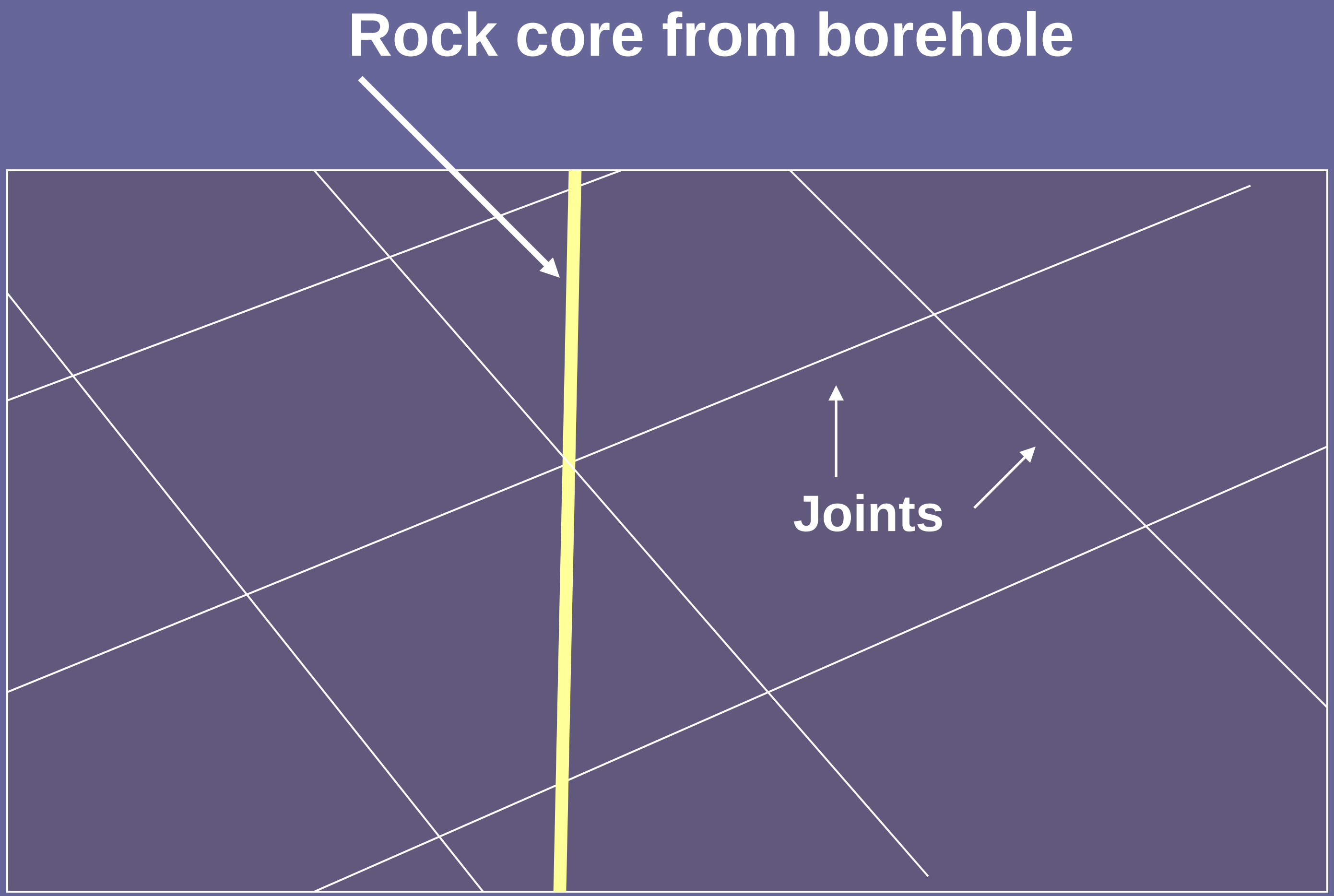
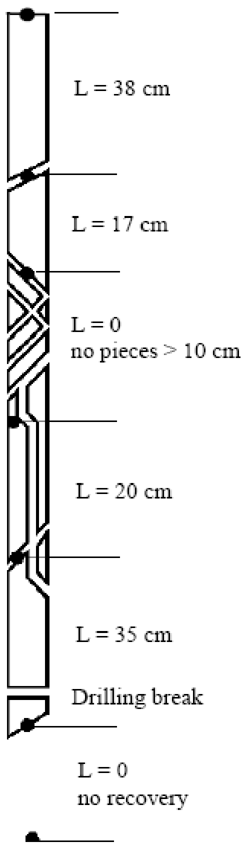
Rock Quality Designation (RQD)

