

TESTS OF CONCRETE AGGREGATES
CARLYLE RESERVOIR
ST. LOUIS DISTRICT

APPENDIX A

TESTS OF HUELSMAN QUARRY STONE
FOR SUITABILITY FOR USE AS RIPRAP
CARLYLE DAM



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by

Lower Mississippi Valley Division
Materials and Concrete Laboratory

U. S. Army Engineer Waterways Experiment Station

CORPS OF ENGINEERS

Vicksburg, Mississippi

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Introduction

1. Rock of the same geological formation as that being quarried at the Huelsman Quarry lies within the reservoir area of the Carlyle Dam. If this stone were suitable for use as riprap it might result in a monetary saving to the Government. Results of tests on material from the Huelsman Quarry should be applicable to the material on the Government property. For this reason tests of ledge rock from the Huelsman Quarry for suitability for riprap were authorized in telephone conversation between Mr. A. J. Kochanski of the St. Louis District and Mr. T. B. Kennedy of the LMVD Materials and Concrete Laboratory on 14 November 1958.

Samples

2. Eight limestone blocks were received on 8 December 1958, assigned CRD Serial No. STL-9 G-2(2), were examined, and tested. This same source of material was evaluated for concrete aggregate and the results were included in U. S. Army Engineer Waterways Experiment Station Miscellaneous Paper No. 6-281, August 1958. The material was considered to be of inferior quality for use as concrete aggregate. The petrographic report in MP 6-281 stated that the two most abundant varieties of carbonate rocks

in the sample were fine-grained limestone containing shale streaks and somewhat porous fossiliferous limestone. The eight blocks examined were typical of the material described in MP 6-281. Most of the blocks contained shaly seams spaced at intervals ranging from 1/4 in. to 2 in. apart (table 1). The blocks were rectangular to somewhat irregularly shaped and consisted of unweathered medium gray and light brownish gray fossiliferous limestone. The average thickness of the blocks was slightly more than 7 in. (table 1). The blocks were bounded on the upper and lower surfaces by dark gray fossiliferous, calcareous, semi-fissile shale beds that averaged about 1/4 in. in thickness. Five of the blocks contained one or more dark gray calcareous shaly seams alternating with beds of paler fine-grained limestone and limestone with a high disseminated shale content (table 1). Three of the blocks did not contain clear cut shaly zones, but did contain darker bands of limestone with a high disseminated shale content.

3. If rock such as that represented by these blocks were exposed to weathering under circumstances in which the shale could become saturated and then freeze, it is expected that each block would presently split along each shale bed that it contains, reducing the blocks to sheets. The porous limestone in the sheets would then become more susceptible to freezing and thawing as the shale failed and spalled off.

Preparation of Samples

4. a. Prior to petrographic examination, the blocks were thoroughly washed. The dimensions of each block, and the thickness of and distances between shaly streaks within the block were measured and recorded. Two

blocks were selected and two slices 2-in. thick were sawed from the central area of each. Each of these slices was, in turn, sawed into three samples and one sample from each slice tested as follows:

(1) Two of the samples were subjected to 10 cycles of wetting and drying (soaked in water for 16 hr and then dried at 212 F for 8 hr).

(2) Two of the samples were subjected to 10 cycles of freezing and thawing immersed and unconfined in plain water (freezing at -15 F for 16 hr and thawing at 100 F for 8 hr).

(3) Two of the samples were subjected to 10 cycles of freezing and thawing immersed unconfined in 0.5 per cent ethyl alcohol and water solution using the same freezing and thawing procedure as in (2).

b. Tests were stopped if splitting occurred before 10 cycles.

c. Freezing and thawing in 0.5 per cent ethyl alcohol water solution is used by the Iowa State Highway Department to provide a method of test for aggregate materials, the results of which correlate fairly well with service records. This test was described by R. H. Brink, "A Rapid Freezing and Thawing Test for Aggregate," in a report to the Highway Research Board, January 1958.

d. Representative portions of all blocks were used to prepare samples for specific gravity (unit weight), absorption, soundness in magnesium sulfate, resistance to the Los Angeles abrasion test, and toughness.

Results

5. The LMVD Materials and Concrete Laboratory has been directed to use the following standard test methods on samples of material proposed for use as riprap. The limits shown are those frequently employed in LMVD project specifications (e.g. Port Allen Lock). The results of these tests on the present sample are shown for comparison.

<u>Test</u>	<u>Item</u>	<u>Limit</u>	<u>Result</u>
CRD-C			
107	Unit weight, lb/cu ft	150 min	165.7
107	Absorption, per cent	1.5 max	1.6
117	Abrasion, per cent	35.0 max	33.1
132	Toughness, cm	5 min	10
137	Soundness, 5 cy MgSO ₄ , per cent	5.0 max	3.1

It will be noted that this material complies with these requirements except for absorption. These results may be compared with those reported in MP 6-281 on previous samples from this source.

