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Trap Rocks of Palouse Region as Road Material

PART II

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BULLETIN NO. 2

TRAP ROCKS OF PALOUSE REGION AS ROAD MATERIAL

PROGRESS REPORT

BY

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WITH THE CO-OPERATION OF

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BULLETINS

The regular bulletins of the Station are sent free to all citizens of Idaho who request them. Late bulletins are:

43. Planting the Apple Orchard.
44. Alkali and the Treatment of Alkali Lands.
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Trap Rocks of Palouse Region as Road Material.

C. N. LITTLE

In the fall of 1903 the writer, recognizing the importance of good roads to the Palouse country and the desirability of testing the stone available for macadam in advance of road construction, planned a systematic investigation by the Civil Engineering department of Idaho University of the exposures of trap rock in the Palouse region.

In July 1904 a bulletin was published by the experiment Station of Idaho University giving results obtained in this investigation up to that time. This bulletin is referred to throughout the following discussion as Bull. No. 1. The bulletin now in hand gives an account of a continuation of the work therein described, bringing it down to date.

The information contained in the present bulletin was obtained by Mr. W. G. Turley in preparation for his thesis for the degree of B. C. E., given him by Idaho University in June last. He collected the stone in the field, either broke it himself or supervised its breaking, did all the work involved in making the tests of hardness, toughness and cementation quality and recorded the results. Much credit should be given Mr. Turley for the energy and fidelity with which he carried through this laborious piece of independent work.

HARDNESS AND TOUGHNESS.

There has been no change in the methods employed. The tests for hardness and toughness were made in a standard Olsen machine or rattler, in the barrel of which was placed a charge of seventy-five pounds of clean stone, broken so as to pass in every position a two and three-quarters inch ring and not to pass a one and one-half inch ring, with fifty pounds of cast iron blocks, each weighing a little over seven pounds and one hundred pounds of cast iron cubes each weighing a little less than a pound. The machine was then driven by a 3 H.P. motor for approximately half an hour until 1050 revolutions had been automatically recorded. Plate I, which is reprinted from Bull. No. 1., shows the laboratory in Fig. 1, and the abrasion machine and shot in Fig. 2. For a full description see Bull. No. 1, p. 7.

The stone remaining in the barrel of the abrasion machine was then weighed. This weight subtracted from seventy-five pounds gave the weight of dust and fragments passing between the slats of the machine and the inverted ratio of this difference to seventy-five furnishes a rough measure of the toughness of the stone tested.

All dust and fragments were sifted on a standard twenty-mesh sieve. The weight of material not passing this sieve was added to the weight of stone remaining in the barrel of the rattler and this sum subtracted from seventy-five pounds. The inverted ratio of this difference to seventy-five is taken as a rough measure of hardness. It should be noted that in a closed cylinder the dust would be increased. The tests as made give an apparent advantage to the softer rocks and therefore unfavorable conclusions as to these rocks are all the more certain.

The results of these tests are given in Table I following.

TABLE 1—ABRASION TESTS

Reference Number	LOCATION OF QUARRY	TOUGHNESS Per cent. passing slats of machine		HARDNESS Per cent. passing through 20-mesh sieve	
		Test	Average	Test	Average
1	About 200 ft. n. and 500 ft. w. of O.R.& N. Depot, Pullman.	11.3 12 8 17.6	13.9	4.0 6.1 7.0	5.7
2	First curve east of Armstrong on O. R. & N.	15.3 12.8 15.0	14.4	7.3 7.0 5.7	6.7
3	Knoll about 1200 ft. west of O. R. & N. Depot, Guy.	18.7 19.3	19.0	9.7 10.4	10.1
4	About 100 feet south of first trestle on O. R. & N. east of Guy.	27 8 32.1 23.0	27.6	13.7 10.6 10.5	11.6
5	About 500 feet northwest of Riverside.	16.0 13 9 13.2	14.4	6.1 5.0 5 3	5.5
6	100 ft. n. of Palouse R. and 200 ft. e. of Main street, Colfax.	10.9 13.9 11.5	12.1	3.5 4.9 4.5	4.3
7	About 1-4th mile s.w. of city quarry (No. 6) Colfax.	12.7 12.0 12.3	12.3	6.0 6.0 4 8	5.6
8	University farm, s. e. ¼ sec. 12, t. 39 n, r. 6, w, B. m.	52.8 50.5 50.0	51.1	30.9 31.6 28.9	30.5
9	Byrn's farm, nw. ¼, sec. 19, t. 39 n, r. 5 w. B. m.	36.4 41.7 40.0	39.4	9.1 9 3 10.3	9.6
10	Forty ft. s. 2d bridge over Paradise, e. of N. P depot, Moscow.	50.0 47.7 48.4	48.7	39 1 34 1 38.2	37.1
11	Stinson's farm, se. ¼ sec. 7, t. 39 n., r. 3 w, B. m.	13.3 14.7 14.0	14.0	6 7 6.7 7.3	6.9
12	About 100 ft. n. of Main and 40 ft. w. of Fifth street, Kendrick	11.3 11.2 11.3	11.3	6.1 6.0 6.0	6.0
13	Platte's farm. sw. ¼ sec. 13, t. 27 n., r 5.w, B. m.	10.1 10.1 9.9	10.0	6 0 5.8 5.7	5.8

