

Influence of Intra-particle saturation ratio for strength degradation of Pumice Soil

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Landslides in the 2018 Hokkaido Earthquake

The 2018 Hokkaido Eastern Iburi earthquake (M 6.7) triggered more than 3,000 landslides near the Atsuma Town of Hokkaido. The earthquake occurred a day after typhoon Jebi, however, it didn't bring considerable rain to the affected area.

Continuous rainfall had been occurring in the affected areas for three weeks prior to the earthquake. The pumice soils on the slopes may become saturated from prolonged exposure to rain. In this study, the direct shear test (DST) is used to examine the link between soaking duration and the degradation in shear strength characteristics.



Fig 1 – Landslide in Atsuma Town

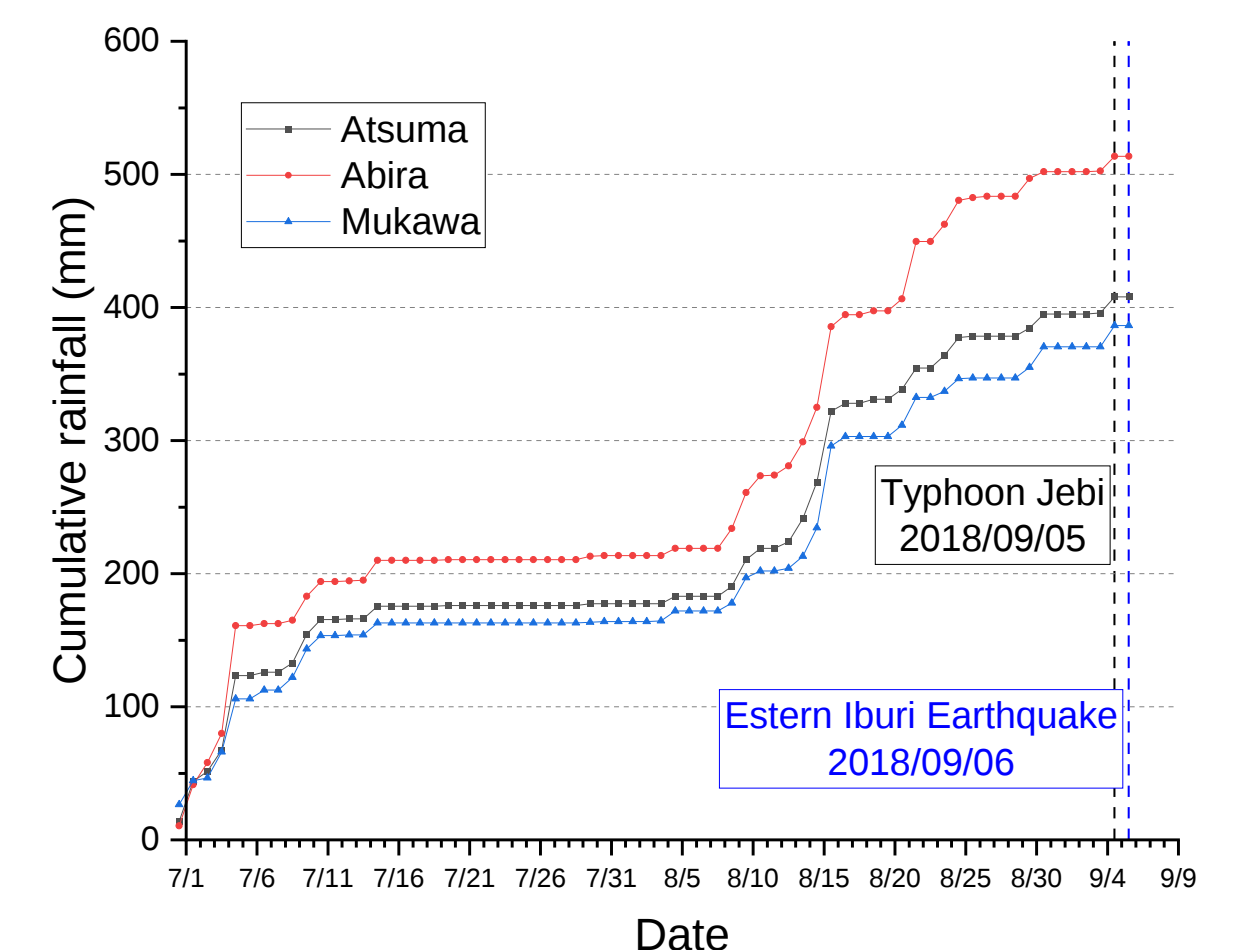


Fig 2 – Rainfall records of AMeDAS stations from July – September 2018

Testing Method

- A series of constant-volume cyclic loading DST for different soaking times were carried out for reconstitute samples to investigate the changes of shear strength properties with soaking time for the Ta-d pumice soil collected at the landslide site.
- Selected soil particles of Ta-d with a mean diameter D_{50} of 4.75 mm were subjected to crushing test under different soaking conditions to investigate the variation of single particle fragmentation strength (σ_f) with soaking time.
- A parameter "intra-particle saturation ratio, ISR" is used to refer to the saturation of pores within soil particles. A series of particle soaking tests were carried out for several particle sizes, 6.7 mm, 4.75 mm, and 2.8 mm, in order to determine the ISR with soaking time.

