GR-80-7

CONCRETE PERFORMANCE AT PUEBLO DAM, COLORADO, INITIAL CORE REPORT

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16. ABSTRACT
Physical properties of initial cores extracted from the dam and river plug at Pueblo Dam, Colorado, indicate a good quality, uniform, well-consolidated concrete. This study is part of a series in the long-term evaluations of strength and elastic properties of concrete in various dams. The river plug concrete included two mix designs designated as interior and exterior. The dam concrete included two mix designs noted as high or low water to cement plus fly ash ratio. Results of the tests on the 3-year cores from the river plug show the average compressive strength of the concrete to be about 40 MPa, with no increase over the 6-month strength. The average 1-year dam concrete compressive strength was about 30 MPa, which is an increase over that at 6 months age. The modulus of elasticity for the interior plug concrete at 3 years is about 30 GPa with no significant increase with age. The 1-year dam concrete modulus of elasticity is about 35 GPa. Poisson's ratio, density, mix design, and tensile strengths of construction joints and monolithic specimens are also discussed.

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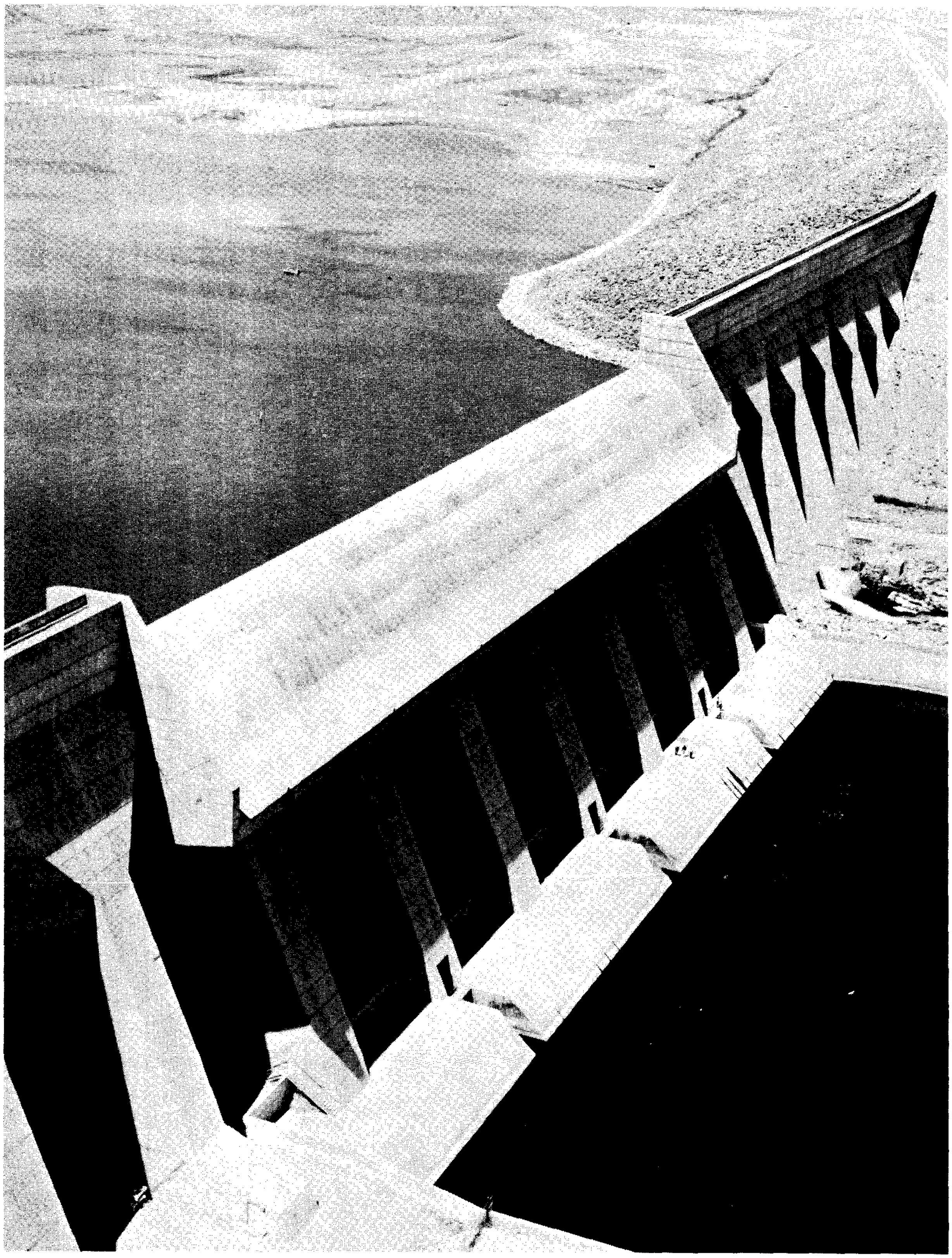

Pueblo Dam and Reservoir. Photo P801-D-79442

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[1] All "A" tables are in SI units.
All "B" tables are in "inch-pound" units.

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INTRODUCTION

Pueblo Dam is located in the Arkansas River about 13 km (8 mi) west of Pueblo, Colorado, in Pueblo County. It is an earthfill and concrete dam about 58 m (190 ft) high and approximately 3000 m (10 000 ft) long. The concrete portion of the dam, approximately 533 m (1750 ft) long, consists of 23 massive-head buttresses that rise 53 m (175 ft) above the elevation of the top of the concrete plug in the river canyon. The plug was placed as part of the foundation work, preparatory to construction of the dam. Mass concrete was placed in the river plug in 1971, and in the dam during 1973 and 1974.

Cores were extracted from the plug before the dam was built to evaluate the strength and elastic properties of the concrete. This was necessary to verify, before final construction, design assumptions made for the dam. Later, additional cores from both the plug and dam were extracted to evaluate the effects of age on various physical properties of the concrete.

This report presents the results of tests made on the 150- and 250-mm (6- and 10-in)[2] diameter cores extracted from the river plug at 6 months and at 3 years after placement, as well as those made on the 250-mm diameter cores extracted from the dam at 6 months and at 1 year after placement. Included in this report are results of a construction joint investigation made on cores taken from both the river plug and the dam. Additional cores will be taken at later ages to further evaluate the long term properties of the concrete in this structure.

CONCLUSIONS

1. The overall quality of the concrete in the cores from Pueblo Dam is indicative of a well-designed, durable concrete, having compressive strengths exceeding the design

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[2] The data reported in this document were measured in inch-pound units and converted to SI metric units.

criteria and the concrete is, therefore, expected to have a long service life with normal maintenance.

2. The tensile strength of the concrete in Pueblo Dam is similar to that of mass concrete used in other Bureau projects.

3. The use of a chlorinated-rubber resin-base curing and bonding compound in lieu of wet sandblasting or water-jetting of construction joints was found to be unacceptable.

4. The tensile strength of concrete across "intact" construction joints equaled that in monolithic specimens.

5. A significant percentage of weakly bonded construction joints was found in concrete placed during the first construction season. The quality of the construction joints improved during the second construction season. This can be attributed, in part, to an increased effort to ensure adequate consolidation and cleanup. Also of significance was the fact that all of the cores extracted from the second season concrete were from areas where the total cementitious content (cement plus fly ash) was higher.

6. Other properties of the mass concrete such as the modulus of elasticity, Poisson's ratio, and density were within expected ranges.

PUEBLO DAM CONCRETE, AND TEST SPECIMENS

Concrete placed in the river plug and dam contains type II low-alkali cement, class F fly ash, 75-mm (3-in) maximum-size aggregate, and a water-reducing set-controlling admixture. An air-entraining admixture was used to entrain 3.5 percent air by volume of concrete. Calcium chloride, 1 percent by mass of cementitious material, was added to the mix as an accelerator during the cold weather placements. Concrete aggregate for the dam and river plug was obtained from the Walking "O" borrow area, a flood plain deposit in the reservoir area approximately 3 km (2 mi) upstream from the dam.

Two different concrete mix designs were used in both the river plug and the dam. A high cement content (or lower water-to-cement plus fly-ash-ratio) mix was used to increase the durability of concrete that was placed in severe exposure areas. In the river plug, the higher cement content mix was designated as "exterior" and the lower cement content mix as "interior." This designation was not used in the dam; however, specifications required different mix designs based on the $[w/(c+p)]$ (water-to-cement plus fly-ash-ratio). In this report, concrete in the dam will be referred to, as having either a low or a high $w/(c+p)$ ratio. Concrete with a low $w/(c+p)$ ratio was needed in portions of the structure where freeze-thaw durability of the concrete was of prime importance. The low $w/(c+p)$ ratio (0.50 to 0.55) was used in portions of the structure such as on the top exterior faces of the buttresses. A high $w/(c+p)$ ratio of 0.56 to 0.60 was used where it would be protected from repeated cycles of freezing and thawing.

- In the river plug, exterior concrete had a $w/(c+p)$ ratio of 0.45, a cement content of 195.8 kg/m^3 (330 lb/yd^3), and a fly ash content of 48.6 kg/m^3 (82 lb/yd^3). Interior concrete had a $w/(c+p)$ ratio of 0.53, a cement content of 147.7 kg/m^3 (249 lb/yd^3), and a fly ash content of 49.2 kg/m^3 (83 lb/yd^3). Both mixes were designed for a 50-mm (2-in) slump. Design strength for the exterior concrete was 20.7 MPa (3000 lb/in^2) at 28 days and for the interior concrete was 20.7 MPa at 90 days.

- In the dam the high $w/(c+p)$ ratio mixes were proportioned for a $w/(c+p)$ ratio of 0.57, a cement content of 125.8 kg/m^3 (212 lb/yd^3), and a fly ash content of 42.1 kg/m^3 (71 lb/yd^3). Low $w/(c+p)$ ratio mixes were proportioned for a $w/(c+p)$ ratio of 0.53, a cement content of 137.6 kg/m^3 (232 lb/yd^3), and a fly ash content of 45.7 kg/m^3 (77 lb/yd^3). Both mixes were designed for a 50-mm slump, and a strength of 20.7 MPa at 180 days.

The ASTM (American Society for Testing and Materials) Designation: C42-77, "Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete," specifies that the diameter of concrete cores extracted for compressive strength testing should be at least three times, and must be at least twice, the maximum nominal aggregate size. Therefore, since the concrete in the river plug and dam contains 75-mm maximum-size aggregate, the diameter of the concrete cores, by ASTM standards, should have been 225 mm (9 in), but at least 150 mm (6 in). A few of the cores extracted from the river plug, and all dam cores, were 250 mm (10 in) in diameter.

It was decided to extract mostly 150-mm-diameter cores from the river plug for the following reasons:

1. Extraction of the larger diameter cores is significantly more costly. The smaller 150-mm core size was chosen to permit more specimens to be extracted, thereby obtaining a more statistically significant set of test data with the available funds.

2. The primary interest was to obtain tensile strength properties of the concrete and lift joints of the plug to verify design assumptions made relative to the dam design. The 150 mm diameter cores would be adequate to verify the tensile strength design assumptions.

Specimen Extraction and Shipment

There were 14 cores extracted from the river plug, 11 at 6 months and 3 at 3 years after placement. Of the 11 cores extracted at 6 months, 8 were 150 mm and 3 were 250 mm in diameter. The 3 cores extracted at 3 years were all 150 mm in diameter. Twenty-six 250-mm cores were extracted from the dam, 14 at 6 months and 12 at 1 year age.

The actual diameter of the cores ranged from 149.4 to 151.1 mm (5.88 to 5.95 in) for the nominal 150-mm cores, and from 241.3 to 251.0 mm (9.50 to 9.88 in) for the nominal 250-mm cores. All cores in the dam and river plug were drilled vertically. After extraction, the cores were wrapped in plastic and packed in wooden crates with damp sawdust. They were then shipped to the Bureau of Reclamation, Division of Research, Denver, Colorado, for testing. Core drilling locations are shown in table 1 and figures 1 and 2.

When the cores were unpacked in Denver, they were all damp, and no shipping damage was evident, (fig. 3). The cores were logged to provide a record of specimen location, presence of construction joints, and unusual characteristics such as embedded reinforcing steel or rock pockets. All cores were photographed individually (figs. 4, 5), or in groups showing where each core specimen for testing was obtained and how they were marked for cutting.

Specimen Preparation

Cores to be used for elastic properties and compressive strength tests were sawed to 300-and 500-mm (12- and 20-in) lengths to conform to the standard l/d (length/diameter) ratio of 2 to 1. The ends of the 150-mm specimens were sulfur capped to provide a flat bearing surface for the compression tests. The 250-mm-diameter cores were ground flat and smooth on a lapping machine. Cores to be tested in tension were sawed to 455- and 760-mm (18- and 30-in) lengths, after which 50-mm-thick steel plates were cemented with epoxy to each end of the specimen. Cores to be used in evaluating construction joints had at least 150 mm of concrete on each side of the joint. Subsequent to grinding or capping, and prior to testing, all specimens were stored in a 100-percent relative humidity, 23 °C (73 °F), controlled atmosphere.

Specimen Tests

The apparent density of each specimen to be tested in compression was determined prior to testing for strength and elastic properties. The specimens prepared for compressive strength testing were also measured for bulk specific gravity similar to ASTM C97-47, "Absorption and Bulk Specific Gravity of Natural Building Stone." However, specimens were not ovendried because the specified 107 °C (225 °F) drying temperature could have some unwanted effect upon the physical behavior of the concrete during subsequent testing. The dry mass of the specimen was measured at the time density determinations were started.

Modulus of elasticity and Poisson's ratio of the specimens were determined with the aid of an extensometer-compressometer frame, and dial deflection gages mounted such that longitudinal and lateral deformations could be measured while axial load was being applied. Depending on the diameter of the core, each specimen was preloaded to an axial compressive stress of about 7 MPa (1000 lb/in^2). Axial deformation was monitored during preloading to be certain the specimen remained in its elastic range during testing. As the specimen was loaded the second time, axial and lateral deflections were read and recorded at 0, and approximately 0.7- and 7-MPa (100- and 1000-lb/in^2) stresses. The modulus of elasticity and Poisson's ratio were computed on the basis of the net strain between 0.7 and 7 MPa stresses.

After being tested for elastic properties, compression test specimens were loaded axially at the increasing rate of 14 MPa (2000 lb/in^2) per minute until failure occurred, and at that time, the maximum load was recorded. After failure, several specimens were loaded until break-down of the specimen occurred to allow a thorough visual inspection of the failure pattern.

Tension test specimens were loaded axially at the increasing rate of 1.4 MPa (200 lb/in^2) per minute until failure occurred. The load was recorded, and in some cases where failure occurred away from the construction joint (in cores from the river plug), a second test was made. A condensed presentation of test results is given in table 2, and detailed data in tables 3A,B through 8A,B.

Density.—The apparent density of the hardened concrete was as expected. The lowest value was 2310 kg/m^3 (144 lb/ft^3) for specimen No. 16-4-0.0 from the dam. The concrete in the river plug and dam generally had densities greater than 2355 kg/m^3 (147 lb/ft^3), which is comparable to mass concrete in other Bureau structures.

Compressive strength.—Compressive strength development shows strengths in excess of design requirements for both the river plug and dam.

- River plug cores that were tested in compression were 150 mm diameter. The compressive strength of interior concrete averaged 41.8 MPa (6070 lb/in^2) at 6 months and 37.0 MPa (5360 lb/in^2) at 3 years. The compressive strength of the exterior concrete averaged 44.3 MPa (6420 lb/in^2) at 6 months and 41.2 MPa (5980 lb/in^2) at 3 years (fig. 6). Although, the average compressive strengths indicate a slight decrease with time, the number of specimens and the relative magnitudes show that the apparent decrease is insignificant. Paralleling the strength trends, the ratio of core compressive strength to 28-day control cylinder strength declined from 6 months to 3 years. For interior concrete, the ratio dropped from 173 to 167 percent; the exterior concrete ratio dropped from 134 to 128 percent (fig. 7).

- Dam cores showed a definite increase in compressive strength from 6 months to 1 year. Compressive strengths in high $w/(c+p)$ ratio concrete increased from 22.4 MPa (3250 lb/in^2) to 28.1 MPa (4080 lb/in^2). Compressive strengths in low $w/(c+p)$ ratio concrete increased from 26.0 MPa (3770 lb/in^2) to 31.1 MPa (4510 lb/in^2). Average low $w/(c+p)$ ratio concrete strengths were greater than high ratio concrete strengths at both 6 months and 1 year, as would be expected. Cores from dam concrete tested in compression had diameters of 250 mm in contrast to the 150-mm cores from the plug concrete.

Compressive strengths in high $w/(c+p)$ ratio concrete averaged 171 and 199 percent of their 28-day cylinder strengths at 6 months and 1 year, respectively (figs. 6, 7). Compressive strengths in low $w/(c+p)$ ratio concrete averaged 160 and 186 percent of their 28-day cylinder strengths. The core strengths at 6 months and 1 year are in excess of that expected for sealed-cured mass cylinders. *The Concrete Manual*[1][3] Designation 33 (page 572, fig. 226) indicates average strengths of 135 and 145 percent of the strength of 28-day, 150- by 300-mm cylinders.

[3] Numbers in brackets refer to entries in the bibliography.

Modulus of elasticity.—The elastic properties of the concrete from the river plug were determined from tests conducted on 150-mm-diameter cores. In contrast, the elastic properties of the concrete from the dam were determined from tests made on 250-mm-diameter cores. Figure 8 shows the modulus of elasticity plotted against time for the dam and river plug cores.

- In the river plug the average modulus for interior concrete increased from 30.8 GPa (4.46 x 10^6 lb/in^2) at 6 months to 31.4 GPa (4.56 x 10^6 lb/in^2) at 3 years. Exterior concrete had an average modulus of 30.5 GPa (4.42 x 10^6 lb/in^2) at 6 months, and a somewhat smaller modulus of 30.1 GPa (4.37 x 10^6 lb/in^2) at 3 years. The slight change in the modulus for the exterior concrete is insignificant due to the limited number of cores tested and the variability of the data.

