

MICHIGAN
STATE HIGHWAY DEPARTMENT
G. Donald Kennedy
State Highway Commissioner

PROGRESS REPORT ON
COOPERATE RESEARCH PROJECT BETWEEN
MICHIGAN STATE HIGHWAY DEPARTMENT AND
MICHIGAN COLLEGE OF MINING AND TECHNOLOGY
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By

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FOREWORD

This work constitutes primarily a progress report on the status of the cooperative research project, as of July 1, 1942, between the Michigan State Highway Department and the Michigan College of Mining and Technology.

This work was performed and reported by W. A. Keranen, of the Testing and Research Division who was in responsible charge of the project at Houghton.

INTRODUCTION

In March 1941, at the request of Grover C. Dillman, President of the Michigan College of Mining and Technology, State Highway Commissioner, G. Donald Kennedy, instructed the Research Division to proceed with the establishment of a cooperate research project between the Michigan College of Mining and Technology and the State Highway Department. The Research Division to assume the responsibility for the general direction of the work.

It was understood that the branch research laboratory would be established at Houghton for the purpose of using the laboratory facilities of the College for convenience in investigating the problems of immediate concern to the construction of highways in the Upper Peninsula.

After considerable delay in obtaining and training a man to assume the responsibility for this particular project, the project was started in December 1941 under the following program.

The program was prepared on the basis of suggested projects recommended by the Testing Division and the current activities of the Research Division in the Upper Peninsula.

The research program consists of three major projects as follows:

1. Field scaling studies on concrete pavements.
2. Concrete materials investigation.
3. Stabilized base course investigation.

The major studies listed above will be discussed in the order presented.

Field Scaling Studies on Concrete Pavements

Accelerated scaling studies were made on certain concrete pavements to supplement similar scaling studies on the Michigan Test Road as well as laboratory studies being conducted at East Lansing.

The field scaling projects include a comparative study of calcium chloride salt versus natural freezing and thawing, the effect of calcium chloride on concrete containing stamp sand and the effect of calcium chloride on stone sand with and without silica dust and containing Orvus.

Investigation of Calcium Chloride Salt versus Natural Freezing and Thawing of Water on Concrete Pavement

The purpose of this project was to conduct comparative scaling studies on a concrete slab not previously treated with calcium chloride to determine in what degree calcium chloride or natural freezing and thawing are inducive to scaling of concrete surfaces.

Scaling panels similar to those used on the Test Road were installed on US-41, Baraga County near L'Anse. The pavement was constructed in 1941 using Champion Sand and Gravel.

Investigation of Calcium Chloride on Stamp Sand Fine Aggregate Concrete Pavement

The purpose of this study was to determine the resistance to scale of concrete pavement containing stamp sand as a fine aggregate.

A scaling panel was established on pavement surface containing stamp sand. The scaling panel is on US-41 about 8 miles north of Hancock toward Calumet, station 440+00.

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Investigation of Calcium Chloride on Stone Sand Fine Aggregate Concrete
With and Without Silica Dust and Containing Orvus

The purpose of this study was to determine the relative resistance to scaling of stone sand concrete pavement with and without silica dust as a mineral filler and containing Orvus.

Scaling panels were installed on stone sand project in the City of Manistique. Project M 75-28, C2. Panels at station 53+00 right (Orvus and silica dust). Station 54+15 left (Orvus only).

The field scaling projects have been completed. The results from these studies are being incorporated into a major report on concrete scaling to be submitted at a later date.

Concrete Materials Investigation

It was proposed to make a comprehensive study of local mine wastes to determine their suitability for use in highway construction. The study includes both stamp sand and crushed mine rock.

Study of Stamp Sand as Fine Aggregate for Concrete

The purpose of this study was to determine the suitability of stamp sand, ground and reground for use in concrete mixtures. This work will entail field and laboratory studies on the aggregate separately and in concrete specimens.

To date, the work has consisted of collection of samples and running routine laboratory tests on materials from different sources.

