COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

1959 NO. 122.

SEISMIC REFRACTION SURVEY AT A DAWSON RIVER DAM SITE QUEENSLAND (1958),

by

E.J. POLAK and P.E. MANN.

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C O N T E N T S.

P L A T E S.

ABSTRACT.

The dynamic elastic properties of the bedrock (consisting of Bundamba Sandstone) of the Dawson River damsite (190.94 mile) were determined by the seismic refraction method. The longitudinal wave velocity is 11,000 ft/sec. Poisson's Ratio was determined as 0.32 ± 0.01, and Young's Modulus as $2.7 \times 10^6 \pm 0.2 \times 10^6$ lb/sq.in.

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1. INTRODUCTION.

In 1955 a seismic refraction survey of the proposed Dawson River Dam Sites was carried out by the Bureau of Mineral Resources, Geology and Geophysics, at the request of Irrigation and Water Supply Commission, Queensland (Polak and Hawkins, 1956). In response to a request from the Commission for further information, an additional short traverse was surveyed by the seismic refraction method in September 1958, on a new site referred to as 190.94m.

This site is located upstream from the end section of the traverses surveyed in the previous survey (Plate 1). The main purpose of the test was to measure in situ the dynamic elastic properties of the rocks.

2. GEOLOGY.

The geology of the area is described in an earlier report by Polak and Hawkins, 1956. Several drill holes located on the damsite (Plate 2) indicate the boundary between the main formations, the Bundamba sandstone and the Upper Bowen Group. The geological section at drill hole 46 is shown on Plate 2.

3. EQUIPMENT AND METHOD.

A Midwestern shallow reflection-refraction seismograph was used, with Midwestern geophones of natural frequency of 6 cycles per second to measure the longitudinal wave velocities, and a T.I.C. three component geophone with a natural frequency of 20 cycles per second to measure transverse wave velocities.

Full details of the seismic refraction method were given in earlier reports (Polak and Hawkins, 1956, Polak and Mann, 1959). The latter report indicates fully the way in which the dynamic elastic properties of rocks may be evaluated.

Theoretically, the velocity of the longitudinal and transverse waves in elastic media is given by the following formulae (Leet, 1950):-

$$V_L = \frac{1}{12}\sqrt{\frac{E}{\delta}\,\frac{1-\sigma}{(1+\sigma)(1-2\sigma)}} \qquad \ldots\ldots (1)$$

$$V_t = \frac{1}{12}\sqrt{\frac{E}{\delta}\,\frac{1}{2(1+\sigma)}} \qquad \ldots\ldots (2)$$

in which:-

V_L = Longitudinal wave velocity in ft/sec.

V_t = Transverse velocity wave in ft/sec.

E = Young's Modulus in lb/sq. in.

σ = Poisson's Ratio

δ = Density in lbs. sec.^{2} in^{-1}/in^3

From (1.) and (2) all other dynamic properties of rocks may be derived as follows:-

$$\left(\frac{V_L}{V_t}\right)^2 = \frac{\sigma - 1}{\sigma - \frac{1}{2}}$$

$$E = 144\, V_L^2\, \frac{(1+\sigma)(1-2\sigma)}{1-\sigma} \qquad \ldots\ldots (3)$$

The modulus of rigidity, G (in lb/sq. in.), is -

$$G = \frac{E}{2(1+\sigma)} \qquad \ldots\ldots (4)$$

and the bulk modulus, B (in lb/sq. in), is:-

$$B = \frac{E}{3(1-2\sigma)} \qquad \ldots\ldots (5)$$

4. RESULTS.

(a) Seismic Velocity.

The seismic velocity of the main refractor indicated on the time distance curve is 11,000 ft/sec. The refractor is indicated by drillhole 46 to be at the bottom of the alluvium (11 ft. deep) and consists of the medium to coarse sandstone of the Bundamba Group. No higher velocity than 11,000 ft/second was noted (even with a second shot point 400 ft. further away) indicating that there is no thicker bed of higher velocity within the first 100 ft. below the ground level along the traverse. Any bed with a velocity less than 11,000 ft/sec. would not be revealed below the higher velocity bed. The velocity of 11,000 ft/sec. corresponds with the 10,000 to 12,000 ft/sec. velocities found on other damsites in the same areas. (Polak and Hawkins, 1956).

(b) Depth to the Bedrock.

The depth to the refractor increases gradually from approx. 8 feet below geophone No. 1 (Plate 2) to approx. 17 feet below geophone No. 11. The percentage error of the depth determination for a very shallow depth may be high, especially in the area where the upper layer consists of mud, gravel and large angular stones, as is found in this section of the Dawson River Valley.

(c) Elastic Properties of Rocks.

Table 1 shows the values of the elastic properties of the rocks and the data from which they were calculated. An apparent velocity value was used to calculate Poisson's Ratio. Apparent velocity is defined as the velocity obtained by dividing the distance between the shot point and the geophone by the time taken for the wave to cover the distance. The true velocity is obtained from the time-distance curve.

Other elastic properties were calculated by using the formulae given in part 3 of this report.

It has been proved (U.S. Bureau of Reclamation, 1953) that the values of all elastic properties of rocks obtained by dynamical methods (seismic wave propagation) are generally higher than those obtained statically.

TABLE 1.