	<u>Previous Results</u>	<u>Present Results</u>
Bulk specific gravity, SSD	2.65 - 2.67	2.66
Absorption, per cent	1.7 - 2.3	1.6
Abrasion loss, per cent	25.7 - 32.7	33.1
Soundness, loss, 5 cycles MgSO ₄ , %	2.1	3.1

6. The results of the wetting and drying and the two freezing and thawing tests are as follows:

a. One of the two samples subjected to the wetting and drying test broke into two pieces along the shale partings after 5 cycles. The

second sample was beginning to crack along the shaly seam at the end of the 10 cycles.

b. One of the samples subjected to the freezing and thawing test immersed in plain water began to crack along the shaly seam and the crack continued to increase in size after each cycle. At the end of 10 cycles it broke into two pieces. The second sample began to crack at the end of 7 cycles and at the end of 10 cycles the cracking was clearly visible along the shaly seams.

c. One of the samples subjected to freezing and thawing tests using 0.5 per cent alcohol-water solution showed signs of cracking after two cycles and broke into two pieces along the shaly seams after five cycles. The second showed signs of cracking after three cycles and pulled apart along shaly seams after six cycles.

7. The data in table 1 indicate that the samples include numerous closely spaced shale zones. Typical requirements for riprap stone require that the blocks be free of seams, fissures, and planes of weakness. The results of the wetting-and-drying and freezing-and-thawing tests indicate that these shale zones are planes of weakness. It would appear that if this material were used as riprap, there would be considerable reduction in the size of the pieces in a relatively short time due to the natural wetting and drying or freezing and thawing actions.

3 Incl

Table 1

WES Form 726

WES Form 477

TABLE 1

Dimensions of Blocks and Spacing of Shale Within Blocks,
Huelsman Quarry Ledge Rock (STL-9 G-2(2))

Block No.	Dimensions, in.			Spacing and Thickness of Shale Zones Within Blocks	
	Length	Width	Thickness (a)	Distance Below Top, in.	Thickness, in.
6	19	15	11-1/2	4 6-3/4 7-3/4	1 (Approx) 1/2 (Approx) 1/4 (Approx)
7	15-1/2	12-1/2	7	2-1/4 4	1/2 1/2
8	24	18	7	3-1/2	3/8 (Approx)
10	14-1/2	14-1/2	9-1/2	3	3/8 (Approx)
11	11	10	7	-	-
12	8-1/2	8	7	-	-
13	15	7	7	-	-
14	11	7	8	3 6-1/2	7/8 1/2

(a) Normal to bedding.

All of the blocks except No. 10 had shale beds 1/8 - 1/4 in. thick on the top and bottom surfaces. Block No. 10 had 2 in. of shale at the top and 7/8 in. at bottom. All of the blocks contained one or more beds of limestone high in disseminated clay.

STATE: Ill.	INDEX NO.: 2	AGGREGATE DATA SHEET	TESTED BY: WES
LAT.: 38	LONG.: 89	DATE: 30 January 1959	
LAB. SYMBOL NO.: TL-9 G-2(2) Job 6344		TYPE OF MATERIAL: Limestone	
LOCATION: Approx 3 mi SW of Carlyle on the Barteloo Rd off Ill Hwy No. 127, NE 1/4 Sec 25, T2N, R3W, Clinton County, Illinois			
PRODUCER: Huelman Quarry, Carlyle, Illinois			
SAMPLED BY: St. Louis District Personnel			
TESTED FOR: Carlyle Reservoir			
PROCESSING BEFORE TESTING: None			

GEOLOGICAL FORMATION AND AGE.

Ledge
Rocks

GRADING (CRD-C 103)(CUM. % PASSING):						TEST RESULTS				
SIEVE	3-6"	1 1/2-3"	3/4-1 1/2"	3/8-3/4"	FINE AGG.	3-6"	1 1/2-3"	3/4-1 1/2" (c)	3/8-3/4" (c)	FINE AGG.
6 IN.						BULK SP. GR, SAT SURF DRY (CRD-C 107,108):				2.66
5 IN.						ABSORPTION, PER CENT (CRD-C 107,108):				1.6
4 IN.						ORGANIC IMPURITIES, FIG. NO. (CRD-C 121):	---	---	---	---
3 IN.						SOFT PARTICLES, PER CENT (CRD-C 130):				---
2 1/2 IN.						PER CENT LIGHTER THAN SP. GR. (CRD-C 129):				---
2 IN.						PER CENT FLAT AND ELONGATED (CRD-C 119,120):		1.37		---
1 1/2 IN.						WEIGHTED AV % LOSS, 5 CYC. MgSO ₄ ((c) 1/2-1", "4-1/2") (CRD-C 115)				3.1
1 IN.						ABRASION LOSS (L. A.), % (CRD-C 117) <i>Gradeg A</i>				33.1
3/4 IN.						UNIT WT., LB/CU FT (CRD-C 106):				165.7
3/8 IN.						CLAY LUMPS, % (CRD-C 118):				---
NO. 4						COAL AND LIGNITE, % (CRD-C 122):	---	---	---	---
NO. 8						SPECIFIC HEAT, BTU/LB/DEG. F. (CRD-C 124):				---
NO. 16						REACTIVITY WITH NaOH (CRD-C 128):				---
NO. 30						Sc, mM/L:				---
NO. 50						Rc, mM/L:				---
NO. 100						MORTAR-MAKING PROPERTIES (CRD-C 116)				---
NO. 200						TYPE _____ CEMENT, RATIO _____ DAYS, _____ % _____ DAYS, _____ %				---
- 200 (a)						LINEAR THERMAL EXPANSION X10 9/DEG. F. (CRD-C 125,126):				---
F.M. (b)										---

