

CONCRETE, SULFURCRETE, SHIELDING RESEARCH
FOR THE SUDBURY NEUTRINO OBSERVATORY

SM-STR-90-76

PROGRESS REPORT CON-6-90

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SUMMARY:

- Work at Laurentian over the period April - June 1990, has been centred on:
- a) the refining of a boronated (1% B) concrete mix, using the Haley dolomite aggregate.
 - b) a check of the feasibility of substituting a quartz aggregate available in N. Ontario.
 - c) a survey of Ontario Portland cements re radioactivity
 - d) ongoing strength and stability testing of previously prepared samples.
 - e) preparation of several shotcrete samples with various surface textures and shapes.
 - f) an initial survey of coatings available for shotcrete and some testing of their use.
 - g) continuing exploration of the sulfurcrete option for shielding blocks, using boron carbide additive or internal cavities for boron compound filling.
 - h) preparation of cost figures for materials and block preparation for both concrete and sulfurcrete options.
 - i) discussions with MONENCO re R & D interface.

PROGRESS:

(a) BORONATED CONCRETE

We have demonstrated that four concrete mixtures, containing up to at least 1 % boron (by weight) have suitable mixing, setting and strength properties for the cavity shielding blocks.

Mixture	A	B	C	D
Boron form	borax +	boric acid +	boric acid +	borax +
	calcium oxide	calcium hydrox.	calcium oxide	calcium hydrox.
Aggregate	Haley dolomite	Haley dolomite	Haley dolomite	Timmins quartz
Cement %	18	23	22	19
Water %	17	21	17	13
Mixing	10 - 20 min (all samples)			
Setting	30 hr	12 hr	60 hr	2 hr
Strength 7 day	N/A	N/A	N/A	9.0 MPa
28 day	16.3 MPa	15.9 MPa	18.2 MPa	N/A
Water resistance	similar to normal portland cement - tests continuing			

(b) QUARTZ AGGREGATE (sample D)

The quartz aggregate material has low radioactivity and apparently gives strong concrete of good stability, but faster setting time.

(c) SURVEY OF PORTLAND CEMENTS

The collecting of samples from N. Ontario suppliers and quarries is continuing, with radioactivity tests later this summer.

(e,f) SHOTCRETE SAMPLES AND COATINGS

Three test squares (2 ft by 4 inches) of shotcrete coatings were prepared at INCO's Frood mine, with various surface textures and roughness. Three types of coatings have been used in preliminary tests:

- a latex water-based emulsion, applied on the surface, or mixed with the ingredients in a concrete parging coating.
- an acrylic (in water emulsion form) coating compound.
- a 'one-step' epoxy coating material.

The tests show that all three types will waterproof the shotcrete surface, but only the epoxy material builds a strong thick coating capable of preventing any shedding of loose shotcrete during water cleaning. Several other industrial coatings have been selected, and tests will begin next week.

(g) SULFURCRETE OPTION UPDATE

Tests of boron additives in sulfurcrete by Alan Vroom show that only boron carbide (B4C) can be added at a 1% boron level. Other additives, such as borax or boric acid cause swelling and cracking when the sulfurcrete is exposed to water. Alternatives to provide 1 % boron include filling block cavities with another boron compound, or using sheet borated polyethylene. Given the low radioactivity of the sulfurcrete made with Haley dolomite, we have kept this option open. A group of shielding blocks will be ordered soon for the low-level gamma counting facility, and one further additive (calcium borate) will also be tested.

(h) SHIELDING BLOCK COST ESTIMATES

The current budget for the shielding blocks at the detector waist (150 cu. m) is \$ 48,000 - block costs (std. concrete)
\$ 20,000 - boron additive.

The boronated concretes now available should be close to this figure in cost.

Given a preliminary estimate (Alan Vroom - January 1990) for 65 lb sulfurcrete blocks of \$ 5.00 per block, total block costs would be close to \$ 60,000. For 0.5% boron (as boron carbide) the additive cost (at \$ 33. / kg) would amount to \$ 75,000. Further detailed costing of various block options is in progress.

(i) DISCUSSIONS WITH MONENCO

Background reports and product information is being passed on to Ray Sandham. A report on the coating tests for shotcrete is scheduled for completion at the end of June.