A measure of rock mass integrity
based on the condition
of core samples.


Rock core from borehole
Joints

Rock Quality Designation (RQD)



Total length of core run = 200 cms

$$\text{RQD} = \frac{\Sigma \text{ Length of core pieces} > 10 \text{ cm length}}{\text{Total length of core run}} \times 100$$

$$\text{RQD} = \frac{38 + 17 + 20 + 35}{200} \times 100 = 55\,\%$$

USACE, 1989

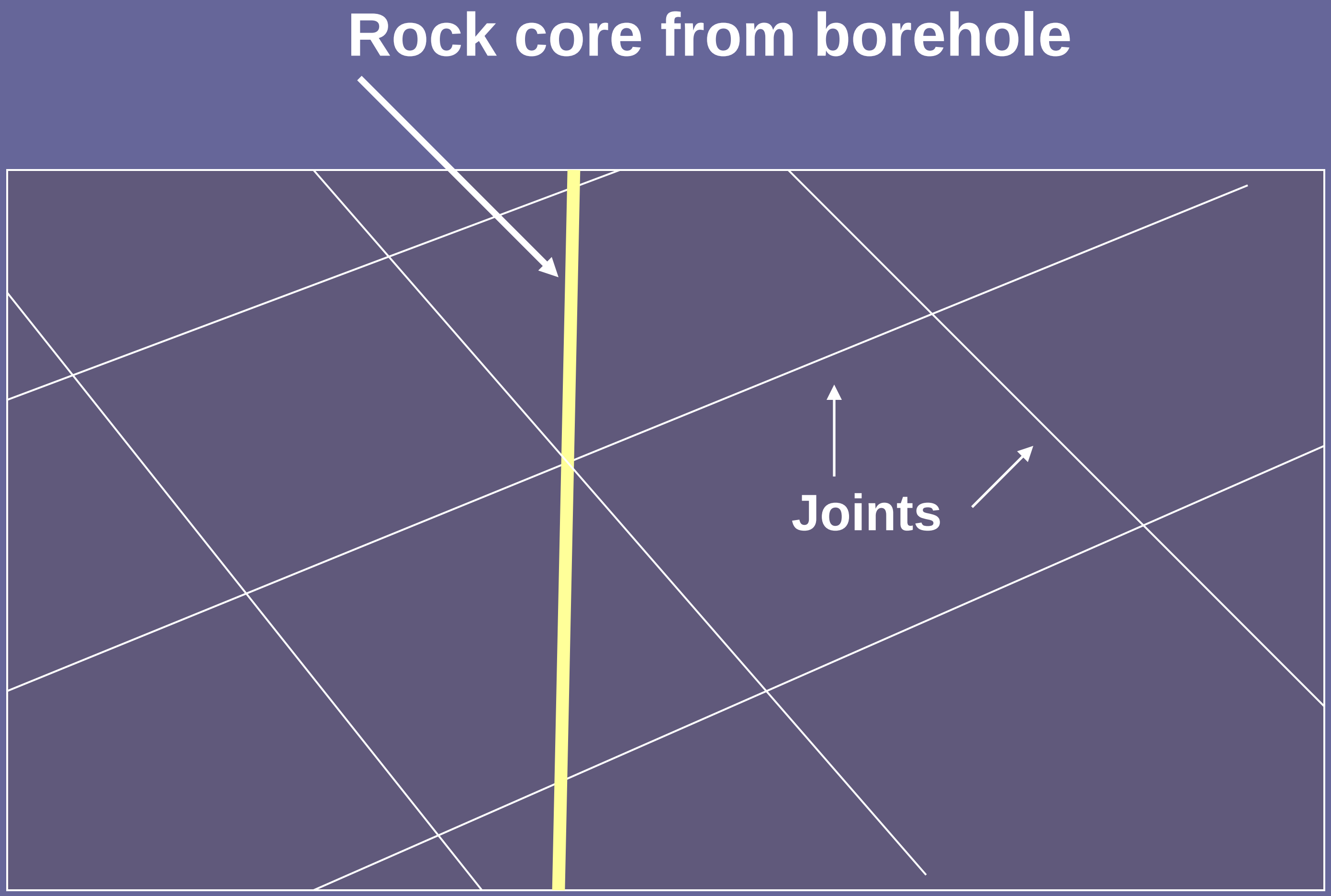
Rock Mass Rating (RMR)

