Point Load Index Test for the Indication of the Directional Strength Behaviour of Soft Sedimentary Rocks

EUROCK 15
64th GEOMECHANICS COLLOQUIUM

Ronald Haselsteiner, Christoph Hartmann, Alexander Schmitt, Burkhard Reingen

Björnsen Consulting Engineers, Koblenz

Experimental Preparation /Rig

The point load index test is a simple test for estimation of rock parameters. A specimen of rock is fixed between two platen pointed and pressure is until break. The peak applied load is recorded and used to calculate the Point Load Index. The experiment can be used directly on site to determine the point load strength of drilling cores. A sketch of the test rig is shown in figure 1.

Figure 1. Picture of a point load test rig device (Avantech Engineering Consortium Pvt, 2015)

Point Load Index i_S [kN/m²]

The Point Load Index i_S is defined as the quotient of the breaking force F_B [kN] and the corresponding area of the specimen A [m²] (equation 1) (Thuro, 2010). The corresponding area is depending on the type of failure and is to be determined after the failure according to the failure/breaking mode.

$$i_S = \frac{F_B}{A} \qquad (1)$$

The uniaxial compressive strength UCS* (= σ^*_u) [kN/m²]

The dimensionless factor c describes the correlation between the Point Load Index and Uniform Compressive Strength in form of a linear curve (equation 2). The empirical correlation factor c is depending on geotechnical conditions (e.g. the rock type). Table 1 shows different values for the factor c.

$$UCS^* = \sigma^*_u = c \cdot i_S \qquad (2)$$

Table 1. Factor c values (Broch & Franklin 1972)

c = 24	strong rock types	Broch & Franklin (1972)
c = 10 – 20, or c < 10	soft/weak rock types	
c = 15,5	slate rock	Mark & Molinda (1996)
c = 17,4	sandstone	
c = 11,1	weak rock	Akram & Bakar (2007)

$i_{s(50)}$

The point load index is often related to a load point distance of 50 mm (equation 3).

$$i_{s(50)} = \left(\frac{A}{2500}\right)^{0,225} \cdot i_s \qquad (3)$$

Broch (1983) is reporting that the point load index is a reliable tool for investigating the directional strength behaviour of also soft to medium rocks. The strength reduction is strongest for load direction angles α = 30 - 60° referring to the foliation/stratification. Parallel to the foliation/stratification the obtained values are weaker (α = 90°).

Example: Rhine Slate

Two types of rocks were tested, siltstone and shale. For each rock type six classes of the load direction were defined in table 2.

Table 2. Classification according to the load angle (BCE 2014))

1:	α = 0° - 15°
2:	α = 15° - 30°
3:	α = 30° - 45°
4:	α = 45° - 60°
5:	α = 60° - 75°
6:	α = 75° - 90°

106 tests with different load angles were carried out of which only 94 results have shown a clear and comprehensible break behaviour. The specimen were one and a half years old, so the test could not reflect the in-site conditions (water content). The strongest value was measured at an angle of α = 0° and the weakest value was measured at an angle of α = 50° - 70° (Table 3).

Table 3. Test results of rock samples (siltstone and shale) of the Rhine slate. (BCE 2014)

Class	Angle	Number	Average	Min	Max
	α [°]	n [-]	$I_{S,50,m}$ [MPa]	$I_{S,50,min}$ [MPa]	$I_{S,50,max}$ [MPa]
1	0 - 15	19	2,339	1,099	5,648
2	16 - 30	19	1,552	0,049	4,127
3	31 - 45	17	0,716	0,019	2,232
4	46 - 60	4	0,44	0,065	0,985
5	61 - 75	10	0,333	0,004	1,833
6	76 - 90	25	0,674	0,004	2,101

The test results document a distinct load angle dependent point load index. Relative strong values were obtained perpendicular and parallel to the foliation/stratification, lowest values resulted at load angles of α = 30 – 60°. Corresponding to the roughness of the shear surface the weakest shear strength is not obtained for loads parallel to the foliation but parallel to the roughness pattern (see diagram 1 to 3) .

