Ring-shear test data of rock analogue materials from Chengdu University of Technology (EPOS Transnational Access Call 2017)

(http://doi.org/10.5880/GFZ.4.1.2018.---)

Citation

Deng , B. Rosenau, M., Schönebeck, J. (2018): Ring-shear test data of rock analogue materials from Chengdu University of Technology (EPOS Transnational Access Call 2018). GFZ Data Services, http://doi.org/10.5880/GFZ.4.1.2016.008

The data are supplementary material to:

Jiang, Z., Deng, B., Fan, C., He, Y., Lai, D., Liu, S., Wang, X., Jansa, L.: To what degree the geometry and kinematics of accretionary wedges in analogue experiments is dependent on material properties. Solid Earth Discussions, https://doi.org/10.5194/se-2018-45

Data Description

This dataset provides friction data from ring-shear test (RST) on natural and artificial granular materials used for analogue modelling in Jiang et al. (2018) and in the experimental lab of Chengdu University of Technology (CDUT, China). Six samples, 4 quartz sands and 2 glass beads, have been characterized by means of friction coefficients and cohesion. The material samples have been analysed at GFZ Potsdam in the framework of the EPOS (European Plate Observing System) Transnational Access (TNA) call of the Thematic Core Service (TCS) Multi-scale Laboratories (MSL) in 2017 as a remote service for CDUT.

A first application of the materials tested as well as further details of the materials, measuring techniques as well as interpretation and discussion of results can be found in Jiang et al. (2018) to which this dataset is supplement material.

1. Measurement procedure:

The data presented here are derived by ring shear testing using a SCHULZE RST-01.pc (Schulze, 1994, 2003, 2008) at the laboratory for tectonic modelling of the Helmholtz Centre Potsdam (GFZ Potsdam, HelTec). The RST is specially designed to measure friction coefficients and cohesion in loose granular material accurately at low confining pressures and shear velocities similar to sandbox experiments. In this tester, a sand layer is sheared internally at constant normal load and velocity while the shear stress and volume change is measured continuously. For more details see Klinkmüller et al. (2016) and Ritter et al. (2018).

Each sample has been carefully prepared by the same person and measured consistently following the same protocol. The measurements presented here correspond to internal friction, i.e. shearing inside the material.

Preparation included sieving (sieves specified in table 1) from 30 cm height into a shear cell of type No. 1. Measurements have been done at normal loads (normal stress) of 500, 1000, 2000, 4000, 8000, and 16.000 Pa. A shear velocity of 30 mm/min was imposed. Normal and shear load, velocity and lid displacement (volume change) were measured at 100 Hz and then down sampled to 5 Hz.

During the measurement the material is sheared for 3 minutes until a plateau is reached indicating shear has localized into a shear zone. The sample is unloaded by reversing rotation and immediately re-sheared for 3 minutes simulating reactivation of an existing shear zone.

Laboratory conditions were air conditioned during all the measurements (Temperature: 23°C, Humidity: 45%).

GFZ-ID	CDUT-ID	Material	Sieve	File name
373-01	DB2017-X1_40-60_0.3-0.45mm	Qtz-sand	Fast/coarse	373-01_CDUT-X1
374-01	DB2017-X2_40-60_0.2-0.3mm	Qtz-sand	250 ml/min (Geomod)	374-01_CDUT-X2
377-01	DB2017-L1_40-60_0.3-0.45mm	Qtz-sand	Fast/coarse	377-01_CDUT-L1
378-01	DB2017-L2_60-80_0.2-0.3mm	Qtz-sand	250 ml/min (Geomod)	378-01_CDUT-L2
379-01	DB2017-B1_40-60_0.3-0.45mm	Glassbeads	250 ml/min (Geomod)	379-01_CDUT-B1
380-01	DB2017-B2_60-80_0.2-0.3mm	Glassbeads	250 ml/min (Geomod)	380-01_CDUT-B2

Table 1: Sample overview

2. Analysis method

From the resulting shear stress curves (see e.g. Figure 1) three characteristic values (strengths) have been picked manually:

(1) The shear strength at ***peak friction*** corresponding to the first peak in the shear curve reflecting hardening-weakening during strain localization
(2) the shear strength at ***dynamic friction*** corresponding to the plateau after localization and representing friction during sliding
(3) the shear strength at ***reactivation friction*** corresponding to the second peak corresponding static friction during reactivation of the shear zone.