The following notes are taken from Mr. Turley's thesis. The different stones are designated by their tabular numbers.—

1. This stone is from a well opened quarry on N. W. ¼, Sec. 5, Twp. 14 N., R. 45 E., Willamette Meridian. It is gray, close grained, resonant, and almost free from pitting. The streets of Pullman are macadamized with stone from this quarry.

2. This is surface rock from the N. W. ¼, Sec. 25, Twp. 15 N., R. 44 E., W. M. It is gray, medium grained, almost free from pitting and resonant.

3. From an outcrop on the N. W. ¼, Sec. 15, Twp. 15 N. R. 44 E., W. M. It is coarse grained, gray, free from pitting and resonant.

4. From a well opened quarry on the S. E. ¼, Sec. 15, Twp. 15 N., R. 44 E., W. M. It is coarse grained, gray, free from pitting and resonant. It is quarried for building stone.

5. From a newly opened quarry on the N. E. ¼, Sec. 29, Twp. 16 N., R. 44 E., W. M. It is dark gray, coarse grained, resonant, free from pitting and shows a crystalline fracture.

6. From the S. W. ¼, Sec. 14, Twp. 14 N., R. 43 E., W. M. It is dark gray, fine grained, free from pitting, resonant and shows a crystalline fracture. Stone from this quarry was used in macadamizing the business street of Colfax.

7. From the S. W ¼, Sec. 14, Twp. 14 N., R. 43 E., W. M. It is dark gray, medium grained, free from pitting and resonant. The quarry is well opened and the exposed stone stands in columnar formation. This stone was used in macadamizing the country road running southwest from Colfax and extensively for building purposes. The M. E. Church of Moscow and the basement story of the University Gymnasium are constructed of this stone.

8. University Farm Stone.

9. The Byrns' Farm stone.

10. From an outcrop on S. W. ¼ of Sec. 17, Twp. 39 N., R.

5 W., Boise Meredian. It is a gray, fine grained stone, honeycombed with pits up to three sixteenths of an inch in diameter and gives a dull sound when struck.

11. From a newly opened quarry about half a mile east of Troy. It is a gray, medium grained stone with a few small pits and is resonant. It is used as building stone.

12 From the S. E. ¼ of Sec. 24, Twp 38 N., R. 3 W., B. M. It is a dark gray, coarse grained, resonant stone free from pitting.

13. From a well opened quarry. It is a gray, medium grained, resonant stone free from pitting This rock was used in macadamizing the business streets of Genesee.

COMPARISON OF RESULTS OBTAINED IN 1904 AND 1905.

In order that the work reported in Bul. No. 1 might be compared with that done this year Mr. Zeigler's experiments 3, 6 and 7 p 9, Bul. No. 1 were repeated by Mr. Turley as 9, 8, 7, respectively of Table 1, this bulletin.

The comparison is shown as follows:

LOCATION OF QUARRY	TOUGHNESS		HARDNESS	
	Zeigler	Turley	Zeigler	Turley
Byrns' Farm	33.8	39 4	8 5	9.6
University Farm ..	61.9	51.1	35.8	30.5
Colfax	.....	12 3	8.3	5 6

The differences are to be accounted for by personal equation, differences of location in quarry, and condition of shot. The effort was made this year as last to keep the shot in a uniform condition of wear, by substituting a fixed number of new shot for old ones in each successive charge. But a delay in

receiving an order for new shot caused a shortage and Mr. Turley's shot were more worn than those used by Mr. Zeigler.

CEMENTATION TEST.

The dust passing the twenty inch sieve was resifted on a standard 100 mesh sieve (10,000 meshes to the square inch.) Of the dust passing this sieve seventeen ounces were mixed with three and one-half ounces of water, worked ten minutes with the trowel, and then molded into four briquettes in standard cement molds for tension. The dough was thoroughly rammed into the molds and the briquettes removed as soon as made. These briquettes were allowed to dry fourteen days in air and then broken by a Fairbanks cement testing machine. In certain cases other briquettes were made with a ratio of dust to water of 17 : 4½. These briquettes were stronger than the ones with the ratio 17 : 3½., All the briquettes were made on the same day and made stored and broken under as nearly uniform conditions as practicable. The results therefore should be comparable. The matter of testing cementing quality is confessedly a difficult one and this part of the investigation is regarded as tentative only. The results are published for record and study, and for comparison with the information to be derived from other sources and especially from observation of the behavior of these stones on roads already built.

