Liivakivi tugevus. Kivimi tugevus v mäemassiivi tugevus.

Ettekanne Fosforiidiseminaril
07.01.2014

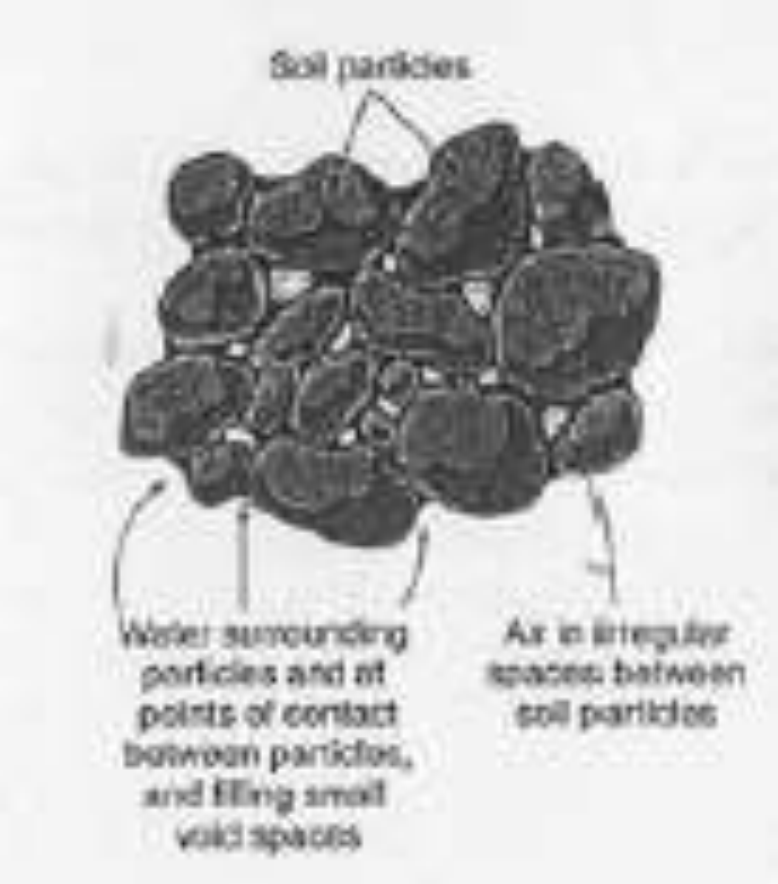
Liivakivi tugevus

Katsete tulemuste analüüs – teoreetilised alused

- Millest liivakivi tugevus sõltuda võiks?
  1. Liivakivi on tsementeerunud liiv
  2. Sarnastes tingimustes – sama terade mineraalkoostis, samad HG tingimused = sama tsement – peaks tugevus sõltuma tsementeeriva materjali hulgast
  3. Kuidas seda sõltuvust väljendada ?

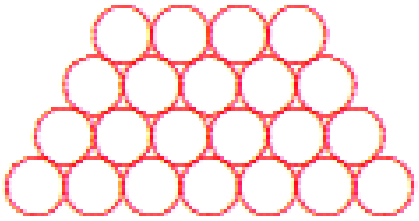
Liivakivi tugevus

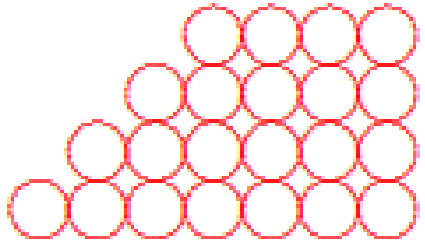
1. Tsementeeriv materjal on aegade jooksul välja settinud liivakivis olevast veest
2. Tsementeeriv materjal täidab liivaterade vahel oleva tühja ruumi (pooriruumi)
3. Sarnase algse pooriruumi korral on tugevaim vähima pooriruumiga kivimitükk (seal on enim tsementi)

