



AD FALCON API Manual

Fixed Time Stepping in FALCON

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1 Fixed Time Stepping in FALCON

In addition to modern adaptive substepping, **FALCON** also supports a traditional **fixed time stepping** mode where each simulation step is subdivided into a predefined number of equally spaced substeps.

Fixed time stepping is simpler, easier to control, and appropriate for problems where the solution is expected to be smooth and predictable without needing aggressive error control.

1.1 Syntax

Fixed time stepping is configured inside % Step Definitions (per step). Use @@NumberSteps: together with @@StepTime: and keep automatic stepping disabled.

```
% Step Definitions
@@Step 1:
  @@StartStep: 0
  @@StepTime: 10.0
  @@NumberSteps: 100
  @@ModernAutoInc: No
%%%
```

1.2 Objectives of Fixed Time Stepping

- **Predictability:** Substeps are executed uniformly based on a fixed schedule.
- **Simplicity:** No step size adjustment or rollback mechanisms.
- **Control:** Useful for problems where stability and accuracy can be guaranteed manually.

Note: In highly nonlinear and coupled problems, a fixed time increment is often preferred because it avoids step-size oscillations and repeated rollbacks that can occur with adaptive schemes. Fixed increments provide repeatable integration points for constitutive updates and pore-pressure coupling, which can improve robustness when strong nonlinearity (e.g., plasticity, contact, saturation transitions) causes erratic error estimates.

1.3 Step Execution Logic

In fixed increment mode, each full step is divided into numberSteps substeps of equal duration.

The fixed substep size is computed as:

$$\Delta t = \left\lfloor \frac{\text{stepTime}}{\text{numberSteps}} \right\rfloor \quad (1)$$

At each substep:

1. Increment the simulation time by Δt .
2. Solve the system of equations using an iterative solver.
3. If convergence is achieved, move to the next substep.

