REPORT

ON

WESTERN BEAUFORT REGION
CONCRETE AGGREGATE STUDY

Phase 2:
Elaboration of Original Study

PREPARED FOR

INDIAN AND NORTHERN AFFAIRS CANADA
OTTAWA, ONTARIO

PA 2291

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CONSULTING ENGINEERS

This data translates into aggregates considered innocuous in both cases as may be noted on the graph following as page 3 of this summary report. This is excerpted from the standard with the foregoing values plotted thereon.

2.0 ASTM C87 -Effect of Organic Impurities in Fine Aggregate on Strength of Mortar.

This procedure compares a sand sample as is which is deemed to be contaminated by organic impurities, with the same sand that has been washed in a 3% solution of sodium hydroxide for neutralizing purposes, followed by thorough rinsing in water. The comparison is by means of cube strengths at the age of 7 days.

In this case sand samples from King Point, Willow River and Jacobs Ridge were tested according to that procedure. These three samples were chosen for these procedures because they were the three that had previously failed the test, being ASTM C40 - Organic Impurities in Fine Aggregates for Concrete. Results are listed in Table 1.

Table 1

Summary of Results of ASTM C87

Test No.	Sample Description	Condition	Compressive Strength, MPa (Average of 3 cubes in each case) 7 day	28 day	91 day
1	Jacob's Ridge	Untreated	23.3	33.3	
		Treated	21.0	30.7	
2	King Point	Untreated	21.4	30.9	
		Treated	14.5	21.2	
3	Willow River	Untreated	24.9	31.3	
		Treated	21.7	29.6	