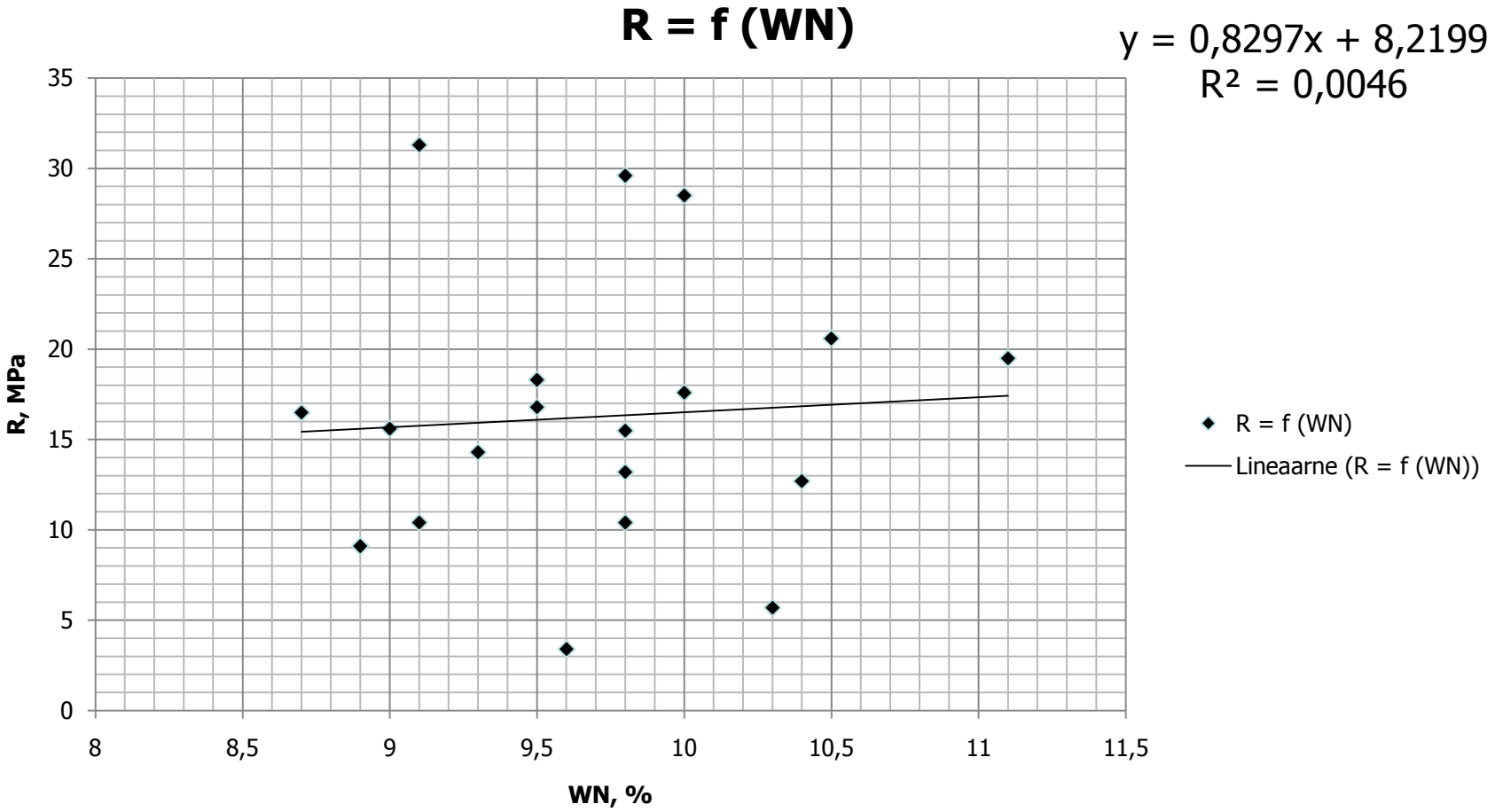


Pooriruum

- Pooriruumi iseloomustab poorsustegur e – pinnases või kivimis oleva pooride mahu suhe tahke faasi mahtu.
- Ühtlase suurusega teradega (kuulidega) täidetud ruumi poorsustegur on näiteks e = 0,35 (min)...0,88 (max)






R = f (WN)
y = 0,8297x + 8,2199
R² = 0,0046
R, MPa
WN, %
0
5
10
15
20
25
30
35
8
8,5
9
9,5
10
10,5
11
11,5
R = f (WN)
Lineaarne (R = f (WN))

Järeldus

- Liivakivi proovitüki tugevus sõltub otseselt tsemendi hulgast pooriruumist, mida kirjeldab vähenenud poorsustegur.
- Liivakivi teraline koostis võib aga paikkonniti muutuda
- Ka tsementeeriv aine võib paikkonniti varieeruda, põhjustades erineva tugevuse.
- Seetõttu on vaja kindlasti kivimi kohta konkreetseid andmeid konkreetses asukohas.

