
Convergence

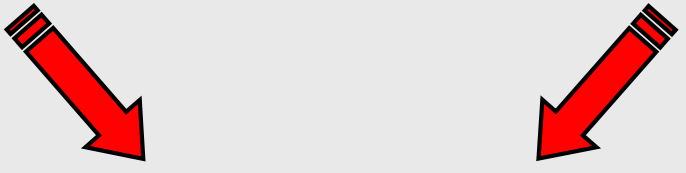
# CONVERGENCE

## CONSISTENCY REQUIREMENTS

- As the size of the elements ( i. e. the *discretization* ) tends to zero, the approximated equations will represent the exact differential equations to be solved and the boundary conditions

## STABILITY CONDITIONS

- The solution of the dicrete equation system is unique
- Avoid spurious mechanisms which may pollute the solutions for all sizes of elements



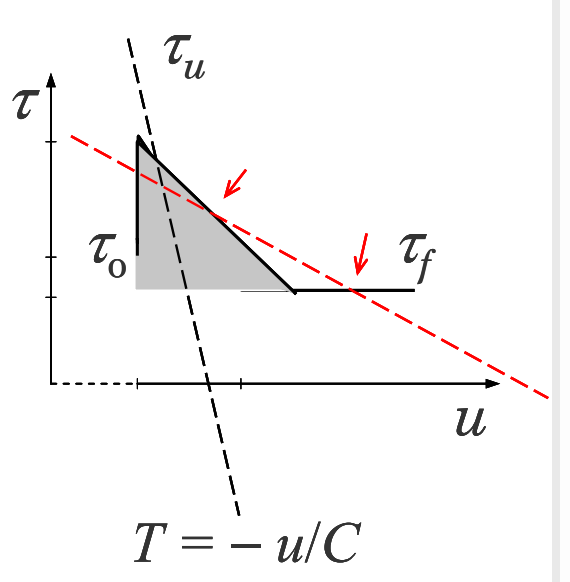
***CONVERGENCE***

- **How good** the approximation is;
- How can it **systematically improved** to approach the *exact* solution of the problem.

# Convergence conditions for BIE with SW constitutive law

**Uniqueness of the solution in the integration of linear system ( *Andrews*, 1985; B2001 )**

$$dx < -\frac{v_P\,\mu}{\beta\,\frac{dS}{du}} \quad \Leftrightarrow \quad \frac{L_c^{(II)}}{dx} > \frac{2}{\pi}\frac{a-1}{\sqrt{a}}(1+S)^2; a^2 = \alpha/\beta$$