Matlab-based regression analysis of these friction data by means of calculating all possible two point slopes (friction coefficient) and intercepts (cohesion) for mutually combined data pairs of shear strength and normal load. These data (i.e. friction coefficients and cohesions) are then evaluated by means of univariate statistics by means of calculating mean and standard deviation and comparing the probability density function (pdf) to that of a normal distribution (see e.g. Figure 2).

Two Matlab scripts “RSTshow.m” and “RSTanalysis.m” is provided along with this data set allowing analyzing and visualizing the data.

3. File description:

For each material sample there exists

(i) shear curve data (txt format, example Table 2)
(ii) shear curve plot (pdf format, example Figure 1)
(iii) friction data (txt format, example Table 3)
(iv) friction plots (pdf format, example Figure 2).

An overview of all files of the data set is given in the **List fo Files.**

3.1 Shear curve data are given as (i) time series (ts) data in ascii format (“File name_ts.asc”) and visualized as (ii) shear stress versus displacement plots (“Filename_sc.pdf”). A matlab script “RSTshow.m” is provided to reproduce the plots from the data.

% time (s)	normal load (Pa): 500	1000	2000	…
0.0000	-0.046	-0.025	0.138	
0.0002				
…				

Table 2: Example of shear curve time series data. *First line is header. First column is time in seconds (5 Hz). Columns 2-19 are shear stress (in Pa) for corresponding normal loads as specified in the header of the respective columns (6 load levels from 500 to 16.000 Pa, three repetitions each load level).*

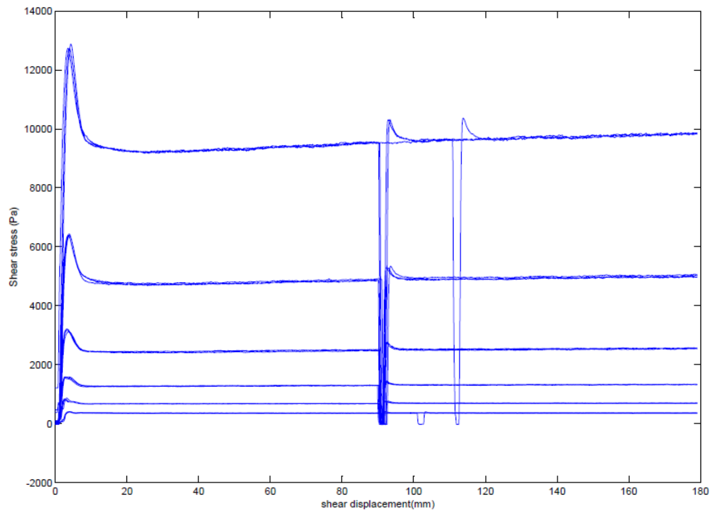

Figure 1: Example of shear curve plot. *Y-axis is shear stress, x-axis is displacement. Each data set consist of 18 shear curves corresponding to 6 levels of normal load with 3 repetitions each load level.*

3.2 Friction data are given as (iii) data pairs (shear strength and normal load) for peak, dynamic and reactivation friction in txt format (“File name_peak.txt, File name_dynamic.txt, File name_reactivation.txt”). They are visualized by (iv) plotting into Mohr Space (normal load vs. shear strength) and histograms for friction coefficients and cohesion (“File name_peak.pdf, File name_dynamic.pdf, File name_reactivation.pdf”).