Kivimi tugevus
v
mäemassiivi tugevus

Kivimi tükk proovina

Kivim massiivis

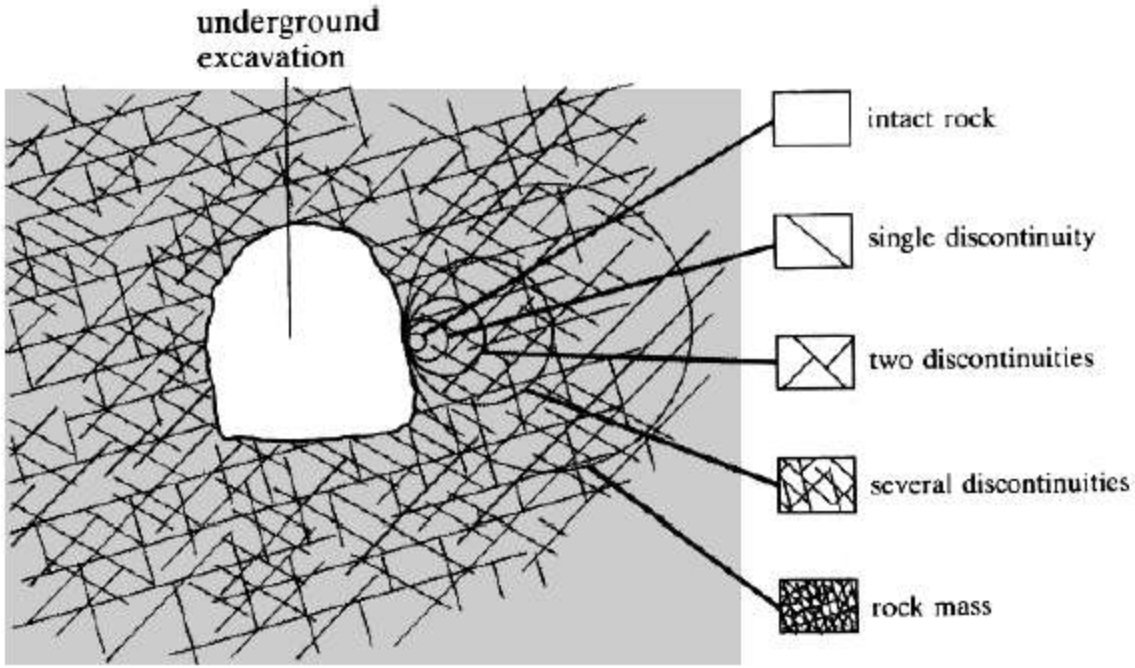


Figure 4.1 Idealised illustration of the transition from intact rock to a heavily jointed rock mass with increasing sample size (after Hoek and Brown, 1980).

QUANTITATIVE DESCRIPTION OF DISCONTINUITIES IN ROCK MASSES

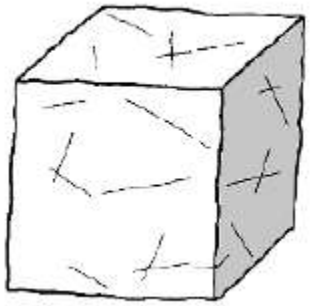
1. Rock material description
   A. Rock type
   B. Wall strength
   C. Weathering

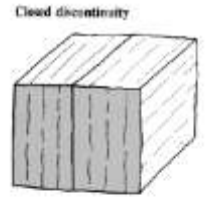
2. Discontinuity description
   D. Type
   E. Orientation
   F. Roughness
   G. Aperture

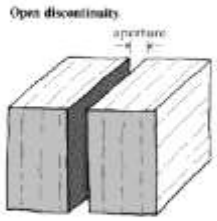
3. Infilling
   H. Infilling type/Width

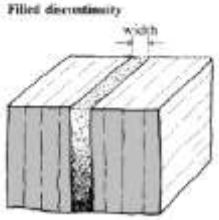
4. Rock mass description
   I. Spacing
   J. Persistence
   K. Number of sets
   L. Block size and shape

