“On the use of a split Hopkinson pressure bar in structural geology: High strain rate of the Seeberger sandstone and Carrara marble under uniaxial compression”

A presentation by Richard Butts

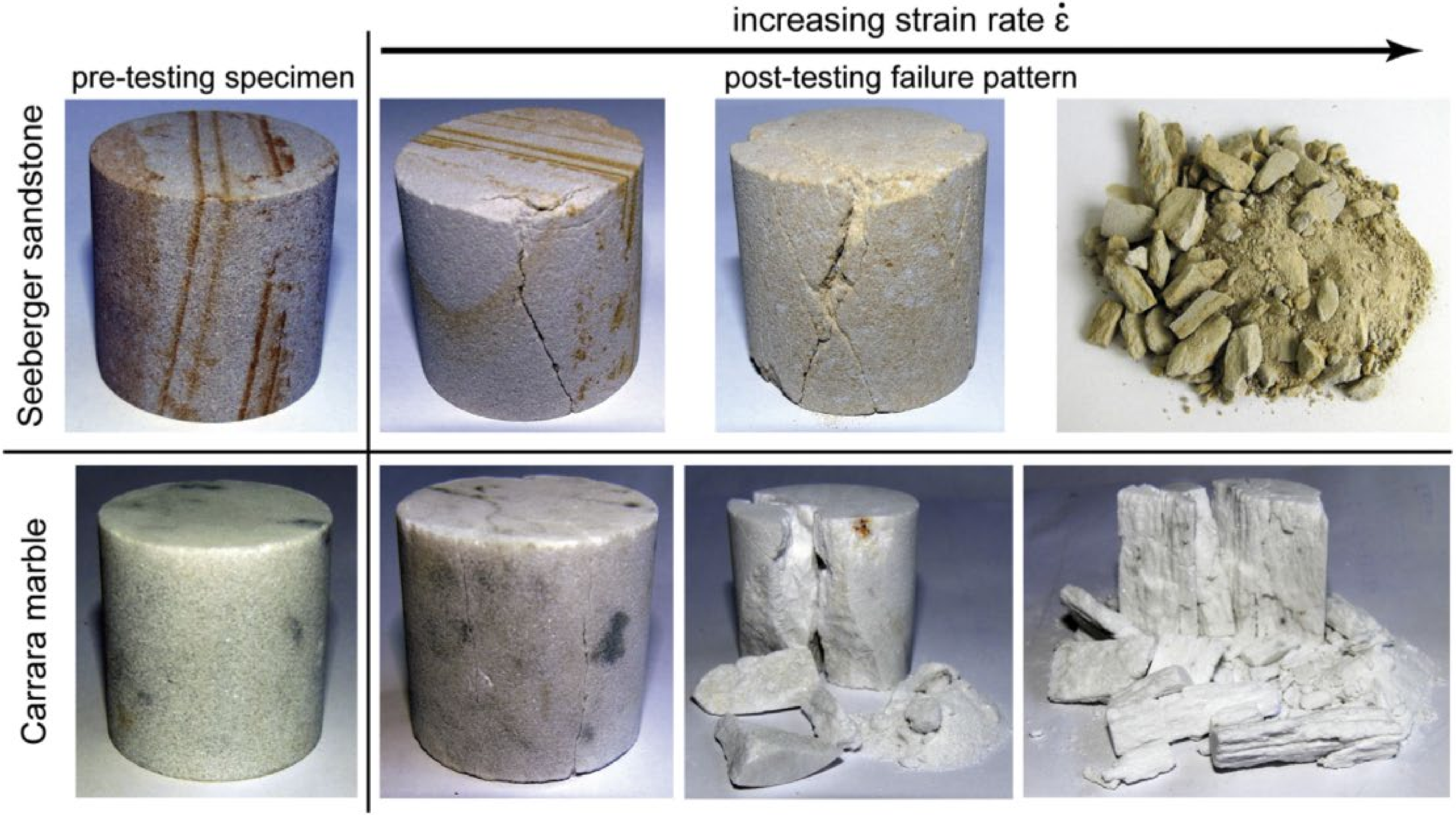
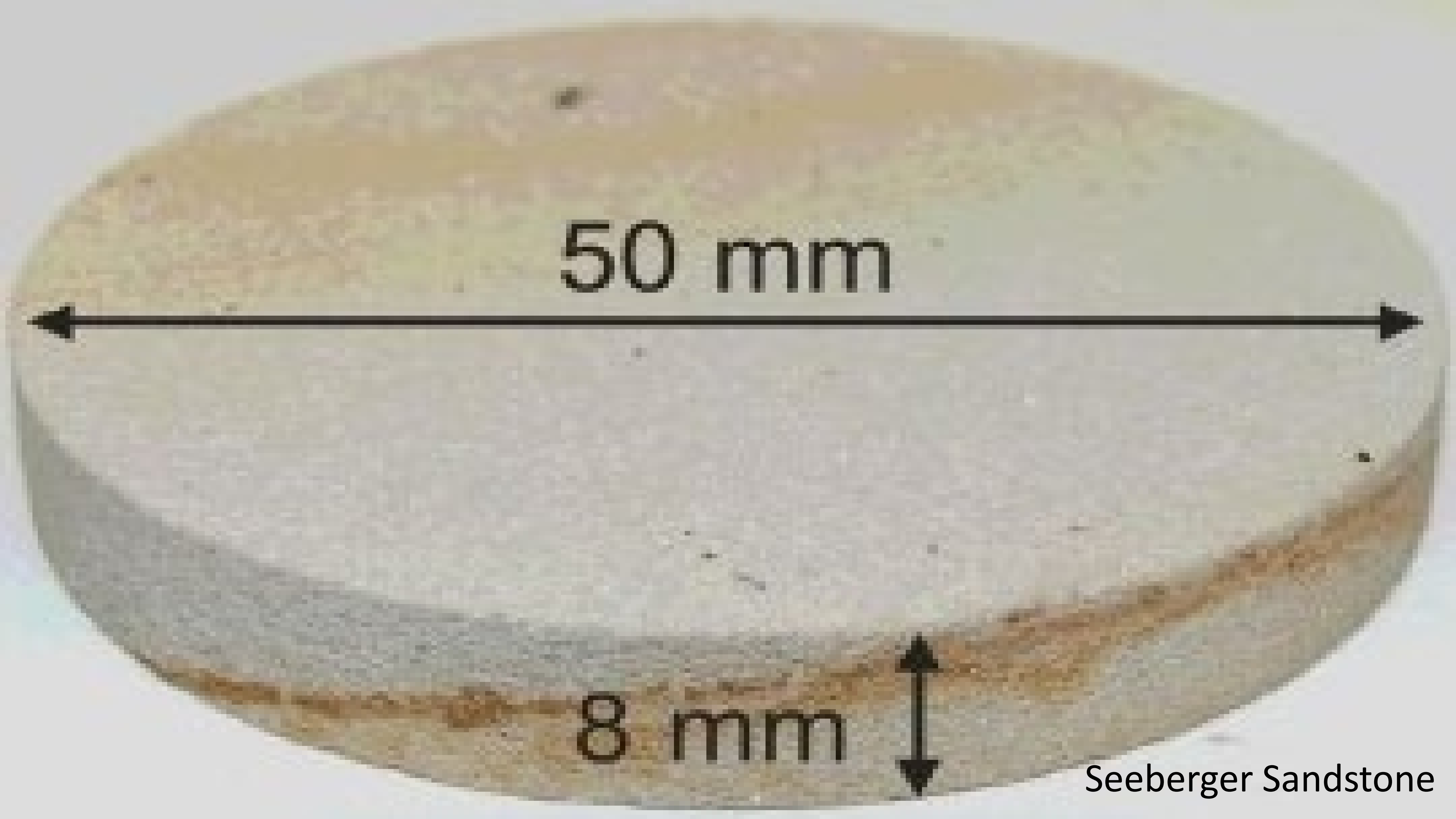


