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# rdbsp: An Open Source Rock Dynamic Behavior Simulation Program

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**Software**

- Review
- Repository
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## Summary

Rock dynamics has become one of the most important topics in the fields of rock mechanics and rock engineering. The spectrum of rock dynamic behavior broadly includes phenomena of rockbursting, spalling, popping, collapse, toppling, sliding, and so on, which are induced by the stress redistribution and energy release after excavation (Aydan, 2017). The current version of `rdbsp` aims to simulate the processes of displacement field redistribution and stress wave propagation in deep underground rock using a finite element method (Wang, Zhang, Li, Ma, & Fan, 2015). A Forward Euler time integration scheme is adapted in this program to simulate the dynamic procedure (Ascher, Chin, & Reich, 1994). The elastic constitutive model and Mohr-Coulomb plastic model are implemented in this version (Ottosen & Ristinmaa, 2005).

To speed up the simulation as well as to overcome the over-stiff effect of fully integrated elements during a dynamic simulation (Zienkiewicz, Taylor, & Zhu, 2013), a three-dimensional solid element type with a single integration point is implemented. Zero energy modes, so-called hourglass effects, could happen for the single point integrated element; the hourglass resistance is applied to eliminate that effect (Flanagan & Belytschko, 1981). The Jaumann derivative is added into the program and considers the effect of the rigid body rotation; this addresses the difficulty of the large deformation calculation for the deep rock mass (Valanis, 1990). For dynamic analysis, Rayleigh damping and artificial viscosity are also available to control damping. With local nonviscous damping, `rdbsp` could also obtain the static results of a rock mass excavation (Cundall, 1987). The convergence of the system to a steady state is controlled by the ratio of total unbalanced force and nodal mass. The finite element model can be generated by the Hypermesh via the template of DYNA3D with minor changes. The results of simulation can be exported for use in Paraview (Kitware, 2019) and Tecplot (Tecplot, 2019).

`rdbsp` is a fully functional simulation program with modules of input interpretation, memory management, and node/element index remapping. Figure 1 shows the workflow of `rdbsp`. The input file of a sample test of quarter symmetrical circle tunnel excavation is included with the source files.

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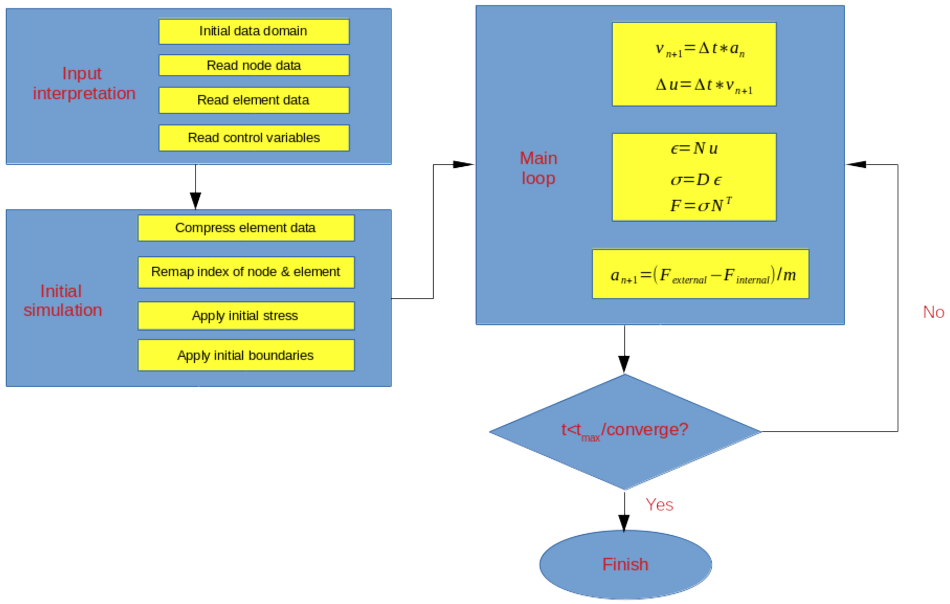


**Figure 1:** Working flow of rdbsp.

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