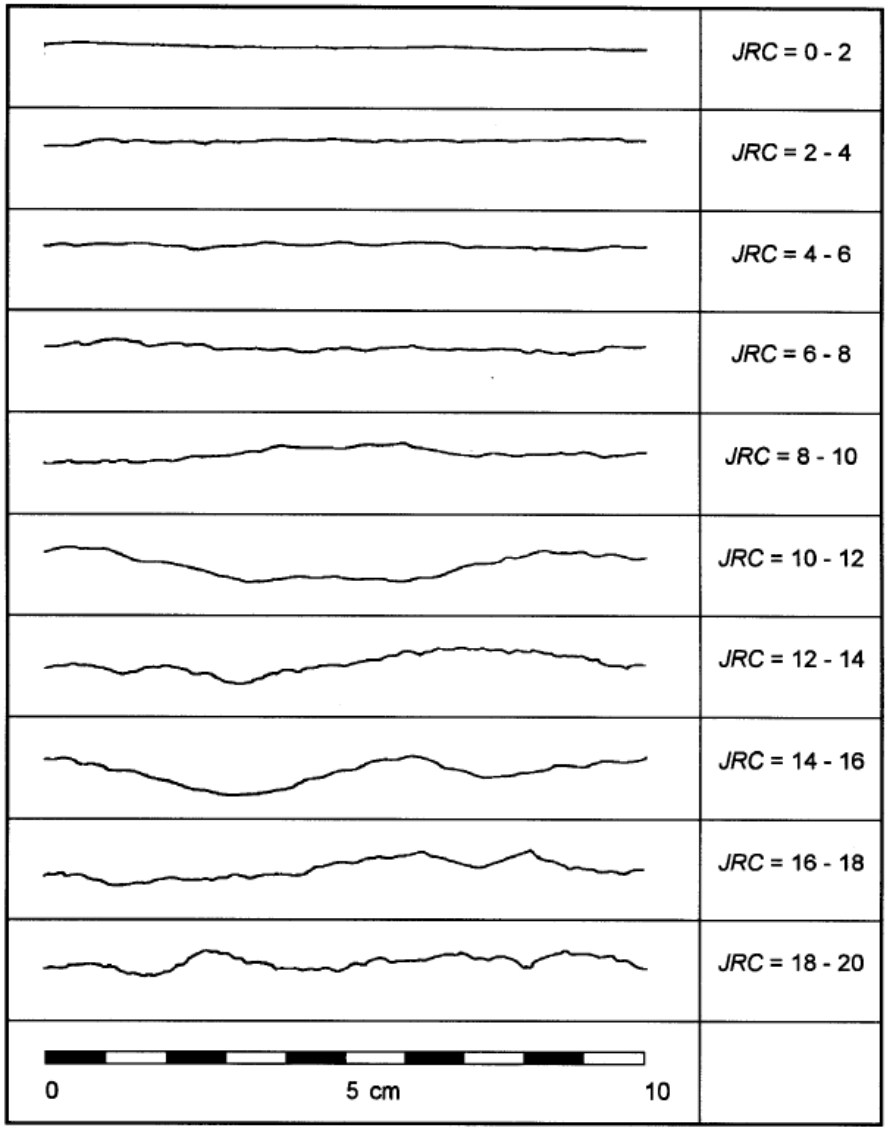
5. Groundwater
   M. Seepage

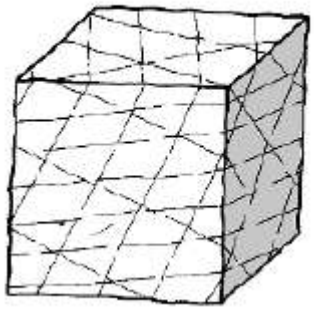






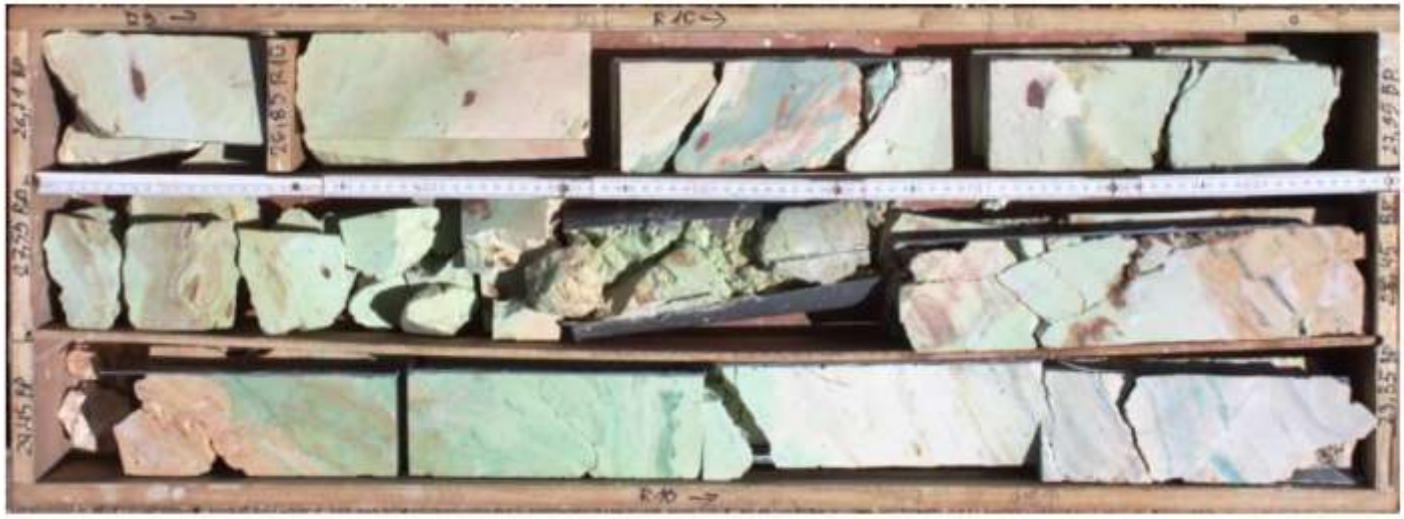


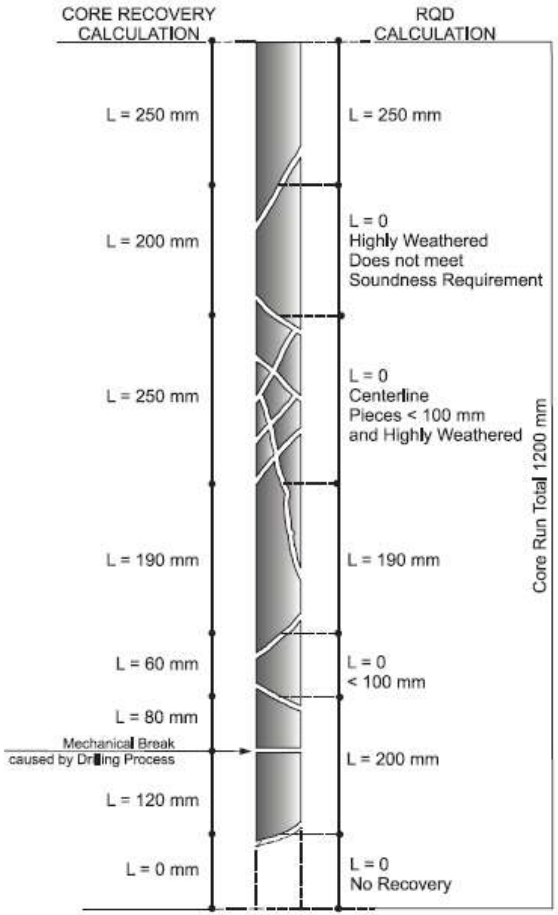




STRUCTURE	DECREASING SURFACE QUALITY →				
INTACT OR MASSIVE - intact rock specimens or massive in situ rock with few widely spaced discontinuities	90	80	N/A	N/A	
BLOCKY - well interlocked undisturbed rock mass consisting of cubical blocks formed by three intersecting discontinuity sets	80	70	60	50	40
VERY BLOCKY- interlocked, partially disturbed mass with multi-faceted angular blocks formed by 4 or more joint sets	60	50	40	30	20
BLOCKY/DISTURBED/SEAMY - folded with angular blocks formed by many intersecting discontinuity sets. Persistence of bedding planes or schistosity	40	30	20	10	
DISINTEGRATED - poorly interlocked, heavily broken rock mass with mixture of angular and rounded rock pieces	20	10			
LAMINATED/SHEARED - Lack of blockiness due to close spacing of weak schistosity or shear planes	N/A	N/A			