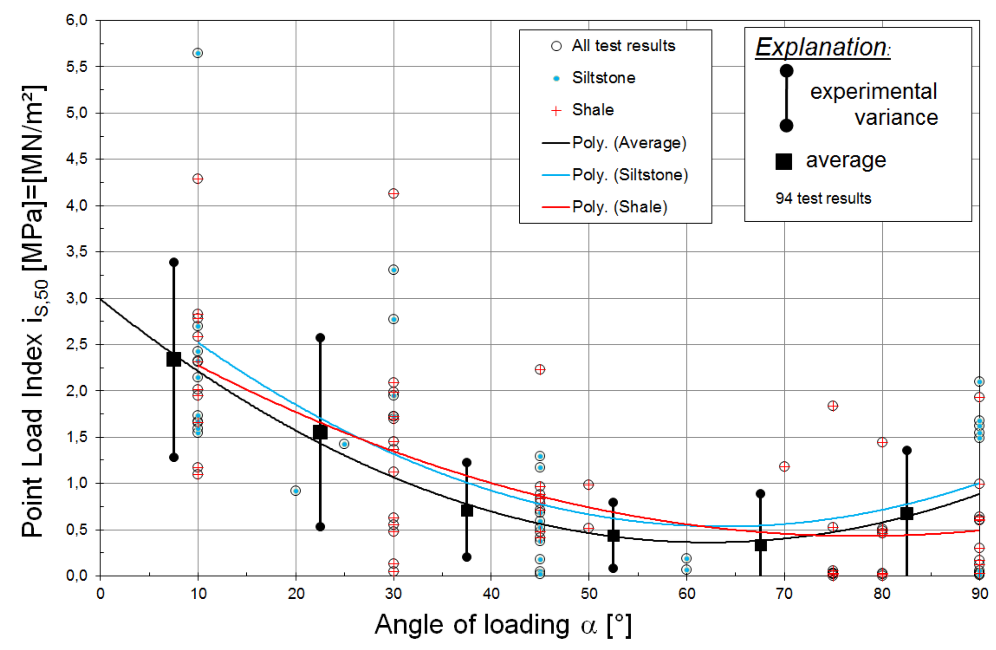

Diagram 1. Results of the point load tests with different angle of load evaluated for siltstone and shale and both (BCE 2014)

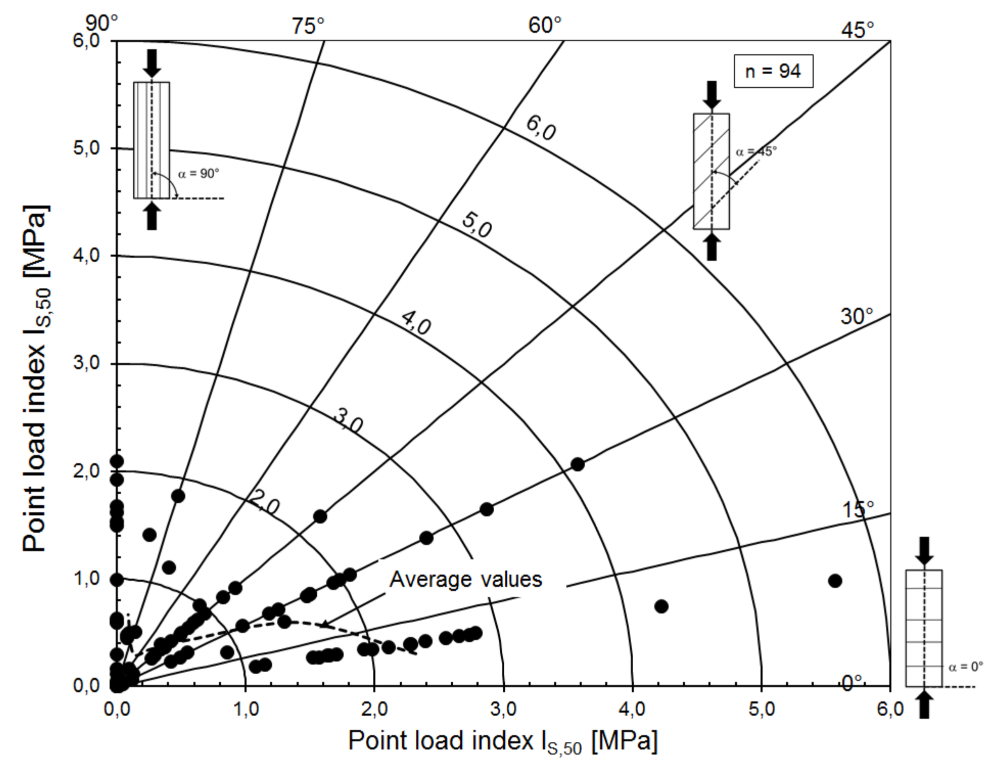

Diagram 2. Results of the point load test evaluated for the different load angles. (BCE 2014)