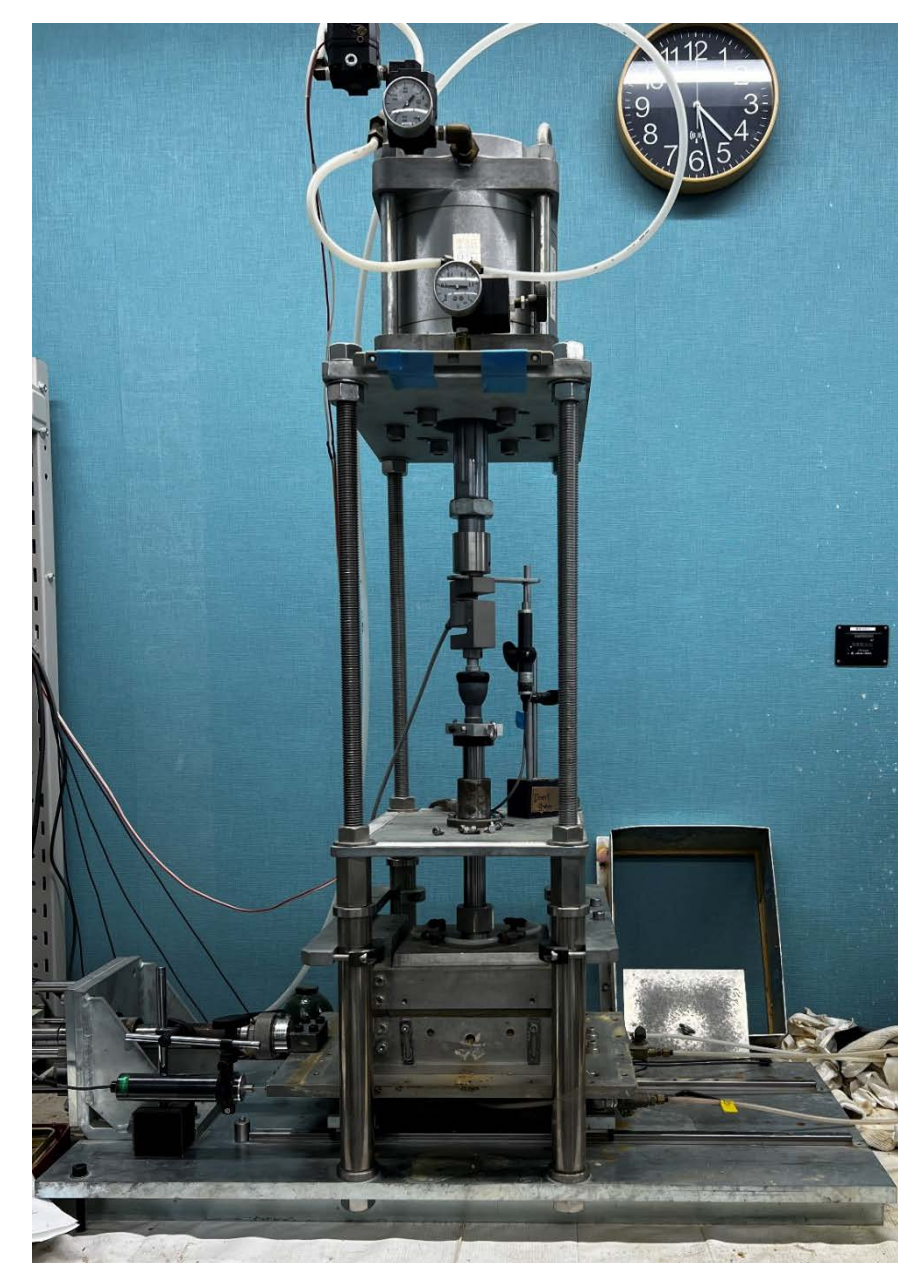


Fig 3 – Modified Direct shear apparatus



Fig 4 – Single particle crushing apparatus

Results and discussion