↓ DECREASING INTERLOCKING OF ROCK PIECES





$$\text{Core Recovery, } CR = \frac{\text{Total length of rock recovered}}{\text{Total core run length}}$$

$$CR = \frac{(250+200+250+190+60+80+120)\,mm}{1{,}200\,mm}$$

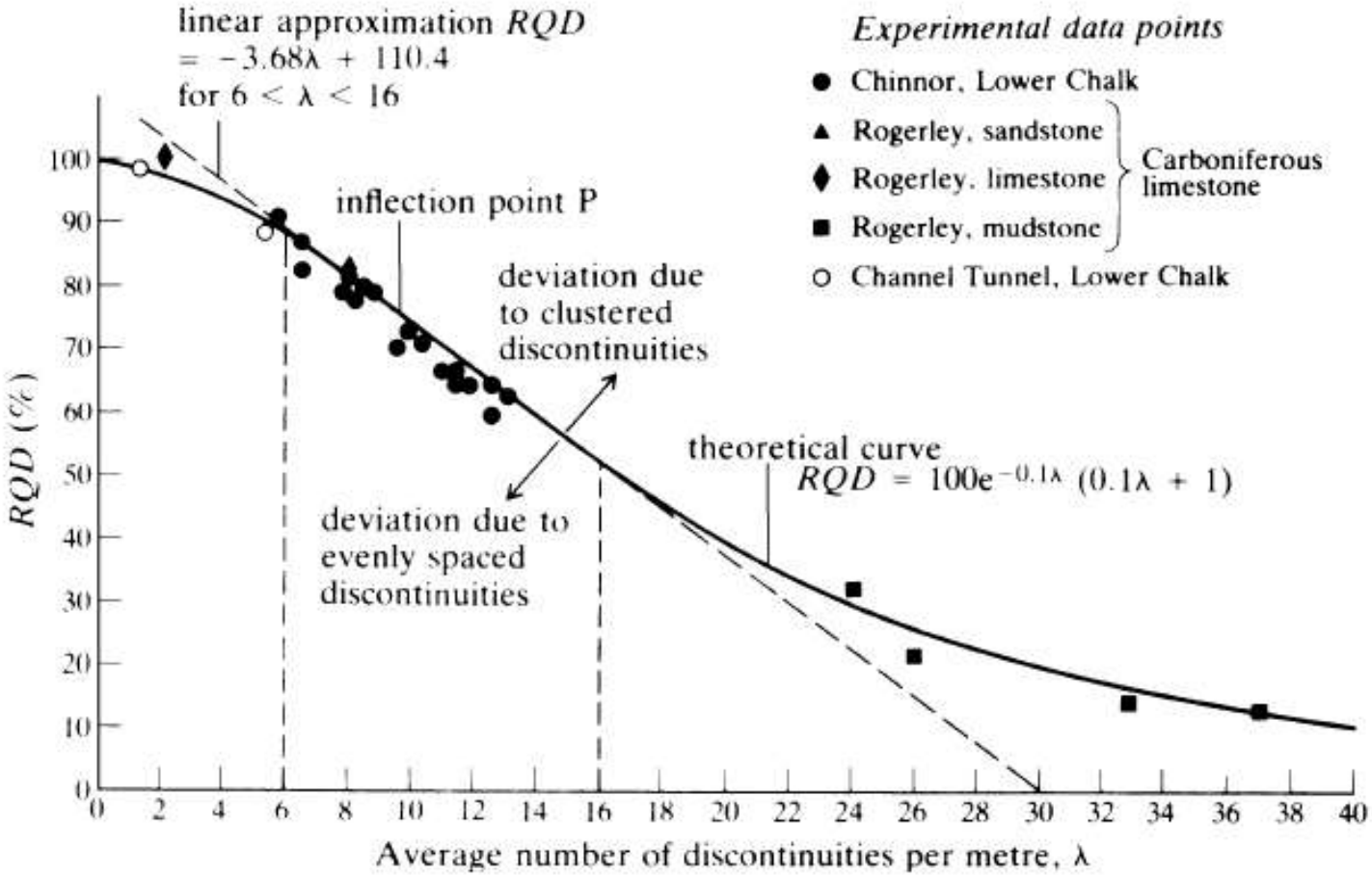
$$CR = 96\%$$

$$RQD = \frac{\sum \text{Length of sound pieces} > 100\,mm}{\text{Total core run length}}$$