Table 4.19 Geomechanics Classification Parameters, Ranges, Ratings, and Classes

a. Classification Parameters and Their Ratings						
1	USC of intact rock	>200 MPa	100–200 MPa	50–100 MPa	25–50 MPa	<25 MPa
	Rating	10	5	2	1	0
2	*Drill-core quality RQD*	90% to 100%	75% to 90%	50% to 75%	25% to 50%	<25% or highly weathered
	Rating	20	17	14	8	3
3	Spacing of joints	>3 m	1–3 m	0.3–1 m	50–300 mm	<50 mm
	Rating	30	25	20	10	5
4	Strike and dip orientations of joints	Very favorable	Favorable	Fair	Unfavorable	Very unfavorable
	Rating	15	13	10	6	3
5	Condition of joints	Very tight: separation <0.1 mm Not continuous		Tight: <1 mm and continuous *No gouge*	Open: 1–5 mm Continuous *Gouge <5 mm*	Open >5 mm Continuous *Gouge >5 mm*
	Rating	15		10	5	0
6	Groundwater inflow *(per 10 m of tunnel length)*	None		<25 l/min	25–125 l/min	>125 l/min
	Rating	10		8	5	2

b. Rock-Mass Classes and Their Ratings					
Class No.	I	II	III	IV	V
Description of class	Very good rock	Good rock	Fair rock	Poor rock	Very poor rock
Total rating	100 ← 90	90 ← 70	70 ← 50	50 ← 25	<25

Source: Modified from Bieniawski, 1974.


Rock core from borehole
Joints

General Guidelines for Determining RQD

- Valid for NX core (2-inch diameter) or greater.
- Length measured along centerline of core.
- Slightly or moderately weathered core that cannot be hand broken should be counted if >4”.
- Pieces of core obviously broken to fit into core box do not count as separate pieces.
- Unrecovered core is assumed to be < 4”.