Study of Crushed Mine Rock as Coarse Aggregate for Concrete

The purpose of this study was to determine the suitability of crushed mine rock for use as coarse aggregate in concrete mixtures. This work will entail field and laboratory studies on the aggregate separately and in concrete specimens.

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This study was in progress in conjunction with the stamp sand investigation.

Stabilized Base Course Investigation

The purpose of this project was to determine the suitability of stamp sand for bituminous or portland cement stabilized base courses. The project will consist of two parts -

1. Bituminous stabilization studies
2. Cement stabilization studies

It was proposed to conduct laboratory studies on these materials for the purpose of developing proper mix design and prepare specifications for base or surface construction.

This phase of the program has not been started.

This report presents a compilation of the data obtained from the work pertaining to the Concrete Materials Investigation. The work up until July 1, 1942 included field surveys and material analyses pertinent to the following sources of materials:

1. Atlantic (Bosch) Sand Deposit
2. Boston Stamp Sand Deposit
3. Calumet and Hecla Re grind Deposit
4. Franklin and Centennial Deposit
5. Isle Royal Stamp Sand Deposit
6. Quincy Stamp Sand Deposit
7. Trimountain and Baltic Stamp Sand Deposit
8. Winona Stamp Sand Deposit
9. Calumet Crushed Trap Rock.

ATLANTIC (BOSCH) SAND DEPOSIT

Type of Material

Crushed amygdaloid rock sand.

Location and Accessibility

The deposit is located in section 34, T55N, R34W, in two portions, the one located near the Bosch brewery and the other near the Michigan Smelter slag deposit a short distance west. It is easily accessible by either a good highway or railroad.

Quantity

There is an estimated 15,000 cubic yards available. However, the deposit is pretty well worked out.

Type of Deposit

These sands have been used on Michigan State Highway Department concrete jobs, also for oil aggregate and sheet asphalt work.

Owner

Bosch Brewing Company.

Physical Properties

- 1. Unit Weight 109 lbs./cubic foot
- 2. Organic Plate 1
- 3. Stone dust (through No. 200)0.7%
- 4. Fineness Modulus 3.07
- 5. Bulk Specific Gravity 2.67

6.	Bulk Specific Gravity (Surface dry)	. . . . .	2.75
7.	Apparent Specific Gravity	. . . . .	2.89
8.	Absorption, percent	. . . . .	2.86
9.	Percent Voids	. . . . .	34.5
10.	Mechanical Analysis		
	Cumulative passing No. 4	. . . . .	100%
	" " No. 8	. . . . .	91%
	" " No. 16	. . . . .	58%
	" " No. 30	. . . . .	30%
	" " No. 50	. . . . .	11.3%
	" " No. 100	. . . . .	2.2%
11.	Structural Soundness	. . . . .
12.	Compression and Tension Tests	. . . . .
13.	Soundness thru 5 cycles of magnesium sulphate	. . . . .
14.	Weighted average (corrected percent)	. . . . .	2.89 first
			3.04 second

BOSTON STAMP SAND DEPOSIT

Type of Material

Conglomerate nature

Location and Accessibility

The deposit is located near the former mining town of Boston, near US-41, approximately 8 miles from Houghton, section 8, T56N, R33W.

Accessible to US-41.

Quantity

Too high in organic material to be practical.

Type of Deposit

Apparently too high in organic material to be practical for bituminous or concrete work.

Owner

Boston Mining Company

Physical Properties

1. Unit Weight	
2. Organic	Plate 1
3. Stone dust (through No. 200)	0.6%
4. Fineness modulus	2.67
5. Bulk specific gravity	2.53
6. Bulk specific gravity (surface dry)	2.66
7. Apparent specific gravity	2.73
8. Absorption	1.44%

9. Percent voids 35.2

10. Mechanical analysis

Cumulative passing No. 4	. . . . .	100%
" " No. 8	. . . . .	94%
" " No. 16	. . . . .	66%
" " No. 30	. . . . .	43%
" " No. 50	. . . . .	22.9%
" " No. 100	. . . . .	7.0%

CALUMET AND HECLA REGRIND DEPOSIT

Type of Material

This deposit is the tails from a reground conglomerate stamp sand with some reground amygdaloid stamp sand mixed with the conglomerate.