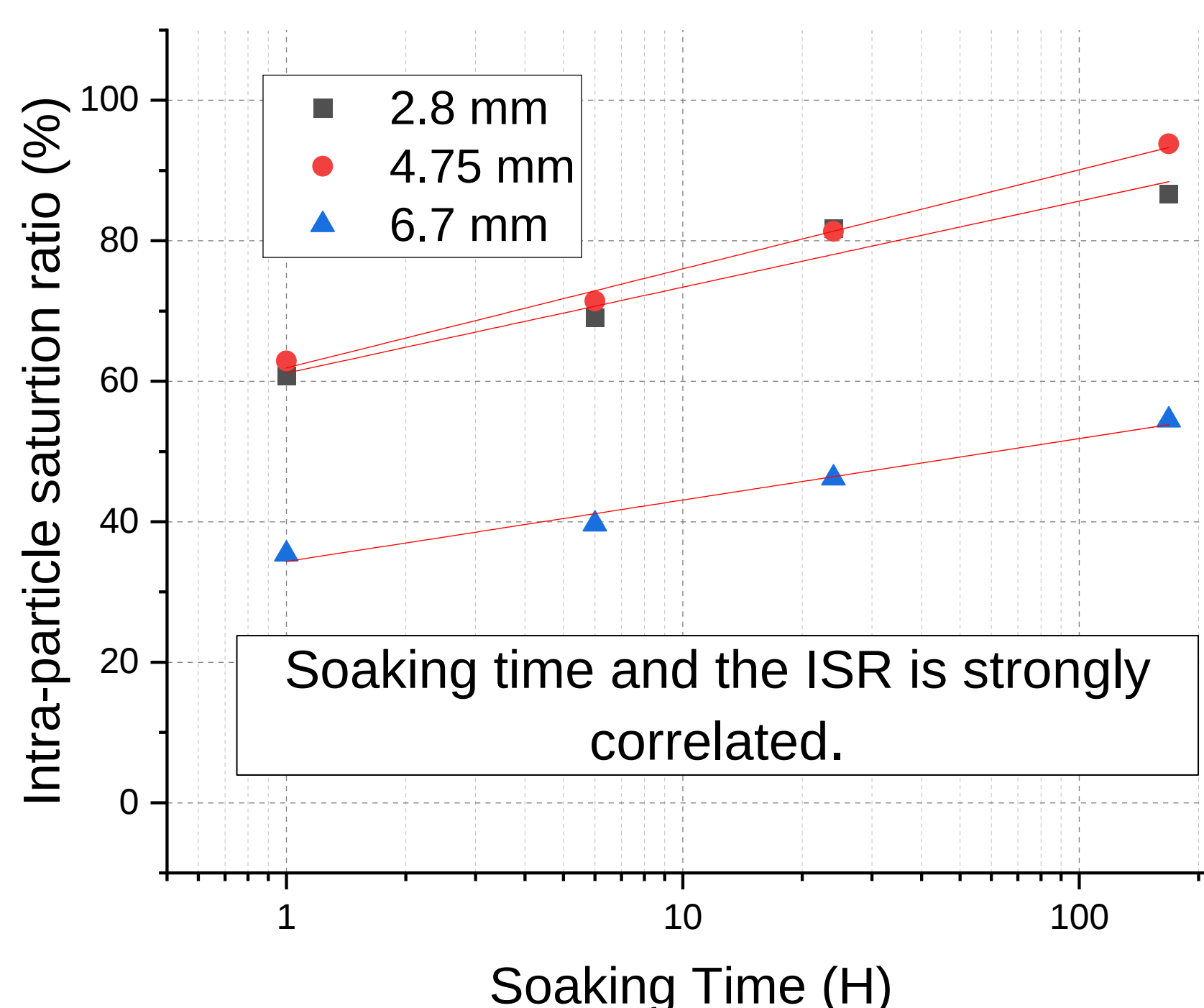


Fig. 5 – Change of Intra-particle saturation ratio of different particles sizes with log value of time (H)