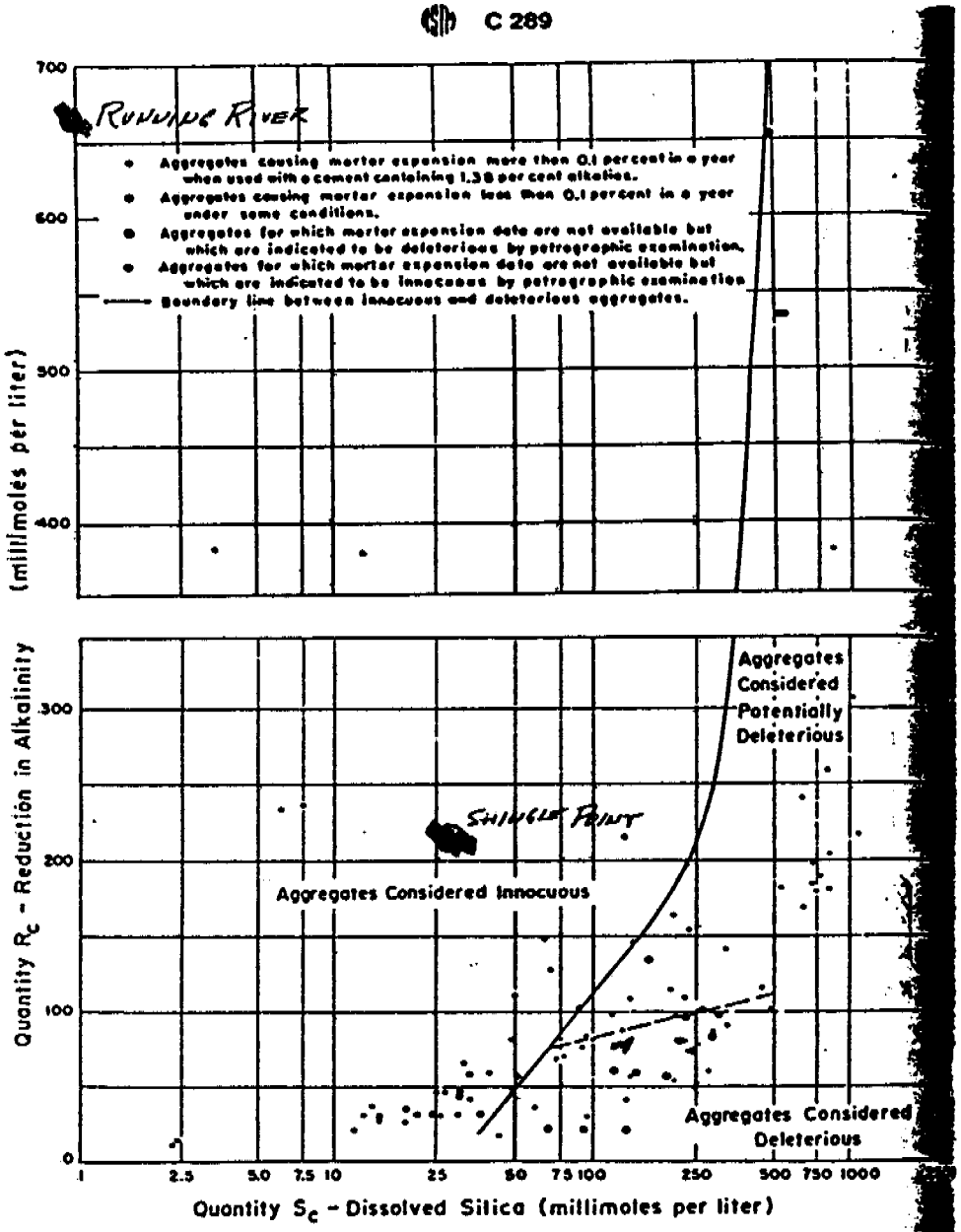


FIG. 2 Illustration of Division Between Innocuous and Deleterious Aggregates on Basis of Reduction in Alkalinity

From Table 1 it is noted that in all cases the untreated sand in the 'as is' condition, produced cubes of higher compressive strength than the same sand when treated with the sodium hydroxide solution. From this result it is concluded the substance or substances responsible for the high organic number initially, are not injurious to portland cement concrete.

We might add that this somewhat unexpected result of the treated sand producing lower strengths than the 'as is' or untreated sand, has been noted on numerous occasions previously in our own experience. It leads one to question the test itself but we have not pursued that purely research topic in this instance.

3.0 ASTM C227 - Alkali Reactivity of Cement-Aggregate Combinations (Mortar-bar Method).

Of all the fine aggregate samples from the six different sources, only the sample from Moose Creek reached the maximum expansion allowed by specification at three months.

All of the samples were acceptable in terms of expansion less than the maximum allowable after exposure to the testing regime for six months.

This standard test does not provide guidance in the interpretation of expansions beyond the six month term. However after fourteen months exposure only the samples from Moose Creek and Willow River have exceeded even the 3 months limits.

4.1 CSA A23.2-14A: Alkali - Aggregate Reaction.

This procedure deals with coarse aggregate only and requires measurements for length change after 7, 14, 28, 56, 84, 112 and 168 days of standard moist storage. This data has previously been submitted in this case, in the first phase of the study. The specification goes on to require measurements at intervals of approximately 6 months thereafter.

The most recent edition of the standard, being Supplement No. 2-1986 specifies expansion limits under clause B 3.4.4 - Table B 1, of 0.01% and 0.025% at 3 months and 1 year respectively.

In any event only samples from Shingle Point, Running River and Jacobs Ridge had expanded to that 3 month range and since then all six samples have remained relatively static up to the fifteen month period. Therefore none of the samples approached the foregoing allowable expansion limits for one year.

4.2 Non-standard Alkali-Aggregate Reaction.

All samples from each of the six sources showed immediate and relatively large expansions when cured in seawater brine at 0° C. The expansion rates slowed considerably after about two months immersion and levelled off after six to eight months immersion.

At that point readings became erratic. Subsequent investigation has revealed a failure of the thermostat governing the freezer had occurred at about that time. The readings obtained since that time are therefore considered unreliable and so will not be reported.

This is of course an unfortunate development but nevertheless we feel that the stabilized readings coupled with the details we'll get from sections 5.0 and 6.0 below, will enable a fair assessment of the aggregate possible in the proposed third phase of the evaluation.