- In the dam, the average moduli of low and high $w/(c+p)$ ratio concrete increased from 6 months to 1 year. The average modulus for high $w/(c+p)$ ratio concrete rose from 28.1 GPa (4.07 x 10^6 lb/in^2) to 36.0 GPa (5.22 x 10^6 lb/in^2). The average modulus for low $w/(c+p)$ ratio concrete rose from 28.7 GPa (4.16 x 10^6 lb/in^2) to 32.3 GPa (4.69 x 10^6 lb/in^2).

Poisson's Ratio.—In the river plug, the interior concrete exhibited a lower ratio than exterior concrete at both 6 months and 3 years. Interior concrete showed a slight decrease in the average ratio from 0.18 to 0.16. Exterior concrete showed an increase in the average ratio from 0.20 to 0.27. These ratios are within ranges found for other Bureau mass concrete dams.

- In the dam no significant change occurred in the average value of Poisson's ratio in either high or low $w/(c+p)$ ratio concrete. In high ratio concrete, Poisson's ratio averaged 0.20 at both 6 months and 1 year. In low ratio concrete, the Poisson's ratio went from an average of 0.22 at 6 months to 0.20 at 1 year.

Construction Joint Investigation and Tensile Strengths

- In the river plug, an experimental field application of a chlorinated-rubber resin-base curing and bonding compound was made on a small test area in block 5. Results from test cores indicated that this compound was generally unacceptable because of the resultant loss of bond at the construction joint.

At 6 months, two 150-mm cores were drilled which extended through two horizontal construction joints where the resin-base compound had been applied. Three of these cores broke at the joint during drilling which indicated poor bonding. The joint in the remaining specimen developed a tensile strength of 1.37 MPa (198 lb/in^2). At 3 years, one 150-mm core was drilled through two horizontal construction joints prepared with the same compound, and both joints broke during drilling.

For comparison, at 6 months, eight 150-mm cores were drilled through horizontal construction joints which had been cleaned and prepared by the traditional wet-sandblast method. One of these broke in handling, and another was cracked when received. Six cores, containing exterior concrete, were tested in tension. Four cores failed at some distance from the joint and had an average tensile strength of 1.45 MPa (210 lb/in^2). The other two cores failed at the joint and had an average tensile strength of 1.25 MPa (182 lb/in^2). The average for these six tests was 1.39 MPa (201 lb/in^2). Also at 6 months, four 250-mm cores containing exterior concrete, were tested in tension. All four cores failed at some distance from the joint, and had an average tensile strength of 1.70 MPa (246 lb/in^2) which compared favorably with the 150-mm cores.

Tensile strengths for specimens containing intact construction joints were comparable to strengths developed by nonjointed or monolithic specimens (fig. 9). Combined data from both interior and exterior river plug concrete showed that at 6 months, jointed specimens had an average overall tensile strength of 1.50 MPa (217 lb/in^2), while nonjointed specimens had an average tensile strength of 1.39 MPa (202 lb/in^2). At 3 years, jointed specimens had an average tensile strength of 1.16 MPa (168 lb/in^2), while nonjointed specimens had an average tensile strength of 1.52 MPa (221 lb/in^2). No significant change occurred in the average tensile strengths from 6 months to 3 years. In all cases exterior concrete showed a higher average tensile strength than did interior concrete, as might be expected.

Average tensile strengths are shown expressed as a percentage of their respective compressive strengths (fig. 10). Based on 150-mm-diameter cores only, and combining exterior and interior and jointed and nonjointed test data, 6 months tensile strengths averaged about 3.1 percent of 6 months compressive strengths. Three years tensile strengths averaged about 3.6 percent of 3 years compressive strengths, showing a slight increase with age. A significant reduction in the tensile strength occurred when the area of aggregate disbonding exceeded 50 percent of the total break area. When more than half of the total break area failed to bond around large cobbles, the strength reduction was even greater. There were, however, a few exceptions to this general trend.

- In the dam, a total of 24 cores were drilled through horizontal construction joints, cleaned, and prepared by a high-pressure water jet method. Of these joints 9 were separated when received, and two additonal ones broke in handling, indicating a possible problem with the cleanup procedures.

For concrete with a high $w/(c+p)$ ratio, only two cores with joints were tested, one at 6 months and the other at 1 year. Both specimens failed at the joint. At 6 months, a tensile strength of 1.1 MPa (159 lb/in^2) was recorded; while at 1 year, a tensile strength of only 0.79 MPa (115 lb/in^2) was recorded.

For concrete with a low $w/(c+p)$ ratio, 11 cores with joints were tested, 7 cores at 6 months age and 4 cores at 1 year. At 6 months, only one of the cores did not break at the joint. The apparent minimum average joint strength was 1.44 MPa (209 lb/in^2). At 1 year, three of the four cores tested failed at the joint. The apparent minimum average joint strength was 1.51 MPa (219 lb/in^2) which is 0.07 MPa (10 lb/in^2) over that shown at 6 months.

Tensile strength of intact jointed specimens averaged slightly higher than tensile strengths of nonjointed specimens (fig. 9). At 6 months, jointed specimens averaged 1.40 MPa (203 lb/in^2) in tensile strength, while nonjointed specimens averaged 1.28 MPa (186 lb/in^2) in tensile strength. At 1 year, jointed specimens averaged 1.37 MPa (198 lb/in^2), while nonjointed specimens averaged 1.26 MPa (183 lb/in^2) in tensile strength. No significant change occurred in the tensile strengths from 6 months to 1 year. In all cases, low $w/(c+p)$ ratio concrete exhibited an equal or stronger average tensile strength than did high $w/(c+p)$ ratio concrete. Tensile strengths at 6 months averaged about 5.4 percent of 6 months compressive strengths. One year tensile strengths averaged 4.3 percent of 1 year compressive strengths (fig. 10).

Areas of inadequate consolidation in parts of the dam were indicated by the presence of rock pockets and small air voids at several of the construction joints which were disbonded when received. Some joints which indicated the lack of bond were also possibly due to poor joint cleanup. Five of the nine joints which were disbonded when received, and one of the two joints which broke in handling, showed some signs of inadequate cleanup. No obvious reason for bond failure was found for the other disbonded joints. One joint from the equipment access gallery in buttress 9 broke during drilling, and the other broke in handling. Both joints showed signs of inadequate cleanup, and one joint showed signs of poor consolidation. The joint in the 6-month core from the equipment access gallery in buttress 15 broke during drilling and showed signs of inferior cleanup. The joint from placement 8F6, downstream from the dam, broke during drilling because of a large rock pocket, the largest one that was found (fig. 4). The joint obtained from buttress 20 at 1 year also broke during drilling. Small rock pockets were visible near the joint.

Considering these references to poor joint cleanup, apparently the ability to discern what constitutes adequate construction joint preparation is often quite difficult, regardless of the method used. The presence of oil, curing compound, sawdust, and in some cases laitance, observed on the disbonded joints of cores indicated inadequate joint cleanup.

When such substances are evident on only a few of the disbonded construction joints, admittedly it is difficult to determine by this method of observation, just how completely the laitance was removed. Another cleanup problem resulted from using the recirculated water in the water-jet. This water contained very fine sand particles, which caused severe wear on the water-jet nozzle orifices. The worn, enlarged orifices reduced the pressure and effectiveness of the water jet. When the worn nozzles were not replaced as frequently as the situation required, this ineffectiveness likely left some areas inadequately cleaned.

The need to control temperature rise in the concrete necessitated the use of a concrete mix with a low mortar-aggregate ratio. The lower mortar content in the concrete mixture would also limit the potential bond strength. This created another problem since the consolidation of concrete with low mortar-aggregate ratios requires more than normal vibration, something that is difficult to achieve consistently at a construction site.

Requiring the extraction of cores in the early stages of construction proved beneficial. Forty-six percent of the cores containing construction joints, that were obtained from the 1973 placements, were bonded. In contrast 82 percent of the cores from the 1974 placements were bonded. This is partially due to the greater percentage of low $w/(c+p)$ cores which contained approximately 30 kg/m^3 (50 lb/yd^3) more cementitious material, but also is due to the greater efforts to improve cleanup operations and consolidation. This investigation clearly demonstrates the need for detailed inspection of both cleanup and concrete placement operations.

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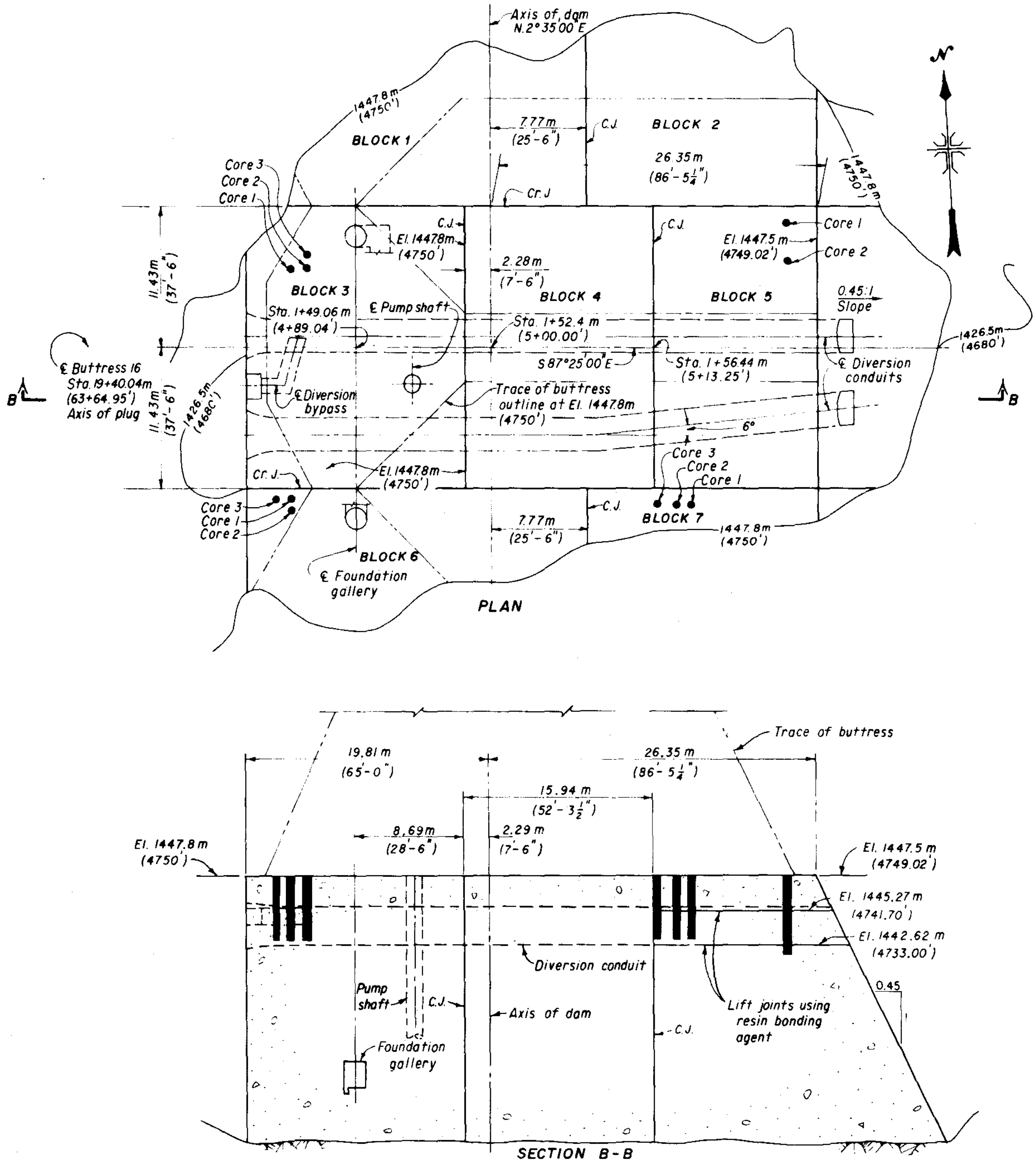

Figure 1. — Location of cores extracted from river plug.

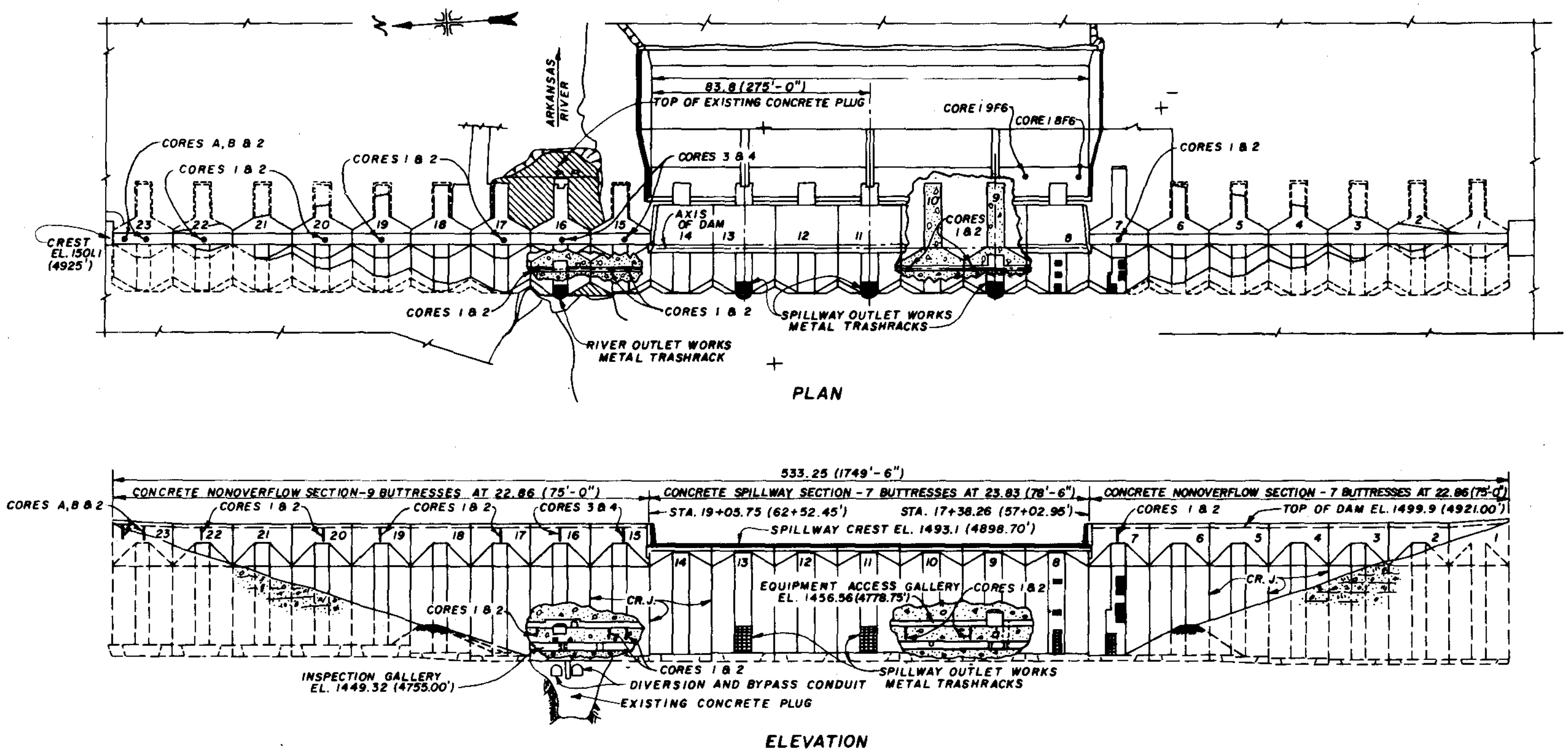

Figure 2. — Location of cores extracted from Pueblo Dam.