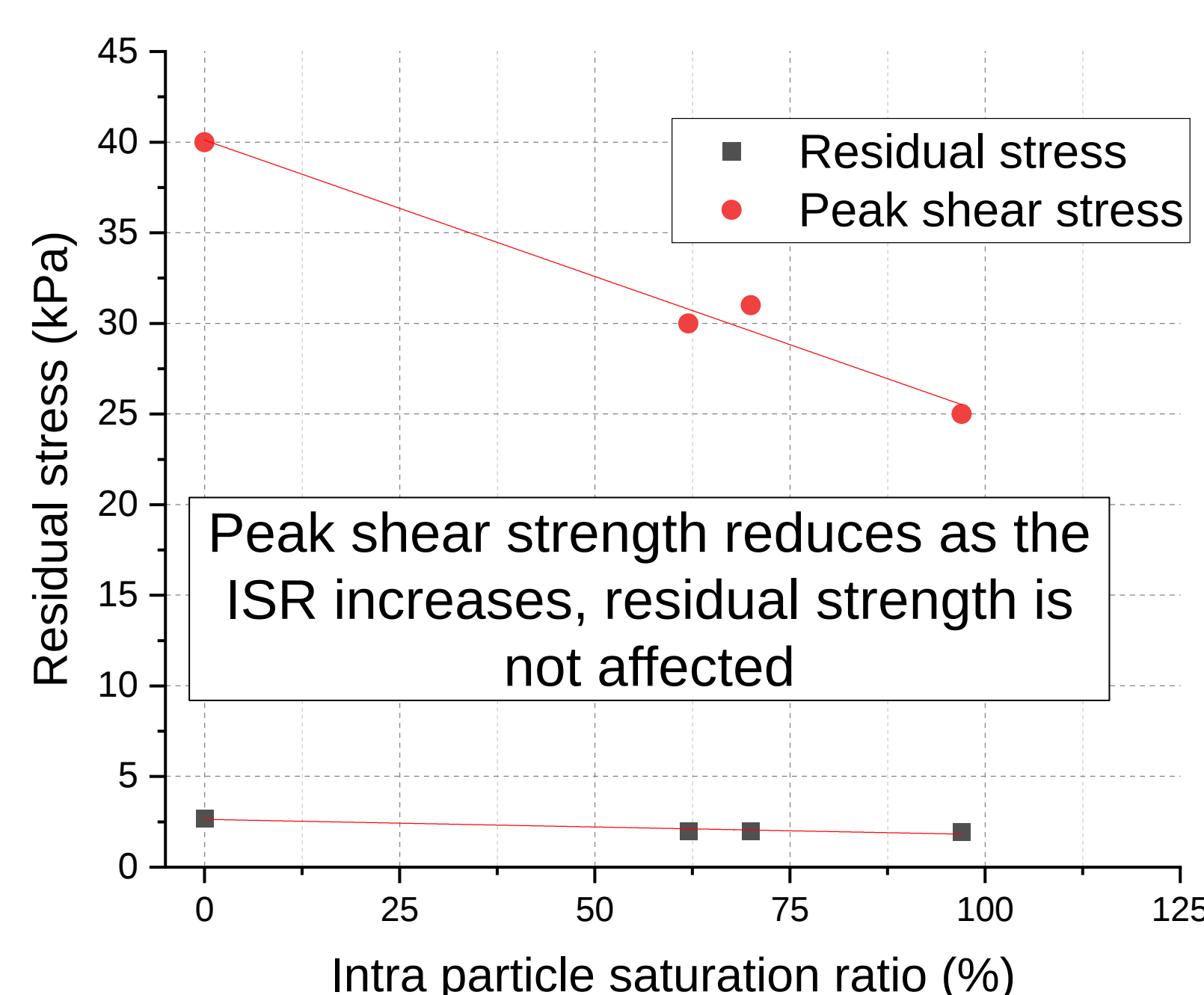


Fig. 6 – Relationship between peak shear stress and residual stress with intra-particle saturation ratio