The results of the tests are given in Table II following.

TABLE 2—CEMENTATION TESTS.

Refere'ce Number	LOCATION OF QUARRY	Tensile strength of briquettes in lbs per sq. in.	Average Strength
1	Pullman, Wash.— Nw ¼, Sec 5, T 14 N, R 45 E	36-62 56-55 85-80 ( )	52 *82
2	Armstrong, Wash.— Nw ¼, Sec 25, T 15 N, R 44 E	65-67-82-100 80-77-96	78 *84
3	Guy, Wash.— Nw ¼, Sec 15, T 15 N, R 44 E	33-27-( )-21 22-32-43	27 *32
4	Guy, Wash.— Se ¼, Sec. 15, T 15 N, R 44 E	12-10-8-9 14-20-16	10 *17
5	Riverside, Wash.— Ne ¼, S 29, T 16 N, R 44 E,	23-20-77-55	44
6	Colfax, Wash.— Sw ¼, S 14, T 14 N, R 43 E,	65-79-125-112	95
7	Colfax, Wash.— Sw ¼, S 14, T 14 N, R 43 E,	81-69 82-84	79
8	University Farm, Moscow— Se ¼, S 12, T 39 N, R 6 W, BM	41-36-36-38	38
9	Byrns' Farm. Moscow— Nw ¼, S 19, T 39 N, R 5 W, BM	42-41-40-44	42
10	Moscow— Sw ¼, S 17, T 39 N, R 5 W, BM	16-12-21-14	16
11	Troy— Se ¼, S 7, T 39 N, R 3 W, BM	39-38-36-36	37
12	Kendrick— Se ¼, S 24, T 38 N, R 3 W, BM	56-40-58-52	52
13	Genesee— Sw ¼, S 13, T 37 N, R 5 W, BM	52-48-63-77	60

*Ratio of dust to water in these: 17 to 4½

TESTS MADE AT WASHINGTON.

By the courteous permission of Logan Waller Page, Chief of the Division of Tests, Bureau of Chemistry, Department of Agriculture, Washington D. C., samples of Nos. 7, 8, and 9 were sent to that fully equipped road material laboratory and the following is a copy of the report of the results of tests there made, signed by A. S. Cushman, Acting Chief.

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY
WASHINGTON, D C.
DIVISION OF TESTS

May 16, 1905.

Report on sample No. 1271 (see No. 8, tables I and II) of road material from Moscow, Latah county, Idaho.

Material: Basalt.

Determinations.

Specific gravity	2.45
Weight per cubic foot	152.8 pounds
Water absorbed per cubic foot	5.14 pounds
Per cent of wear	7.69
French coefficient of wear	5.20
Hardness	13.9
Toughness	6
Cementing value	89 dry 464 wet

An explanation of tests is given in Bulletin No. 79, Bureau of Chemistry, Department of Agriculture.

Remarks—This sample was vesicular in character and consequently the hardness and toughness are not absolute. An excellent road material with a high cementing value. It should be rolled wet if possible.

Mineral Analysis of Sample No. 1271, (No. 8, University Farm,) of Rock from Moscow, Idaho.

Character of material: Effusive rock.

Name: Basalt.

Essential Minerals.

Name.	Composition.	Per Cent
Plagioclase.	Silicate of alumina, lime and soda	41.2
Augite	Silicate of lime, magnesia, iron, alumina	38.1

Accessory Minerals.

Name.	Composition.	Per Cent
Magnetite	Magnetic oxide of iron	6.8
Rock glass		3.6

Secondary Minerals.

Name.	Composition.	Per Cent
Serpentine	Hydrated silicate of iron and magnesia	10.3
Limonite	Hydrated oxide of iron	

Remarks: Specimen is light gray, vesicular basalt composed essentially of plagioclase (labradorite) augite and serpentine and limonite, the decomposition products of olivine.

Report on sample No. 1273, (see No. 9, Tables I and II,) of road material from Moscow, Latah county, Idaho.

Material: Basalt.

Determinations.

Specific gravity	2.85
Weight per cubic foot	177.8 pounds
Water absorbed per cubic foot	1.41 pounds
Per cent of wear	4.61
French coefficient of wear	8.67
Hardness	
Toughness	
Cementing value	2 dry, 27 wet

Remarks: A poor material with a low cementing value. It might be used if No. 1271 were used for the binder course.

