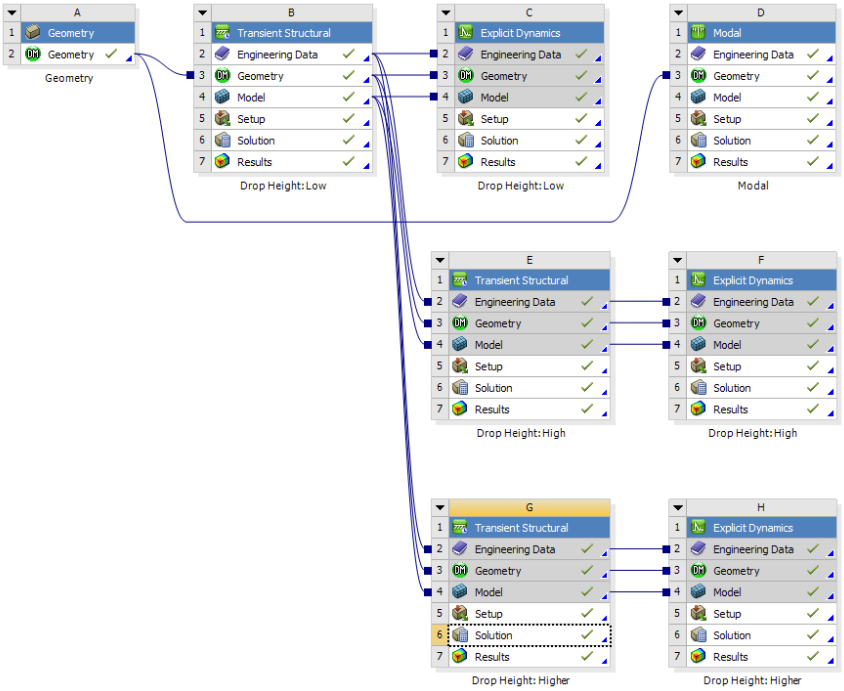

Figure 1 Project Schematic of the Workbench Project

Analysis Settings

Modal Analysis is conducted first to obtain the fundamental frequency of the plate: f. The fundamental period of the plate is $T = 1/f$.

In Transient Structural system, for the first two drop height scenarios – low and high, the initial time step and minimum time step are equal to $\Delta t = T/20$. For the drop height scenario – higher, the initial time step is $\Delta t = T/100$ and the minimum time step is $\Delta t = T/1000$ to ensure the convergence of the solution. The maximum time step is $\Delta t = T$ for all scenarios. Large deformation is on.

In Explicit Dynamics system, initial time step, minimum time step, and maximum time step are all set to Program Controlled. Mass Scaling is not used.

Comparison of Running Time

The Table below shows the comparison of running time of Transient Structural and Explicit Dynamics Analysis on the same model under three different drop impact velocities.

Analysis System	Impact Velocity	*w/h*	σ/Y	Scaled Computing Time
Transient Structural	0.5 m/s	0.007	0.1	0.9
Explicit Dynamics		0.007	0.1	1
Transient Structural	20 m/s	0.4	1	4
Explicit Dynamics		0.4	1	1
Transient Structural	100 m/s	3	2	9
Explicit Dynamics		3	2	1

w is the maximum deformation of the plate. *h* is the plate thickness. σ is the maximum von-Mises stress in the plate. *Y* is the initial yield stress of the plate material.

Discussion

When the final material state is still linear elastic, running Transient Structural Analysis will reduce running time. This is because larger time step can be used to reduce the running time without losing the solution accuracy.

When the final material state has a lot of plasticity and very large deformation, running Explicit Dynamics Analysis will reduce running time. This is because smaller time step must be used in Transient Structural system to ensure the convergence of the solution. The number of equilibrium iterations at each time step is also increased to make the solution converged in the time step. Although the time step in Explicit Dynamics system is still smaller than the Transient Structural system, Explicit Dynamics system runs faster since it doesn't require equilibrium iterations and inverse of large matrix at each iteration.

KEY WORDS

Impact, Explicit Dynamics, Drop Test, Transient Structural

FILES

1) 2054219 - Transient Structural vs Explicit Dynamics Analysis.pdf - this document
2) 2054219 - Transient_Structural_vs_Explicit_Dynamics_R190.wbpz - Workbench Project