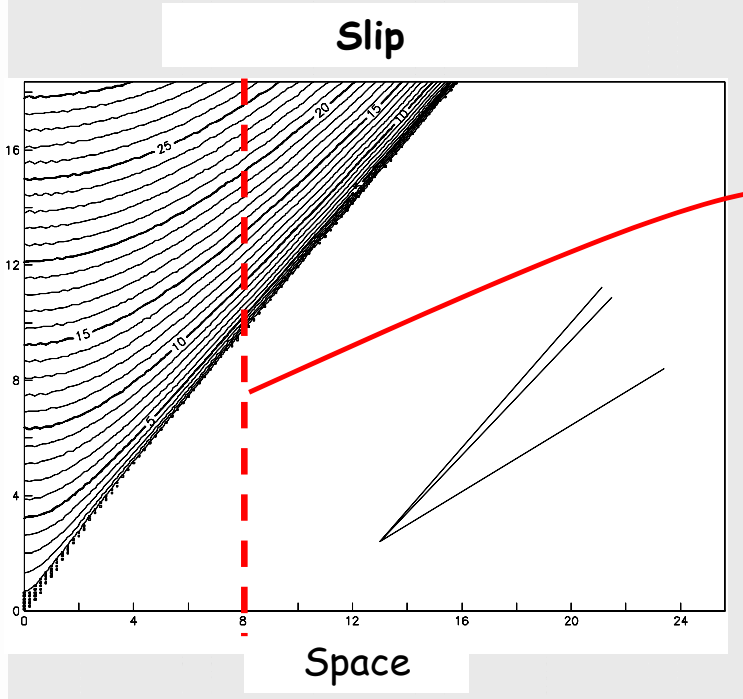

**Resolution of the cohesive zone**

$$\Delta t << T_b \qquad \text{or} \qquad \Delta x << X_b$$

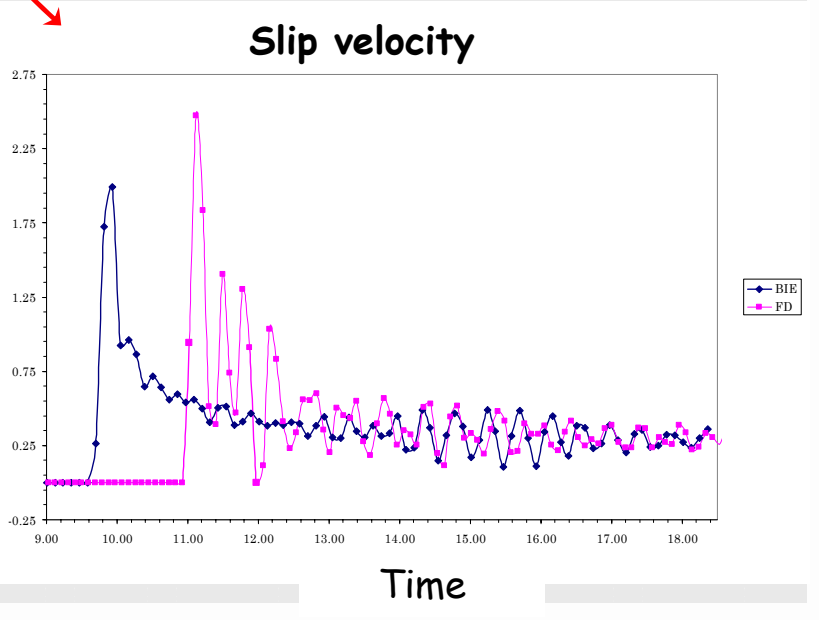
**First neighbours decoupling**

$$\Delta t << \Delta x \;/\; v_P$$

# Convergence – Example #1: No resolution of the cohesive zone




**BIE and FD 2 – D simulations with the classical slip – weakening law.**



# Convergence conditions for FD with RS constitutive law

**Continuum approximation ( *Rice*, 1993 )**

$k_{diag} >> k_{cr}$ $\quad \Delta t << \Delta t^* \quad$ or $\quad \Delta x << \Delta x^*$

$$\Delta t^* = \frac{v_S \rho L}{(b-a)\sigma_n^{eff}} \quad \text{or, alternatively,} \quad \Delta x^* = \frac{v_S^2 \rho L}{w_{CFL}(b-a)\sigma_n^{eff}}$$

**Resolution of the cohesive zone**

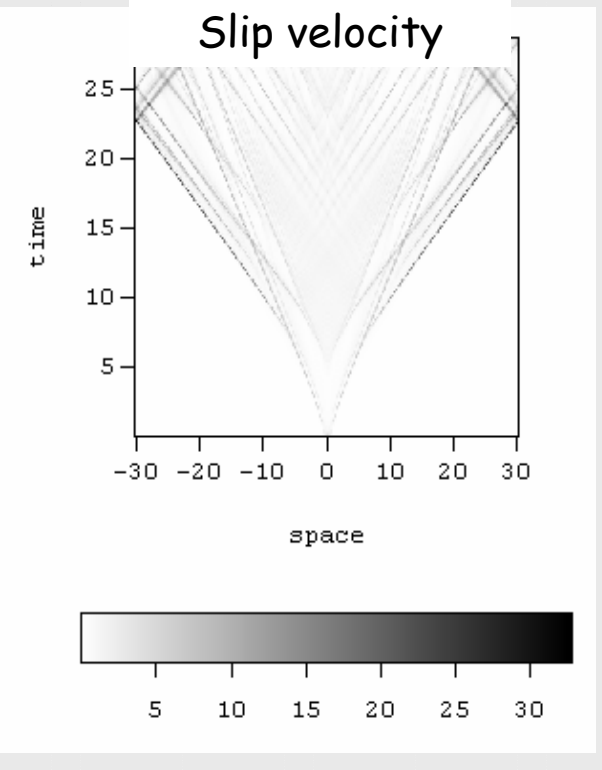
$\Delta t << T_b^{eq} \quad$ or $\quad \Delta x << X_b^{eq}$

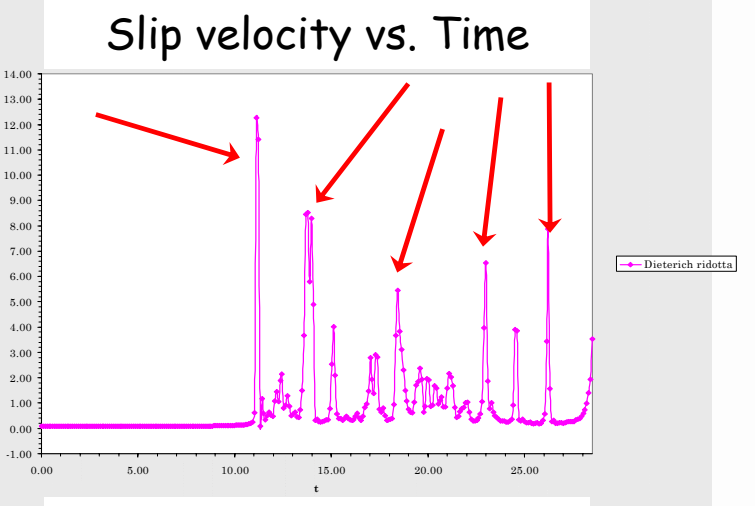
**First neighbours decoupling**

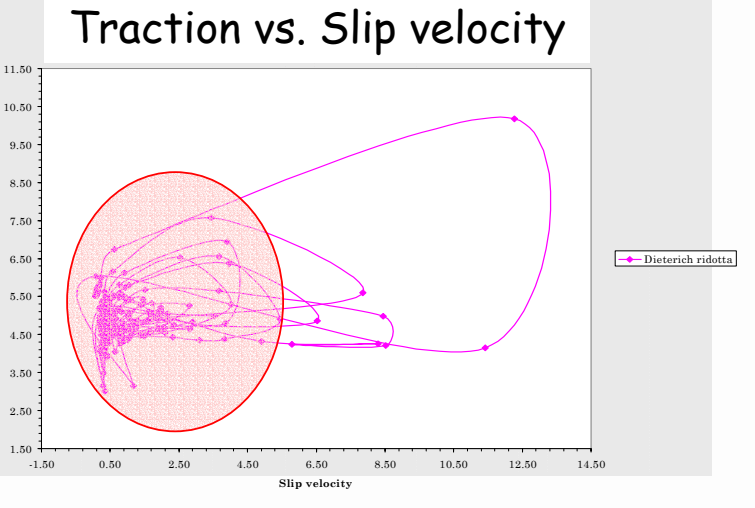
$\Delta t << \Delta x \ / \ v_P$

# Convergence – Example #2: Continuum approximation violation

**FD 2 – D simulations with Dieterich in reduced form friction law.**



This slide is empty intentionally.