	Data from shot points (see Plate 2)	
	SP(A).	SP(B).
Distance, shot point-geophone in ft.	400	225
Apparent longitudinal velocity, ft/sec.	10,600	8,600
Apparent transverse velocity, ft/sec.	5,300	4,600
True velocity, ft/sec.	11,000	11,000
Poisson's Ratio	0.33	0.315
Young's Modulus, lb/sq.in.	2.53×10^6	2.87×10^6
" " dynes/sq.cm.	1.74×10^{11}	1.98×10^{11}
Modulus of Rigidity lb/sq.in.	0.97×10^6	1.09×10^6
" " dynes/sq.cm.	0.67×10^{11}	0.75×10^{11}
Bulk Modulus, lb/sq.in.	2.53×10^6	2.60×10^6
" " dynes/sq.cm.	1.74×10^{11}	1.78×10^{11}

Poisson's Ratio calculated from longitudinal and transverse velocities was found to be higher than that assumed by Polak and Hawkins 1956; therefore the present values for Young's Modulus are 9% lower than those indicated in 1956.

5. CONCLUSIONS.

The geophysical survey on site 190.94m. provided information on the elastic properties of the foundation rock.

From a comparison of data from this site (190.94m.) with data from sites located downstream the following conclusions could be reached.

(1) The seismic velocity of 11,000 ft/sec. is of the same order as the velocity indicated on the downstream sites.

(2) The Poisson's Ratio calculated from longitudinal and transverse velocities is higher than that assumed for the downstream sites.

(3) The value of Young's Modulus of the foundation rock is 2.53×10^6 to 2.87×10^6 lb/sq.in (1.74×10^{11} to 1.98×10^{11} dynes/sq.cm.).

6. REFERENCES.

LEET, D.L.	1950	-	Earth Waves. Harvard University Press, New York.
POLAK, E.J., HAWKINS, L.V.	1956	-	Seismic Refraction Survey of the Dawson River Dam Site, Queensland. Aust.Bur.Min.Res. Record 1956/108.
POLAK, E.J., MANN, P.E.	1959	-	Seismic Refraction Survey of the Moogerah Dam Site, Nr. Kalbar, Qld. Aust.Bur.Min.Res. Record 1959/62.
U.S. Bureau of Reclamation	1953	-	Physical Properties of some Typical Foundation Rocks. Concrete Lab. Report No. SP-39.

PLATE 1

Cattle Ck

176m
177m
178m
179m
180m
181m
182m CAMP No 2.
183m
184m
185m
186m
187m
188m
189m
190m
191m
192m
193m
194m

DAWSON R.

Back Ck.

Precipice Ck

Cables Ck

Cabbagetree Ck

Cracow Ck

25°20'S. (Approx.)

25°20'S

DAM SITE 181.9m

DAM SITE 183.5m

DAM SITE 184.9m

DAM SITE 185.3m

DAM SITE 187.5m

DAM SITE 189.0m

DAM SITES 189.8m–190.9m

DAM SITE 190.94m

CAMP No 1

THEODORE

From Theodore

EIDSVOLD

CRACOW

To Eidsvold

ROAD

CRACOW ROAD

Cracow. H.S.

TAROOM ROAD

Fairyland. H.S.

T.R.

150°15'E (Approx.)

Fr. Taroom

DAM SITES SURVEYED IN 1955

DAM SITE SURVEYED IN 1958

(PLAN No M 13926
IRRIGATION AND WATER SUPPLY COMMISSION)

LOCATION

MILES 0 400

CAIRNS

TOWNSVILLE

MT ISA

ROCKHAMPTON

Mundubbera

CRACOW

Reference to 4 Mile Military Map Series.

BRISBANE

SEISMIC SURVEY (1958)
DAWSON RIVER - QUEENSLAND
DAM SITE INVESTIGATIONS
LOCALITY PLAN

G 220-1

MILES 0 1 2 3

To accompany Records 1959, No 122

PLATE 2

▲A

True North

DRILL HOLE Nº46

0	ALLUVIUM	
11'	MEDIUM TO COARSE SANDSTONE	BUNDAMBA GROUP
19'-8"	VERY FINE SANDSTONE	
26'-5"	MEDIUM GRAIN SANDSTONE	
29'-9"	SLIGHTLY WEATHERED	
31'-9"	WEATHERED	
37'-0"	VERY WEATHERED AND DECOMPOSED	UPPER BOWEN GROUP
57'-0"	WEATHERED	
69'-10"		

7300 7200 7100 7000 6900 6800 6700 6600

2800 2900 3000 3100 3200 3300

680 660 640 620 600 580 560 540 520 500 480 480 500 520 540 560 580 600 620 640 660 680

DAWSON RIVER

THREE COMPONENT GEOPHONE

(S1) (S2) (S3) (S4) (S5) (S6) (S7) (D1) (D2) (D3) (D4) (D5) (D6)

1 2 3 4 5 6 7 8 9 10 11

LEGEND

TRAVERSE — ● 43 DIAMOND DRILL HOLE

▲A SHOT POINT — □(S5) TEST PIT

AXIS OF PROPOSED DAM — AXIS OF DRILL HOLE

480 500 CONTOURS (IN FEET)

SCALE IN FEET

50 0 50 100 150

▲B

LEVEL DATUM—
DAWSON RIVER IRRIGATION
ADD 1·50 TO EQUATE STATE DATUM
(THEODORE)

SEISMIC SURVEY (1958)
DAWSON RIVER, QUEENSLAND
DAM SITE 190-94
SEISMIC TRAVERSE

(BASED ON PLAN L15344
IRRIGATION AND WATER SUPPLY COMMISSION)

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 220-26

To accompany Records 1959, No 122