Fig. 1. Samples of Seeberger sandstone and Carrara marble before and after testing for different strain rates. The observed fracture mechanism changes with strain rate from single- to multiple fracturing. Sample dimensions are 4 cm in length and diameter.

Carrara Marble



Seeberger Sandstone

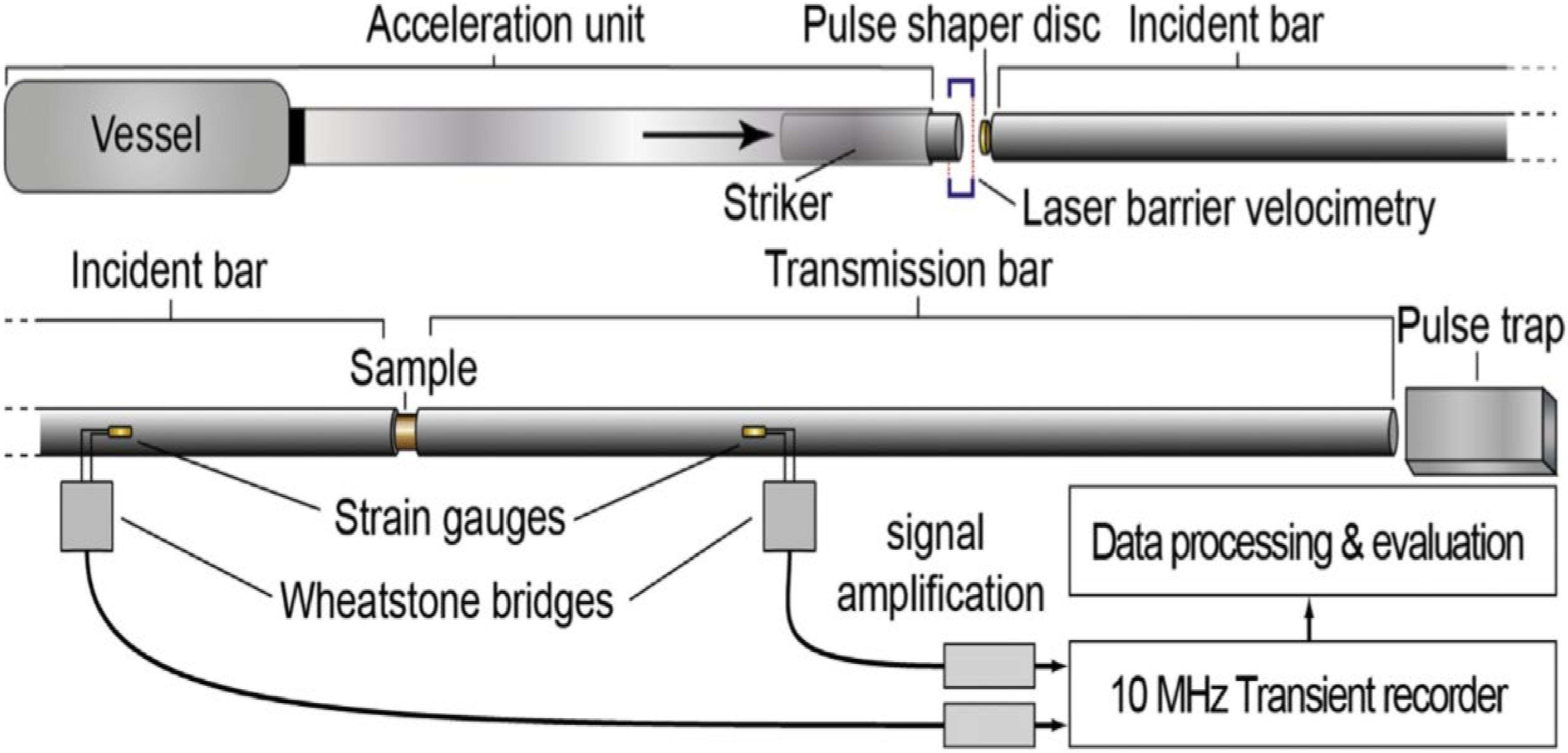


Fig. 2. Schematic illustration of the split Hopkinson pressure bar setup.