$$RQD = \frac{(250+190+200)\,mm}{1{,}200\,mm} * 100\%$$

$$RQD = 53\%$$

Figure 94. Calculation of core recovery and RQD.


linear approximation RQD
= −3.68λ + 110.4
for 6 < λ < 16
inflection point P
deviation due to clustered discontinuities
deviation due to evenly spaced discontinuities
theoretical curve
RQD = 100e^−0.1λ (0.1λ + 1)
Experimental data points
Chinnor, Lower Chalk
Rogerley, sandstone
Rogerley, limestone
Rogerley, mudstone
Carboniferous limestone
Channel Tunnel, Lower Chalk
RQD (%)
Average number of discontinuities per metre, λ

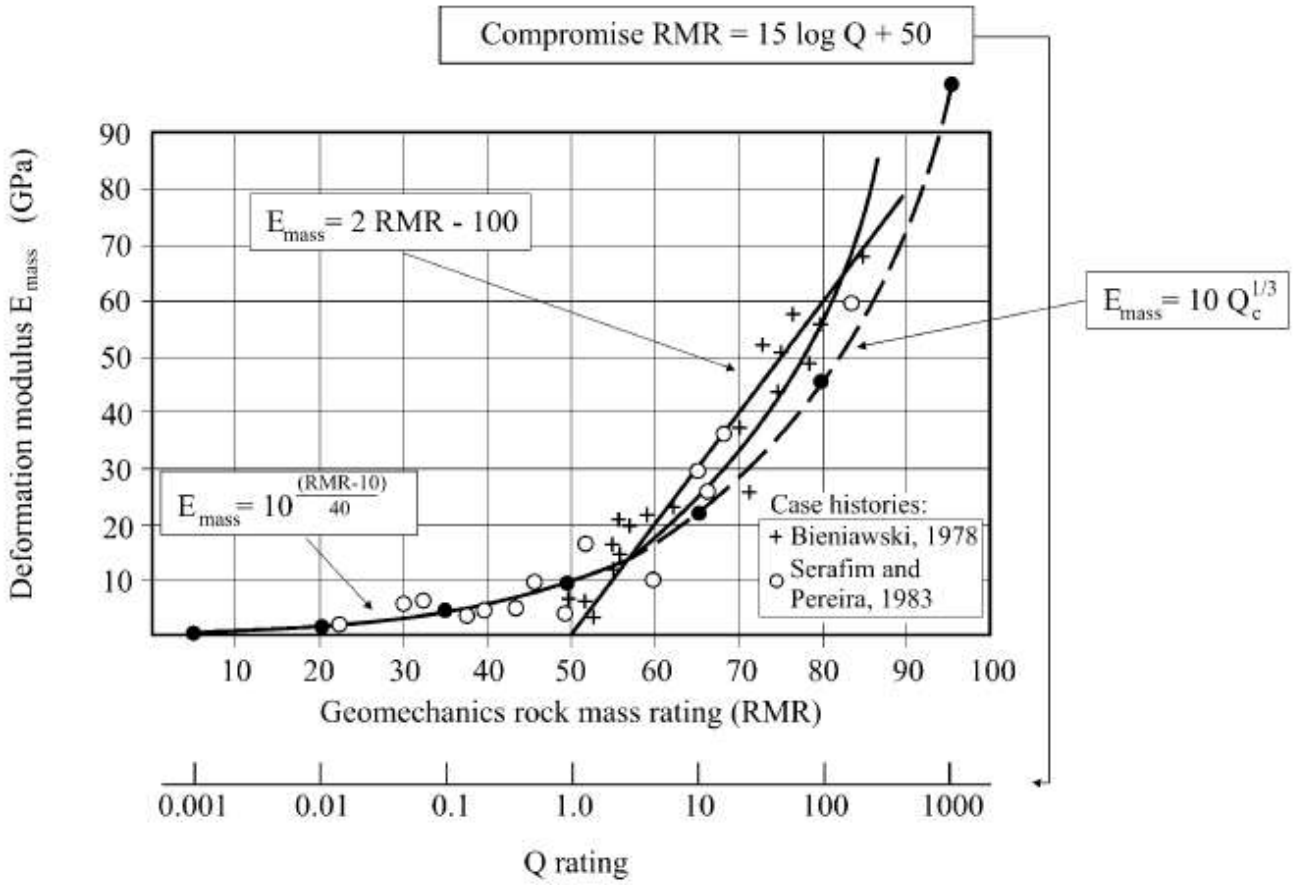