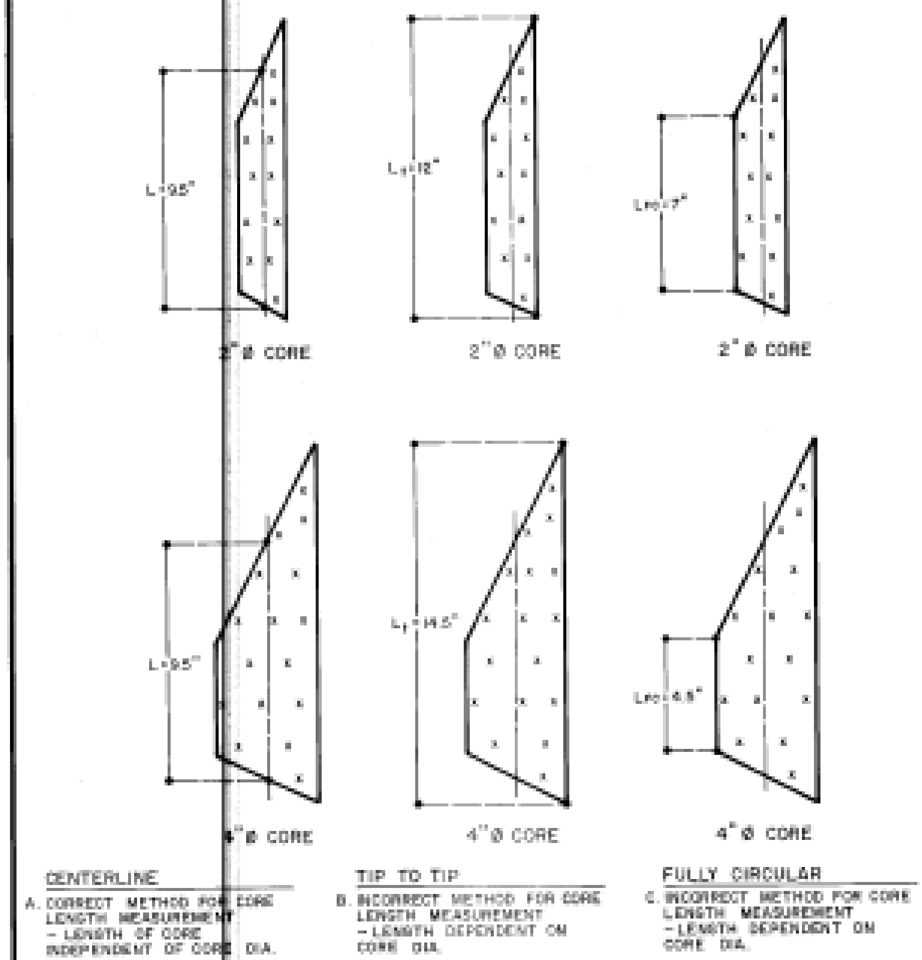


FIG. 2 — LENGTH MEASUREMENT OF CORE FOR RQD.

USACE, 1989

Issues with RQD

- Problems with core breakage / loss common in schistose rocks and interbedded argillaceous and harder rocks (sound familiar?).

- Larger-diameter core and longer coring runs are generally helpful with the above.

- RQD ignores joint orientation and continuity.