Figure 3. — Typical core sample placed in packing crate. Photo P-801-D-79443

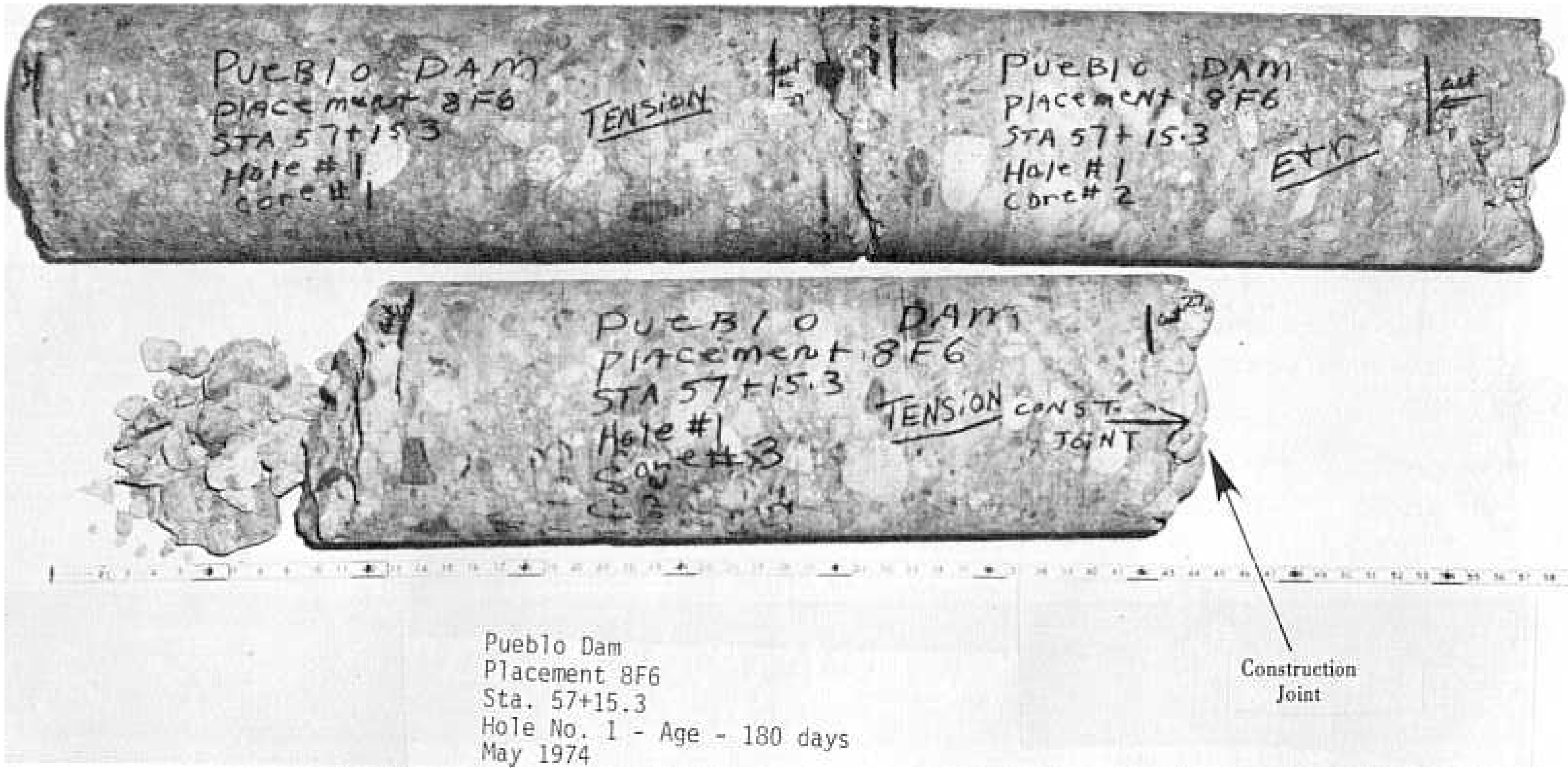

Figure 4. — Inadequate consolidation at construction joint (shown in core from placement 8F6). Photo P-801-D-79444

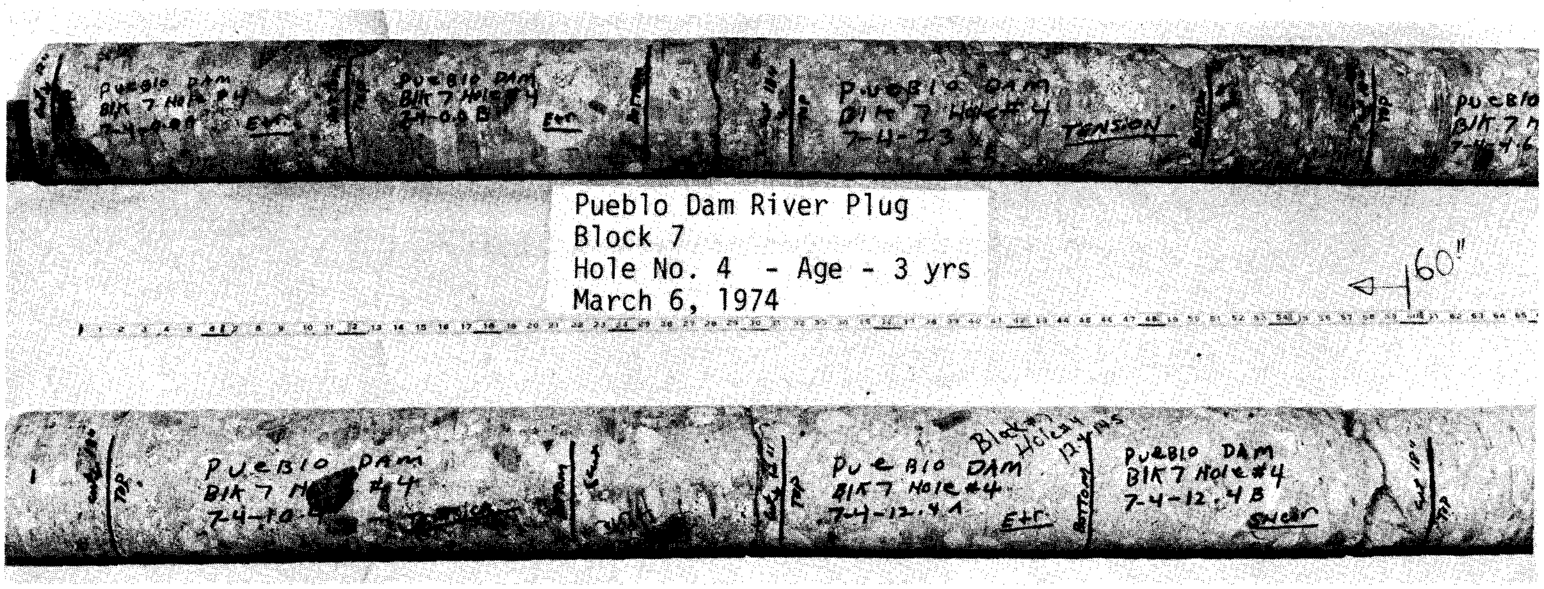

Figure 5. — Typical concrete core sample marked for cutting. Note good consolidation at construction joint. Photo C-8327-36

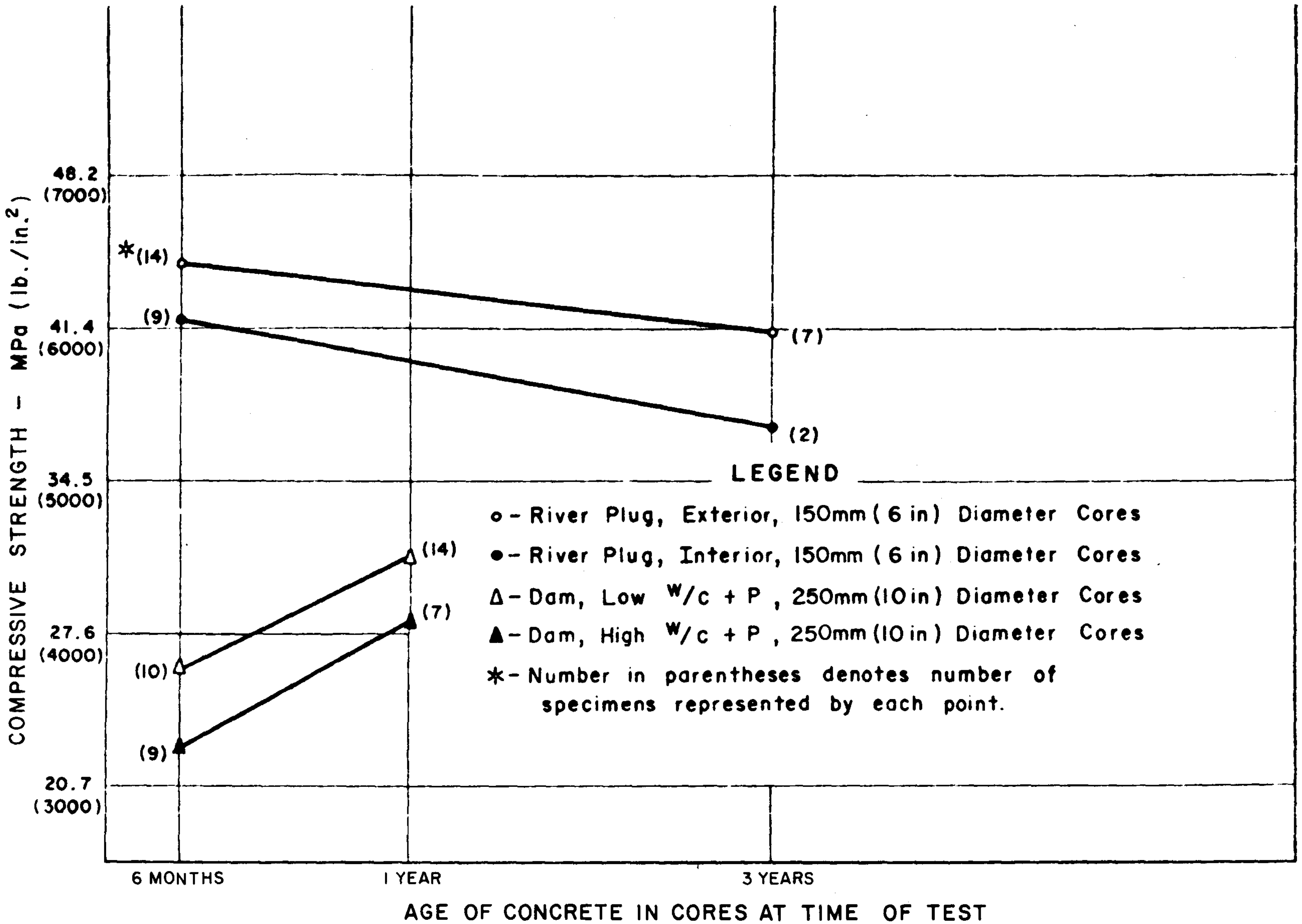

Figure 6. — Average compressive strengths of mass concrete.

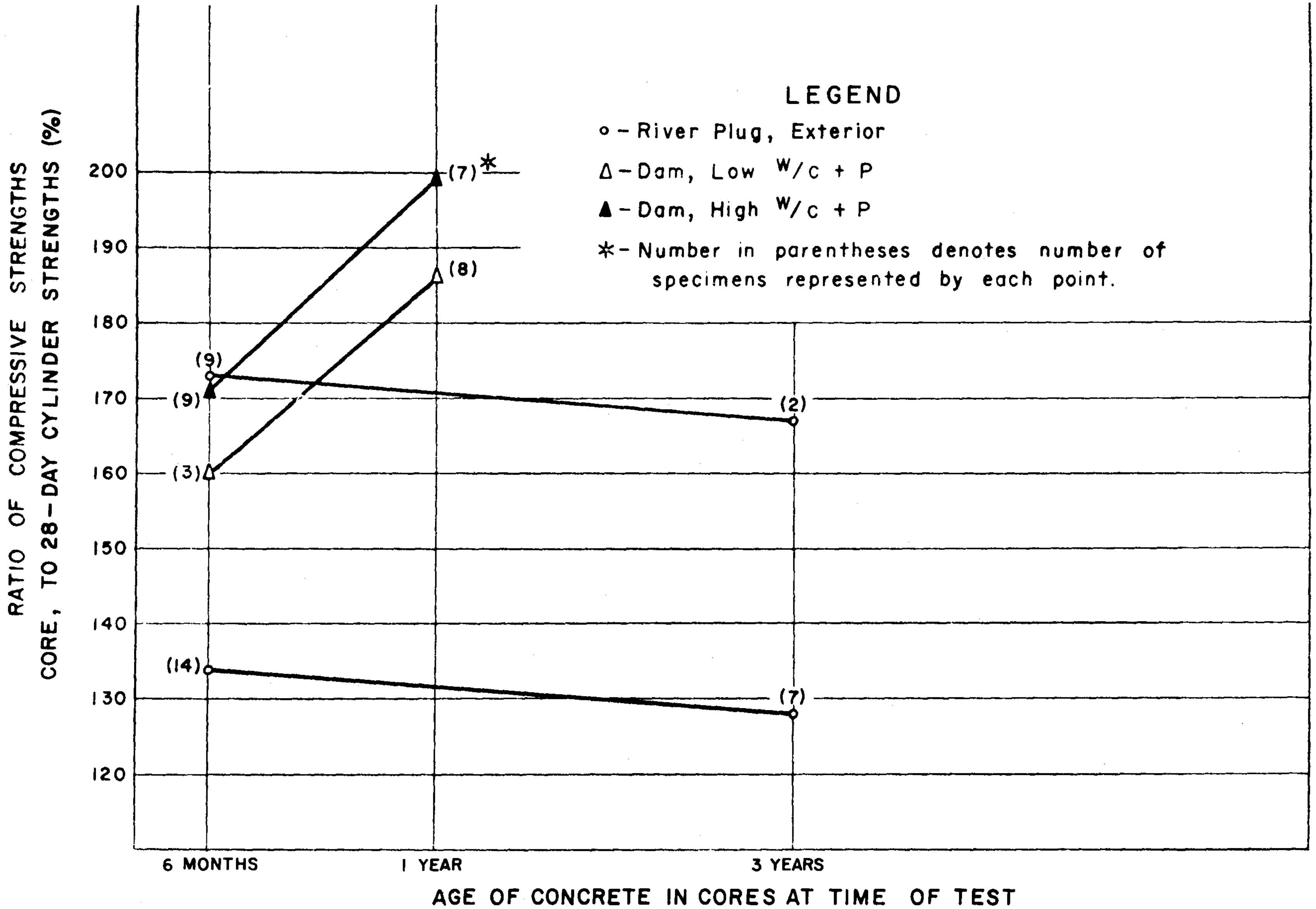

Figure 7. — Ratio of core to companion cylinder strengths.

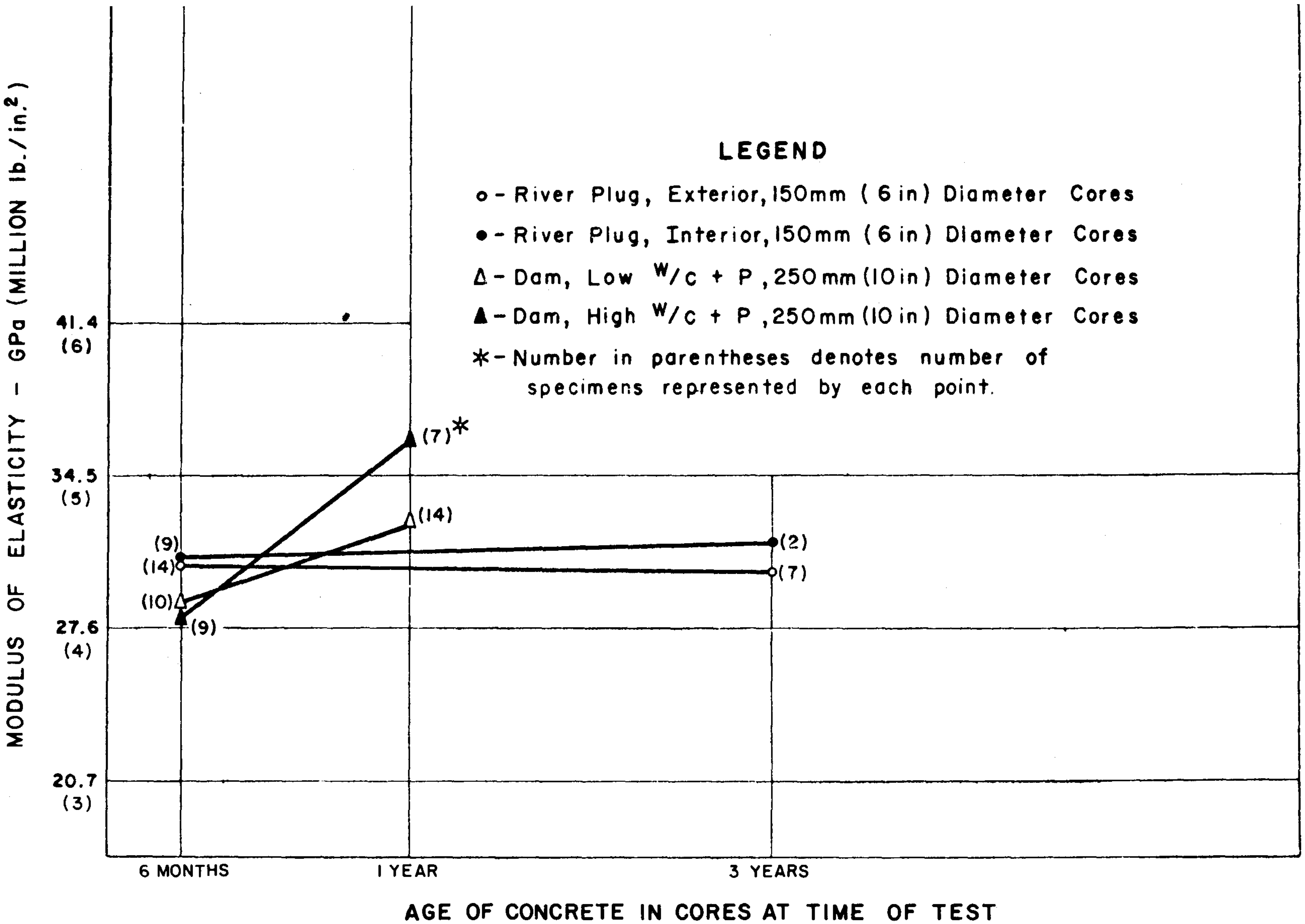

Figure 8. — Average moduli of elasticity of mass concrete.

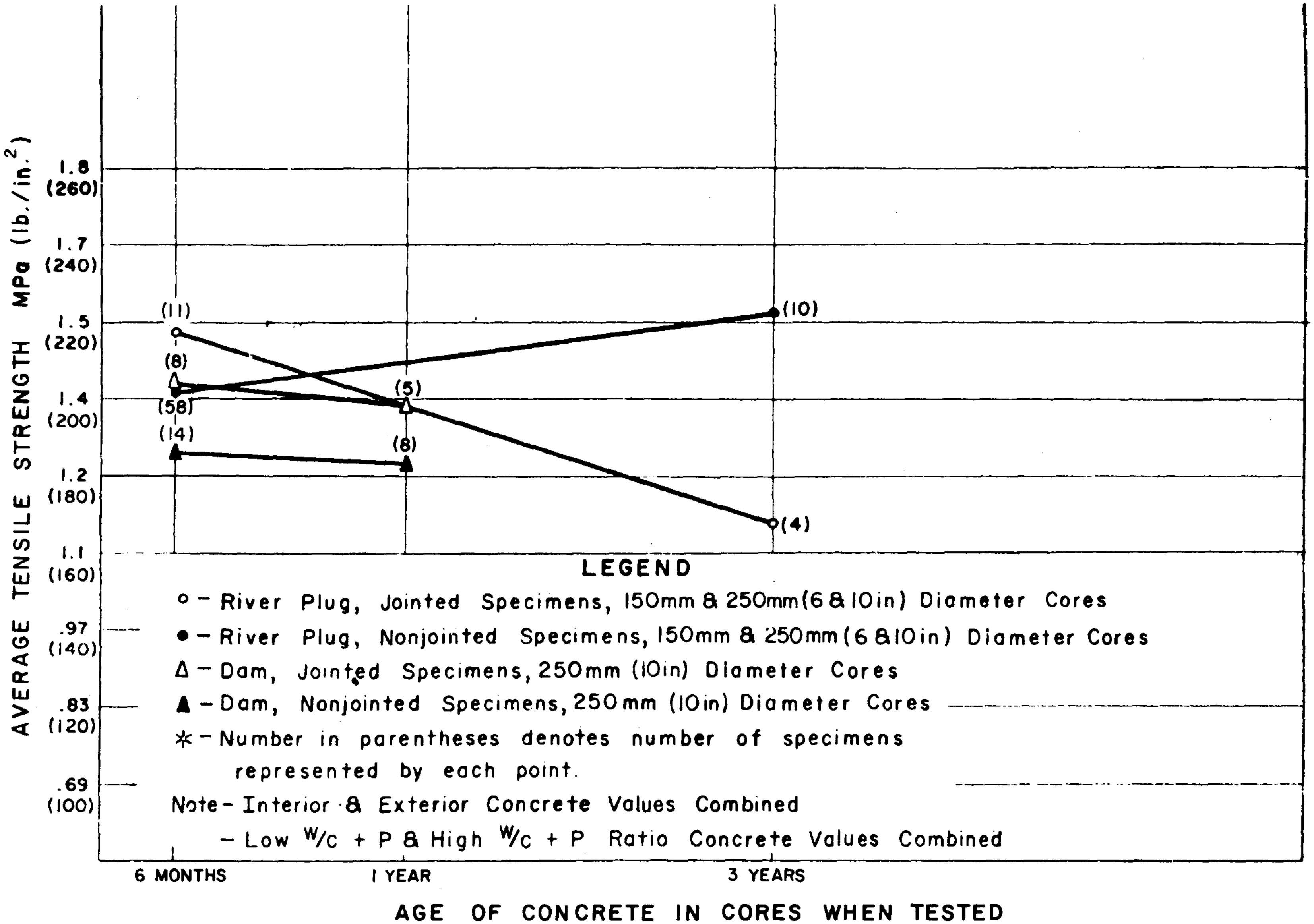

Figure 9. — Average tensile strengths of mass concrete.