Location and Accessibility

Lake Linden approximately 1500 feet from highway M-26, covering about a half section in Torch Lake, in the east 1/2 of section 5, T55N, R52W. The deposit is adjacent to the Mineral Range railroad and easily accessible from highway M-26.

Quantity

Unlimited.

Type of Deposit

This material was stamp sand which was hydraulically treated for its copper content and then deposited into Torch Lake. It was then dredged and repumped into the mills, reground and remilled and after being ammonia leached was deposited into Torch Lake again.

Owner

The Calumet and Hecla Mining Company, Calumet, Michigan.

Physical Properties

- 1. Unit weight 103 lbs./cu.ft.
- 2. Organic Plate 1
- 3. Stone dust (through No. 200) 13.5%

4.	Fineness modulus	1.12
5.	Bulk specific gravity	2.58
6.	Bulk specific gravity (surface dry)	2.63
7.	Apparent specific gravity	2.71
8.	Absorption	2.06%
9.	Percent voids	36
10.	Mechanical analysis	
	Cumulative passing No. 4	100%
	" " No. 8	99.6%
	" " No. 16	98.5%
	" " No. 30	92.4%
	" " No. 50	64.8%
	" " No. 100	32.5%
	" " No. 200 (by rotap)	12.8%

FRANKLIN AND CENTENIAL DEPOSITS

Type of Material

These sands are a mixture from various mines in this locality. These mills, especially the Franklin, did custom milling for independent mining companies in the copper country. Therefore, they are a mixture of the red conglomerates as well as the gray amygdaloids.

Location and Accessibility

Village of Point Mills, about 14 miles from Houghton on the shore of Portage Lake in sections 10 and 11, T53N, R33W, and are easily accessible by road or lake transportation in the summer months.

Quantity

Unlimited

Type of Deposit

Mixture of red conglomerates as well as the gray amygdaloids.

Owner

Calumet and Hecla Mining Company

Physical Properties

(Franklin Stamp Sand)

- 1. Unit Weight 110.5 lbs/cu.ft.
- 2. Organic Plate No. 1
- 3. Stone dust (through No. 200) 2.5%
- 4. Fineness Modulus 2.73

5.	Bulk specific gravity	2.63
6.	Bulk specific gravity (surface dry)	2.68
7.	Apparent specific gravity	2.78
8.	Absorption	2.14%
9.	Percent voids	32.5%
10.	Mechanical analysis	
	Cumulative passing No. 4	100%
	" " No. 8	93%
	" " No. 16	64%
	" " No. 30	39%
	" " No. 50	22%
	" " No. 100	9.3%

(Centennial Stamp Sand)

1.	Unit Weight	118.2 lbs./cu.ft.
2.	Organic	Plate No. 1
3.	Stone dust (through No. 200)	2.8%
4.	Fineness Modulus	2.70
5.	Bulk specific gravity	2.71
6.	Bulk specific gravity (surface dry)	2.78
7.	Apparent specific gravity	2.91
8.	Absorption	2.55%
9.	Percent voids	30.1
10.	Mechanical analysis	
	Cumulative passing No. 3/8	100%

Cumulative passing No. 4	99.4%
" " No. 8	88%
" " No. 16	60%
" " No. 30	41%
" " No. 50	27.1%
" " No. 100	13.3%

ISLE ROYAL STAMP SAND DEPOSIT

Type of Material

Amygdaloid crushed rock sand.

Location and Accessibility

Two miles east of Houghton and approximately 500 feet north of highway US-41, covering approximately a half section in the north 1/2 of section 5, T54N, R33W and a small portion of the SW 1/4 of section 32, T33N, R33W. The deposit is adjacent to the DSS and R railroad and easily accessible from US-41 by a good road.

Quantity

Unlimited.