(a) CRD-C 105 (b) CRD-C 104

MORTAR:

MORTAR-BAR EXPANSION AT 100F, % (CRD-C 123):	FINE AGGREGATE				COARSE AGGREGATE			
	3 MO.	6 MO.	9 MO.	12 MO.	3 MO.	6 MO.	9 MO.	12 MO.
LOW-ALK. CEMENT: % Na ₂ O EQUIVALENT:								
HIGH-ALK. CEMENT: % Na ₂ O EQUIVALENT:								
SOUNDNESS IN CONCRETE (CRD-C 40, 114):					F & T	HW - CD	HD - CW	
FINE AGG. COARSE AGG:					DFE 300			
FINE AGG. COARSE AGG:					DFE 300			

PETROGRAPHIC DATA (CRD-C 127)

Toughness (CRD-C 132):

Test No.	Height of Blow at Failure, cm	
	Perpendicular to Plane of Structural Weakness	Parallel to Plane of Structural Weakness
1	9	11
2	9	10
3	9	10
Avg	9	10

REMARKS:

FROM: CORPS OF ENGINEERS
 U. S. ARMY
 Lower Mississippi Valley DIVISION

REPORT OF
 SOUNDNESS TEST
 (CRD-C-15)
 5 cycles MgSO₄

ADDRESS:
 USAE Waterways Experiment Station
 P. O. Drawer 2131
 Jackson, Mississippi

SYMBOL: STL-9 Job 6344
 PROJECT: Carlyle Reservoir
 MATERIAL: Limestone

SERIAL NO.: STL-9 G-2(2)
 SOURCE: Huelman Quarry, Carlyle, Illinois

COARSE AGGREGATE

SIEVE SIZE	GRADING FOR CALCULATION (Per Cent)	WEIGHT OF TEST FRACTIONS BEFORE TEST (Grams)		WEIGHT OF TEST FRACTIONS AFTER TEST (Grams)		WEIGHT PASSING FINER SIEVE AFTER TEST ACTUAL LOSS (g)		% PASSING FINER SIEVE AFTER TEST ACTUAL % LOSS		WEIGHTED AVG CORRECTED PER CENT LOSS	
		RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
Ledge Rock											
NO. 4 TO 1 IN.	50	5000		4847		153		3.1			
1 TO 1 IN.	50										
TOTALS											

SUM WEIGHTED AVG RUNS 1 & 2

AVG TOTAL WEIGHTED AVG RUNS 1 & 2

PER CENT

CONSTITUENT (Size 3/4 to 1 in.)	NO. OF PARTICLES BEFORE TEST	NO. PARTICLES AFTER TEST											
		SPLIT		CRUMBLD		CRACKED		FLAKED		SOUND		TOTAL	
		RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
Limestone	50	1	0	0	45	4	50						

FINE AGGREGATE

SIEVE SIZE	GRADING FOR CALCULATION (%)	WEIGHT OF TEST FRACTIONS BEFORE TEST (Grams)		WEIGHT OF TEST FRACTIONS AFTER TEST (Grams)		% PASSING FINER SIEVE AFTER TEST ACTUAL % LOSS		WEIGHTED AVERAGE CORRECTED % LOSS	
		RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
3/8-IN.-NO. 4	2								
NO. 4-8	13								
NO. 8-16	20								
NO. 16-30	20								
NO. 30-50	24								
NO. 50-100	14					0.0	0.0	0.0	0.0
NO. 100-PAN	7					0.0	0.0	0.0	0.0
TOTALS		100							

SUM WEIGHTED AVG RUNS 1 & 2

AVG TOTAL WEIGHTED AVG RUNS 1 & 2

PER CENT

REMARKS

COARSE BY: JFJ
 CHECKED: RLC

FINE BY: _____
 DATE OF REPORT: 30 January 1959

COMPUTED: JFJ