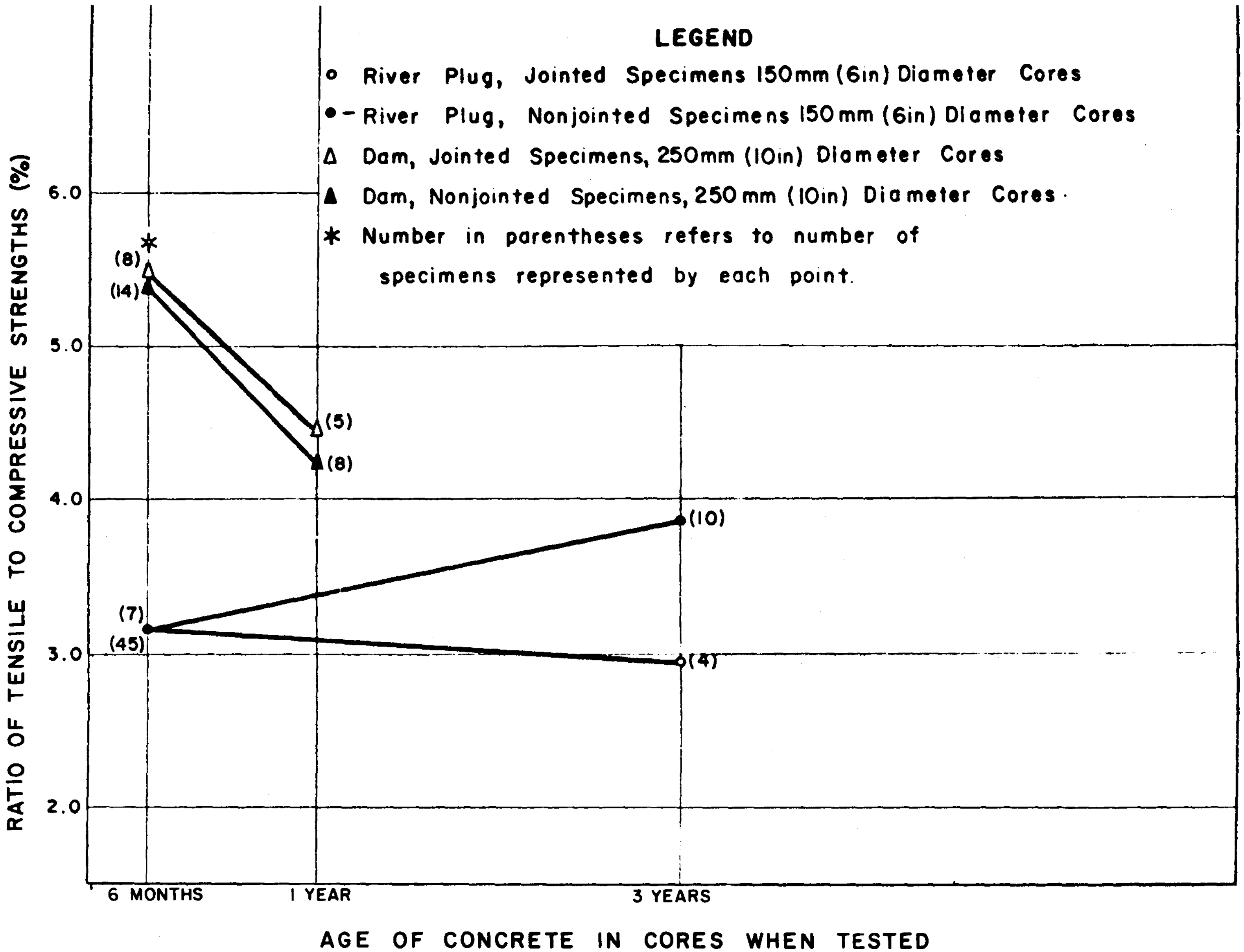

Figure 10. — Ratio of tensile to compressive strengths.

Table 1. — *Concrete core, location and diameter*

River Plug

Block No.	Core hole No.	Hole location[1] Elevation m	ft	Station m	ft	Offset m	ft	Core diameter mm	in
3	1	1447.8	4750.0	1+36.5	4+47.7	6.2 L	20.5 L	150	6
3	2	1447.8	4750.0	1+37.7	4+51.9	6.2 L	20.5 L	150	6
3	3	1447.8	4750.0	1+37.8	4+52.0	7.3 L	23.9 L	250	10
5	1	1447.5	4749.15	1+75.9	5+77.2	9.8 L	32.3 L	150	6
5	2	1447.5	4749.15	1+75.9	5+77.0	6.8 L	22.2 L	150	6
5	3	1447.5	4749.15	*	*	*	*	150	6
6	1	1447.8	4750.0	1+36.6	4+48.0	12.0 R	39.3 R	150	6
6	2	1447.8	4750.0	1+36.6	4+48.0	12.9 R	42.3 R	150	6
6	3	1447.8	4750.0	1+35.3	4+44.0	12.3 R	40.4 R	250	10
6	4	1447.8	4750.0	*	*	*	*	150	6
7	1	1447.6	4749.5	1+68.2	5+51.8	12.2 R	40.2 R	150	6
7	2	1447.6	4749.5	1+67.0	5+47.9	12.5 R	41.1 R	150	6
7	3	1447.6	4749.5	1+65.5	5+43.0	12.4 R	40.8 R	250	10
7	4	1447.6	4749.5	*	*	*	*	150	6

Dam

Buttress or placement No.	Core hole No.	Hole location[2] Elevation m	ft	Station m	ft	Offset m	ft	Core diameter mm	in
7	1	1499.9	4921.0	17+25.6	56+61.45	℄ of roadway		250	10
7	2	1499.9	4921.0	17+28.1	56+69.45	℄ of roadway		250	10
9	1	1456.56	4778.75	17+84.0	58+52.95	0.1 d/s E.A. Gallery	0.33	250	10
9	2	1456.56	4778.75	17+83.4	58+50.95	0.1 d/s E.A. Gallery	0.33	250	10
10	1	1456.56	4778.75	18+07.9	59+31.45	0.1 d/s E.A. Gallery	0.33	250	10
10	2	1456.56	4778.75	18+07.3	59+29.45	0.1 d/s E.A. Gallery	0.33	250	10
15	1	1456.56	4778.75	19+13.5	62+77.9	In floor at E.A. Gallery		250	10
15	2	1456.56	4778.75	19+19.6	62+97.95	℄ E.A. Gallery		250	10
15	3	1499.9	4921.0	19+16.0	62+85.95	℄ of roadway		250	10
15	4	1499.9	4921.0	19+18.4	62+93.95	℄ of roadway		250	10
16	1	1456.56	4778.75	19+50.6	63+99.45	In floor at E.A. Gallery		250	10
16	2	1456.56	4778.75	19+48.6	63+92.95	℄ E.A. Gallery		250	10
16	3	1499.9	4921.0	19+38.8	63+60.95	℄ of roadway		250	10
16	4	1499.9	4921.0	19+41.3	63+68.95	℄ of roadway		250	10
17	1	1499.9	4921.0	19+61.7	64+35.95	℄ of roadway		250	10
17	2	1499.9	4921.0	19+64.1	64+43.95	℄ of roadway		250	10
19	1	1499.9	4921.0	20+07.4	65+85.95	℄ of roadway		250	10
19	2	1499.9	4921.0	20+09.8	65+93.95	℄ of roadway		250	10
20	1	1499.9	4921.0	20+30.3	66+60.95	℄ of roadway		250	10
20	2	1499.9	4921.0	20+32.7	66+68.95	℄ of roadway		250	10
22	1	1499.9	4921.0	20+79.3	68+22	℄ of buttress		250	10
22	2	1499.9	4921.0	20+77.2	68+14.95	℄ of buttress		250	10
23	1A[3]	1501.03	4924.65	21+02.2	68+97	℄ of buttress		250	10
23	1B	1501.03	4924.65	21+09.5	69+21	℄ of buttress		250	10
23	2	1500.38	4922.50	20+97.2	68+80.65	℄ of buttress		250	10
8F6	1	1449.3	4755	17+42.0	57+15.3	24.7 d/s of axis	81	250	10
9F6	1	1449.3	4755	17+62.9	57+83.7	24.7 d/s of axis	81	250	10

* Data not available.
1 Stations taken along centerline buttress 16. Station 1+52 (5+00) = centerline axis of dam with stations increasing in downstream direction. Left of center (L), right of center (R).
2 Stations are along axis of dam. Offsets are distances upstream or downstream from axis of dam.
3 Hole 1A abandoned.

Table 2. — *Summary of physical properties*

75-mm (3-in) MSA 1/
(Detailed data contained in tables 3A through 8B and figures 7 and 8)

Mass Concrete From River Plug

Age	English units: Interior concrete	English units: Exterior concrete	SI units: Interior concrete	SI units: Exterior concrete
	Compressive strength (averages)			
	Values in lb/in² 6-in-diameter cores		Values in MPa 150-mm-diameter cores	
6 months	2/ 6070 (9)	6420 (14)	41.8 (9)	44.3 (14)
3 years	5360 (2)	5980 (7)	37.0 (2)	41.2 (7)
	Ratio core strengths to companion 28-day control cylinder strength (averages)			
	Values in percent 6-in-diameter cores		Values in percent 150-mm-diameter cores	
6 months	173 (9)	134 (14)	173 (9)	134 (14)
3 years	167 (2)	128 (7)	167 (2)	128 (7)
	Modulus of elasticity (averages)			
	Values in 10^6 lb/in² 6-in-diameter cores		Values in GPa 150-mm-diameter cores	
6 months	4.46 (9)	4.42 (14)	30.8 (9)	30.5 (14)
3 years	4.56 (2)	4.37 (7)	31.4 (2)	30.1 (7)
	Poisson's ratio (average)			
	6-in-diameter cores		150-mm-diameter cores	
6 months	0.18 (9)	0.20 (14)	0.18 (9)	0.20 (14)
3 years	0.16 (2)	0.27 (7)	0.16 (2)	0.27 (7)
	Tensile strengths of construction joints (averages)			
	Values in lb/in² 6-in-diameter cores		Values in MPa 150-mm-diameter cores	
6 months	198 (1) resin 3/	201 (6) WS	1.37 (1) resin	1.39 (6) WS
3 years	144 (2) WS	192 (2) WS	0.99 (2) WS	1.32 (2) WS
	10-in-diameter cores		250-mm-diameter cores	
6 months	-	246 (4) WS	-	1.70 (4) WS
3 years	-	-	-	-
	Tensile strengths of nonjointed concrete (averages)			
	Values in lb/in² 6-in-diameter cores		Values in MPa 150-mm-diameter	
6 months	184 (17)	206 (28)	1.27 (17)	1.42 (28)
3 years	215 (4)	226 (6)	1.48 (4)	1.56 (6)
	10-in-diameter cores		250-mm-diameter cores	
6 months	153 (3)	233 (10)	1.05 (3)	1.61 (10)
3 years	-	-	-	-
	Ratio tensile strengths to companion compressive strengths (averages)			
	Jointed (%)	Nonjointed (%)	Jointed (%)	Nonjointed (%)
6 months	3.15 (7)	3.14 (45)	3.15 (7)	3.14 (45)
3 years	2.95 (4)	3.87 (10)	2.95 (4)	3.87 (10)

Table 2. — *Summary of physical properties - (continued)*

75-mm (3-in) MSA 1/
(Detailed data contained in tables 3A through 8B and figures 7 and 8)

Mass Concrete From the Dam
[All values based on 250-mm (10 in) diameter cores]

Age	English units: High W/(C+P) 4/ ratio concrete	English units: Low W/(C+P) 5/ ratio concrete	SI units: High W/(C+P) ratio concrete	SI units: Low W/(C+P) ratio concrete
	Compressive strength (averages)			
	Values in lb/in²		Values in MPa	
6 months	3250 (9)	3770 (10)	22.4 (9)	26.0 (10)
1 year	4080 (7)	4510 (14)	28.1 (7)	31.1 (14)
	Ratio compressive strength to companion 28-day control cylinder strength (averages)			
	Values in percent		Values in percent	
6 months	171 (9)	160 (3)	171 (9)	160 (3)
1 year	199 (7)	186 (8)	199 (7)	186 (8)
	Modulus of elasticity (averages)			
	Values in 10^6 lb/in²		Values in GPa	
6 months	4.07 (9)	4.16 (10)	28.1 (9)	28.7 (10)
1 year	5.22 (7)	4.69 (14)	36.0 (7)	32.3 (14)
	Poisson's ratio (average)			
6 months	0.20 (9)	0.22 (10)	0.20 (9)	0.22 (10)
1 year	0.20 (7)	0.20 (14)	0.20 (7)	0.20 (14)
	Tensile strengths of construction joints (averages)			
	Values in lb/in²		Values in MPa	
6 months	159 (1) WS	209 (7) WJ	1.1 (1) WJ	1.44 (7) WJ
1 year	115 (1) WS	219 (4) WJ	0.79 (1) WJ	1.51 (4) WJ
	Tensile strengths of nonjointed concrete (averages)			
	Values in lb/in²		Values in MPa	
6 months	186 (8)	186 (6)	1.28 (8)	1.28 (6)
1 year	152 (4)	213 (4)	1.05 (4)	1.47 (4)
	Ratio tensile strengths to companion compressive strengths			
	Jointed (%)	Nonjointed (%)	Jointed (%)	Nonjointed (%)
6 months	5.46 (8)	5.38 (14)	5.46 (8)	5.38 (14)
1 year	4.45 (5)	4.23 (8)	4.45 (5)	4.23 (8)

1/ 75-mm (3-in) maximum-size aggregate with 100 percent passing 100-mm (4-in) screen.
2/ Number in parentheses indicates number of specimens tested.
3/ Method of joint preparation: Resin - Rubber - Resin Base Compound
WS - wet sandblast
WJ - water jet

4/ High ratio indicates 0.55 ≤ W(C+P) ≤ 0.60.
5/ Low ratio indicates 0.50 ≤ W(C+P) ≤ 0.55.