Type of Deposit

This material is the tails from the amygdaloid rock crushed for its copper content by the Isle Royal Copper Company. It is deposited from water, which is run down a sluice from the mill to the place of deposit and is deposited in layers, the coarse settling out first, and then grading to the finer, until a layer of such fineness is reached that the percolation of the water stops and a coarse layer is deposited again. The material comes from an ore that is considered easy milling and crushing for this district. It contains considerable of the soft minerals such as calcite, etc. Although the material is not uniform in grading throughout the deposit, the material taken from the face of the pit gives a uniform grading by mixing.

Owner

Isle Royal Mining Company, Houghton, Michigan

Physical Properties

1. Unit weight	118.0 lbs./cu.ft.
2. Organic	Plate No. 1
3. Stone dust (through No. 200)	3.5%
4. Fineness modulus	3.17
5. Bulk specific gravity	2.71
6. Bulk specific gravity (surface dry)	2.77
7. Apparent specific gravity	2.89
8. Absorption	2.29
9. Percent voids	30.0
10. Mechanical analysis	
Cumulative passing No. 4	99.7%
" " No. 8	78%
" " No. 16	52%
" " No. 30	31%
" " No. 50	18.4%
" " No. 100	8.7%
11. Structural soundness	OK
12. Compression and tension tests	OK
13. Soundness through 5 cycles of magnesium sulphate	
Weighted average (corrected %)	2.89 1st test
	3.04 2nd test

QUINCY STAMP SAND DEPOSIT

Type of Material

Amygdaloid rock.

Location and Accessibility

Near the village of Mason, approximately 6 miles from Houghton, on highway M-26, sections 25 and 26, T55N, R33W. The deposit is easily accessible.

Quantity

Unlimited.

Type of Deposit

There are two deposits of amygdaloidal nature from rock which is mined in the vicinity of Hancock.

Owner

Quincy Mining Company

Physical Properties

	<u>No. 1 Mill</u>	<u>No. 2 Mill</u>
1. Unit Weight	117.1 lbs/cu.ft.	118.2 lbs./cu.ft.
2. Organic	Plate No. 1	Plate No. 1
3. Stone dust (through No. 200)		
4. Fineness modulus	2.40	3.05
5. Bulk specific gravity	2.78	2.76
6. Bulk specific gravity (surface dry).	2.84	2.83
7. Apparent specific gravity	2.97	2.96
8. Absorption, percent	2.40	2.48

	<u>No. 1 Mill</u>	<u>No. 2 Mill</u>
9. Percent voids	32.2	31.3
10. Mechanical analysis		
Cumulative passing No. 4	100%	98%
C " " No. 8	91%	74%
" " No. 16	76%	58%
" " No. 30	48%	34%
" " No. 50	28.9%	20.3%
" " No. 100	13.6%	8.8%

TRIMOUNTAIN AND BALTIC STAMP SAND

Type of Material

This deposit contains tailings from five mills.

Location and Accessibility

Shore of Lake Superior in the vicinity of Redridge and Beacon Hill. They are spread out along the shore line in sections 19 and 20, T55N, R35W, and are easily accessible.

Quantity

Unlimited.

Type of deposit

The deposit contains tailing from the Freda mill of the Champion Copper Company and the now extinct Trimountain, Baltic, Edgemeer and Atlantic mills. These sands have been washed along the shores for miles.

Owner

The Champion Copper Company of Painesdale, Michigan

Physical Properties

	<u>Trimountain</u>	<u>Baltic</u>
1. Unit weight	112.1 lbs/cu.ft.	107.6 lbs/cu.ft.
2. Organic	Plate No. 1	Plate No. 1
3. Stone dust (through No. 200)	3.2%	0.2%
4. Fineness modulus	2.67	2.76
5. Bulk specific gravity	2.74	2.82
6. Bulk specific gravity (surface dry)	2.80	2.85

	<u>Trimountain</u>	<u>Baltic</u>
7. Apparent specific gravity	2.94	2.91
8. Absorption	2.43%	1.17%
9. Percent voids	34.3	38.8
10. Mechanical analysis		
Cumulative passing No. 4	100%	100%
" " No. 8	94%	99%
" " No. 16	70%	91%
" " No. 30	38%	29%
" " No. 50	21.5%	1.2%
" " No. 100	8.6%	1.2%

WINONA STAMP SAND DEPOSIT

Type of Material

Amygdaloid crushed rock sand.

