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Supplement of

Micromechanical modeling of snow failure

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1 Weak layer thickness homothetic transformation scaling study

Applying homothetic transformation to the system allows to scale it while keeping it's mechanical behavior. The equation to characterize macroscopic properties can be written as:

$$E_{wl\,macro} = (\beta_0 + \beta_1 E_{particle}) / (\frac{h_{wl\,ref}}{h_{wl}})$$

$$\sigma^{th}_{wl\,macro} = (\gamma_0 + \gamma_1 \sigma^{th}_{bond}) / (\frac{h_{wl\,ref}}{h_{wl}})$$

Where $h_{wl\,ref} = 3cm$ and h_{wl} correspond to the new weak layer thickness.

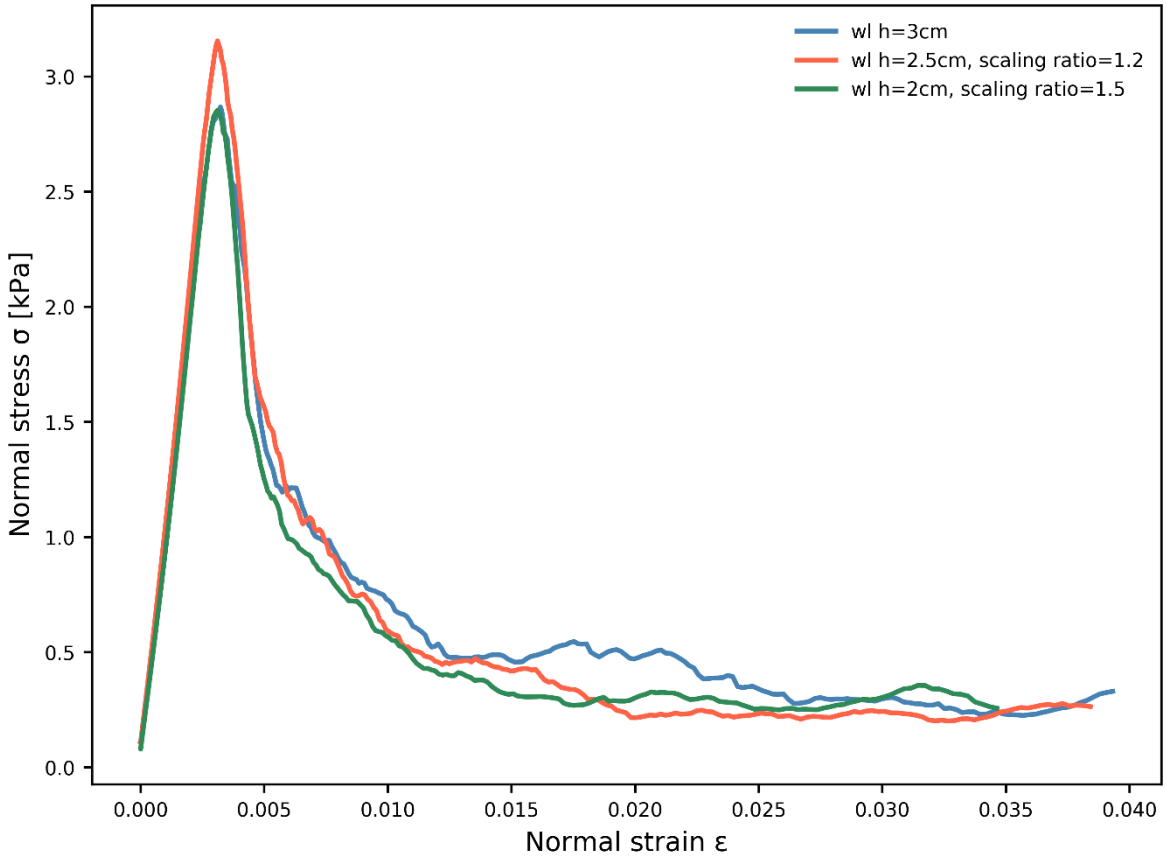

Figure a: Stress-strain curves for weak layers of different thickness (colors) under load-controlled compression. The blue line shows the reference weak layer with a thickness of 3 cm.