Table 3A. — *River plug compressive strengths, 150-mm-diameter cores (6 months and 3 years age) (SI)*

Core No.	Elevation above sea level (m)	Dates: Concrete placed	Dates: Specimen drilled	Dates: Specimen tested	Concrete temperature (°C)	Properties of fresh concrete: W/(C+P) by mass	Cement content (kg/m³)	Pozzolan content (kg/m³)	Water content (kg/m³)	Percent sand	Density (kg/m³)	Properties of hardened concrete: 3/ 28-day compressive strength (MPa)	Compressive strength (MPa)	Modulus of elasticity (GPa)	Poisson's ratio	Density (kg/m³)	Strength ratio core to 28-day control cylinder (%)
6 months' age 150-mm-diameter cores																	
Interior concrete																	
		1971	1971	1971													
1/ 5-1-6.7	1447.54	Apr. 19	Sept. 16	Nov. 10	16	0.54	148	49	106	27	2380	22.5	56.6	30.1	0.19	-	2.51
5-1-8.5	1447.54	Apr. 19	Sept. 16	Nov. 10	16	0.54	148	49	106	27	2380	22.5	48.9	32.5	0.18	-	2.17
5-1-16.9	1447.54	Apr. 9	Sept. 16	Nov. 5	13	0.52	147	49	102	27	2371	24.8	28.5	31.7	0.18	-	1.15
5-2-16.4	1447.54	Apr. 10	Sept. 17	Nov. 10	10	0.53	147	49	104	27	2372	25.3	35.7	33.0	0.17	-	1.41
5-2-17.7	1447.54	Apr. 9	Sept. 17	Nov. 10	13	0.52	147	49	102	27	2371	24.8	32.5	26.7	0.18	-	1.31
6-1-9.4	1447.80	Mar. 27	Sept. 18	Nov. 5	18	0.54	148	49	106	27	2387	25.8	41.4	31.8	0.15	-	1.61
6-1-12.6	1447.80	Mar. 27	Sept. 20	-	18	0.54	148	49	106	27	2387	25.8	41.0	27.2	0.15	-	1.59
6-2-11.6	1447.80	Mar. 27	Sept. 20	Nov. 12	18	0.54	148	49	106	27	2387	25.8	45.6	28.3	0.20	-	1.77
5-2-6.1	1447.54	Apr. 19	Sept. 16	Nov. 12	15	0.54	148	49	106	27	2380	22.5	46.1	33.2	0.20	-	2.04
Average												24.4	41.8	30.7	0.18	-	1.73
Exterior concrete																	
		1971	1971	1971													
3-1-0.1	1447.80	Mar. 28	Sept. 21	Nov. 12	13	0.43	196	49	105	25	2371	34.8	32.3	27.8	0.20	-	0.93
3-1-4.6	1447.80	Mar. 23	Sept. 21	Nov. 12	14	0.42	197	49	103	25	2387	37.8	54.9	29.9	0.18	-	1.45
3-2-1.1	1447.80	Mar. 28	Sept. 22	Nov. 12	13	0.43	196	49	105	25	2371	34.8	45.8	31.0	0.16	-	1.31
3-2-4.5	1447.80	Mar. 23	Sept. 22	Nov. 12	14	0.42	197	49	103	25	2387	37.8	46.9	32.5	0.19	-	1.24
3-2-13.8	1447.80	Mar. 22	Sept. 22	Nov. 12	11	0.44	196	49	107	25	2374	34.9	45.8	33.6	0.23	-	1.31
5-2-0.4	1447.54	Apr. 27	Sept. 16	Nov. 10	13	0.44	195	49	107	25	2371	32.4	32.4	30.4	0.14	-	1.00
5-2-3.3	1447.54	Apr. 27	Sept. 16	Nov. 5	10	0.45	193	48	107	25	2352	30.4	45.8	34.3	0.18	-	1.50
6-1-5.9	1447.80	Apr. 5	Sept. 18	Nov. 12	9	0.43	195	49	104	24	2368	32.7	51.1	27.8	0.22	-	1.56
6-2-0.0	1447.80	Apr. 5	Sept. 20	Nov. 5	11	0.43	197	49	104	25	2384	35.6	31.3	29.0	0.31	-	1.36
6-2-5.8	1447.80	Apr. 5	Sept. 20	Nov. 12	9	0.43	195	49	104	24	2368	32.7	44.6	30.1	0.16	-	1.61
7-1-4.3	1447.65	Apr. 29	Sept. 13	Nov. 12	14	0.44	196	49	107	25	2377	30.8	49.6	29.2	0.16	-	1.74
7-1-5.3	1447.65	Apr. 29	Sept. 13	Nov. 12	14	0.44	196	49	107	25	2377	30.8	53.4	32.7	0.18	-	1.30
7-2-2.3	1447.65	Apr. 29	Sept. 15	Nov. 5	14	0.44	196	49	107	25	2377	30.8	39.9	29.2	0.18	-	1.50
7-2-3.3	1447.65	Apr. 29	Sept. 15	Nov. 5	14	0.44	196	49	107	25	2377	30.8	46.1	28.8	0.23	-	
Average												33.4	44.3	30.5	0.20	-	1.34
3 years' age 150-mm-diameter cores																	
Exterior concrete																	
		1971	1973	1974													
2/ 5-3-0.0A	1447.54	Apr. 27	Dec. 8	Mar. 14	13	0.44	195	49	107	25	2371	32.4	30.0	28.8	0.17	2460	0.93
5-3-0.0B	1447.54	Apr. 27	Dec. 8	Mar. 14	13	0.44	195	49	107	25	2371	32.4	39.3	28.4	0.16	2440	1.71
6-4-0.0B	1447.80	Apr. 5	Nov. 29	Mar. 14	11	0.43	197	49	104	25	2384	35.6	29.2	30.5	0.37	2430	0.82
6-4-5.0	1447.80	Apr. 5	Nov. 30	Mar. 14	9	0.43	195	49	104	24	2368	32.7	51.1	29.0	0.32	2460	1.56
6-4-9.4	1447.80	Apr. 5	Dec. 4	Mar. 14	9	0.43	195	49	104	24	2368	32.7	47.6	29.8	0.38	2450	1.46
7-4-0.0A	1447.65	Apr. 29	Dec. 5	Mar. 14	14	0.44	196	49	107	25	2377	30.8	47.7	33.0	0.15	2450	1.55
7-4-0.0B	1447.65	Apr. 29	Dec. 5	Mar. 14	14	0.44	196	49	107	25	2377	30.8	43.5	31.5	0.36	2470	1.41
Average													41.2	30.1	0.27	2450	12.8
Interior concrete																	
		1971	1973	1974													
5-3-10.4B	1447.54	Apr. 19	Dec. 10	Mar. 14	16	0.54	148	49	106	27	2380	22.5	39.2	26.0	0.15	2460	1.74
7-4-12.4A	1447.80	Apr. 20	Dec. 7		14	0.52	147	49	102	27	2368	21.7	34.7	37.0	0.16	2520	1.60
Average													37.0	31.4	0.16	2490	1.67

1/ First number, block number; second number, hole number; and third number, depth to top of core (ft).
2/ Letters are added when original core is cut into more than one test specimen.
3/ Test specimen 150- x 300-mm cylinder.

Table 3B. — *River plug compressive strengths, 6-in-diameter cores (6 months and 3 years age)*

Core No.	Elevation above sea level (ft)	Dates: Concrete placed	Dates: Specimen drilled	Dates: Specimen tested	Properties of fresh concrete: Concrete temperature (°F)	W/(C+P) by weight	Cement content (lb/yd³)	Pozzolan content (lb/yd³)	Water content (lb/yd³)	Percent sand	Unit weight (lb/yd³)	Properties of hardened concrete: 3/ 28-day compressive strength (lb/in²)	Compressive strength (lb/in²)	4/ Modulus of elasticity E x 10⁻⁶ (lb/in²)	Poisson's ratio	Density (lb/ft³)	Strength ratio core to 28-day control cylinder (%)
6 months' age 6-in-diameter cores																	
Interior concrete																	
		1971	1971	1971													
1/ 5-1-6.7	4749.15	Apr. 19	Sept. 16	Nov. 10	60	0.54	249	83	178	27	149	3,270	8,210	4.36	0.19	-	2.51
5-1-8.5	4749.15	Apr. 19	Sept. 16	Nov. 10	60	0.54	249	83	178	27	149	3,270	7,100	4.72	0.18	-	2.17
5-1-16.9	4749.15	Apr. 9	Sept. 16	Nov. 5	56	0.52	248	83	172	27	148	3,600	4,130	4.60	0.18	-	1.15
5-2-16.4	4749.15	Apr. 10	Sept. 17	Nov. 10	50	0.53	248	83	175	27	148	3,660	5,180	4.78	0.17	-	1.41
5-2-17.7	4749.15	Apr. 9	Sept. 17	Nov. 10	56	0.52	248	83	172	27	148	3,600	4,720	4.16	0.18	-	1.31
6-1-9.4	4750.00	Mar. 27	Sept. 18	Nov. 5	65	0.54	249	83	179	27	149	3,740	6,010	4.62	0.15	-	1.61
6-1-12.6	4750.00	Mar. 27	Sept. 20	-	65	0.54	249	83	179	27	149	3,740	5,940	3.95	0.15	-	1.59
6-2-11.6	4750.00	Mar. 27	Sept. 20	Nov. 12	65	0.54	249	83	179	27	149	3,740	6,620	4.11	0.20	-	1.77
5-2-6.1	4749.15	Apr. 19	Sept. 16	Nov. 12	60	0.54	249	83	178	27	149	3,270	6,680	4.81	0.20	-	20.4
Average												3,540	6,070	4.46	0.18	-	1.73
Exterior concrete																	
		1971	1971	1971													
3-1-0.1	4750.00	Mar. 28	Sept. 21	Nov. 12	56	0.43	330	82	177	25	148	5,050	4,680	4.04	0.20	-	0.93
3-1-4.6	4750.00	Mar. 23	Sept. 21	Nov. 12	57	0.42	332	82	174	25	149	5,480	7,970	4.34	0.18	-	1.45
3-2-1.1	4750.00	Mar. 28	Sept. 22	Nov. 12	56	0.43	330	82	177	25	148	5,050	6,640	4.50	0.16	-	1.31
3-2-4.5	4750.00	Mar. 23	Sept. 22	Nov. 12	57	0.42	332	82	174	25	149	5,480	6,800	4.71	0.19	-	1.24
3-2-13.8	4750.00	Mar. 22	Sept. 22	Nov. 12	51	0.44	330	82	181	25	148	5,060	6,640	4.88	0.23	-	1.31
5-2-0.4	4749.15	Apr. 27	Sept. 16	Nov. 10	55	0.44	328	82	180	25	148	4,690	4,700	4.41	0.16	-	1.00
5-2-3.3	4749.15	Apr. 27	Sept. 16	Nov. 5	50	0.45	326	81	181	25	147	4,410	6,640	4.98	0.18	-	1.50
6-1-5.9	4750.00	Apr. 5	Sept. 18	Nov. 12	49	0.43	329	82	175	24	148	4,740	7,410	4.04	0.22	-	1.56
6-2-0.0	4750.00	Apr. 5	Sept. 20	Nov. 5	52	0.43	332	82	176	25	149	5,170	4,540	4.21	0.31	-	0.88
6-2-5.8	4750.00	Apr. 5	Sept. 20	Nov. 12	49	0.43	329	82	175	24	148	4,740	6,470	4.36	0.16	-	1.36
7-1-4.3	4749.50	Apr. 29	Sept. 13	Nov. 12	57	0.44	330	82	180	25	148	4,460	7,190	4.23	0.16	-	1.61
7-1-5.3	4749.50	Apr. 29	Sept. 13	Nov. 12	57	0.44	330	82	180	25	148	4,460	7,750	4.74	0.18	-	1.74
7-2-2.3	4749.50	Apr. 29	Sept. 15	Nov. 5	57	0.44	330	82	180	25	148	4,460	5,790	4.24	0.18	-	1.30
7-2-3.3	4749.50	Apr. 29	Sept. 15	Nov. 5	57	0.44	330	82	180	25	148	4,460	6,690	4.18	0.23	-	1.50
Average												4,840	6,420	4.42	0.20	-	1.34
3 years' age 6-in-diameter cores																	
Exterior concrete																	
		1971	1973	1973													
2/ 5-3-0.0A	4749.15	Apr. 27	Dec. 8	Mar. 14	55	0.44	328	82	180	25	148	4,690	4,350	4.18	0.17	154	0.93
5-3-0.0B	4749.15	Apr. 27	Dec. 8	Mar. 14	55	0.44	328	82	180	25	148	4,690	5,700	4.12	0.16	152	1.21
6-4-0.0B	4750.00	Apr. 5	Nov. 29	Mar. 14	52	0.43	332	82	176	25	149	5,170	4,240	4.42	0.37	152	0.82
6-4-5.0	4750.00	Apr. 5	Nov. 30	Mar. 14	49	0.43	329	82	175	24	148	4,740	7,410	4.20	0.32	154	1.56
6-4-9.4	4750.00	Apr. 5	Dec. 4	Mar. 14	49	0.43	329	82	175	24	148	4,740	6,910	4.33	0.38	153	1.46
7-4-0.0A	4749.50	Apr. 29	Dec. 5	Mar. 14	57	0.44	330	82	180	25	148	4,460	6,920	4.78	0.15	153	1.55
7-4-0.0B	4749.50	Apr. 29	Dec. 5	Mar. 14	57	0.44	330	82	180	25	148	4,460	6,310	4.57	0.36	154	1.41
Average													5,980	4.37	0.27	153	1.28
Interior concrete																	
		1971	1973	1974													
5-3-10.4B	4749.15	Apr. 19	Dec. 10	Mar. 14	60	0.54	249	83	178	27	149	3,270	5,680	3.77	0.15	153	1.74
7-4-12.4A	4749.50	Apr. 20	Dec. 7	-	58	0.52	248	83	172	27	148	3,150	5,040	5.36	0.16	157	1.60
Average													5,360	4.56	0.16	155	1.67

1/ First number, block number; second number, hole number; and third number, depth to top of core (ft).
2/ Letters are added when original core is cut into more than one test specimen.
3/ Test specimen 6- x 12-in cylinder.
4/ Modulus of elasticity times 10^{-6} equals table values ($4,360,000 \times 10^{-6} = 4.36$).

Table 4A. — *River plug tensile strengths, 150- and 250-mm-diameter cores (6 months and 3 years age) (SI)*

Core No.	Elevation above sea level (m)	Dates: Concrete placed	Dates: Specimen drilled	Dates: Specimen tested	Concrete temperature (°C)	Properties of fresh concrete: W/(C+P) by mass	Cement content (kg/m³)	Pozzolan content (kg/m³)	Water content (kg/m³)	Percent sand	Density (kg/m³)	Tensile strength (MPa)	Number of large debonded cobbles	Percent area of large debonded cobbles	Percent total debonded area
Nonjointed specimens 6 months' age 150-mm-diameter core															
Interior concrete															
		1971	1971	1971											
1/ 5-1-9.8	1447.54	Apr. 19	Sept. 16	Oct. 22	16	0.54	148	49	106	27	2380	1.57	1	40	50
5-1-11.8	1447.54	Apr. 19	Sept. 16	Oct. 20	16	0.54	148	49	106	27	2380	1.22	3	40	45
5-1-13.5	1447.54	Apr. 10	Sept. 16	Oct. 22	10	0.53	147	49	104	27	2372	0.89	1	30	65
5-1-17.9	1447.54	Apr. 9	Sept. 16	Oct. 22	13	0.52	147	49	102	27	2371	0.88	2	40	50
5-2-7.2A	1447.54	Apr. 19	Sept. 16	Oct. 27	16	0.54	148	49	106	27	2380	1.16	1	35	45
5-2-9.6	1447.54	Apr. 19	Sept. 17	Oct. 27	16	0.54	148	49	106	27	2380	1.14	1	35	55
5-2-12.8	1447.54	Apr. 19	Sept. 17	Oct. 20	16	0.54	148	49	106	27	2380	0.97	1	25	45
5-2-14.6	1447.54	Apr. 10	Sept. 17	Oct. 20	10	0.53	147	49	104	27	2372	1.45	2	35	40
6-1-10.5	1447.80	Mar. 27	Sept. 18	Oct. 14	18	0.54	148	49	106	27	2387	1.13	1	25	35
6-1-13.6	1447.80	Mar. 27	Sept. 20	Oct. 13	18	0.54	148	49	106	27	2387	1.94	1	25	35
6-2-9.2	1447.80	Mar. 27	Sept. 20	Oct. 22	18	0.54	148	49	106	27	2387	1.50	0	0	40
6-2-12.6	1447.80	Mar. 27	Sept. 20	Nov. 1	18	0.54	148	49	106	27	2387	1.96	0	0	20
2/ 7-1-10.6A	1447.65	Apr. 20	Sept. 13	Nov. 3	14	0.52	147	49	102	27	2368	1.26	2	20	50
7-1-10.6B	1447.65	Apr. 20	Sept. 13	Nov. 3	14	0.52	147	49	102	27	2368	1.26	2	20	50
7-1-12.8	1447.65	Apr. 20	Sept. 13	Nov. 3	14	0.52	147	49	102	27	2368	1.14	1	25	55
7-2-10.2	1447.65	Apr. 20	Sept. 15	Oct. 22	14	0.52	147	49	102	27	2368	0.81	2	50	65
7-2-12.2	1447.65	Apr. 20	Sept. 15	Nov. 1	14	0.52	147	49	102	27	2368	1.24	1	30	50
Average												1.27			
Exterior concrete															
		1971	1971	1971											
3-1-5.6	1447.80	Mar. 23	Sept. 21	Nov. 3	14	0.42	197	49	103	25	2387	1.83	0	0	15
3-1-10.6	1447.80	Mar. 23	Sept. 22	Oct. 14	9	0.42	198	49	103	25	2400	1.29	1	35	45
3-1-12.5	1447.80	Mar. 22	Sept. 22	Oct. 18	11	0.44	196	49	107	25	2374	1.21	0	0	25
3-2-2.1A	1447.80	Mar. 23	Sept. 22	Nov. 3	14	0.42	197	49	103	25	2387	1.23	1	20	50
3-3-2.1B	1447.80	Mar. 23	Sept. 22	Nov. 3	14	0.42	197	49	103	25	2387	1.41	2	25	40
3-2-5.5	1447.80	Mar. 23	Sept. 22	Nov. 3	14	0.42	197	49	103	25	2387	1.57	1	15	20
3-2-8.1A	1447.80	Mar. 23	Sept. 22	Oct. 27	9	0.42	198	49	103	25	2400	1.59	0	0	10
3-2-10.5	1447.80	Mar. 23	Sept. 22	Oct. 22	9	0.42	198	49	103	25	2400	1.09	1	35	50
3-2-12.2A	1447.80	Mar. 22	Sept. 22	Nov. 3	11	0.44	196	49	107	25	2374	1.45	0	0	20
3-2-12.2B	1447.80	Mar. 22	Sept. 22	Nov. 3	11	0.44	196	49	107	25	2374	1.48	0	0	35
5-1-0.5	1447.54	Apr. 27	Sept. 15	Oct. 22	13	0.44	195	49	107	25	2371	1.60	2	30	40
5-1-2.6	1447.54	Apr. 27	Sept. 16	Oct. 22	10	0.45	193	48	107	25	2352	1.37	1	15	30
5-1-4.5	1447.54	Apr. 27	Sept. 16	Oct. 20	14	0.43	194	48	105	25	2361	1.63	1	15	20
5-2-1.7	1447.54	Apr. 27	Sept. 16	Oct. 20	10	0.45	193	48	107	25	2352	1.60	1	10	25
5-2-4.4	1447.54	Apr. 27	Sept. 16	Oct. 14	14	0.43	194	48	105	25	2361	1.59	0	0	25
6-1-0.4	1447.80	Apr. 5	Sept. 18	Oct. 14	11	0.43	197	49	104	25	2384	0.96	1	40	60
6-1-2.2	1447.80	Apr. 5	Sept. 18	Oct. 13	9	0.43	195	49	104	24	2368	0.79	1	40	55
6-1-3.7A	1447.80	Apr. 5	Sept. 18	Oct. 17	9	0.43	195	49	104	24	2368	1.66	1	40	50
6-1-3.7B	1447.80	Apr. 5	Sept. 18	Oct. 27	9	0.43	195	49	104	24	2368	2.28	1	20	25
6-2-1.1	1447.80	Apr. 5	Sept. 20	Oct. 20	11	0.43	197	49	104	25	2384	0.77	2	45	50
6-2-3.8A	1447.80	Apr. 5	Sept. 20	Oct. 13	9	0.43	195	49	104	24	2368	0.61	1	50	65
6-2-3.8B	1447.80	Apr. 5	Sept. 20	Oct. 18	9	0.43	195	49	104	24	2368	1.33	2	65	65
7-1-0.3	1447.65	Apr. 29	Sept. 13	Nov. 3	14	0.44	196	49	107	25	2377	1.90	0	0	40
7-1-2.5	1447.65	Apr. 29	Sept. 13	Oct. 20	14	0.44	196	49	107	25	2377	1.43	2	45	60
7-2-0.4	1447.65	Apr. 29	Sept. 15	Oct. 22	14	0.44	196	49	107	25	2377	1.48	3	60	75
7-2-4.8	1447.65	Apr. 29	Sept. 15	Nov. 1	14	0.44	196	49	107	25	2377	1.94	0	0	40
6-1-6.9A	1447.80	Apr. 5	Sept. 18	-	9	0.43	195	49	104	24	2368	1.70	0	0	25
6-2-6.8A	1447.80	Apr. 5	Sept. 20	Oct. 27	9	0.43	195	49	104	24	2368	1.02	1	35	45
Average												1.42			
3 years' age 150-mm-diameter cores															
Exterior concrete															
		1971	1973	1974											
5-3-4.6	1447.54	Apr. 27	Dec. 8	Mar. 13	14	0.43	194	48	105	25	2361	2.06	-	15	50
6-4-0.0A	1447.80	Apr. 5	Nov. 29	Mar. 13	11	0.43	197	49	104	25	2384	1.16	-	45	85
6-4-3.0	1447.80	Apr. 5	Nov. 30	Mar. 15	9	0.43	195	49	104	24	2368	1.26	-	40	50
6-4-11.5	1447.80	Apr. 5	Dec. 4	Mar. 15	9	0.43	195	49	104	24	2368	2.06	-	15	20
7-4-2.3	1447.65	Apr. 29	Dec. 6	Mar. 13	14	0.44	196	49	107	25	2377	1.45	-	40	50
7-4-4.6	1447.65	Apr. 29	Dec. 6	Mar. 13	14	0.44	196	49	107	25	2377	1.33	-	30	70
Average												1.56			
Interior concrete															
		1971	1973	1974											
5-3-7.9	1447.54	Apr. 19	Dec. 8	Mar. 15	16	0.54	148	49	106	27	2380	2.04	-	0	10
5-3-10.4A	1447.54	Apr. 19	Dec. 10	Mar. 13	16	0.54	148	49	106	27	2380	1.35	-	50	70
5-3-14.0	1447.54	Apr. 19	Dec. 11	Mar. 15	16	0.54	148	49	106	27	2380	1.03	-	40	60
7-4-10.4	1447.65	Apr. 20	Dec. 7	Mar. 13	14	0.52	147	49	102	27	2368	1.50	-	20	95
Average												1.48			
6 months' age 250-mm-diameter cores															
Exterior concrete															
		1971	1971	1971											
6-3-0.1	1447.80	Apr. 5	Sept. 20	Oct. 27	11	0.43	197	49	104	25	2384	1.44	2	10	60
6-3-3.0A	1447.80	Apr. 5	Sept. 20	Oct. 20	9	0.43	195	49	104	24	2368	1.41	1	10	45
6-3-3.0B	1447.80	Apr. 5	Sept. 20	Oct. 22	9	0.43	195	49	104	24	2368	2.19	1	15	40
6-3-3.0C	1447.80	Apr. 5	Sept. 20	Oct. 27	9	0.43	195	49	104	24	2368	1.99	1	10	35
7-3-0.1	1447.65	Apr. 29	Sept. 14	Nov. 1	14	0.44	196	49	107	25	2377	1.80	1	10	55
7-3-2.3	1447.65	Apr. 29	Sept. 14	Nov. 1	14	0.44	196	49	107	25	2377	1.42	1	30	60
7-3-4.6	1447.65	Apr. 29	Sept. 14	Nov. 1	14	0.44	196	49	107	25	2377	1.62	1	15	45
3-3-4.8	1447.80	Mar. 23	Sept. 23	Nov. 9	14	0.42	197	49	103	25	2387	1.60	1	10	35
3-3-10.6	1447.80	Mar. 23	Sept. 23	Oct. 27	9	0.42	198	49	103	25	2400	1.19	1	10	25
3-3-12.7	1447.80	Mar. 22	Sept. 23	Oct. 27	11	0.44	196	49	107	25	2374	1.44	1	5	25
Average												1.61			
Interior concrete															
		1971	1971	1971											
6-3-9.2	1447.80	Mar. 27	Sept. 21	Nov. 9	18	0.54	148	49	106	27	2387	1.30	1	15	30
7-3-9.5	1447.65	Apr. 20	Sept. 14	Nov. 12	14	0.52	147	49	102	27	2368	1.08	0	0	30
7-3-12.4	1447.65	Apr. 20	Sept. 14	Nov. 12	14	0.52	147	49	102	27	2368	0.79	1	25	55
Average												1.05			

