Supplement of
Delayed State Evolution in Rate-and-State Earthquake Nucleation: Amplification, Localization, and Scaling

S1 Master configuration and numerical classification

Table S1 reports the complete reference configuration used for Figs. 1–7. The table distinguishes adopted physical parameters, derived quantities, study variables, and reduced-order numerical closures.

Category	Parameter	Value	Classification	Basis / source
Formulation	Rupture mode	2-D in-plane (Mode II)	Study choice	Bizzarri et al. (2001)
Formulation	Model	1-D distributed reduced-order fault	Study implementation	Controlled constitutive test
Elastic medium	Density, ρ	2670 kg m^{-3}	Adopted	Wei and Chen (2026)
Elastic medium	Shear-wave speed, c_s	3464 m s^{-1}	Adopted	Wei and Chen (2026)
Elastic medium	P-wave speed, c_p	6000 m s^{-1}	Adopted	Wei and Chen (2026)
Elastic medium	Shear modulus, G	32 GPa	Derived	$\rho\, c_s^2$
Elastic medium	Poisson ratio, ν	0.25	Derived	c_p/c_s
Stress	Effective normal stress, σ_{eff}	10 MPa	Adopted	Master configuration
Friction	Reference coefficient, f_0	0.600	Adopted	Master configuration
Friction	Reference velocity, V_0	1×10^{-6} m s^{-1}	Adopted	Master configuration
Friction	a, velocity weakening	0.010	Adopted	Literature-range choice
Friction	b, velocity weakening	0.015	Adopted	Literature-range choice
Friction	a, velocity strengthening	0.015	Adopted	Literature-range choice
Friction	b, velocity strengthening	0.010	Adopted	Literature-range choice
Friction	Characteristic distance, D_c	0.010 m	Adopted	Wei and Chen (2026); Guatteri et al. (2001)
Initial state	Initial velocity, V_{init}	1×10^{-12} m s^{-1}	Adopted	Quasi-locked initial state
Initial state	Initial shear traction, τ_0	6 MPa	Adopted	Master configuration
Initial state	Stress ratio, τ_0/σ_{eff}	0.60	Derived	τ_0/σ_{eff}
Initial state	Initial θ	Frictionally consistent	Calculated	$\tau_f(V_{init},\theta_0)=\tau_0$
Nucleation	Trigger	Smooth localized stress perturbation	Adopted	Controlled nucleation
Nucleation	Perturbation radius, R_{nuc}	1 km	Adopted	Master configuration
Nucleation	Perturbation width, L_{nuc}	2 km	Derived	$2R_{nuc}$
Nucleation	Maximum stress increment	2 MPa	Adopted	Pilot calibration
Geometry	Fault length, L_f	40 km	Adopted	Master configuration
Geometry	Velocity-weakening length, L_{VW}	24 km	Adopted	Master configuration
Geometry	Strengthening margins	8 km + 8 km	Derived	$(L_f-L_{VW})/2$
Geometry	Transition width, W_{tr}	0.5 km	Adopted	Master configuration

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Category	Parameter	Value	Classification	Basis / source
Numerics	Grid points, N	2048	Adopted	Master discretization
Numerics	Grid spacing, Δx	19.53125 m	Derived	L_f/N
Numerics	Time step, Δt	2.5×10^{-4} s	Refined	Refined from 1×10^{-3} s pilot
Numerics	Simulation duration, T_{max}	12 s	Adopted	Analysis window
Closure	Effective thickness, H	$\Delta x = 19.53125$ m	Numerical closure	Distributed model
Closure	Radiation damping, η	$\rho\, c_s/2$	Derived closure	Standard radiation damping
Memory	Response time, t_c	0–0.12 s	Study variable	Eight tested values
Memory	Memory strength, Π_d	$t_c\, V_{max}/D_c$	Derived diagnostic	This study

The original pilot time step was 1×10^{-3} s. All reported figures and metrics use the refined value 2.5×10^{-4} s. H and η are numerical closure quantities rather than independently measured fault properties.

S2 Diagnostic definitions

The moderate-velocity footprint is the total grid length for which $\max_t V \geq 10^{-3}$ m s^{-1}. The high-velocity core is defined analogously at 10^{-2} m s^{-1}. A local velocity-threshold crossing is not equated with distributed propagation. Distributed propagation would require the 10^{-2} m s^{-1} region to exceed the 2 km prescribed nucleation width.

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