%normal load [Pa]	shear strength [Pa]
500	413.10
1000	830.39
…	

Table 3: Example of friction data. *First line is header. First column is normal load. Second column is shear strength. 19 rows in total.*

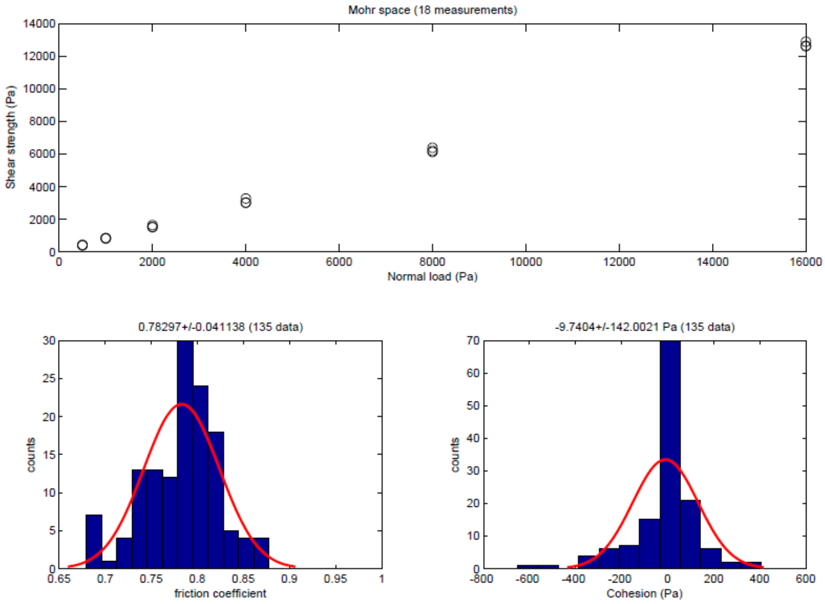

Figure 2: Example of friction plot. *Upper panel = Plot of all data pairs in the Mohr space (normal load vs. shear strength), lower panel = histograms of mutual two-point regression results for slope (friction coefficient) and y-axis intercept (cohesion). Red curve is a synthetic normal distribution with the same mean and standard deviation as the data set for comparison.*

Cited reference:

Schulze, D. (1994), Entwicklung und Anwendung eines neuartigen Ringschergerätes. Aufbereitungstechnik 35 (10), 524-535.

Schulze, D. (2003) Time- and velocity-dependent properties of powders effecting slip-stick oscillations, Chemical Engineering & Technology, 26, 1047-1051.

Schulze, D. (2008): Powders and Bulk Solids - Behavior, Characterization, Storage and Flow, Springer Berlin Heidelberg New York, ISBN 978-3-540-73767-4, 511 pp.

Klinkmüller, M., G. Schreurs, M. Rosenau, and H. Kemnitz (2016), Properties of granular analogue materials: A community wide survey, Tectonophysics, 666, doi.: 10.1016/j.tecto.2016.01.017.

Ritter, M., K. Leever, M. Rosenau, and O. Oncken (2016): Scaling the Sand Box - Mechanical (Dis-) Similarities of Granular Materials and Brittle Rock, J. Geophys. Res - Solid Earth, doi.: 10.1002/2016JB012915.

begin with description/ abstract from the DOI Landing Page

Content wish list – the further information may be different between the different data types, the list below can be regarded as "wish" list/ proposed content and is not meant to be mandatory for each data publicatoin:

The general aim is to describe the data sufficiently to allow others working with the data without requiring additional information from the author (you).

Whenever necessary, we are providing a standardised data description with the content above (mandatory) that is followed by the parts below. This data description will be made available via the DOI landing page (for direct download) and also included in the data (e.g. zip folder).

- **File inventory**: please provide a table with the file name, format and description of all files/folders → to allow people easily understand the files of the data publication. This may also be provided as in the example below
- **Tables**: please define the table contents, ideally via a table with the following columns: (1) abbreviation of the column heads; (2) unit or notation rule (e.g . for data dd-mm-yyyy or mm/dd/yyyy); (3) Description of the field
- **Figures/ Images/ Photos**: are welcome, if helpful for understanding a model setup or provide an example of the file content..
- **References**: in case there are citations in the description