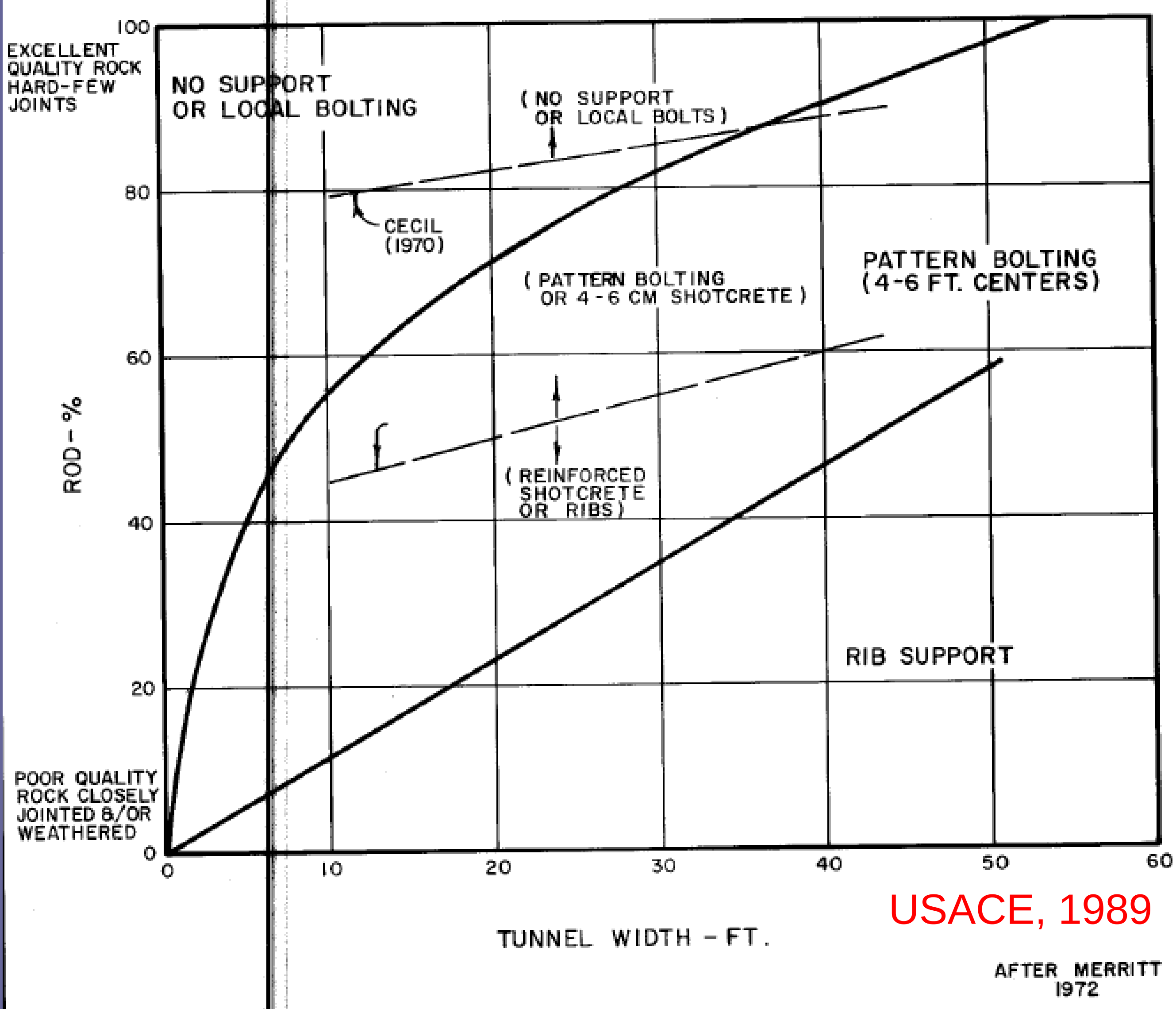
- RQD simple, inexpensive, and reproducible.

- **RQD is not a stand-alone design parameter !**

RQD Correlations

- Tunneling (original use of RQD).
- Modulus of Elasticity (E).
- Seismic velocity.
- Joint volume (J_v)
- Fracture frequency
- Input to rock mass rating