5.0 ASTM C666 - Resistance of Concrete to Rapid Freezing and Thawing.

Three samples were chosen for this test. One, Running River because it had performed the most poorly on the standard alkali-aggregate test; Shingle Point because that sample had performed best on the same test and finally the sample from King Point which was exactly in between the expansive results on the other two samples. In other words these these samples produced the most widely spaced results on the standard alkali test and hence might be expected to be distinguished most easily if there were a direct correlation between the alkali aggregate test and the rapid freeze-thaw test.

In fact this was not the case and examination of these results in detail would be required as part of Phase C.

6.0 Scanning Electron Microscope.

Four of the six samples had excessively large amounts of chert relative to the other two so it was the samples containing the large quantities of chert - which of course is potentialy expansive in concrete, depending on the crystalline structure - which were submitted for examination by the scanning electron microscope. Specificallly these were samples from Jacob's Ridge, King Point, Shingle Point and Running River.

Again the results have to be analyzed in conjunction with the other test data and it is intended this procedure form part of Phase C.

7.0 Thin Section Petrographic Examination.

The object of petrographically examining the aggregate by thin section technique was primarily to investigate the amount if any, of rim material that might be built up on the circumference: paste interface as a result of alkali-aggregate reaction. It is this material or rather the quantity of this material, that is the cause of expansion when this phenomenon is involved.

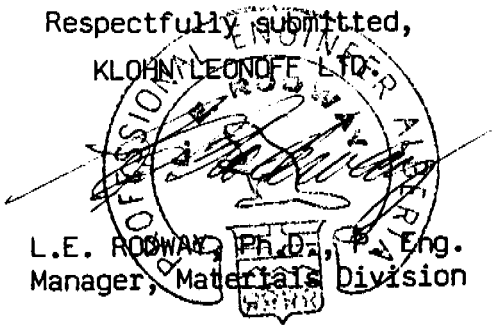
For this reason the samples chosen for this procdure were those that produced the greatest expansion in the various expansive curing regimes. Therefore from the standard alkali reactivity test we chose the sample from Running River. The sample from Moose Creek was amongst the most reactive in the nonstandard brine curing reactivity test and the Moose Creek sample was again most reactive in the standard alkali-aggregate reaction test of the fine portion. Therefore those three prisms were submitted for processing by this technique.

It will be necessary to produce the actual photos of each of the three sections to adequately discuss this question in detail and once again this is to form part of Phase C of this evaluation as per our original proposal.

Items 5.0, 6.0, and 7.0 were conducted at the University of Calgary by J.E. Gillot, D.Sc. (Eng.), P.Geol. His summary, attached completes this report.

As noted above it is recommended a more detailed report including longer term expansive results to 18 months be commissioned as Phase C of the total evaluation, as per our original proposal of June 3, 1987.

Respectfully submitted,
KLOHN LEONOFF LTD.



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LER/dbs
Attachment

Summary

1. Three concrete prisms were subjected to cyclical freezing and thawing in an apparatus similar to that described in ASTM C666. Changes in fundamental transverse frequency, weight and dimensions were determined.
2. A sample is considered to have failed the test if its fundamental frequency drops below 60% of its initial value in less than 300 cycles of freezing and thawing.
3. Sample KP6 failed the test after 4 cycles, sample SP3 failed after 57 cycles and sample RR6 failed after 59 cycles. Durability factors were low in all three cases. Concrete of that sort may be expected to show poor resistance to frost action.
4. Sample KP6 registered the largest increase in length and the greatest decrease in weight of the three samples.
5. Petrographic examination showed that the aggregate was made from a gravel composed of an assortment of rock types. Greywacke, chert, quartzite, argillite and limestone were present with smaller particles of similar rocks and individual grains of strained quartz in the sand fraction.
6. Aggregate particles showed only a few rims and the concrete and mortar displayed relatively little microcracking. Voids were generally empty but a thin lining of silica gel was present in a few instances.
7. Rocks and minerals of the type present in these gravels have been associated with alkali-aggregate reactions in other places.
8. If used as aggregate in portland cement concrete it is very probable that durability problems will develop due to deleterious alkali-aggregate reactions.

BY J. E. GILLOTT, D. Sc. (ENG.), F. GEOL.

MARCH 1988