Mineral analysis of sample No. 1273, (No. 9, Byrns' Farm,) of rock from Moscow, Idaho.

Character of material: Effusive rock.

Name: Basalt.

Essential Minerals.

Name	Composition	Per Cent
Plagioclase.	Silicate of alumina, lime and soda	38.1
Augite	Silicate of lime, magnesia, iron and alumina	24.4
Rock glass		27.0

Accessory Minerals.

Name	Composition	Per Cent
Olivine	Silicate of magnesia and iron	2.3
Magnetite	Magnetic oxide of iron	6.0

Secondary Minerals.

Name	Composition	Per Cent
Limonite	Hydrated oxide of iron	2.2
Serpentine	Hydrous silicate of magnesia and iron	

Romarks: Specimen is fine grained, dark steel gray vesicular rock composed essentially of plagioclase (labradorite), augite and rock glass.

Report on sample No. 1272, (see No. 7, Tables I and II,) of road material from Colfax, Whitman county, Washington.

Material: Basalt.

Determinations.

Specific gravity	2.92	
Weight per cubic foot	180.9	pounds
Water absorbed per cubic foot	1.11	pounds
Per cent of wear	2.00	
French coefficient of wear	20.00	
Hardness	15.5	
Toughness	22	
Cementing value	1 dry	9 wet

Remarks: A poor material with low cementing value.

Mineral analysis of sample No. 1272 (No. 7) of rock from Colfax, Washington.

Character of material: Effusive rock.

Name: Basalt.

Essential Minerals.

Name	Composition	Per Cent
Plagioclase	Silicate of alumina, lime and soda	40.9
Augite	Silicate of lime, magnesia, iron and alumina	39
Magnetite	Magnetic oxide of iron	8.7
Rock glass		7.2

Accessory Minerals.

Name	Composition	Per Cent
Olivine	Silicate of magnesia and iron	2 7

Secondary Minerals.

Name	Composition	Per Cent
Limonite ..	Hydrated oxide of iron.....	1.5

Remarks: Specimen is a fine grained, steel gray rock composed essentially of plagioclase (labradorite) augite, magnetite and rock glass.

The unqualified approval by the Department expert of the University Farm stone is a surprise to the writer in view of the inferiority in hardness and toughness of this stone and also in view of its rapid wear on the Moscow streets particularty on the eighteen foot strip on Main street from Fourth street south, which, after less than four years wear, urgently needs resurfacing.

It is also a matter of surprise that the Colfax rock, condemned as "a poor material with low cementing value" should show an average tensile strength of 79 lbs., per square inch and be next to the strongest material tested by Mr. Turley (see No. 7, Table II.)

CONCLUSION.

The department has now completed the examination of the exposures of trap on the line of the O. R. & N. railroad from Colfax to Moscow. The investigation finds in these rocks a great variation in the qualities required in road material; but there is an abundance of suitable stone well distributed for road making.

Information as to cost and wear of stone roads construct ed in the Palouse Country is accumulating in the records of the Civil Engineering department and will be published in a later bulletin.

The hearty thanks of the Civil Engineering department are hereby extended to the traffic officials of the O R. & N., and to Mr. W. C. Wilkes, Moscow agent, for transporting stone for testing without charge, and for other favors.

Fig. 1—Cement and Stone Laboratory Civ. Eng. Dept., Univ. of Idaho

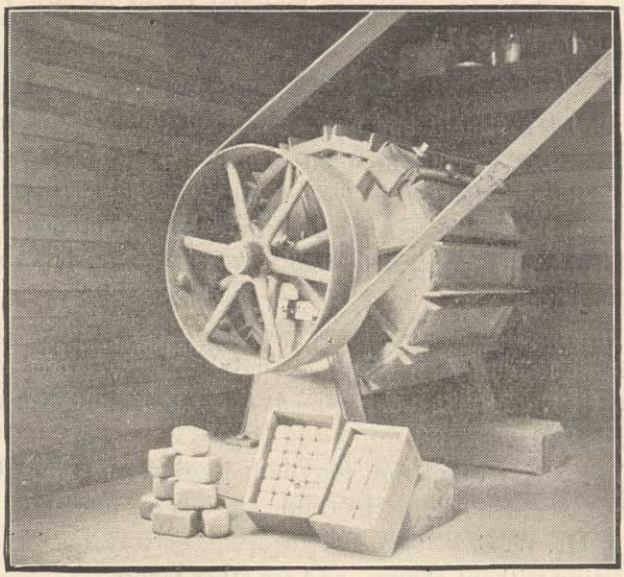

Fig. 2—Abrasion Machine Civ. Eng. Lab., Univ. of Idaho