Location and Accessibility

30 miles south of Houghton and 1.7 miles from M-26, near the village of Winona which is the site of the now extinct Winona Copper Company. This deposit is easily accessible by a good road, especially in the summer months.

Quantity

There is an estimated 15,000 to 20,000 cubic yards of this material available.

Type of Deposit

This material is the tails from the crushed amygdaloid rock from the old Winona Mining Company's stamp mill. The material is the larger size from the tails. The fines were all washed out and sluiced away. The pile is conical in shape and the sand is especially clean.

Owner

Privately owned by Mr. R.R. Seeber, Mr. Dean Robinson and Mr. William Smith, of Houghton, Michigan

Physical Properties

- 1. Unit weight 110.6 lbs/cu.ft.
- 2. Organic Plate No. 1
- 3. Stone dust (through #200) 0.81%
- 4. Fineness modulus 3.64

5.	Bulk specific gravity	2.85
6.	Bulk specific gravity (surface dry).	2.89
7.	Apparent specific gravity	2.96
8.	Absorption	1.34%
9.	Percent voids	37.6%
10.	Mechanical analysis	
	Cumulative passing No. 4	100%
	" " No. 8	77%
	" " No. 16	41%
	" " No. 30	14%
	" " No. 50	2.6%
	" " No. 100	1.7%

CALUMET CRUSHED TRAP ROCK 4-A AND 10-A

This coarse aggregate is from the Houghton County Road Commission crusher at the former Tamarch Mining Company borrow pile at Calumet, Michigan

Physical Properties

	<u>4-A</u>	<u>10-A</u>
1. Unit Weight	97 lbs/cu.ft.	97 lbs/cu.ft.
2. Stone dust (through No. 200)	0.6%	0.8%
3. Fineness modulus		
4. Bulk specific gravity	2.75	2.72
5. Bulk specific gravity (surface dry)	2.79	2.78
6. Apparent specific gravity	2.88	2.89
7. Absorption	1.76%	2.23%
8. Mechanical Analysis		
Cumulative passing 2"	100%	—
" " 1-1/2"	90%	100%
" " 1"	77%	98%
" " 1/2"	—	44%
" " 3/8"	1%	—
" " No. 4		3%
The so-called 4-A does not pass the screen analysis specification.		
9. Thin and elongated particles	10%	12.5%
10. Soft particles	3.6%	3.7%
11. Sandstone and Chert (some wood chips present)	None	None
12. Abrasion, 10,000 revolutions on the Dewal	10.3%	—

CONCLUSIONS

As outlined in the introduction, the Houghton project at its inception consisted of three main research problems, namely, scaling studies, concrete materials investigation and subgrade stabilization.

The scaling studies were conducted during the winter of 1941-1942. The results from these scaling studies do not appear in this report because it is intended to correlate this information with the information obtained from similar studies conducted on the Michigan Test Road.

The data presented in this report are preliminary to the durability studies which were to follow. Upon completion of the materials surveys and termination of the physical tests on the various aggregates, it was proposed to make concrete specimens using the various materials and then subject the specimens to accelerated freezing and thawing tests. The durability tests were to be made at the Research Laboratory in East Lansing. Up until the time of Mr. Keranen's transfer to other activities, he has been engaged in surveying the local sources of aggregates and conducting the physical tests, the results of which are presented herein. The durability studies have not been started.

This report concludes the work at Houghton for the present, since Mr. Keranen has been transferred to other duties. However, it is anticipated that the project will be resumed at some later date under the supervision of College personnel. The actual work to be carried on by graduate students.