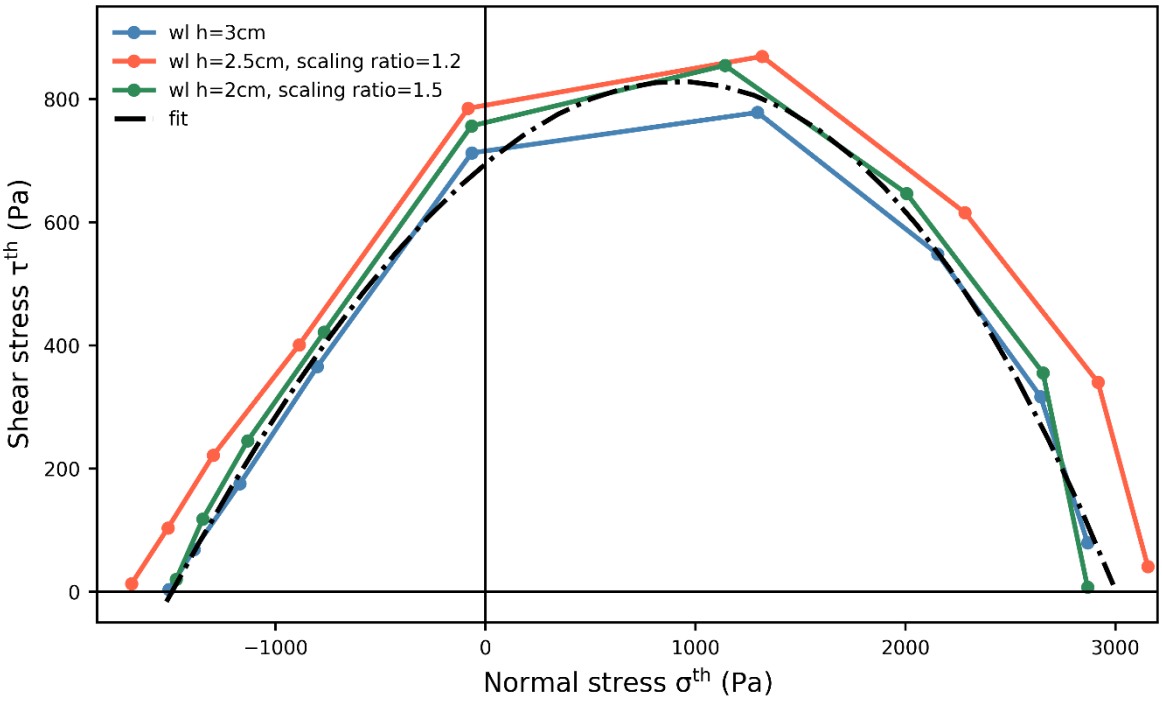

Figure b: Failure envelopes for weak layers with different thicknesses (colors) and fits based on equation (9).

2 Confined vs unconfined load-controlled compression test.

Unconfined and confined loading conditions yield the same results for weak layer behavior. This finding is due to the large porosity (80%) of the weak layer (Figure c: Weak layer behavior under load-controlled compression ($\boldsymbol{E_{particle} = 1\ MPa}$ and $\boldsymbol{\sigma_{bond}^{th} = 5\ kPa}$). The blue line shows the normal stress during confined test and the orange line during unconfined test conditions.).

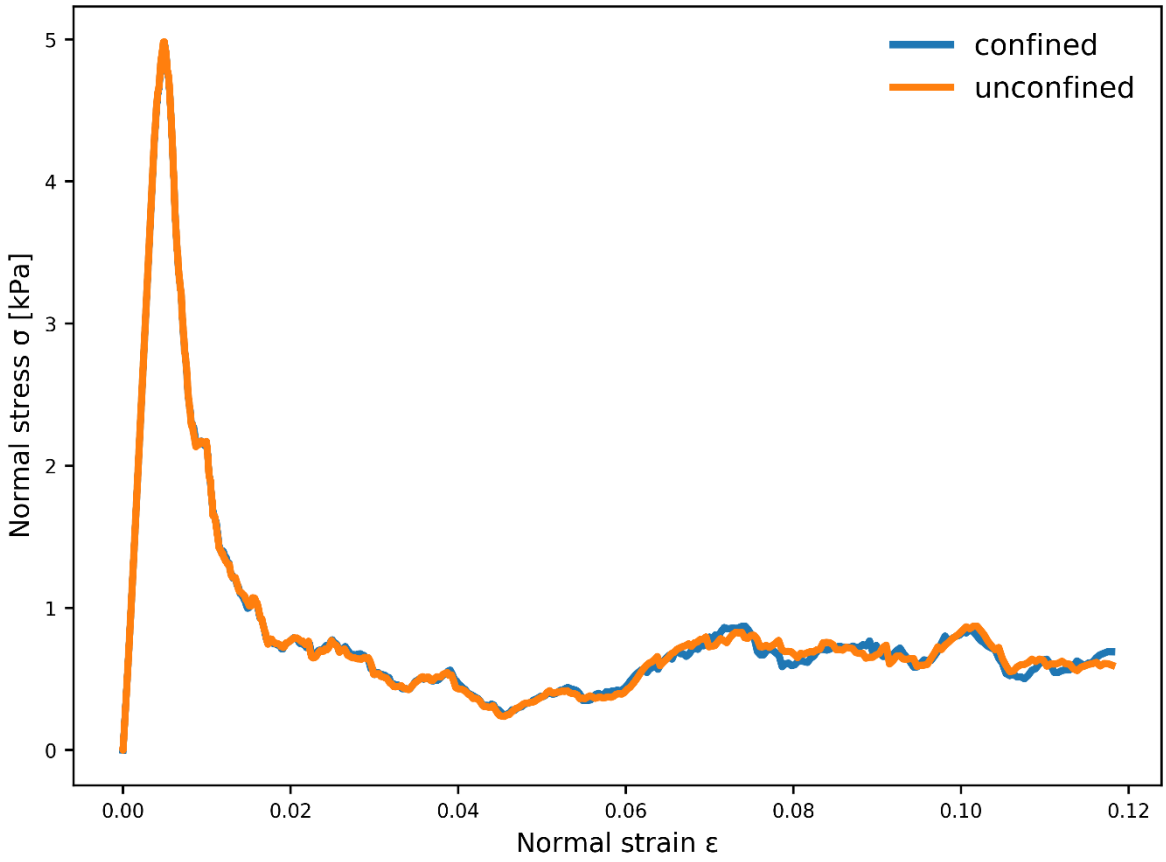

Figure c: Weak layer behavior under load-controlled compression ($E_{particle} = 1\ MPa$ and $\sigma_{bond}^{th} = 5\ kPa$). The blue line shows the normal stress during confined test and the orange line during unconfined test conditions.