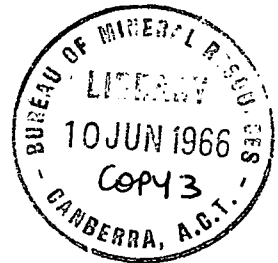


COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1966/74



MEASUREMENT OF DYNAMIC ELASTIC
CONSTANTS OF ROCK SAMPLES
FROM BELLFIELD AND TARAGO
DAM SITES,
VICTORIA 1965

by

M.J. JOHNSTON

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In January, 1965, at the request of the State Rivers and Water Supply Commission of Victoria, the Geophysical Branch of the Bureau of Mineral Resources, Geology and Geophysics, measured the dynamic elastic constants of 14 rock specimens from the foundation sites of the proposed dams at Bellfield and Tarago.

Measurements of the size and weight of a specimen enable its density (ρ) to be calculated.

The velocity of propagation of longitudinal elastic waves in an extended medium, the bulk velocity (V_p), is obtained by using a Cawkell ultrasonic materials tester type UCT2. This equipment measures the transit time of a pulse of longitudinal waves at 120 kc/s through a specimen of known length (L), from which the velocity is calculated.

This velocity of propagation of longitudinal elastic waves in a slender cylindrical bar specimen, the bar velocity (V_b), is obtained by using a Cawkell electrodynamic materials tester type SCT4. With this equipment the fundamental resonant frequency of a specimen (f_o), and the width of the response curve (Δf) at 70.7 percent of the amplitude at the resonant frequency, are measured.

The bar velocity is given by

$$V_b = 2 f_o L$$

Knowing V_p , V_b , and ρ , Young's modulus (E) is given by

$$E = c V_b^2 \rho$$

where c is a constant to adjust for the various units used.

Poisson's ratio (σ) is found from the expression

$$(V_p/V_b)^2 = (1-\sigma)/(1-2\sigma)(1+\sigma)$$

The bulk modulus is given by

$$B = E/3(1-2\sigma)$$

and the rigidity modulus by

$$G = E/2(1+\sigma)$$

The logarithmic decrement (δ) and quality factor (Q) are given by

$$\delta = \pi \Delta f / f_o \text{ and } Q = \pi / \delta$$

Measurements were made on the specimens in their oven-dry and water saturated states. To facilitate the measurements, the ends of the specimens were cut perpendicular to their length.

The rock types, degree of weathering, and physical conditions of the samples are given in Tables 1 and 2. The results of the measurements are shown in Tables 3 and 4.

The values obtained in the measurements are approximately the same as those obtained on similar rocks from other sites.

Two of the samples give values that are suspect :

- a) Sample 1788. The recorded bar velocity is very low, giving a very high value for Poisson's ratio and therefore a very low value of Young's modulus.
- b) Sample 1800. Though the rock is described as fresh hard quartzite, the low bulk and bar velocities, and especially the drop in bar velocity in a wet state, are not consistent with the description.

TABLE 1

Description of samples from Tarago damsite

Sample No.	Depth (feet)	Rock type	Condition	Remarks
1787	14/15	White clay		Disintegrated in water
1788	105/6	Granite	Decomposed	Disintegrated in water
1792	53/54	Quartzite	Fresh, hard	Sample chipped
1793	62	Granite	Fresh, hard	
1794	101	Mica schist	Fresh, hard	

TABLE 2

Description of samples from Bellfield damsite

Sample No.	Depth (feet)	Rock type	Condition	Remarks
1795	57/58	Sandstone	Decomposed	Sample chipped
1796	2/3	Sandstone	Fresh, hard	Sample chipped
1798	43/44	Siltstone mudstone	Fresh, hard	
1799	20/21	Quartzite	Fresh, hard	
1800	14/15	Quartzite	Fresh, hard	

TABLE 3

Dynamic constants of samples from Tarago damsite

Sample No.		1787	1788	1792	1793	1794
Depth (feet)		14/15	105/106	53/54	62	101
Density (g/cm ³)		1.73	2.06	2.61	2.61	2.82
Bulk velocity (ft/s)	dry	5775	4215	18240	19120	19360
	wet			18130	19260	19280
Bar velocity (ft/s)	dry	4360	2140	16680	17720	18260
	wet			16440	17820	18130
Poisson's ratio	dry	0.37	0.45	0.25	0.23	0.21
	wet			0.25	0.23	0.21
Young's modulus (10 ⁶ lb/in ²)	dry	0.43	0.12	9.75	11.00	12.57
	wet			9.60	11.16	12.40
Bulk modulus (10 ⁶ lb/in ²)	dry	5.08	2.58	6.50	6.80	7.20
	wet			6.40	7.00	6.90
Modulus of rigidity (10 ⁶ lb/in ²)	dry	1.80	0.45	3.90	4.50	5.20
	wet			3.80	4.55	5.10
Quality factor	dry	20	23	78	31	50
	wet			187	30	58

TABLE 4

Dynamic constants of samples from Bellfield damsite

Sample No.		1795	1796	1798	1799	1800
Depth (feet)		57/58	2/3	43/44	20/21	14/15
Density (g/cm ³)		2.04	2.52	2.61	2.54	2.42
Bulk velocity (ft/s)	dry	5210	15480	15680	15330	9250
	wet	6620	16120	16100	16020	8910
Bar velocity (ft/s)	dry	4920	15740	15180	14640	8360
	wet	6490	15700	14900	15050	5870
Poisson's ratio	dry	0.21	0.31	0.16	0.17	0.28
	wet	0.12	0.13	0.24	0.21	0.41
Young's modulus (10 ⁶ lb/in ²)	dry	0.67	8.40	8.11	7.20	2.27
	wet	0.94	8.43	7.91	5.82	1.14
Bulk modulus (10 ⁶ lb/in ²)	dry	0.38	7.30	4.10	3.70	1.70
	wet	0.41	2.80	5.10	3.40	1.70
Modulus of rigidity (10 ⁶ lb/in ²)	dry	0.27	3.30	3.50	3.10	0.90
	wet	0.40	2.90	3.20	2.40	0.40
Quality factor	dry	16	74	52	30	22
	wet	6				