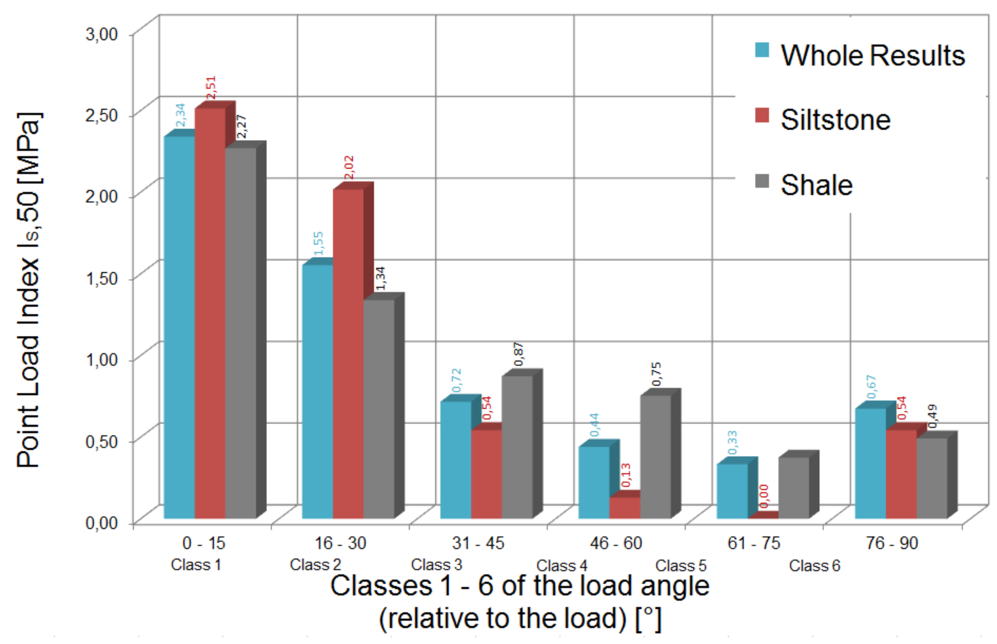

Diagram 3. Point load index for all results and separate for siltstone and shale in the comparison for different classes of load angles. (BCE 2014)

References

Akram, M.; Bakar, M. Z. A. 2007. *Correlation between uniaxial Compressive Strength and Point Load Index for Salt-Range Rocks.* Pak. J. Eng. & Appl. Sci, Vol. 1.

Avantech Engineering Consortium Pvt 2015. *Ltd. Digital Point Load Testing System(PLT-100)* URL: http://www.avantech.in/library/images/products/5c86159c-cb15-4ade-8c2e-ad849c3fb78a.jpg

BCE 2014. *Point load test on the Rhine shale – report.* Björnsen Consulting Engineers, Koblenz, Germany (unpublished)

Broch, E.; Franklin, J. A. 1972. *The point load strength test.* International Journal of Rock Mechanics and Mining Science & Geomechanics Abstract, 9, pp. 669-697.

Broch, E. 1983. *Estimation of Strength Anisotropy Using the Point-Load Test.* Int. J. Rock Mech Min Sci. & Geomech. Abstr., Vol. 30, No. 4, pp. 181-187.

Mark C, Molinda GM. 1996. *Rating Coal Mine Roof Strength from Exploratory Drill Core.* In the Proceeding of the 15th International Conference on Ground Control in Mining, Golden CO, 1996, pp. 415-428.

Rusnak, J,; Mark, C. 2000. *Using the point load test to determine the uniaxial compressive strength of coal measure rock.* 19th Ground Control Conference in Mining, West Virginia University, Proceedings, pp. 362-371.

Thuro, K. 2010. *Empfehlung Nr. 5 „Punktlastversuche an Gesteinsproben" des Arbeitskreises 3.3 „Versuchstechnik Fels" der Deutschen Gesellschaft für Geotechnik.* Bautechnik 87 (2010), Heft 6, S. 322-330

INTERNATIONAL SOCIETY FOR ROCK MECHANICS

AUSTRIAN SOCIETY FOR GEOMECHANICS