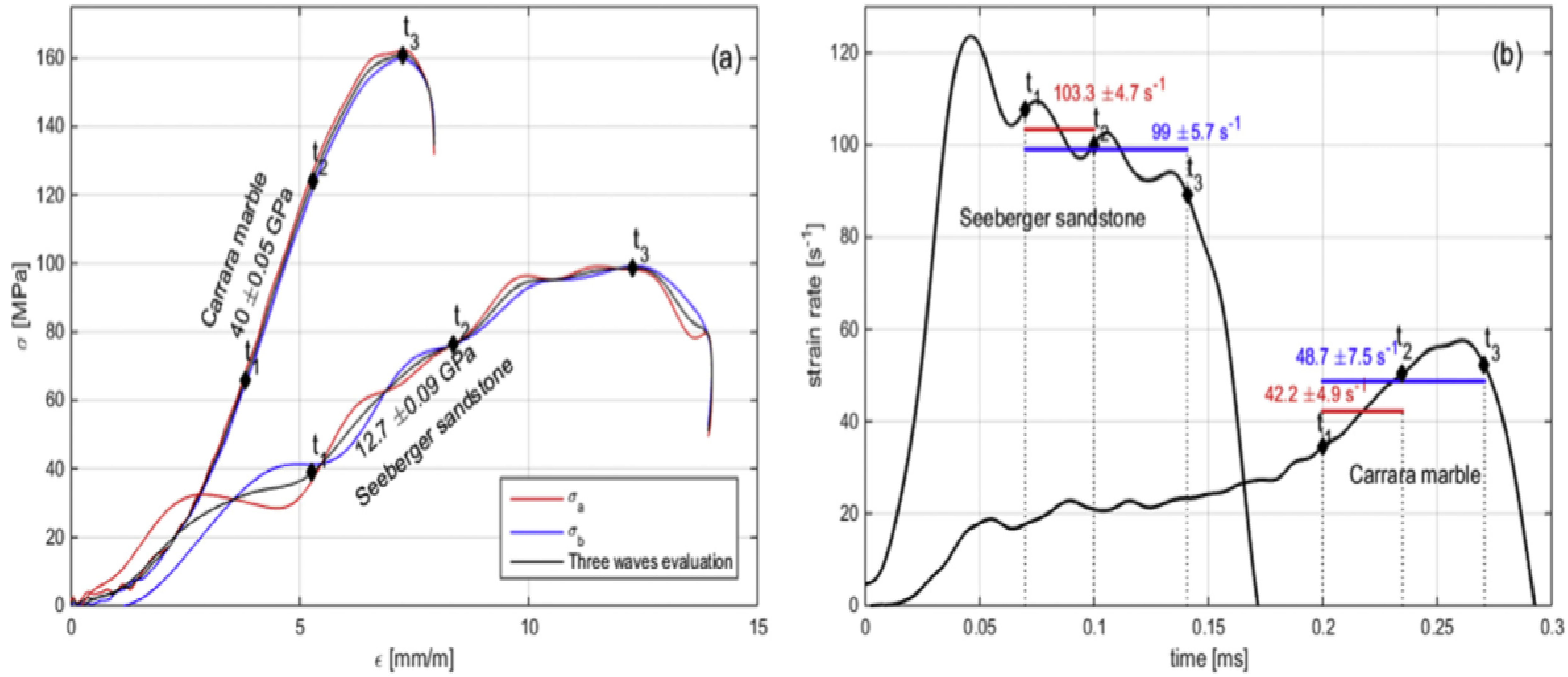


Fig. 5. (a) Axial stress-strain response curves are used to determine the time span of linear elastic response from t_1 to t_2 with associated tangent modulus, which is about 40 GPa for the marble and 12.7 GPa for the sandstone. A second, extended time span from t_1 to the point of failure t_3 is also defined to calculate the representative deformation rate during uniaxial compression. (b) Mean values and standard deviations of representative strain rates are determined from the strain rate histories. Strikers and pulse shaping techniques were used to deform the samples to low maximum strains only, avoiding additional strain after sample failure. Therefore, high strain rate-inducing pulses are characterized by much shorter durations in the strain rate history.