Figure 4.53 Measured values of static rock mass modulus, E_M, and some empirical relations (after Barton, 2002).

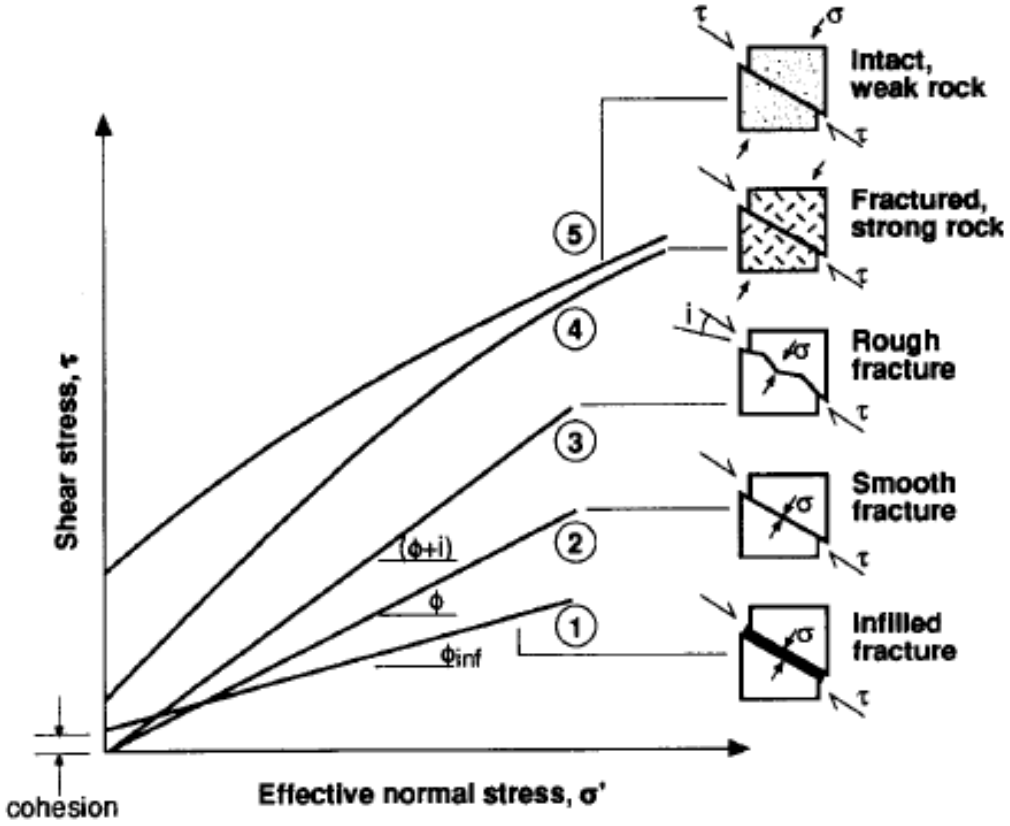


Figure 99. Relationships between shear stress and normal stress on rupture surface for five different geological conditions (TRB, 1996).

Kinnistamiseks

- Fosforiidikaevanduse keskkonnamõjude hindamiseks on vaja eelnevalt teha teatud kogum insener-geotehnilisi arvutusi
- Nende arvutuste tarvis on vajalik teatud lähteandmed
- Lähteandmed on võimalik saada vaid vastavaid uuringuid tehes
- Varasemate uuringute andmete kasutamine ei ole võimalik kuna kivimi geotehniline iseloomustus neis vajalikul (kaasaegsel) määral puudub