RQD as input to tunnel design



USACE, 1989

Deformation of a Rock Mass

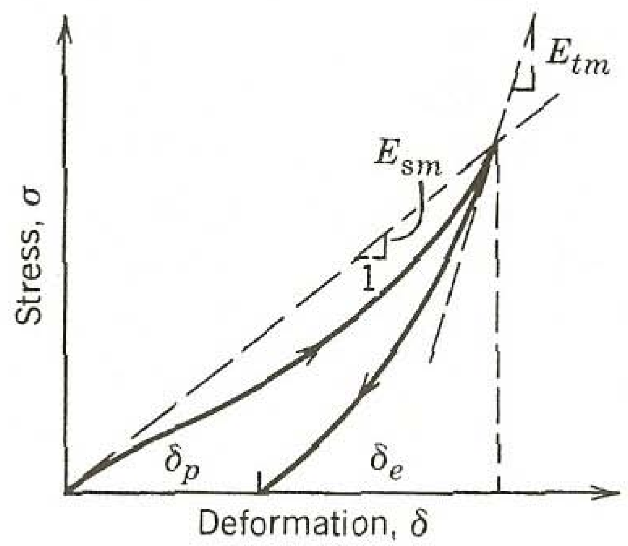
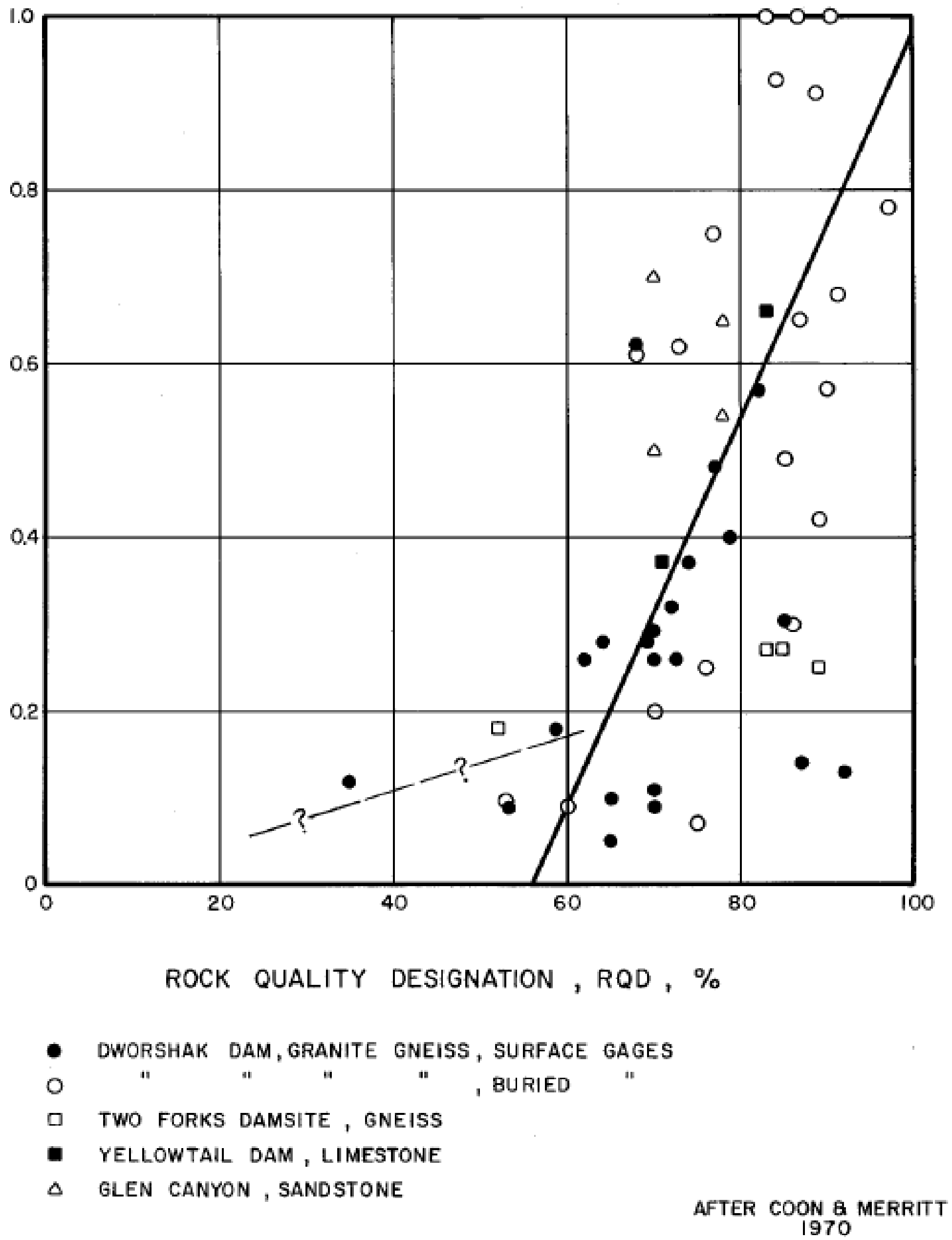