1/ First number, block number; second number, hole number; and third number, depth to top of core (ft).
2/ Letters are added when original core is cut into more than one test specimen.

Table 4B. — *River plug tensile strengths, 6- and 10-in-diameter cores (6 months and 3 years age)*

Core No.	Elevation above sea level (ft)	Dates: Concrete placed	Dates: Specimen drilled	Dates: Specimen tested	Concrete temperature (°F)	Properties of fresh concrete: W/(C+P) by weight	Cement content (lb/yd³)	Pozzolan content (lb/yd³)	Water content (lb/yd³)	Percent sand	Density (lb/ft³)	Tensile strength (lb/in²)	Number of large debonded cobbles	Percent area of large debonded cobbles	Percent total debonded area
Nonjointed specimens 6 months' age 6-in-diameter core Interior concrete															
		1971	1971	1971											
1/ 5-1-9.8	4749.15	Apr. 19	Sept. 16	Oct. 22	60	0.54	249	83	178	27	149	228	1	40	50
5-1-11.8	4749.15	Apr. 19	Sept. 16	Oct. 20	60	0.54	249	83	178	27	149	177	3	40	45
5-1-13.5	4749.15	Apr. 10	Sept. 16	Oct. 22	50	0.53	248	83	175	27	148	129	1	30	65
5-1-17.9	4749.15	Apr. 9	Sept. 16	Oct. 22	56	0.52	248	83	172	27	148	128	2	40	50
2/ 5-2-7.2A	4749.15	Apr. 19	Sept. 16	Oct. 27	60	0.54	249	83	178	27	149	168	1	35	45
5-2-9.6	4749.15	Apr. 19	Sept. 17	Oct. 27	60	0.54	249	83	178	27	149	166	1	35	55
5-2-12.8	4749.15	Apr. 19	Sept. 17	Oct. 20	60	0.54	249	83	178	27	149	140	1	25	45
5-2-14.6	4749.15	Apr. 10	Sept. 17	Oct. 20	50	0.53	248	83	175	27	148	211	2	35	40
6-1-10.5	4750.00	Mar. 27	Sept. 18	Oct. 14	65	0.54	249	83	179	27	149	164	1	25	35
6-1-13.6	4750.00	Mar. 27	Sept. 20	Oct. 13	65	0.54	249	83	179	27	149	282	1	25	35
6-2-9.2	4750.00	Mar. 27	Sept. 20	Oct. 22	65	0.54	249	83	179	27	149	217	0	0	40
6-2-12.6	4750.00	Mar. 27	Sept. 20	Nov. 1	65	0.54	249	83	179	27	149	284	0	0	20
7-1-10.6A	4749.50	Apr. 20	Sept. 13	Nov. 3	58	0.52	248	83	172	27	148	183	2	20	50
7-1-10.6B	4749.50	Apr. 20	Sept. 13	Nov. 3	58	0.52	248	83	172	27	148	183	2	20	50
7-1-12.8	4749.50	Apr. 20	Sept. 13	Nov. 3	58	0.52	248	83	172	27	148	166	1	25	55
7-2-10.2	4749.50	Apr. 20	Sept. 15	Oct. 22	58	0.52	248	83	172	27	148	118	2	50	65
7-2-12.2	4749.50	Apr. 20	Sept. 15	Nov. 1	58	0.52	248	83	172	27	148	180	1	30	50
Average												184			
Exterior concrete															
		1971	1971	1971											
3-1-5.6	4750.00	Mar. 23	Sept. 21	Nov. 3	57	0.42	332	86	174	25	149	265	0	0	15
3-1-10.6	4750.00	Mar. 23	Sept. 22	Oct. 14	49	0.42	334	83	174	25	150	187	1	35	45
3-1-12.5	4750.00	Mar. 22	Sept. 22	Oct. 18	51	0.44	330	82	181	25	148	175	0	0	25
3-2-2.1A	4750.00	Mar. 23	Sept. 22	Nov. 3	57	0.42	332	82	174	25	149	178	1	20	50
3-3-2.1B	4750.00	Mar. 23	Sept. 22	Nov. 3	57	0.42	332	82	174	25	149	204	2	25	40
3-2-5.5	4750.00	Mar. 23	Sept. 22	Nov. 3	57	0.42	332	82	174	25	149	227	1	15	20
3-2-8.1A	4750.00	Mar. 23	Sept. 22	Oct. 27	49	0.42	334	83	174	25	150	231	0	0	10
3-2-10.5	4750.00	Mar. 23	Sept. 22	Oct. 22	49	0.42	334	83	174	25	150	158	1	35	50
3-2-12.2A	4750.00	Mar. 22	Sept. 22	Nov. 3	51	0.44	330	82	181	25	148	210	0	0	20
3-2-12.2B	4750.00	Mar. 22	Sept. 22	Nov. 3	51	0.44	330	82	181	25	148	215	0	0	35
5-1-0.5	4749.15	Apr. 27	Sept. 15	Oct. 22	55	0.44	328	82	180	25	148	232	2	30	40
5-1-2.6	4749.15	Apr. 27	Sept. 16	Oct. 22	50	0.45	326	81	181	25	147	199	1	15	30
5-1-4.5	4749.15	Apr. 27	Sept. 16	Oct. 20	58	0.43	327	81	177	25	147	236	1	15	20
5-2-1.7	4749.15	Apr. 27	Sept. 16	Oct. 20	50	0.45	326	81	181	25	147	232	1	10	25
5-2-4.4	4749.15	Apr. 27	Sept. 16	Oct. 14	58	0.43	327	81	177	25	147	231	0	0	25
6-1-0.4	4750.00	Apr. 5	Sept. 18	Oct. 14	52	0.43	332	82	176	25	149	139	1	40	60
6-1-2.2	4750.00	Apr. 5	Sept. 18	Oct. 13	49	0.43	329	82	175	24	148	114	1	40	55
6-1-3.7A	4750.00	Apr. 5	Sept. 18	Oct. 17	49	0.43	329	82	175	24	148	241	1	40	50
6-1-3.7B	4750.00	Apr. 5	Sept. 18	Oct. 27	49	0.43	329	82	175	24	148	331	1	20	25
6-2-1.1	4750.00	Apr. 5	Sept. 20	Oct. 20	52	0.43	332	82	176	25	148	112	2	45	50
6-2-3.8A	4750.00	Apr. 5	Sept. 20	Oct. 13	49	0.43	329	82	175	24	149	88	1	50	65
6-2-3.8B	4750.00	Apr. 5	Sept. 20	Oct. 18	49	0.43	329	82	175	24	148	193	2	65	65
7-1-0.3	4749.50	Apr. 29	Sept. 13	Nov. 3	57	0.44	330	82	180	25	148	276	0	0	40
7-1-2.5	4749.50	Apr. 29	Sept. 13	Oct. 20	57	0.44	330	82	180	25	148	208	2	45	60
7-2-0.4	4749.50	Apr. 29	Sept. 15	Oct. 22	57	0.44	330	82	180	25	148	214	3	60	75
7-2-4.8	4749.50	Apr. 29	Sept. 15	Nov. 1	57	0.44	330	82	180	25	148	281	0	0	40
6-1-6.9A	4750.00	Apr. 5	Sept. 18	-	49	0.43	329	82	175	24	148	246	0	0	25
6-2-6.8A	4750.00	Apr. 5	Sept. 20	Oct. 27	49	0.43	329	82	175	24	148	148	1	35	45
Average												206			
3 years' age 6-in-diameter cores															
Exterior concrete															
		1971	1973	1974											
5-3-4.6	4749.15	Apr. 27	Dec. 8	Mar. 13	58	0.43	327	81	177	25	147	299	-	15	50
6-4-0.0A	4750.00	Apr. 5	Nov. 29	Mar. 13	52	0.43	332	82	176	25	149	168	-	45	85
6-4-3.0	4750.00	Apr. 5	Nov. 30	Mar. 15	49	0.43	329	82	175	24	148	183	-	40	50
6-4-11.5	4750.00	Apr. 5	Dec. 4	Mar. 15	49	0.43	329	82	175	24	148	299	-	15	20
7-4-2.3	4749.50	Apr. 29	Dec. 6	Mar. 13	57	0.44	330	82	180	25	148	211	-	40	50
7-4-4.6	4749.50	Apr. 29	Dec. 6	Mar. 13	57	0.44	330	82	180	25	148	193	-	30	70
Average												226			
Interior concrete															
		1971	1973	1974											
5-3-7.9	4749.15	Apr. 19	Dec. 8	Mar. 15	60	0.54	249	83	178	27	149	296	-	0	10
5-3-10.4A	4749.15	Apr. 19	Dec. 10	Mar. 13	60	0.54	249	83	178	27	149	196	-	50	70
5-3-14.0	4749.15	Apr. 19	Dec. 11	Mar. 15	60	0.54	249	83	178	27	149	150	-	40	60
7-4-10.4	4749.50	Apr. 20	Dec. 7	Mar. 13	58	0.52	248	83	172	27	148	217	-	20	95
Average												215			
6 months' age 10-in-diameter cores															
Exterior concrete															
		1971	1971	1971											
6-3-0.1	4750.00	Apr. 5	Sept. 20	Oct. 27	52	0.43	332	82	176	25	149	209	2	10	60
6-3-3.0A	4750.00	Apr. 5	Sept. 20	Oct. 20	49	0.43	329	82	175	24	148	204	1	10	45
6-3-3.0B	4750.00	Apr. 5	Sept. 20	Oct. 22	49	0.43	329	82	175	24	148	318	1	15	40
6-3-3.0C	4750.00	Apr. 5	Sept. 20	Oct. 27	49	0.43	329	82	175	24	148	288	1	10	35
7-3-0.1	4749.50	Apr. 29	Sept. 14	Nov. 1	57	0.44	330	82	180	25	148	261	1	10	55
7-3-2.3	4749.50	Apr. 29	Sept. 14	Nov. 1	57	0.44	330	82	180	25	148	206	1	30	60
7-3-4.6	4749.50	Apr. 29	Sept. 14	Nov. 1	57	0.44	330	82	180	25	148	235	1	15	45
3-3-4.8	4750.00	Mar. 23	Sept. 23	Nov. 9	57	0.42	332	82	174	25	149	232	1	10	35
3-3-10.6	4750.00	Mar. 23	Sept. 23	Oct. 27	49	0.42	334	83	174	25	150	172	1	10	25
3-3-12.7	4750.00	Mar. 22	Sept. 23	Oct. 27	51	0.44	330	82	181	25	148	209	1	5	25
Average												233			
Interior concrete															
		1971	1971	1971											
6-3-9.2	4750.00	Mar. 27	Sept. 21	Nov. 9	65	0.54	249	83	179	27	149	188	1	15	30
7-3-9.5	4749.50	Apr. 20	Sept. 14	Nov. 12	58	0.52	248	83	172	27	148	157	0	0	30
7-3-12.4	4749.50	Apr. 20	Sept. 14	Nov. 12	58	0.52	248	83	172	27	148	115	1	25	55
Average												153			

1/ First number, block number; second number, hole number; and third number, depth to top of core (ft).
2/ Letters are added when original core is cut into more than one test specimen.

Table 5A. — *River plug construction joint investigation, 150- and 250-mm-diameter cores (6 months and 3 years age) (SI)*

Core No.	Elevation (m)	Method of joint preparation	Did it break at joint?	Tensile strength (MPa)	Number of large debonded cobbles	Percent area large debonded cobbles	Percent total core area debonded	Dates: Concrete placed	Dates: Specimen drilled	Dates: Specimen tested	Properties of fresh concrete: Concrete temperature (°C)	W/(C+P) by mass	Cement content (kg/m³)	Pozzolan content (kg/m³)	Water content (kg/m³)	Percent sand	Density (kg/m³)
6 months' age 150-mm-diameter cores																	
Exterior concrete																	
								1971	1971	1971							
1/ 3-1-1.1	1447.80	3/ WS	No	0.91	1	30	50	Mar. 28	Sept. 21	Oct. 27	13	0.43	196	49	105	25	2370
3-1-8.1	1447.80	WS	Yes	1.17	-	-	-	Mar. 23	Sept. 22	Oct. 27	9	0.42	198	49	103	25	2400
2/ 3-2-8.1B	1447.80	WS	No	1.99	1	15	35	Mar. 23	Sept. 22	Nov. 1	9	0.42	198	49	103	25	2400
6-1-6.9B	1447.80	WS	No	1.87	1	15	30	Apr. 5	Sept. 18	Nov. 1	9	0.43	195	49	104	24	2370
6-2-6.8B	1447.80	WS	Yes	1.33	-	-	-	Apr. 5	Sept. 20	Nov. 1	9	0.43	195	49	104	24	2370
7-1-7.6	1447.65	WS	No	1.03	1	50	60	Apr. 29	Sept. 13	Nov. 1	14	0.44	196	49	107	25	2380
Average				1.39													
Interior concrete																	
								1971	1971								
5-2-7.2B		4/ Resin	Yes	1.37	-	-	-	Apr. 19	Sept. 16	-	16	0.54	148	49	106	27	2380
6 months' age 250-mm-diameter cores																	
Exterior concrete																	
								1971	1971	1971							
6-3-6.0	1447.80	WS	No	1.91	1	10	20	Apr. 5	Sept. 21	Nov. 9	9	0.43	195	49	104	24	2370
3-3-1.4A	1447.80	WS	No	1.62	0	0	25	Mar. 28	Sept. 22	Nov. 3	13	0.43	196	49	105	25	2370
3-3-1.4B	1447.80	WS	No	1.45	1	10	30	Mar. 28	Sept. 22	Nov. 5	13	0.43	196	49	105	25	2370
3-3-7.7	1447.80	WS	No	1.79	0	0	20	Mar. 23	Sept. 23	Nov. 9	9	0.42	198	49	103	25	2400
Average				1.70													
3 years' age 150-mm-diameter cores																	
Exterior concrete																	
								1971	1973	1974							
6-4-6.0	1447.80	WS	No	1.09	-	50	85	Apr. 5	Dec. 3	Mar. 13	9	0.43	195	49	104	24	2370
7-4-7.0	1447.65	WS	No	1.57	-	40	60	Apr. 29	Dec. 6	Mar. 13	14	0.44	196	49	107	25	2380
Average				1.32													
Interior concrete																	
								1971	1973	1974							
6-4-13.5	1447.80	WS	No	1.25	-	30	70	Mar. 27	Dec. 4	Mar. 15	18	0.54	148	49	106	27	2390
7-4-14.5	1447.65	WS	Yes	0.74	-	-	-	Apr. 20	Dec. 7	Mar. 13	14	0.52	147	49	102	27	2370
Average				0.99													

1/ First number, block number; second number, hole number; and third number, depth to top of core (ft).
2/ Letters are added when original core is cut into more than one test specimen.
3/ Indicates wet-sandblast method.
4/ Indicates rubber resin-base compound.

