

Nonlinear static analysis

This very general template can be used for setting up a general nonlinear implicit analysis. It will provide control card settings and database output request in line with the baseline recommendations of Appendix P of the Keyword Manual, and the Guideline to implicit analyses using Ansys LS-DYNA. Loading, boundary conditions, contacts etc. must be set up by the user. Mortar contacts

(*CONTACT_AUTOMATIC_..._SURFACE_MORTAR_ID) are strongly recommended for implicit analysis.

For a static, implicit analysis to converge, it is required that no rigid-body modes or mechanisms exist in the model. This means that sufficient boundary conditions must be provided in order to prevent rigid body motion of any part. Inertia relief boundary conditions (*CONTROL_IMPLICIT_INERTIA_RELIEF) may also be applied to non-linear analyses.

Many analyses involve an initial stage where rigid body modes exist in the assembly, which are eliminated when the parts come into contact, for example parts that are kept together by bolt pre-tensioning. This type of situations can be handled by performing the initial stage (until for example contacts are established) using implicit dynamics (LS-DYNA keyword *CONTROL_IMPLICIT_DYNAMICS, set *IMASS* = 1).

Sources of non-linearity in a static analysis may be

- non-linear material models (plasticity)
- contact,
- large deformations,
- non-linear constraints (such as joints),
- non-linear loading (such as follower forces, where the force direction is defined relative to the deformed geometry), or
- stress stiffening (guitar string effect).

In the Ansys LS-DYNA software, an implicit analysis is either fully nonlinear or fully linear. (From R15, the option to perform a linear analysis considering nonlinear contacts was added).

To synchronize the simulation time with the loading, create a curve which will serve as a list of key points: at each time specified in the curve, a converged step is obtained¹, see Figure 1. Input -1 * (ID of this curve) for the maximum time step in the template.

¹ If possible. It may also be the case that static equilibrium cannot be found, due to for example structural instability or overload.

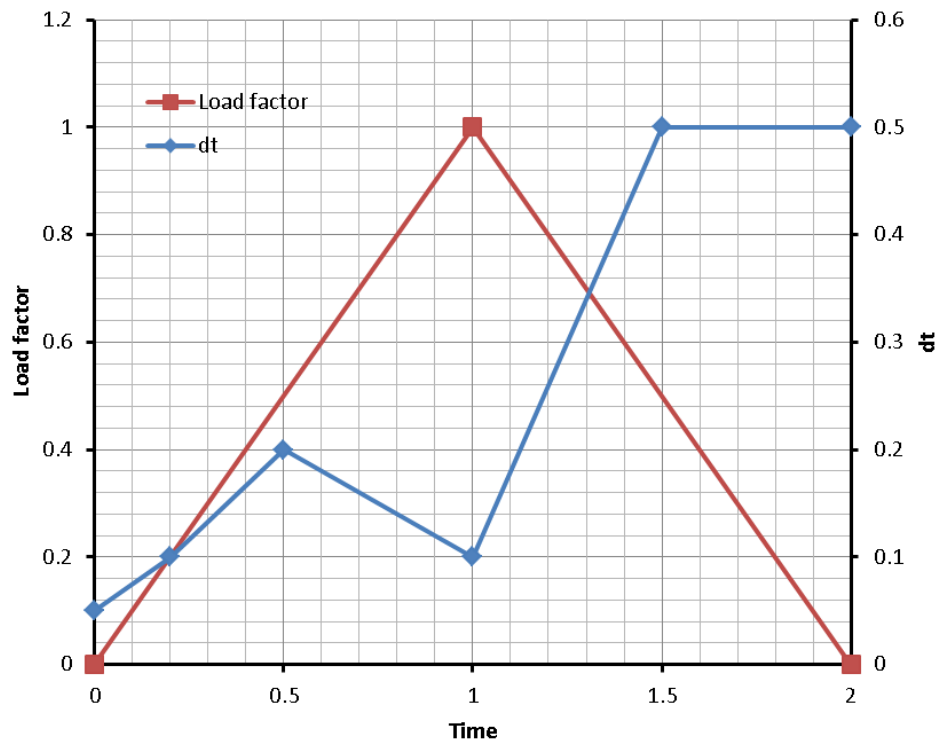


Figure 1. Illustration of the use of the time incrementation curve (blue) to synchronize the simulation with the applied loading (red curve). By specifying a value of (1.0, 0.2) for the time incrementation curve, a step at $t = 1.0$ (coincident with the maximum loading) is obtained.