Figure 4.43 Typical stress-strain relationships for a rock mass where E_{sm} = secant modulus, E_{tm} = tangent modulus, δ_p = plastic deformation and δ_e = elastic deformation. (Reprinted with permission from Proc. 8th Symp. on Rock Mechanics—Failure and Breakage of Rock, D. U. Deere et al., Design of Surface and Near-Surface Construction in Rock, 1967, Am. Inst. Min. Metall. & Pet. Eng.)

How is this response to stress different than that of intact rock?

RQD correlation with E



USACE, 1989

Example application:

If my dam is overtopped during flooding, How much will foundation rock flex underneath dam?

RQD correlation with seismic velocity

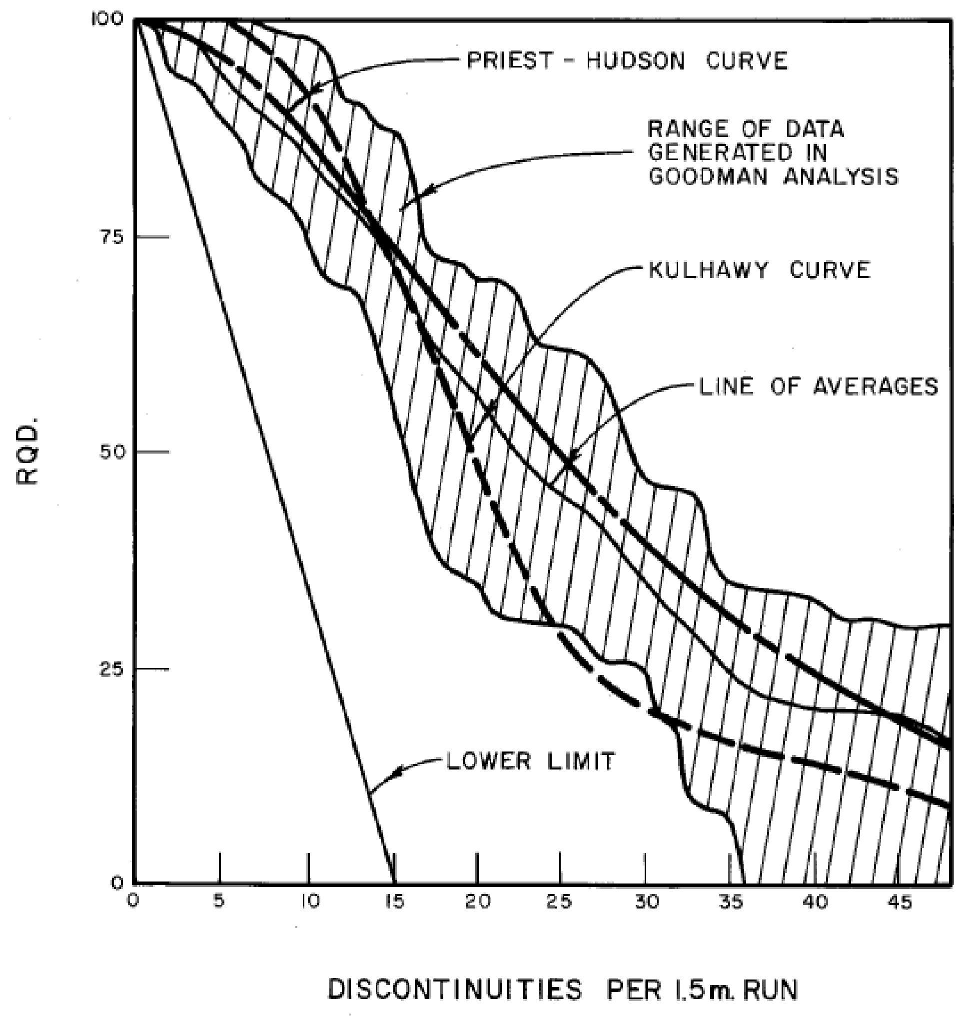
TABLE 3

CORRELATIONS OF MODULUS RATIO WITH RQD AND VELOCITY INDEX

Classification	RQD	Velocity Index	Modulus Ratio $E_{rock-mass}/E_{lab}$
Very Poor	0 - 25	0-0.20	< 0.20
Poor	25 - 50	0.20-0.40	< 0.20
Fair	50 - 75	0.40-0.60	0.20-0.50
Good	75 - 90	0.60-0.80	0.50-0.80
Excellent	90 - 100	0.80-1.00	0.80-1.00

USACE, 1989

RQD correlation with fractures

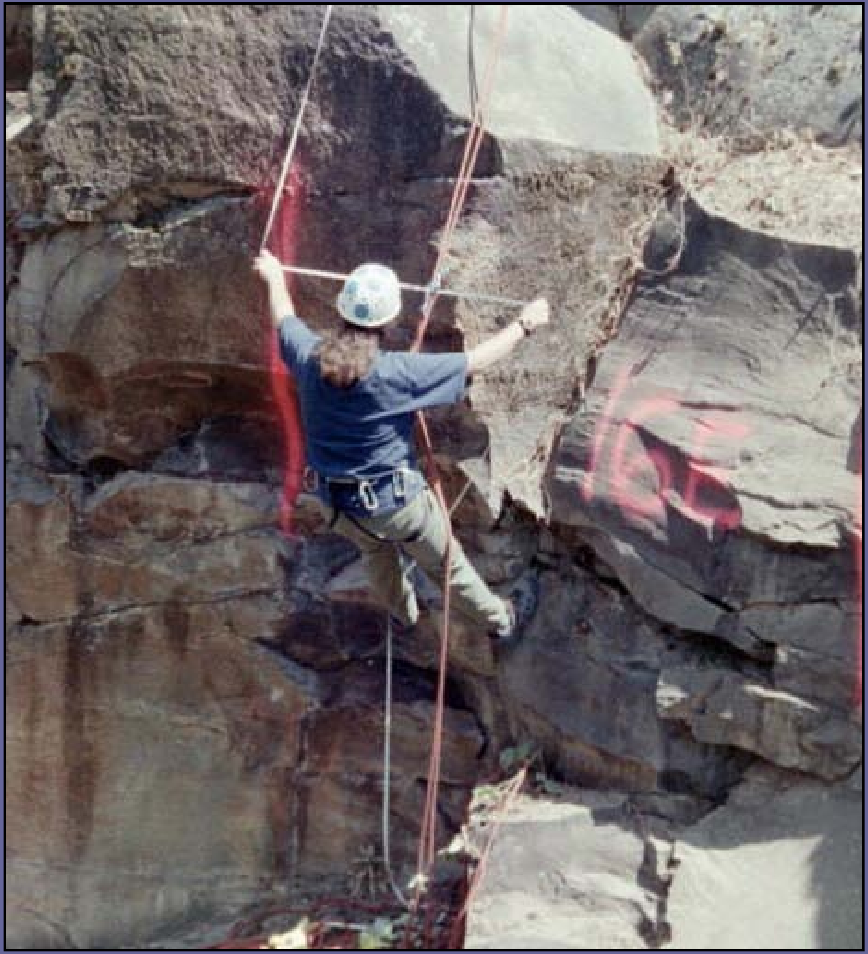


USACE, 1989

AFTER GOODMAN & SMITH 1980

FIG. 5 – RQD. VERSUS FRACTURE FREQUENCY

Estimates of RQD



The Dalles, OR

$$RQD = 115 - 3.3 (J_v)$$

$$J_v = \frac{\Sigma \text{ Discontinuities}}{m^3}$$

Palmström (1982)