REMARKS: 3-3-1.4A Broke 250-mm from end plate
3-3-7.7 Broke near joint
6-4-13.5 Broke near joint
7-4-14.5 Broke at measured or assumed position of joint

Table 5B. — *River plug construction joint investigation, 6- and 10-in-diameter cores (6 months and 3 years age)*

Core No.	Elevation (ft)	Method of joint preparation	Did it break at joint?	Tensile strength (lb/in²)	Number of large debonded cobbles	Percent area large cobbles	Percent total core area debonded	Dates: Concrete placed	Dates: Specimen drilled	Dates: Specimen tested	Properties of fresh concrete: Concrete temperature (°F)	W/(C+P) by weight	Cement content (lb/yd³)	Pozzolan content (lb/yd³)	Water content (lb/yd³)	Percent sand	Density (lb/yd³)
6 months' age 6-in-diameter cores																	
Exterior concrete																	
								1971	1971	1971							
1/ 3-1-1.1	4750.0	3/ WS	No	132	1	30	50	Mar. 28	Sept. 21	Oct. 27	56	0.43	330	82	177	25	148
3-1-8.1	4750.0	WS	Yes	170	-	-	-	Mar. 23	Sept. 22	Oct. 27	49	0.42	334	83	174	25	150
2/ 3-2-8.1B	4750.0	WS	No	288	1	15	35	Mar. 23	Sept. 22	Nov. 1	49	0.42	334	83	174	25	150
6-1-6.9B	4750.0	WS	No	271	1	15	30	Apr. 5	Sept. 18	Nov. 1	49	0.43	329	82	175	24	148
6-2-6.8B	4750.0	WS	Yes	193	-	-	-	Apr. 5	Sept. 20	Nov. 1	49	0.43	329	82	175	24	148
7-1-7.6	4749.5	WS	No	150	1	50	60	Apr. 29	Sept. 13	Nov. 1	57	0.44	330	82	180	25	148
Average				201													
Interior concrete																	
								1971	1971								
5-2-7.2B		4/ Resin	Yes	198	-	-	-	Apr. 19	Sept. 16	-	60	0.54	249	83	178	27	149
6 months' age 10-in-diameter cores																	
Exterior concrete																	
6-3-6.0	4750.0	WS	No	277	1	10	20	Apr. 5	Sept. 21	Nov. 9	49	0.43	329	82	175	24	148
3-3-1.4A	4750.0	WS	No	235	0	0	25	Mar. 28	Sept. 22	Nov. 3	56	0.43	330	82	177	25	148
3-3-1.4B	4750.0	WS	No	210	1	10	30	Mar. 28	Sept. 22	Nov. 5	56	0.43	330	82	177	25	148
3-3-7.7	4750.0	WS	No	260	0	0	20	Mar. 23	Sept. 23	Nov. 9	49	0.42	334	83	174	25	150
Average				246													
3 years' age 6-in-diameter cores																	
Exterior concrete																	
								1971	1973	1974							
6-4-6.0	4750.0	WS	No	158	-	50	85	Apr. 5	Dec. 3	Mar. 13	49	0.43	329	82	175	24	148
7-4-7.0	4749.5	WS	No	227	-	40	60	Apr. 29	Dec. 6	Mar. 13	57	0.44	330	82	180	25	148
Average				192													
Interior concrete																	
								1971	1973	1974							
6-4-13.5	4750.0	WS	No	182	-	30	70	Mar. 27	Dec. 4	Mar. 15	65	0.54	249	83	179	27	149
7-4-14.5	4749.5	WS	Yes	107	-	-	-	Apr. 20	Dec. 7	Mar. 13	58	0.52	248	83	172	27	148
Average				144													

1/ First number, block number; second number, hole number; and third number, depth to top of core (ft).
2/ Letters are added when original core is cut into more than one test specimen.
3/ Indicates wet-sandblast method.
4/ Indicates rubber resin-base compound.

REMARKS: 3-3-1.4A Broke 1 inch from end plate
3-3-7.7 Broke near joint
6-4-13.5 Broke near joint
7-4-14.5 Broke at measured or assumed position of joint

Table 6A. — *Compressive strengths (dam) 250-mm-diameter cores (6 months and 1 year age) (SI)*

		Dates			Properties of fresh concrete							Properties of hardened concrete					
Core No.	Elevation above sea level (m)	Concrete placed	Specimen drilled	Specimen tested	Concrete temperature (°C)	W/(C+P) by mass	Cement content (kg/m³)	Pozzolan content (kg/m³)	Water content (kg/m³)	Percent sand	Density (kg/m³)	Control cyl. 28-day compressive strength (MPa)	Compressive strength (MPa)	Modulus of elasticity (GPa)	Poisson's ratio	Density (kg/m³)	Strength ratio core/28-day control cylinder (%)
6 months' age																	
High W/(C+P) ratio concrete																	
		1973	1974	1975													
1/ 8F6-1-2.8	1449.34	Nov. 17	Apr. 3	-	11	0.60	125.2	41	100	27	2385	12.2	24.4	29.4	0.19	2450	1.99
9F6-1-2.9	1449.34	Nov. 16	Mar. 30	-	9	0.60	125.2	41	100	27	2383	13.7	25.4	26.1	0.13	2420	1,86
9-1-0.0	1456.56	Nov. 1	May 30	-	11	0.58	142.4	25	97	27	2385	16.5	30.1	33.0	0.26	2450	1.83
9-1-9.3	1456.56	Oct. 19	May 31	-	10	0.50	126.4	41	84	27	2396	14.2	27.9	32.3	0.24	2400	1.96
2/ 10-1-3.6A	1456.56	Oct. 2	May 29	-	11	0.59	125.8	41	98	27	2385	11.9	15.9	25.9	0.23	2400	1.33
10-1-9.1	1456.56	Sept. 19	May 29	-	12	0.58	125.8	41	97	27	2388	10.9	20.2	27.9	0.24	2390	1.85
15-1-0.0	1456.56	Oct. 5	Mar. 11	-	12	0.57	125.8	42	95	27	2393	10.9	18.7	22.3	0.18	2350	1.72
15-1-4.8B	1456.56	Oct. 5	Mar. 11	-	-	0.57	125.8	42	95	27	2393	10.9	15.8	26.8	0.14	2410	1.45
16-1-5.2	1456.56	Nov. 1	Mar. 18	-	10	0.58	142.4	25	97	27	2385	16.5	23.4	28.8	0.18	2440	1.42
Average												13.1	22.4	28.1	0.20	2420	1.71
Low W/C ratio concrete																	
		1973	1974	1975													
22-1-0.0A	1499.92	Oct. 20	Feb. 16	-	10	0.51	153.7	51	104	26	2388	-	23.5	24.9	0.21	2400	-
23-1A-0.5	1501.03	Sept. 18	Feb. 15	-	12	0.50	153.7	51	101	26	2382	-	28.0	31.0	0.19	2440	-
23-1B-0.0	1501.03	Sept. 18	Feb. 17	-	12	0.50	153.7	51	103	26	2414	-	27.0	26.7	0.20	2420	-
23-1B-5.3	1501.03	Sept. 18	Feb. 28	-	12	0.51	153.7	51	104	26	2382	-	32.2	30.2	0.21	2390	-
7-1-0.0	1499.92	May 29	Dec. 16	Jan. 18	12	0.50	144.2	48	97	25	2396	15.7	21.9	30.2	0.24	2590	1.39
3/ 15-3-0.0	1499.92	Aug. 21	Dec. 11	Jan. 18	11	0.52	144.2	48	99	26	2388	14.5	25.2	28.8	0.22	2520	1.74
16-3-0.0	1499.92	Sept. 27	Dec. 12	Jan. 18	-	0.51	144.8	48	98	26	-	-	18.5	27.5	0.26	2500	-
17-1-0.0	1499.92	June 11	Dec. 12	Jan. 18	11	0.55	137.6	46	100	26	2398	16.2	27.2	29.0	0.23	2530	1.68
19-1-0.0	1499.92	June 4	Dec. 13	Jan. 18	11	0.51	144.8	48	98	26	2382	-	27.2	31.8	0.20	2590	-
20-1-0.0	1499.92	Sept. 3	Dec. 13	Jan. 18	-	0.51	180.3	45	115	35	-	-	29.2	26.6	0.22	2440	-
Average												15.5	26.0	28.7	0.22	2490	1.60
1 year's age																	
High W/(C+P) ratio concrete																	
		1973	1974	1975													
9-2-4.0B	1456.56	Nov. 1	Oct. 16	Dec. 4	11	0.58	142.4	25	97	27	2385	16.5	30.7	31.9	0.14	2410	1.86
9-2-4.0A	1456.56	Nov. 1	Oct. 16	-	11	0.58	142.4	25	97	27	2385	16.5	26.5	36.7	0.19	2440	1.61
9-2-7.9	1456.56	Nov. 1	Oct. 17	-	11	0.58	142.4	25	97	27	2385	16.5	35.2	35.8	0.21	2430	2.14
10-2-2.1	1456.56	Oct. 2	Oct. 18	-	11	0.59	125.8	41	98	27	2385	11.9	20.5	32.3	0.19	2370	1.73
10-2-9.33	1456.56	Sept. 19	Oct. 21	Dec. 4	12	0.58	125.8	41	97	27	2388	10.9	24.0	38.1	0.23	2360	2.20
15-2-1.8	1456.56	Oct. 5	Oct. 22	-	12	0.57	125.8	42	95	27	2393	10.9	19.9	38.5	0.23	2380	1.83
16-2-1.8	1456.56	Nov. 1	Oct. 22	Dec. 4	11	0.60	126.4	41	100	27	2400	15.7	40.1	38.7	0.18	2440	25.6
Average												14.1	28.1	36.0	0.20	2410	1.99
Low W/(C+P) ratio concrete																	
		1973	1974	1974													
22-2-2.9	1499.92	Oct. 20	Oct. 24	-	10	0.51	153.7	51	104	26	2388	-	39.6	38.1	0.22	2430	-
23-2-3.0	1500.38	Sept. 12	Oct. 26	Dec. 4	12	0.50	153.7	51	103	26	2382	-	37.5	34.8	0.18	2400	-
23-2-5.0	1500.38	Sept. 12	Oct. 26	Dec. 4	12	0.50	153.7	51	103	26	2382	-	37.0	32.3	0.18	2390	-
23-2-7.0	1500.38	Sept. 18	Oct. 26	Dec. 4	12	0.50	153.7	51	103	26	2382	-	42.8	34.1	0.21	2420	-
		1974	1975	1975													
7-2-0.0	1499.92	May 29	Apr. 24	-	12	0.50	144.2	48	97	25	2396	15.7	30.3	30.2	0.24	2400	1.93
7-2-7.4	1499.92	May 8	Apr. 24	-	13	0.54	125.2	42	91	26	2388	15.0	30.8	35.2	0.21	2470	2.05
15-4-0.0	1499.92	Aug. 21	Apr. 16	Aug. 20	-	0.51	180.4	45	115	35	-	-	24.6	30.1	0.21	2370	-
15-4-2.5	1499.92	Aug. 21	Apr. 16	Aug. 20	11	0.52	144.2	48	99	26	2388	14.5	27.0	29.6	0.21	2400	1.87
16-4-0.0	1499.92	Sept. 27	Apr. 17	Sept. 24	12	0.55	174.4	43	119	35	2276	13.8	23.6	27.8	0.17	2310	1.72
17-2-0.0	1499.92	June 11	Apr. 17	-	11	0.55	137.6	46	100	26	2398	16.2	26.7	32.9	0.20	2410	1.65
17-2-2.7	1499.92	June 11	Apr. 17	-	11	0.55	137.6	46	100	26	2398	16.2	29.4	32.1	0.22	2430	1.81
20-2-0.0	1499.92	Sept. 3	Apr. 19	Sept. 3	-	0.51	180.4	45	115	35	-	-	29.7	30.1	0.18	2360	-
20-2-2.7B	1499.92	Sept. 3	Apr. 19	Sept. 3	10	0.53	144.8	48	102	25	2393	14.5	29.6	34.3	0.22	2430	2.04
20-2-5.3B	1499.92	Sept. 3	Apr. 19	Sept. 3	10	0.53	144.8	48	102	25	2393	14.5	26.3	30.9	0.20	2380	1.81
Average												15.0	31.1	32.3	0.20	2400	1.86

1/ First number, buttress or placement number; second number, hole number; and third number, depth to top of core (ft).
2/ Letters are added when original core is cut into more than one test specimen.
3/ MSA - maximum size aggregate.

REMARKS:
15-3-0.0 Top 279 mm is 38 mm MSA
16-3-0.0 Top 356 mm is 38 mm MSA
20-1-0.0 Top 483 mm is 38 mm MSA
15-4-0.0 Top 279 mm is 38 mm MSA
16-4-0.0 Top 356 mm is 38 mm MSA
17-2-2.7 Top 483 mm is 38 mm MSA

Table 6B. — *Compressive strengths (dam) 10-in-diameter cores (6 months and 1 year age)*

Core No.	Elevation above sea level (ft)	Dates			Properties of fresh concrete							Properties of hardened concrete					Strength ratio core/ 28-day control cylinder (%)
		Concrete placed	Specimen drilled	Specimen tested	Concrete temperature (°F)	W/(C+P) by weight	Cement content (lb/yd³)	Pozzolan content (lb/yd³)	Water content (lb/yd³)	Percent sand	Density (lb/yd³)	Control cylinder 28-day compressive strength (lb/in²)	Compressive strength (lb/in²)	3/ Modulus of elasticity E x 10⁻⁶ (lb/in²)	Poisson's ratio	Density (lb/ft³)	
6 months' age																	
High W/(C+P) ratio concrete																	
		1973	1974	1975													
1/ 8F6-1-2.8	4755.00	Nov. 17	Apr. 3	-	52	0.60	211	70	168	27	149	1,770	3,540	4.27	0.19	153	1.99
9F6-1-2.9	4755.00	Nov. 16	Mar. 30	-	48	0.60	211	70	168	27	149	1,980	3,690	3.79	0.13	151	1.86
9-1-0.0	4778.75	Nov. 1	May 30	-	51	0.58	240	42	163	27	149	2,390	4,370	4.79	0.26	153	1.83
9-1-9.3	4778.75	Oct. 19	May 31	-	50	0.50	213	70	142	27	150	2,060	4,050	4.68	0.24	150	1.96
2/ 10-1-3.6A	4778.75	Oct. 2	May 29	-	51	0.59	212	70	165	27	149	1,720	2,300	3.75	0.23	150	1.33
10-1-9.1	4778.75	Sept. 19	May 29	-	54	0.58	212	70	164	27	149	1,580	2,930	4.04	0.24	149	1.85
15-1-0.0	4778.75	Oct. 5	Mar. 11	-	54	0.57	212	71	161	27	149	1,570	2,710	3.23	0.18	147	1.72
15-1-4.8B	4778.75	Oct. 5	Mar. 11	-	-	0.57	212	71	161	27	149	1,570	2,290	3.89	0.14	151	1.45
16-1-5.2	4778.75	Nov. 1	Mar. 18	-	50	0.58	240	42	163	27	149	2,390	3,400	4.18	0.18	153	1.42
Average												1,900	3,250	4.07	0.20	151	1.71
Low W(C+P) ratio concrete																	
		1973	1974	1975													
22-1-0.0A	4921.00	Oct. 20	Feb. 16	-	50	0.51	259	86	176	26	149	-	3,410	3.61	0.21	150	-
23-1A-0.5	4924.65	Sept. 18	Feb. 15	-	53	0.50	259	86	171	26	149	-	4,060	4.50	0.19	153	-
23-1B-0.0	4924.65	Sept. 18	Feb. 17	-	54	0.50	259	86	173	26	151	-	3,920	3.88	0.20	151	-
23-1B-5.3	4924.65	Sept. 18	Feb. 28	-	53	0.51	259	86	176	26	149	-	4,670	4.38	0.21	149	-
7-1-0.0	4921.00	May 29	Dec. 16	Jan. 18	53	0.50	243	81	163	25	150	2,280	3,170	4.38	0.24	162	1.39
4/ 15-3-0.0	4921.00	Aug. 21	Dec. 11	Jan. 18	51	0.52	243	81	167	26	149	2,100	3,650	4.18	0.22	158	1.74
16-3-0.0	4921.00	Sept. 27	Dec. 12	Jan. 18	-	0.51	244	81	166	26	-	-	2,680	3.99	0.26	156	-
17-1-0.0	4921.00	June 11	Dec. 12	Jan. 18	51	0.55	232	77	169	26	150	2,350	3,950	4.21	0.23	158	1.68
19-1-0.0	4921.00	June 4	Dec. 13	Jan. 18	51	0.51	244	81	166	26	149	-	3,950	4.62	0.20	162	-
20-1-0.0	4921.00	Sept. 3	Dec. 13	Jan. 18	-	0.51	304	76	194	35	-	-	4,230	3.86	0.22	153	-
Average												2,240	3,770	4.16	0.22	155	1.60
1 year's age																	
High W/(C+P) ratio concrete																	
		1973	1974	1974													
9-2-4.0B	4778.75	Nov. 1	Oct. 16	Dec. 4	51	0.58	240	42	163	27	149	2,390	4,450	4.63	0.14	151	1.86
9-2-4.0A	4778.75	Nov. 1	Oct. 16	-	51	0.58	240	42	163	27	149	2,390	3,840	5.33	0.19	153	1.61
9-2-7.9	4778.75	Nov. 1	Oct. 17	-	51	0.58	240	42	163	27	149	2,390	5,110	5.19	0.21	152	2.14
10-2-2.1	4778.75	Oct. 2	Oct. 18	-	51	0.59	212	70	165	27	149	1,730	2,980	4.68	0.19	148	1.73
10-2-9.33	4778.75	Sept. 19	Oct. 21	Dec. 4	54	0.58	212	70	164	27	149	1,590	3,480	5.52	0.23	148	2.20
15-2-1.8	4778.75	Oct. 5	Oct. 22	-	54	0.57	212	71	161	27	149	1,580	2,880	5.58	0.23	149	1.83
16-2-1.8	4778.75	Nov. 1	Oct. 22	Dec. 4	51	0.60	213	70	169	27	150	2,280	5,820	5.62	0.18	153	2.56
Average												2,050	4,080	5.22	0.20	150	1.99
Low W/(C+P) ratio concrete																	
		1973	1974	1974													
22-2-2.9	4921.00	Oct. 20	Oct. 24	-	50	0.51	259	86	176	26	149	-	5,750	5.53	0.22	152	-
23-2-3.0	4922.50	Sept. 12	Oct. 26	Dec. 4	53	0.50	259	86	173	26	149	-	5,440	5.05	0.18	150	-
23-2-5.0	4922.50	Sept. 12	Oct. 26	Dec. 4	53	0.50	259	86	173	26	149	-	5,370	4.68	0.18	149	-
23-2-7.0	4922.50	Sept. 18	Oct. 26	Dec. 4	53	0.50	259	86	173	26	149	-	6,210	4.95	0.21	151	-
		1974	1975	1975													
7-2-0.0	4921.00	May 29	Apr. 24	-	53	0.50	243	81	163	25	150	2,280	4,400	4.38	0.24	150	1.93
7-2-7.4	4921.00	May 8	Apr. 24	-	55	0.54	211	71	153	26	149	2,170	4,460	5.10	0.21	154	2.05
15-4-0.0	4921.00	Aug. 21	Apr. 16	Aug. 20	-	0.51	304	76	194	35	-	-	3,570	4.36	0.21	148	-
15-4-2.5	4921.00	Aug. 21	Apr. 16	Aug. 20	51	0.52	243	81	167	26	149	2,100	3,920	4.30	0.21	150	1.87
16-4-0.0	4921.00	Sept. 27	Apr. 17	Sept. 24	54	0.55	294	73	201	35	142	1,990	3,430	4.03	0.17	144	1.72
17-2-0.0	4921.00	June 11	Apr. 17	-	51	0.55	232	77	169	26	150	2,350	3,870	4.77	0.20	151	1.65
17-2-2.7	4921.00	June 11	Apr. 17	-	51	0.55	232	77	169	26	150	2,350	4,260	4.66	0.22	152	1.81
20-2-0.0	4921.00	Sept. 3	Apr. 19	Sept. 3	-	0.51	304	76	194	35	-	-	4,310	4.36	0.18	148	-
20-2-2.7B	4921.00	Sept. 3	Apr. 19	Sept. 3	50	0.53	244	81	172	25	149	2,100	4,300	4.98	0.22	152	2.04
20-2-5.3B	4921.00	Sept. 3	Apr. 19	Sept. 3	50	0.53	244	81	172	25	149	2,100	3,810	4.48	0.20	149	1.81
Average												2,180	4,500	4.69	0.20	150	1.86