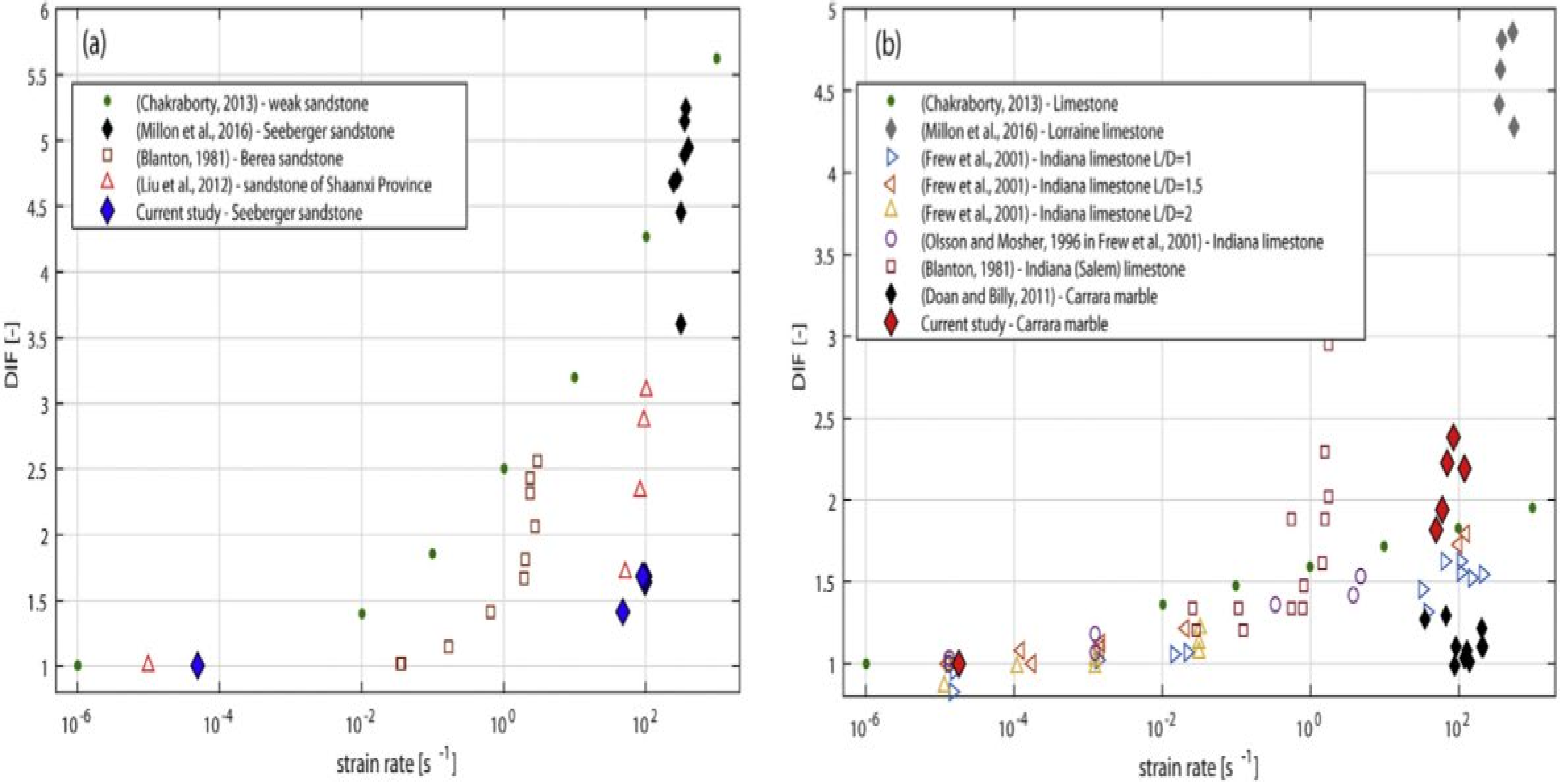


Fig. 10. Comparison of current study results and literature data for different sandstones (a) and carbonate rocks (b). Frew et al. (2001) conducted experiments on samples of various length to diameter ratios (L/D) to investigate the effects of sample size.

Table 3
Summary of textural, compositional and experimental information given in literature data.

source	type/name/location	grain size [mm]	Porosity [%]	static compressive strength [MPa]	sample length; diameter [mm]	comments
Chakraborty (2013)	sandstone	–	–	–	12.7; 12.7	numerical simulation of weak sandstone behavior
Millon et al. (2016)	Seeberger sandstone	Ø 0.1	25	42.3 ± 2.4	[a]50; 60 [b]20; 75	–
Blanton (1981)	Berea sandstone	medium	19.1 ± 0.5	46 ± 4	50; 16.5	average strain rate given as representative rate
Liu et al. (2012)	Sandstone from Shaanxi Province	–	–	61.40	43; 97	high calcite content
Chakraborty (2013)	Limestone	–	–	–	12.7; 12.7	numerical simulation
Millon et al. (2016)	Limestone mined in Lorraine	–	31	9.8 ± 1.5	[a]50; 60 [b]20; 75	–
Frew et al. (2001)	Indiana limestone	0.15–1.0	15	–	12.7–25.4; 12.7	90% calcite, < 10% quartz
Frew et al. (2001)	Indiana limestone	0.15–1.0	15	–	50.8; 25.4	90% calcite, <10% quartz
Blanton (1981)	Indiana (Salem) Limestone	medium	12.5 ± 0.6	44 ± 9	50; 16.5	bioclastic
Doan and Billi (2011)	Carrara marble	0.2–0.4	–	about 100	27.65–28.75; 25.58–25.97	maximum strain rate given as representative rate

[a] Low-medium strain rates (20–83.3 s^{-1}).
[b] High strain rates (>275 s^{-1}).

Berea Sandstone

Sandstone of Shaanxi Province


Lorraine Limestone


Indiana Limestone

The Carrara Marble and Seeberger Sandstone have impurities. The sandstone is a sedimentary quartzite with fused quartz grains.

Marble has bigger grains. Limestone in general responds well to pressure due to deformation banding of cementation. Twinned calcite and bigger grains indicate metamorphism.

The sandstone shatters. It would most likely be stronger if it was cemented with limestone. Throughout the test the marble maintains the cylindrical core shape.

Works Cited

Zweissler R., Kenkmann T., Poelchau M. H., Siegfried N., Hess S., (2016). On the use of a split Hopkinson pressure bar in structural geology: High strain rate of the Seeberger sandstone and Carrara marble under uniaxial compression http://faculty.uml.edu/nelson_eby/89.520/Professional%20Papers/High%20Strain%20Rate%20Deformation.pdf

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