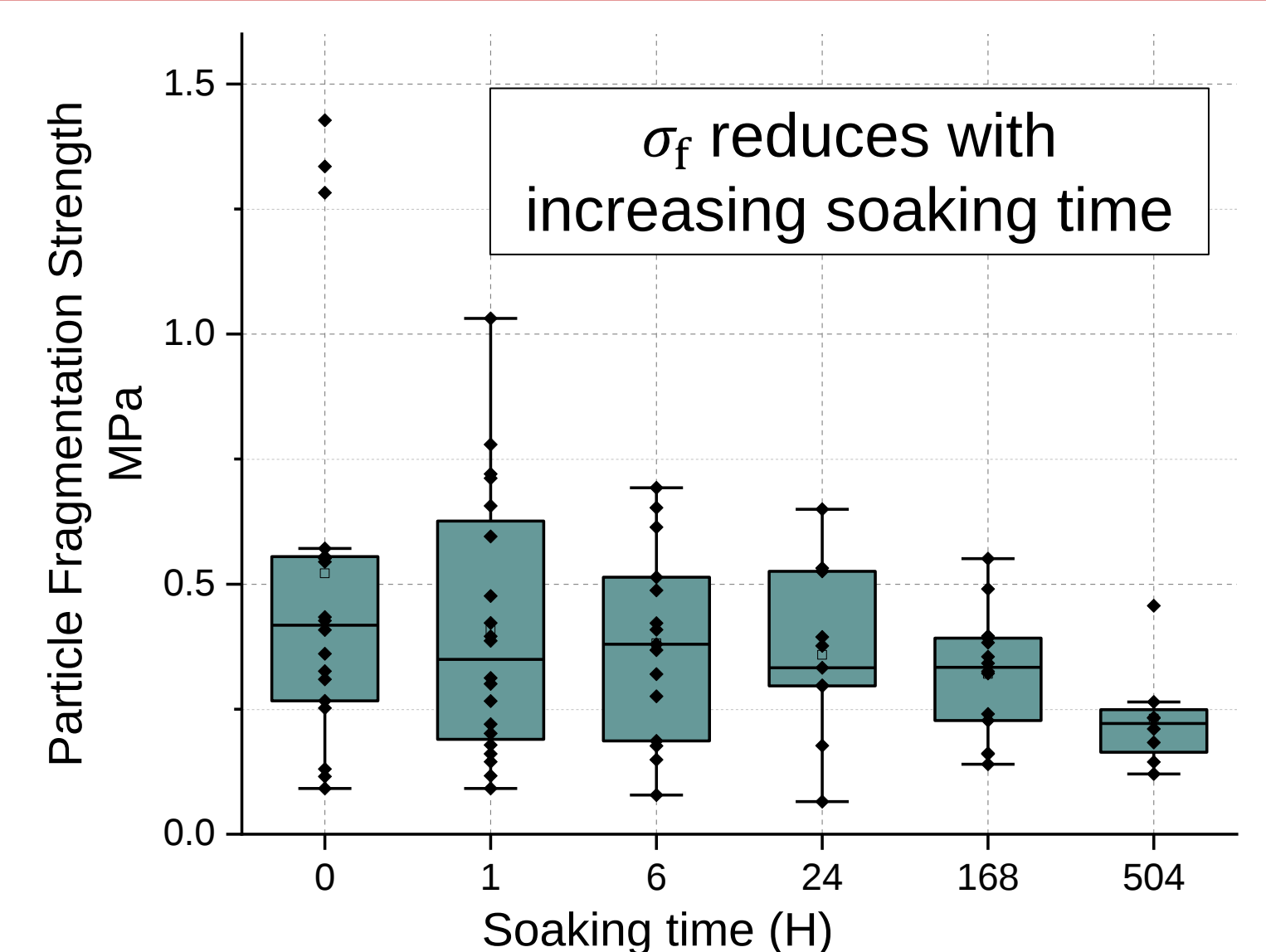


Fig. 7 – Variation of particle fragmentation strength with soaking time

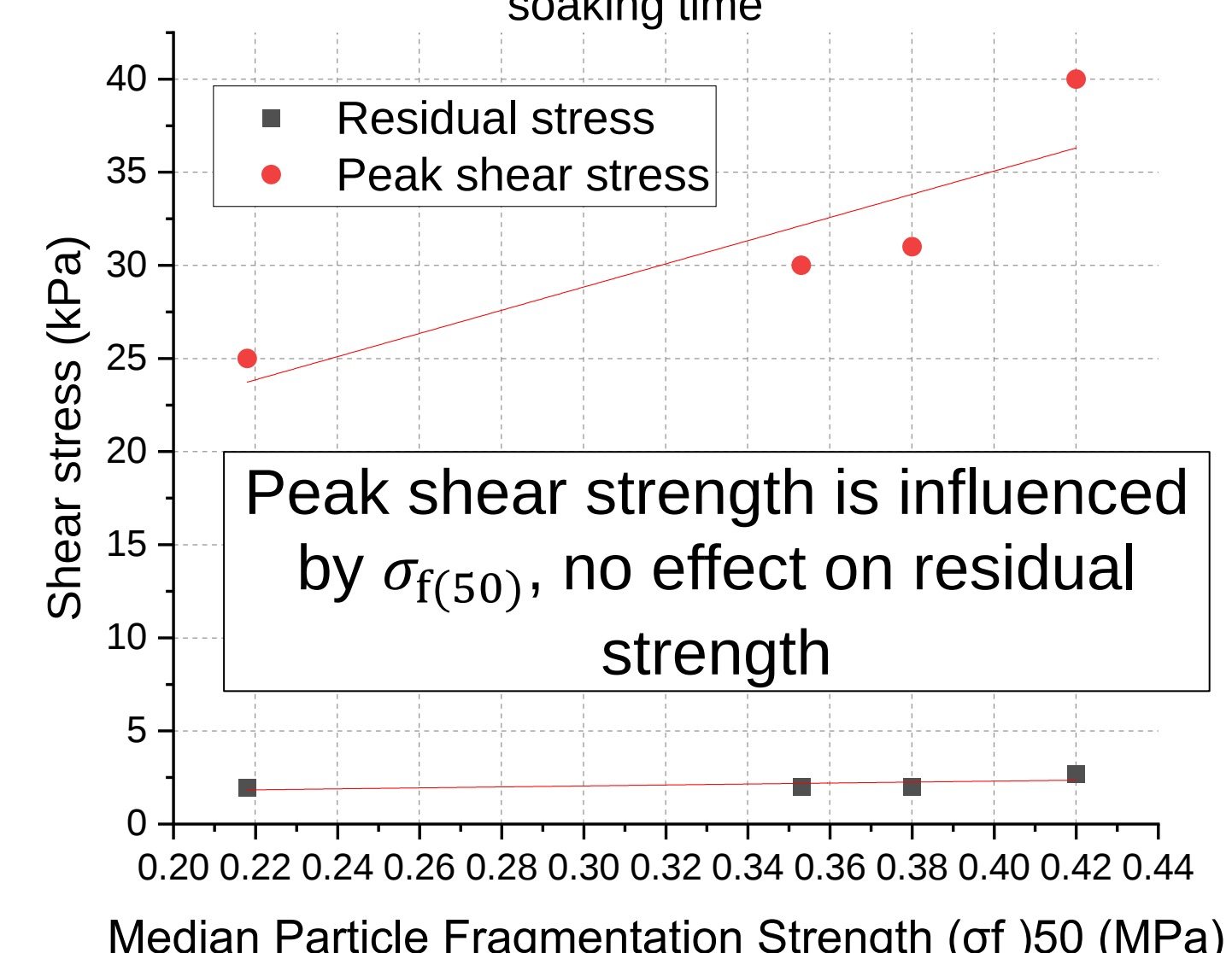


Fig. 8 – Relationship between peak shear stress and residual stress with median particle fragmentation strength

- Exposure to rain has reduced the peak shear strength of Ta-d soil over time, which has also become a key factor to the occurrence of earthquake-induced landslides in Atsuma, Hokkaido.
- Rainfall has little effect on residual strength, which is one of the key factors governing landslide flow distance.