1/ First number, buttress or placement number; second number, hole number; and third number, depth to top of core (ft).
2/ Letters are added when original core is cut into more than one test specimen.
3/ Modulus of elasticity times 10^{-6} equals table value (4,270,000 x 10^{-6} = 4.27).
4/ MSA - maximum size aggregate.

REMARKS:
15-3-0.0 Top 11 in. is 1-1/2 in MSA
16-3-0.0 Top 14 in. is 1-1/2 in MSA
20-1-0.0 Top 19 in. is 1-1/2 in MSA
15-4-0.0 Top 11 in. is 1-1/2 in MSA
16-4-0.0 Top 14 in. is 1-1/2 in MSA
17-2-2.7 Top 19 in. is 1-1/2 in MSA

Table 7A. — *Tensile strengths, (dam) 250-mm-diameter cores (6 months and 1 year age) (SI)*

Core No.	Elevation above sea level (m)	Date: Concrete placed	Date: Specimen drilled	Date: Specimen tested	Properties of fresh concrete: Concrete temperature (°C)	W/(C+P) by mass	Cement content (kg/m³)	Pozzolan content (kg/m³)	Water content (kg/m³)	Percent sand	Density (kg/m³)	Hardened concrete: Tensile strength (MPa)
Nonjointed specimens												
6-months' age												
High W/(C+P) ratio concrete												
		1973	1974									
1/ 8F6-1-0.0	1449.32	Nov. 17	Apr. 2	-	11	0.60	125	41	100	27	2385	1.21
8F6-1-5.3	1449.32	Nov. 17	Apr. 3	-	11	0.60	125	41	100	27	2385	1.13
9F6-1-0.0	1449.32	Nov. 16	Mar. 30	-	9	0.60	125	41	100	27	2383	1.36
9-1-4.0	1449.32	Nov. 1	May 31	-	11	0.58	142	25	97	27	2385	1.83
10-1-0.0	1456.56	Oct. 2	May 23	-	11	0.59	126	41	98	27	2385	1.33
15-1-2.2	1456.56	Oct. 5	Mar. 11	-	12	0.57	126	42	95	27	2393	0.79
16-1-0.0	1456.56	Nov. 1	Mar. 15	-	10	0.58	142	25	97	27	2385	1.43
16-1-2.75	1456.56	Nov. 1	Mar. 18	-	10	0.58	142	25	97	27	2385	1.19
Average												1.28
Low W/(C+P) ratio concrete												
		1973	1974									
22-1-2.8	1499.92	Oct. 20	Mar. 2	-	10.0	0.51	154	51	104	26	2388	0.97
		1974		1975								
7-1-2.1	1499.92	May 29	-	Jan. 20	12	0.50	144	48	97	25	2396	1.35
15-3-2.5	1499.92	Aug. 21	Dec. 11	Jan. 20	11	0.52	144	48	99	26	2388	1.48
16-3-2.1	1499.92	Sept. 27	Dec. 12	Jan. 20	-	0.51	145	48	98	26	-	1.07
17-1-2.6	1499.92	June 11	Dec. 12	Jan. 20	11	0.55	138	46	100	25	-	1.52
19-1-2.5	1499.92	June 4	Dec. 13	Jan. 18	11	0.51	145	48	98	26	-	1.32
Average												1.28
1 year's age												
High W/(C+P) ratio concrete												
		1973	1974	1974								
9-2-0.0	1456.56	Nov. 1	Oct. 15	-	11	0.58	142	25	97	27	2385	0.77
10-2-3.65	1456.56	Oct. 2	Oct. 19	Nov. 25	11	0.59	126	41	98	27	2385	0.97
15-2-4.0	1456.56	Oct. 5	Oct. 22	-	12	0.57	126	42	95	27	2393	1.01
16-2-4.0	1456.56	Nov. 1	Oct. 23	-	10	0.60	126	41	100	27	2400	1.45
Average												1.05
Low W/(C+P) ratio concrete												
		1973	1974	1974								
22-2-0.0	1499.92	Oct. 20	Oct. 24	Nov. 25	10	0.51	154	51	104	26	2388	1.36
		1974	1975									
7-2-2.7	1499.92	May 29	Apr. 24	-	12	0.50	144	48	97	25	2396	1.87
16-4-2.7	1499.92	Sept. 27	Apr. 17	-	-	0.51	145	48	98	26	-	1.54
19-2-1.7	1499.92	June 4	Apr. 17	-	11	0.51	145	48	98	26	2382	1.10
Average												1.47

1/ First number, buttress or placement number; second number, hole number; third number, depth to top of core (ft).

Table 7B. — *Tensile strengths (dam) 10-in-diameter cores (6 months and 1 year age)*

Core No.	Elevation above sea level (ft)	Dates: Concrete placed	Dates: Specimen drilled	Dates: Specimen tested	Concrete temperature (°F)	W/(C+P) by weight	Properties of fresh concrete: Cement content (lb/yd³)	Pozzolan content (lb/yd³)	Water content (lb/yd³)	Percent sand	Density (lb/ft³)	Hardened concrete: Tensile strength (lb/in²)
Nonjointed specimens												
6 months' age												
High W/(C+P) ratio concrete												
		1973	1974									
1/ 8F6-1-0.0	4755.00	Nov. 17	Apr. 2	-	52	0.60	211	70	168	27	149	175
8F6-1-5.3	4755.00	Nov. 17	Apr. 3	-	52	0.60	211	70	168	27	149	164
9F6-1-0.0	4755.00	Nov. 16	Mar. 30	-	48	0.60	211	70	168	27	149	197
9-1-4.0	4755.00	Nov. 1	May 31	-	51	0.58	240	42	163	27	149	265
10-1-0.0	4778.75	Oct. 2	May 23	-	51	0.59	212	70	165	27	149	193
15-1-2.2	4778.75	Oct. 5	Mar. 11	-	54	0.57	212	71	161	27	149	115
16-1-0.0	4778.75	Nov. 1	Mar. 15	-	50	0.58	240	42	163	27	149	208
16-1-2.75	4778.75	Nov. 1	Mar. 18	-	50	0.58	240	42	163	27	149	172
Average												186
Low W/(C+P) ratio concrete												
		1973	1974									
22-1-2.8	4921.00	Oct. 20	Mar. 2	-	50	0.51	259	86	176	26	149	140
		1974		1975								
7-1-2.1	4921.00	May 29	-	Jan. 20	53	0.50	243	81	163	25	150	196
15-3-2.5	4921.00	Aug. 21	Dec. 11	Jan. 20	51	0.52	243	81	167	26	149	214
16-3-2.1	4921.00	Sept. 27	Dec. 12	Jan. 20	-	0.51	244	81	166	26	-	155
17-1-2.6	4921.00	June 11	Dec. 12	Jan. 20	51	0.55	232	77	169	26	-	221
19-1-2.5	4921.00	June 4	Dec. 13	Jan. 18	51	0.51	244	81	166	26	-	192
Average												186
1 year's age												
High W/(C+P) ratio concrete												
		1973	1974	1974								
9-2-0.0	4778.75	Nov. 1	Oct. 15	-	51	0.58	240	42	163	27	149	112
10-2-3.65	4778.75	Oct. 2	Oct. 19	Nov. 25	51	0.59	212	70	165	27	149	140
15-2-4.0	4778.75	Oct. 5	Oct. 22	-	54	0.57	212	71	161	27	149	146
16-2-4.0	4778.75	Nov. 1	Oct. 23	-	50	0.60	213	70	169	27	150	211
Average												152
Low W/(C+P) ratio concrete												
		1973	1974	1974								
22-2-0.0	4921.0	Oct. 20	Oct. 24	Nov. 25	50	0.51	259	86	176	26	149	197
		1974	1975									
7-2-2.7	4921.0	May 29	Apr. 24	-	53	0.50	243	81	163	25	150	271
16-4-2.7	4921.0	Sept. 27	Apr. 17	-	-	0.51	244	81	166	26	-	224
19-2-1.7	4921.0	June 4	Apr. 17	-	51	0.51	244	81	166	26	149	160
Average												213

1/ First number, buttress or placement number; second number, hole number; and third number, depth to top of core (ft).

Table 8A. — *Construction joint investigation (dam) 250-mm-diameter cores (6 months and 1 year age) (SI)*

Core No.	Elevation (m)	Method of joint preparation	Did it break at joint?	Tensile strength (MPa)	Number of large debonded cobbles	Percent area large cobbles	Percent total core area debonded	Dates: Concrete placed	Dates: Specimen drilled	Dates: Specimen tested	Properties of fresh concrete: Concrete temperature (°C)	W/(C+P) by mass	Cement content (kg/m³)	Pozzolan content (kg/m³)	Water content (kg/m³)	Percent sand	Density (kg/m³)
6 months' age																	
Low W/(C+P) ratio concrete																	
								1973	1974	1975							
1/ 22-1-5.4	1499.92	2/ WJ	Yes	1.60	-	-	-	Oct. 20	Mar. 5	-	10	0.51	154	51	104	26	2390
3/ 23-1B-2.4	1501.03	WJ	No	1.06	-	-	80	Sept. 18	Feb. 27	-	12	0.50	154	51	103	26	2410
								1974									
7-1-5.95	1499.92	WJ	Yes	1.77	-	-	-	May 29	Dec. 16	-	12	0.50	144	48	97	25	2400
15-3-5.0	1499.92	WJ	Yes	1.68	-	-	-	Aug. 21	Dec. 11	Jan. 18	11	0.52	144	48	99	26	2390
16-3-5.7	1499.92	WJ	Yes	1.44	-	-	-	Sept. 27	Dec. 12	Jan. 18	-	0.51	145	48	98	26	-
17-1-5.6	1499.92	WJ	Yes	1.37	-	-	-	June 11	Dec. 12	Jan. 20	11	0.55	138	46	100	26	-
19-1-5.45	1499.92	WJ	Yes	1.17	-	-	-	June 4	Dec. 13	Jan. 18	11	0.51	145	48	98	26	-
Average				1.44													
High W/(C+P) ratio concrete																	
								1973	1974								
4/ 9F6-1-5.9B	1449.32	WJ	Yes	1.10	-	-	-	Nov. 16	Apr. 1	-	9	0.60	125	41	100	27	2380
1 year's age																	
Low W/(C+P) ratio concrete																	
								1973	1974								
23-2-0.0	1500.38	WJ	Yes	1.63	-	-	-	Sept. 18	Oct. 25	-	12	0.50	154	51	103	26	2410
								1974	1975								
16-4-5.7	1499.92	WJ	Yes	1.49	-	-	-	Sept. 27	Apr. 17	-		0.51	145	48	98	26	
17-2-5.3	1499.92	WJ	Yes	1.32	-	-	-	June 11	Apr. 17	-	11	0.55	138	46	100	26	2400
19-2-5.7	1499.92	WJ	No	1.60	-	-	95	June 4	Apr. 17	-	11	0.51	145	48	98	26	2380
Average				1.51													
High W/(C+P) ratio concrete																	
								1973	1974	1974							
15.-2-8.0	1456.56	WJ	Yes	0.79	-	-	-	Oct. 5	Oct. 22	Nov. 25	-	0.57	126	42	95	27	2390

1/ First number, buttress or placement number; second number, hole number; and third number, depth to top of core (ft).
2/ Indicates water-jet preparation.
3/ Hole 1A abandoned.
4/ Letters are added when original core is cut into more than one test specimen.

Table 8B. — *Construction joint investigation (dam) 10-in-diameter cores (6 months and 1 year age)*

Core No.	Elevation (ft)	Method of joint preparation	Did it break at joint?	Tensile strength (lb/in^2)	Number of large debonded cobbles	Percent area large cobbles	Percent total core area debonded	Dates: Concrete placed	Dates: Specimen drilled	Dates: Specimen tested	Properties of fresh concrete: Concrete temperature (°F)	W/(C+P) by weight	Cement content (lb/yd^3)	Pozzolan content (lb/yd^3)	Water content (lb/yd^3)	Percent sand	Density (lb/ft^3)
6 months' age																	
Low W/(C+P) ratio concrete																	
								1973	1974	1975							
1/ 22-1-5.4	4921.00	2/ WJ	Yes	232	-	-	-	Oct. 20	Mar. 5	-	50	0.51	259	86	176	26	149
3/ 23-1B-2.4	4924.65	WJ	No	154	-	-	80	Sept. 18	Feb. 27	-	54	0.50	259	86	173	26	151
								1974									
7-1-5.95	4921.00	WJ	Yes	257	-	-	-	May 29	Dec. 16	-	53	0.50	243	81	163	25	150
15-3-5.0	4921.00	WJ	Yes	243	-	-	-	Aug. 21	Dec. 11	Jan. 18	51	0.52	243	81	167	26	149
16-3-5.7	4921.00	WJ	Yes	209	-	-	-	Sept. 27	Dec. 12	Jan. 18	-	0.51	244	81	166	26	-
17-1-5.6	4921.00	WJ	Yes	198	-	-	-	June 11	Dec. 12	Jan. 20	51	0.55	232	77	169	26	-
19-1-5.45	4921.00	WJ	Yes	169	-	-	-	June 4	Dec. 13	Jan. 18	51	0.51	244	81	166	26	-
Average				209													
High W/(C+P) ratio concrete																	
								1973	1974								
4/ 9F6-1-5.9B	4755.00	WJ	Yes	159	-	-	-	Nov. 16	Apr. 1	-	48	0.60	211	70	168	27	149
1 year's age																	
Low W/(C+P) ratio concrete																	
								1973	1974								
23-2-0.0	4922.50	WJ	Yes	236	-	-	-	Sept. 18	Oct. 25	-	54	0.50	259	86	173	26	151
								1974	1975								
16-4-5.7	4921.00	WJ	Yes	216	-	-	-	Sept. 27	Apr. 17	-	-	0.51	244	81	166	26	
17-2-5.3	4921.00	WJ	Yes	191	-	-	-	June 11	Apr. 17	-	51	0.55	232	77	169	26	150
19-2-5.7	4921.00	WJ	No	232	-	-	95	June 4	Apr. 17	-	51	0.51	244	81	166	26	149
Average				219													
High W/(C+P) ratio concrete																	
								1973	1974	1974							
15-2-8.0	4778.75	WJ	Yes	115	-	-	-	Oct. 5	Oct. 22	Nov. 25	-	0.57	212	71	161	27	149

1/ First number, buttress or placement number; second number, hole number; and third number, depth of top of core (ft).
2/ Indicates water-jet preparation.
3/ Hole 1A abandoned.
4/ Letters are added when original specimen is cut into more than one test specimen.

GPO 835-721

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